Journal of Ecohumanism
2024
Volume: 3, No: 1, pp. 104 – 115
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i1.6673

Development of Environmental Awareness as a Pedagogical Strategy for the Preservation of Ecosystems

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Abstract

This article addresses a topic of current interest to the scientific community regarding ecosystem preservation as a pedagogical strategy that seeks to develop environmental awareness in individuals. In this regard, it addresses the importance of integrating environmental education into all academic processes and levels. It identifies environmental education as a key tool for promoting sustainability. This study was conducted using a bibliometric approach, consulting sources on the topic in high-impact databases between 2019 and 2023. Pedagogical strategies implemented to promote environmental awareness were analyzed. The consultation of sources highlighted the use of interdisciplinary approaches, innovative technologies, and the promotion of ecological values. These stand out as fundamental factors for ecosystem preservation. It was identified that environmental education includes, in addition to the transmission of knowledge, the formation of pro-environmental attitudes and behaviors. It can be affirmed that environmental awareness is developed systematically, contributing to transforming practices toward sustainability and the mitigation of environmental problems.

Keywords: *Environmental awareness, Ecosystems, Environmental education, Pedagogy, Sustainability.*

Introduction

It is common to hear lecturers and academics on radio, television, and social media emphasizing the changes that have taken place in recent years due to human impact on the environment (Caruso et al., 2022). This is associated with climate change, biodiversity loss (Daw et al., 2023), global warming (Kabir et al., 2023), pollution of seas, rivers, and lakes, desertification, deforestation, and soil degradation, among others (Chebby et al., 2023). The high levels of exploitation of natural resources, their indiscriminate use, and the effects caused by humanity are evident, making it necessary to adopt urgent measures to mitigate these effects (Jain et al., 2023).

There is an urgent need to revitalize ecosystems and ensure sustainability for future generations (Kumi et al., 2023). Education is one of the main transformative axes in this regard (Monteiro et al., 2023). Therefore, the development of strategies that include actions aimed at environmental sustainability is of utmost interest. Changes in the practice and use of natural resources are necessary, as stated by Pérez Guede & Arufe Padrón (2023). Although the effects on the environment are known, it is also necessary to promote behaviors toward its conservation and educate on values.

When referring to environmental awareness, this category, while having a nuanced approach to the sciences of this branch, also encompasses pedagogical and psychological aspects. It is understood as the understanding and critical analysis of problems affecting the environment. It represents the level of sensitivity to ecological and socio-environmental factors. In turn, it has become a powerful tool for ecosystem preservation (Wittmayer et al., 2022). Studying and promoting environmental awareness requires planning, systematicity, and interdisciplinary approaches that are integrated to foster the active participation of individuals in this regard, whether individually or in communities.

The increase in actions, programs, and strategies designed at different levels—institutions, communities, societies, and regions—focused on environmental education is notable (Vardon et al., 2023). An initial limitation is that many of these have focused on transmitting information or training on these topics (Durrant & Ely, 2022). Developing an environmental culture requires modeling not only cognitive issues but also behavioral and attitudinal ones, as demonstrated by the experiences described by Zabel et al. (2023).

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Therefore, there are public policies, international treaties, general laws, and agreements between different nations that rely on alliances to generate projects, activities, and programs that involve institutions and the community (Drew Smythe et al., 2023).

Progress in this regard cannot be achieved if a differentiation between theoretical knowledge and the development and implementation of educational methodologies that incorporate innovative tools persists (Kock et al., 2023). Participatory approaches, critical analysis, and assessments by all groups and sectors of society must also be taken into account (Tindale et al., 2023).

In this context, this article focuses on a literature review of how environmental awareness is developed as a pedagogical strategy for ecosystem preservation. To this end, a documentary review was undertaken in high-impact databases between 2019 and 2023. The main trends, challenges, and opportunities in this area were identified, and the importance of integrating environmental education into educational processes in an interdisciplinary and systemic manner was substantiated (Diepens et al., 2023). This study provides a systematization of scientific sources on the topic from the last five years. It is geared toward designing effective educational policies and practices that can generate tangible impacts on ecosystem conservation (Johnston et al., 2022) and on building more sustainable and resilient societies (Yan et al., 2022). Another interesting perspective addressed in the literature is the importance of adapting pedagogical strategies to local and global contexts (Tápanes Suárez et al., 2023). To this end, each region's cultural, economic, and ecological specificities are considered (Mallinis et al., 2023). Several authors highlight the role of technology and innovation associated with using digital tools and artificial intelligence as resources to enhance environmental learning and foster citizen participation in decision-making (Vieira et al., 2022).

Among the contributions revealed, in addition to the systematization of sources that allowed for the identification of the main trends and methodologies in this regard, contemporary analyses and a substantial number of sources that address the topic from diverse perspectives are also made available to environmental managers, popular educators, teachers, environmentalists, and other interested parties (Imdad et al., 2023). Pedagogy is highlighted as the main tool for change that enables transformation towards behaviors that respect biodiversity, the implementation of more sustainable practices, and actions that mitigate harmful effects on nature (Gasparek & Hantabal, 2022).

It is a novelty for educational institutions how the training they promote in non-formal or informal settings is completed. That is why, in the design of these strategies, programs or methodologies, other elements are taken into account, such as socializing agencies that include non-teaching institutions, the media, the family and the community. The development of pedagogical strategies is reinforced when all social actors and socializing agencies contribute in a harmonious and integrated manner.

Developing work networks that guarantee the continuity of actions at different stages of life is important. This corresponds to the type of product and service each age group demands. This must be emphasized to achieve an environmentalist approach that transcends the transmission of knowledge and academic contexts (Manuel et al., 2023; Rayan, 2023). Environmental education is a continuous and transformative process that is not limited to groups or geographical areas and adapts to social, technological, environmental, and other changes. This article highlights the need to adopt environmental education as a cross-cutting strategy in all human processes and activities (González Vallejo, 2023). Environmental awareness marked by ethics, morality, respect for diversity, and the protection of natural resources must be fostered. Roman Acosta et al. (2023) pay special attention to issues associated with communities in disadvantaged contexts to implement certain innovations. This leads to the development of systematic and planned actions that consider different contexts and foster attitudes toward ecosystem preservation in individuals (Zikargae et al., 2022). A set of tools must be provided for individuals to become environmental managers who lead change in their environments.

Given the above statement, the value of each individual, both in themselves and as a community, must first be recognized. Furthermore, we cannot lose sight of the role of education as a fundamental right and its contribution to promoting justice, ecosystem conservation, respect for biodiversity, and other aspects. Education promotes a more sustainable, just, and inclusive future (Ramsarup et al., 2023).

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Methodology

The article in question was developed under a bibliometric approach. This favored the search and analysis of the information contained in the scientific texts that were identified on the development of environmental awareness as a pedagogical strategy for the preservation of ecosystems. The general methodological process is described below.

First, the methodology was designed based on the selected approach (bibliometrics). Subsequently, the main databases were identified according to their impact and relationship with the categories of analysis. All this made it possible to locate the most relevant scientific production on the subject in the established period of time. The guidelines stated by Cobben et al. (2022) in their review study on the types of ecosystems were followed, as well as those of Stroud et al. (2022) and Westney et al. (2022), who analyzed these topics in the literature from the perspective of business, environmental sustainability, and circular economies in the latter case (Pietrulla, 2022).

As explained in the previous text, the starting point was the definition of the categories of analysis and their translation into English to access scientific publications in this language. These are:

- Environmental awareness: understanding and sensitivity to ecological problems.
- Pedagogical strategies: educational approaches and methodologies used to promote environmental awareness.
- Ecosystem preservation: actions and practices aimed at the conservation of natural environments.
- Sustainability: integration of environmental, social and economic dimensions to ensure development.

After identifying the categories and their main definitions, the main high-impact databases related to the topic were selected, such as Scopus, Web of Science, PubMed, and Google Scholar. These databases contain large volumes of publications on the educational and environmental fields.

In addition, search criteria were established. These were defined according to the study categories, and filters were applied to ensure the relevance of the results. Some of these are:

- Publication period: 2019-2023.
- Language: English, Spanish and Portuguese mainly.
- Keywords to start your search: "environmental awareness", "environmental education", "pedagogy", "ecosystem preservation", "sustainability", and "pedagogical strategies".
- Document type: Scientific articles, systematic reviews, and book chapters were prioritized.

Consequently, the search and data collection process began. The search strategy was applied based on the main categories and their possible combinations in Spanish and English. These searches in each database were complemented with the use of Boolean operators (AND, OR, NOT). They were used to combine keywords and facilitate the selection results. One of the search algorithms used was:

("environmental awareness" OR "conciencia ambiental") AND ("pedagogy" OR "pedagogía") AND ("ecosystem preservation" OR "preservación de ecosistemas").

Once the sources were identified (an initial total of 226), the articles were selected. First, using the bibliographic manager Zotero, a more detailed review was conducted to determine the correlation between

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titles, abstracts, keywords, and content. Texts that did not directly address the categories of this study were discriminated against.

Once the articles (135) and book chapters (11) were classified, a more comprehensive analysis of the text was conducted. The main trends, challenges associated with the study, the strategies they stated, whether other types of actions were needed, whether the studies addressed the topic from a school-based context, a non-school context, or both, and the methodology they used were reviewed. This process resulted in the selection of 59 texts from the total; the selection also depended on the type of study presented.

The bibliometric analysis was carried out as follows:

- Bibliometric tools such as VOSviewer and Bibliometrix software were used to analyze the collected data.
- The number of publications per year, the most productive authors, and the countries with the greatest contribution were identified.
- Thematic trends: Thematic clusters were identified and the most frequent keywords were analyzed. The data was processed using VOSviewer and recreated in a keyword co-occurrence graph.
- • Scientific impact: the number of publications by country and most outstanding thematic areas was evaluated.

Once this process was completed, the most relevant information was synthesized, and the data was organized. Concept matrices, tables, and graphs were used to facilitate data interpretation. In this regard, trends, patterns, and the most commonly used methodologies in the field of study were identified.

The information was triangulated based on the sources, the main countries of origin, and the types of studies. Comparing publications in different databases helped to achieve a greater understanding of the topic. This led to the development of the theoretical framework, the main results, and the determination of the study's conclusions.

Reviewing the texts and presenting the data strengthened the bibliometric study's results. The main trends in these studies, the most frequently addressed concepts, and the contexts were defined, which led to discussions on the topic at hand.

This bibliometric study allowed for a systematization of the main sources on the subject. Those published within the established timeframe were prioritized, and attention was paid to the Colombian context. The interest in developing environmental awareness that mitigates the effects of environmental degradation and restores ecosystems and biodiversity was discussed. This was achieved from a pedagogical perspective, primarily focusing on the academic context but also considering how these processes complement each other in informal settings.

Results

The study, as stated, allowed us to identify the main trends, patterns, and gaps in the literature on the topic at hand. The development of environmental awareness as a pedagogical strategy for ecosystem preservation has taken center stage in scientific publications over the last five years, not only in specialized publications on the subject but also in others that include these aspects as a cross-cutting theme in their processes. Examples of this are entrepreneurship, the business and commercial sectors (Arévalo Zurita et al., 2023), the public management of urban spaces (Alvarado Arias et al., 2023), the teaching of subjects at universities (Chandra Voumik & Ridwan, 2023), and the training of professionals (Arroix Jiménez et al., 2023).

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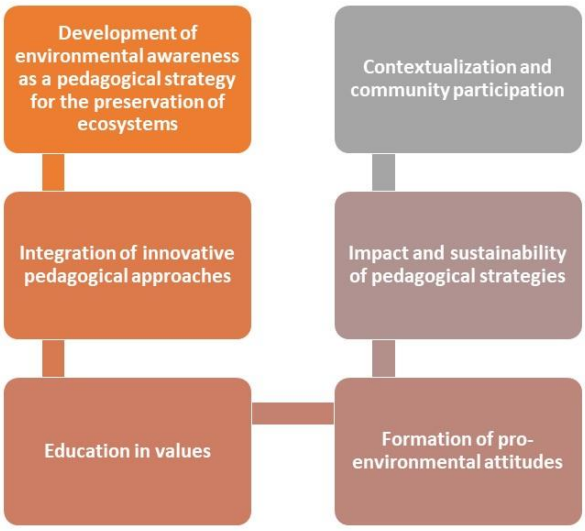
The results focused on several key areas, such as scientific production, the creation of collaborative networks, the main thematic trends, and the scientific impact achieved. The Results section presents the findings corresponding to the analysis of the literature. Figure 1 shows the fundamental aspects that allowed determining how the development of environmental awareness takes place as a pedagogical strategy for the preservation of ecosystems.

Figure (1). Sequence of Analysis in the Literature



It is notable how, between 2019 and 2023, publications on the relationship between environmental awareness and pedagogy stand out. During this period, COVID-19 broke out on a global scale (Corsi et al., 2023), an event that prompted analysis of natural issues and their prevention (Webb et al., 2023). Likewise, different regions recognized the existence of an environmental crisis and the need to address these issues (Tyllianakis, 2022).

A gap in scientific production is evident. Although countries in Europe (van den Burg et al., 2022), Asia (Kapturkiewicz, 2022; Seo et al., 2023), and America (Souza Alonso et al., 2022) stand out, publications are concentrated in a few nations, not always in the most affected (Sibuyi et al., 2022), nor in those with the greatest degenerative impact on the environment (Sabo et al., 2023). The most prominent countries coincide with developed nations with possibilities and resources for research, and they also have an institutional system that facilitates these processes. Figure 2 also includes the publications identified in the period by type and the final balance once the inclusion criteria were applied.

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Figure (2). Publications By Year and Main Countries

Bibliometric analysis			
Publications by years	Scientific articles 2019: 37 2020: 41 2021: 30 2022: 54 2023: 53	Book´s chapters 2019: 1 2020: - 2021: 3 2022: 2 2023: 5	After the classification process: 146 General ending balance: 59
Countries with the highest contribution	United States, China, Germany, Colombia, Mexico, Brazil		

It can be seen that publications on the topic increased in 2022 and 2023, but there is still a need to more specifically promote this type of research in countries affected by climate change, those with a wide variety of natural resources, and where pollution rates are increasing considerably. Attention is also drawn to highlighting research conducted in countries with fewer opportunities to communicate science due to inefficient policies and resources.

The studies reviewed reveal the relevance of collaborative networks and the interdisciplinary work carried out within them. The teams are made up of educators, professionals from the educational sciences (Corvello et al., 2023), social sciences (Maya Jariego et al., 2023), humanities (Moore et al., 2022), and natural sciences (Murgas Téllez et al., 2023). The keyword co-occurrence analysis reveals this interrelation, and terms from different sciences appear, as shown in Figure 3. However, there is evidence of disconnection or poor integration with some branches of knowledge that require input in this regard. It is necessary to integrate diverse approaches to achieve adequate environmental education.

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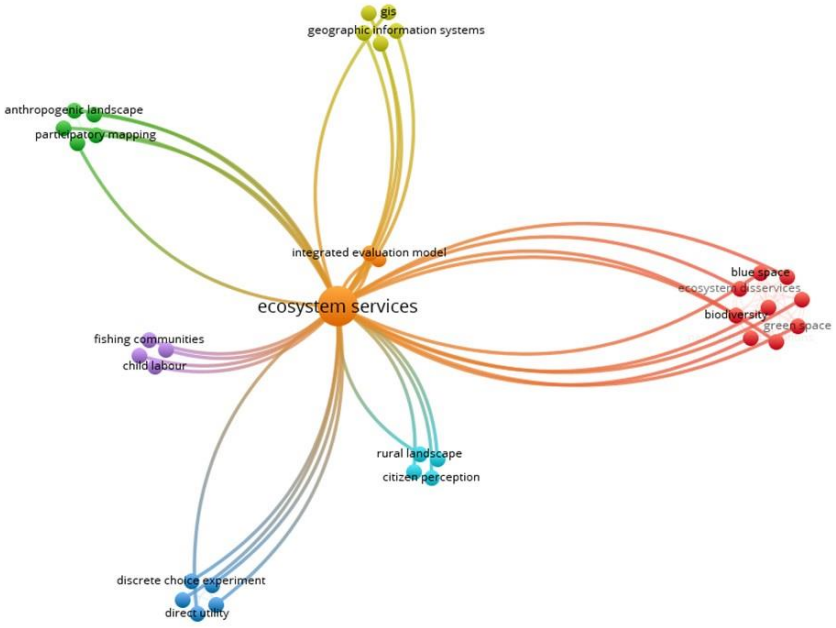
Figure (3). Keyword Co-Occurrence Map



In correspondence with the previous figure, as a result of the analysis of the literature, the following key trends in the development of environmental awareness as a pedagogical strategy for the preservation of ecosystems could be identified:

Innovative Pedagogical Approaches

Active methodologies have gained momentum in recent years as strategies to foster more spontaneous, critical, and inclusive participation. Examples include project-based learning, education in non-school settings, and the use of new technologies and artificial intelligence. These methods connect participants with their surroundings in a natural environment, enabling them to be proactive in addressing humanity's impact on ecosystems (Sato & Kitamura, 2023).

Education in Values and Formation of Attitudes

The sources consulted show a notable commitment to promoting values-based education while fostering attitudes toward ecosystem preservation. Sources frequently link topics such as economic management, urban studies, the improvement of study plans and curricula with a focus on social responsibility, respect for diversity (Sanabria Martínez, 2022), proactive management of nature, and others.

Community Participation

Macro programs are comprised of countless actions. These respond to specific social groups, communities, local actors, and socializing agencies, all of which operate in contexts defined by environmental, border, economic, and political factors, among others (Martins & Marto, 2023). It is emphasized that not only are actions tailored to community contexts but also that the implementation of environmental education is based on the interests and needs of each social group. This allows for greater relevance in the results, for people to identify with what is being done and to become transformative agents committed to their environment.

The literature review identified the areas of knowledge or branches of knowledge that achieved the highest number of publications between 2019 and 2023. This analysis was conducted at an initial stage before applying the inclusion requirements to the bibliography consulted. That is, the sample was estimated based

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on the first 226 sources. Other branches of knowledge with less frequency were overlooked, which was not representative. Figure 4 shows how studies from Sociology achieved the highest frequency (n=36).

Figure (4). Frequency of Publications by Areas of Knowledge

The texts reveal the correlation between the integration of sustainability into educational curricula, the role of technologies in environmental education, and the impact of pedagogical strategies on ecosystem protection (King et al., 2023). The systematization of sources corroborates the relevance of the topic and also reveals gaps in its study.

Discussion

When addressing this topic, it can be identified that several strategies are being implemented through pedagogy to develop environmental awareness and achieve ecosystem preservation. Despite this, gaps or challenges were identified that need to be addressed by science in order to mitigate negative impacts on the environment.

One of the shortcomings detected is that studies are limited to very specific contexts and address topics related to this aspect but in isolation. Strategies are required that are conceived as a program and can be evaluated, that provide feedback, and that positive experiences are systematized for later generalization (Davies et al., 2023). Another challenge relates to innovative approaches that highlight their relevance for this type of study. This also gives rise to analyzing their implementation challenges in other spaces, contexts, and regions. Some of the causes to be addressed are the socioeconomic and ecological characteristics, the main environmental problems and priorities for that region, the lack of resources, training needs, and institutional status and partnerships.

Another issue addressed in the literature concerns the inclusion of environmental education at all educational levels. Formal and informal settings should be included, and methodologies should be adapted to the specific characteristics of each context. In the case of informal settings, it should be kept in mind that they have more flexible schedules, diverse audiences, and more open rules. It is often not possible to determine whether a given individual frequently attends activities or how to ensure that they do so, unless genuine interest and commitment, in addition to motivation, can be fostered.

It was also identified and agreed upon that institutional support, the implementation of solid public policies, and the establishment of collaborative networks that prioritize environmental sustainability as a cross-cutting theme are necessary (Romanazzi et al., 2023). Authors raise the need to consciously strengthen the link between theory and practice (Wu & Wang, 2023; Murphy et al., 2023). They advocate for the inclusion of students, the community, and transformative agents in environmental education, mitigation, and impact assessment projects and actions.

Collaboration between communities, researchers, foundations, and all stakeholders is needed. It is asserted that active participation, the training of community leaders, and the sharing of experiences and best

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practices are extremely useful. Dialogue that leads to the generation of actions based on the criteria and debates that take place is of great value.

The development of environmental awareness as a pedagogical strategy represents a strength for mitigating harmful effects on the environment and for the sustainability of ecosystems. A comprehensive and participatory approach is advocated. This approach must also be inclusive and contextualized to the conditions of each space. Along with knowledge, it must promote values education and the development of attitudes toward sustainability.

The study identified that these general trends reflect theoretical advances in the development of environmental awareness, as well as practical achievements and how researchers systematize these. The progress and challenges presented are presented. For the purposes of this study, it was important to determine, in the case of Colombia, whether these trends are similar or vary and what the underlying causes are.

The literature reviewed revealed that Colombia is a diverse country with a wide variety of ecosystems, a high level of interest in soil protection, efficient production, and the development of innovative initiatives with positive impacts, such as agroecology, as reported by Higuera Carrillo (2022), the recovery of traditions, and the implementation of sustainable practices.

Projects were identified that apply innovative practices in agricultural production, the circular economy, and natural processes. Highlights include non-formal education, project-based work, constant improvement, active participation, and a commitment to ecosystem preservation.

Despite this, Colombia faces many limitations associated with a lack of adequate infrastructure, a scarcity of technological resources, and insufficient teacher training to implement pedagogical strategies in this regard. Progress toward integrating environmental education into educational levels, along with actions carried out on peasant farms and research projects focused on sustainability and ecosystem conservation, cannot be denied. Education in values and the development of attitudes that foster environmental awareness and environmental awareness itself is still insufficient. They lag behind in terms of knowledge development. It is necessary to foster values in the new generations, such as responsibility, respect, and empathy toward nature. A profound respect must mark the interrelationship between community and nature for the environment and the development of an awareness that allows it to be preserved for future generations.

In Colombia, this is hampered by social inequalities, changes brought on by conflict, unequal access to education, and other factors. These are offset by achievements in the development of educational programs that promote environmental sustainability, the active participation of indigenous communities and cultures, respect for diversity, and the protection of declared heritage areas, natural landscapes, or reserves (Araque Geney, 2023).

Once the topic has been analyzed based on the identified literature, it can be affirmed that the development of environmental awareness represents an opportunity that favors a transformation toward the proper management of natural resources and the conservation of biodiversity and, therefore, of ecosystems. The success of this will depend on the ability to overcome existing challenges and barriers. It is necessary to prioritize a comprehensive approach, inclusion, active participation, and cooperation toward sustainability.

Conclusions

There is no doubt that environmental education can be adopted as one of the pedagogical strategies that can be implemented at all educational levels and across the lifespan. It contributes to the preservation of ecosystems while fostering awareness and developing skills for their conservation. This strategy is not limited to the transmission of knowledge but transcends to the development of skills and critical appraisals of the ecological problems that affect ecosystems. It also teaches values that enable responsible behavior and the conscious sharing of these good practices with others.

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Active commitment and participation in environmental protection are necessary to counteract the degrading effects on ecosystems. Implementing interdisciplinary approaches in environmental education and creating alliances are strengths for achieving decisive results. Fields such as bioethics, sociology, psychology, and pedagogy, which complement citizenship education and study topics related to the natural sciences, cannot be overlooked. Society must be aware of the harmful effects on ecosystems and their short-, medium-, and long-term impact. They must be taught the importance of developing actions to mitigate these effects and regenerate a sustainable environment for present and future generations. Furthermore, collaborative work among different agencies and social actors must be promoted through collaborative networks, participatory programs, and interdisciplinary networks.

The main aspects identified were the need for innovative and participatory methodologies. There is a need for strategies with a theoretical basis that promote the development of projects, community actions, research, and others that allow real movements toward the protection of ecosystems and the solution of environmental problems. The goal is for individuals and their communities to become environmental managers and defenders of their surroundings. These actions require governmental and institutional support, as well as public policies that support the strategies being developed and the work of social agents and groups. Cooperative and active work is necessary to achieve true transformations at the individual, regional, and global levels.

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