STUDIES OF ECOPEDAGOGY IN THE MANAGEMENT OF ORGANIC AQUACULTURE WASTE IN LA LAGUNA DE LA COCHA.

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Abstract.

Eco-pedagogy emerges as a promising strategy to raise awareness among producers and promote sustainable practices, while aquaculture is consolidating as an important economic activity in Cocha Lagoon or Lake Guamuez (Nariño). However, negative environmental impacts have arisen due to the inadequate management of organic aquaculture waste. This article is based on a literature review conducted through major academic databases such as Scopus, Web of Science, ScienceDirect, and Google Scholar, where principles of eco-pedagogy are presented, based on the harmony between humans and nature, ecological awareness, and the dialogue of knowledge. Additionally, concepts of a theoretical-practical methodology grounded in community environmental education, experiential learning, participatory research, and the training of environmental leaders are explored. Although specific literature is limited, the analyzed cases highlight the importance of involving communities and adopting public policies that complement eco-pedagogy to achieve profound cultural change and effective waste management. It is concluded that further research is needed to critically analyze the application of these approaches and their integration with innovative technologies to ensure the long term sustainability of aquaculture in Cocha Lagoon.

Keywords: Organic waste, rainbow trout, eco-pedagogy, Laguna de la Cocha.

Resumen.

La ecopedagogía emerge como una estrategia prometedora para sensibilizar a los productores y fomentar prácticas sostenibles, mientras que la acuicultura se consolida como una importante actividad económica en la laguna de La Cocha o Lago Guamuez (Nariño). Sin embargo, se han generado impactos ambientales negativos por el inadecuado manejo de residuos orgánicos acuícolas. Para desarrollar el artículo, se llevó a cabo una revisión bibliográfica en las principales bases de datos académicas, como Scopus, Web of Science, ScienceDirect y Google Scholar, donde se exponen principios de la ecopedagogía, basados en la armonía del ser humano-naturaleza, la conciencia ecológica y el diálogo de saberes. Además, se exploran conceptos de la metodología teórico-práctica sustentada en la educación ambiental comunitaria, aprendizaje experiencial, investigación participativa y formación de líderes ambientales. Si bien la literatura específica es limitada, los casos analizados resaltan la importancia de involucrar a las comunidades y adoptar políticas públicas que complementen la ecopedagogía para lograr un cambio cultural profundo y una gestión integral de residuos. Se concluye que se requieren más investigaciones que analicen críticamente la aplicación de estos enfoques y su integración con tecnologías innovadoras para garantizar la sostenibilidad de la acuicultura en la Laguna de La Cocha.

Palabras Clave: Residuos orgánicos, trucha arcoíris, ecopedagogía, Laguna de la Cocha.

ESTUDIOS DE LA ECOPEDAGOGÍA EN EL MANEJO DE RESIDUOS ORGÁNICOS ACUÍCOLAS EN LA LAGUNA DE LA COCHA.

I. INTRODUCTION.

The Laguna de la Cocha or Guamuez Lake is located in the village of El Encano, municipality of Pasto, department of Nariño, Colombia. It is a valuable and emblematic ecosystem that faces environmental challenges due to anthropogenic activities in the region, especially aquaculture. The economic activity is constantly growing, becoming a source of food and economic income for the local communities, but, at the same time, it has generated negative impacts on the aquatic ecosystem.

Numerous studies (López and Madroñero, 2015; González et al., 2018; González et al., 2022; Burbano-Gallardo et al., 2021) have evidenced the detrimental effects of aquaculture on water quality, sediment acumulation, and bacterial proliferation, one of the main reasons is the inadequate management of organic waste created during production. This poor management can cause adverse impacts on aquatic ecosystems, which underscores the urgent need to implement strategies to optimize the management of aquaculture organic waste in aquacultural practices .

Faced with this problem, it is essential to implement environmental education strategies aimed at aquaculture producers in order to raise awareness about the importance of adopting sustainable techniques or

activities that minimize environmental damage and ensure the long-term sustainability of aquaculture. In this context, eco-pedagogy emerges as an educational approach focused on environmental awareness and sustainability, becoming a promising tool to address aquaculture organic waste management in La Cocha Lagoon.

The article presents a literature review that delves into the environmental challenges facing this valuable aquatic ecosystem, the research that has documented the impacts of aquaculture, and the potential of eco-pedagogy as an educational strategy to promote the sustainability of this growing economic activity in the region.

II. METHODOLOGY.

To carry out this literature review, a search was conducted in academic databases such as Scopus, Web of Science, ScienceDirect, and Google Scholar, using keywords such as "eco-pedagogy", "aquaculture organic waste", "Laguna de la Cocha" and "environmental education". Scientific articles, theses, technical reports, and official publications related to the topic of the study were selected, giving priority to those that specifically addressed the context of Laguna de la Cocha and the implementation of eco-pedagogical approaches in aquaculture waste management.

In addition, a manual review of the references cited in the selected documents was carried out in order to identify additional relevant sources. Studies published from 1998 to the most recent studies, the last one from 2023, were included, which present significant contributions to the research topic.

III. PRINCIPLES OF ECOPEDAGOGY.

Eco-pedagogy is based on the coexistence between human beings and nature, promoting a relationship of respect, care, and appreciation of the natural environment (Gadotti, 2008; Gutiérrez and Prado, 2015; Leff, 2004). This educational approach seeks to develop an ecological awareness in individuals, fostering the understanding of natural systems and their interdependence with anthropic activities. Likewise, eco-pedagogy promotes community participation, the dialogue of empirical knowledge, and the collective construction of knowledge to address local environmental issues (López, 2017, p. 24).

Eco-pedagogy is based on the following key principles:

1. **Coexistence between human beings and nature:** Recognizes the interdependence between human beings and the natural environment, promoting a relationship of mutual respect and care.

2. **Ecological awareness:** Promotes the understanding of natural systems, their cycles, and the importance of preserving them for human well-being and environmental sustainability.

3. **Community participation:** Involves local communities in the educational process, valuing their traditional knowledge and promoting their empowerment in decision-making.

4. **Dialogue of knowledge:** Promotes the exchange of knowledge between different actors, integrating scientific knowledge and traditional knowledge of the communities.

5. **Collective construction of solutions:** Encourages collaboration and the joint search for solutions to environmental challenges, through participatory and inclusive processes.

These principles constitute the philosophical and practical basis of eco-pedagogy, guiding its implementation in different contexts and environmental problems, including organic waste management in aquaculture.

IV. ECOPEDAGOGICAL METHODOLOGIES APPLIED TO ORGANIC WASTE MANAGEMENT.

Eco-pedagogy proposes various methodologies and strategies to address aquaculture organic waste management in a participatory and sustainable manner. Some of these methodologies are listed below:

1. **Community environmental education:** Involve fishermen, farmers, and surrounding communities in training programs on the impact of aquaculture organic waste and best practices for its management. These programs foster awareness and commitment to care for the lake ecosystem (Mayer, 1998; Sauvé, 2010; Castro and Gómez, 2019).

2. **Experiential learning:** implement practical organic waste management projects, such as composting, bio-fertilizers, or silage, in which participants can acquire knowledge and skills through direct experience (Espinar and Vigueras, 2019, p. 8-11).

3. **Participatory research:** involves local communities in the research and monitoring of the environmental impacts of organic aquaculture waste, encouraging the exchange of empirical knowledge and the collective development of solutions (Chevalier and Buckles, 2019).

4. **Training of environmental leaders:** guiding community leaders and producers in environmental management, eco-pedagogy, and organic waste management, enabling them to act as agents of change and multiply the knowledge they acquired (Rojas, 2013, p. 70-72).

These methodologies foster a participatory, experiential, and contextualized approach, tailored to the specific realities and needs of the communities involved in aquaculture in La Cocha Lagoon.

V. CASE STUDIES.

Although available information is limited, some studies carried out in the context of Laguna de la Cocha highlight the importance of environmental education, community involvement , and responsible management of economic activities to achieve a sustainable balance between the development and conservation of this ecosystem.

Ecopedagogy is significantly linked in different aquaculture studies, as suggested by the research of Molina, Andrade, and Bravo (2023) who have proposed guidelines and strategies for sustainable environmental management and management for sustainable aquaculture, as well as the efficient use of water and the use of waste for the production of compost. (p.5)

The researchers state that the implementation of these guidelines not only seeks to reduce the environmental impact in La Cocha Lagoon but also to promote ecological awareness and community commitment, fundamental principles of eco-pedagogy.

Complementing this vision, Portillo, Ruáles et al. (2021), explored alternatives to give value to the waste generated by the production of rainbow trout in the village of El Encano, finding the willingness and interest of the actors of the aquaculture chain for processes of the utilization of these wastes, which represents an opportunity to develop a more circular and sustainable economy around fish farming (p.49).

This approach is aligned with the eco-pedagogical methodology since it promotes the valorization of resources through practical learning in environmental management and strengthening of knowledge.

Similarly, Rúales, Portillo, Burgos et al (2020), analyzed in depth the potential of valorizing the various residues of trout production, such as skin, viscera, and skeletons, through the development of new products such as fishmeal and oil (p. 341-345). (p. 341-345).

He authors emphasize that these alternative uses could represent an important socioeconomic contribution for producer families, generating new income and jobs, so the practical and participatory approach is essential, as it seeks to empower communities through knowledge and joint action.

The integration of eco-pedagogical principles and methodologies in aquaculture activities not only allows for more sustainable resource management but also strengthens the social and economic fabric of the communities involved. The adoption of these practices can lead to a profound cultural change towards greater environmental responsibility and sustainable development in the region.

According to the above, Jurado (2020); proposes a comprehensive eco-pedagogical strategy that approaches environmental education from a community and participatory perspective, based on the creation of a community unit focused on eco-pedagogy, the development of leaders trained in sustainable environmental projects and the integration of pedagogical projects with an environmental approach in the educational curriculum. Likewise, Botina and Guerrero (2021) suggest promoting cooperative work by

incorporating topics related to the Laguna de la Cocha Ramsar wetland into the educational curriculum, along with the development of eco-pedagogical guides and outings (p.5).

These initiatives seek to foster community awareness and commitment to the conservation of the ecosystem.

On the other hand, the creation of an eco-educational ecotourism complex in Laguna de la Cocha has been proposed with the objective of harmonizing eco-pedagogy, environmental conservation, responsible tourism, and community development (Díaz del Castillo, 2015, p. 12). Although it faces funding and inter-institutional coordination challenges, this proposal seeks to contribute to the preservation of the natural and cultural heritage of the region.

Another relevant study was the classroom project "La Cocha, the Environment and Me" by Mora and Morán (2015) developed with eighth-grade students in Pasto. This research sought to sensitize participants on the importance of caring for and protecting La Cocha Lagoon, framed in a qualitative and action-research methodology, the project generated attitudes of belonging and valuing the natural and cultural spaces of the region (p. 54).

The authors highlight the need to promote ecological campaigns that raise awareness about the cycles of nature, helping to understand and manage environmental and social risks. These types of contextualized educational initiatives lay the groundwork for greater community awareness and commitment to the conservation of Laguna de la Cocha.

Finally, in the Burgos news story (2022) broadcast by Radio Nacional de Colombia, Professor Efrén Muñoz has implemented an innovative eco-pedagogical strategy in Laguna de la Cocha using photography as an educational tool. Students go on field trips to explore and document the biodiversity of the lake ecosystem, which has increased student and community awareness despite challenges such as access, resources and lack of awareness.

These studies highlight the importance of environmental education, community participation, and responsible management of economic activities to achieve a balance between the development and conservation of the Laguna de la Cocha ecosystem.

To achieve truly sustainable development, it is essential to promote collaboration and joint work among all stakeholders, including local communities, environmental authorities, the productive sector, and academia. The need for further research and responsible approaches to ensure the sustainability of activities without compromising the local ecosystem is emphasized.

VI. ANALYSIS.

Based on the literature review, it is possible to identify strengths and limitations in the implementation of environmental education through eco-pedagogy in the management of organic aquaculture waste in Laguna de la Cocha. The various studies propose an integral and multidimensional approach to achieve a balance between development needs and the conservation of this important ecosystem.

Based on the literature review, several strengths and limitations can be identified in the implementation of environmental education through eco-pedagogy for managing organic aquaculture waste in Laguna de la Cocha. The studies reviewed advocate for a comprehensive and multidimensional approach aimed at balancing developmental needs with the conservation of this vital ecosystem.

One of the key elements that emerges from the review is the relevance of strengthening the processes of environmental education and awareness, actively involving the local community; therefore, eco-pedagogical strategies are proposed that are distinguished by their participatory and contextualized approach, such research promotes the active participation of local communities and the valuation of their traditional or empirical knowledge. These strategies seek to create community units focused on education for sustainability, develop environmental leaders, and link wetland-related issues in educational programs. These initiatives aim to foster a greater sense of belonging and commitment of the population to the protection of the lagoon.

Based on the literature review, it is possible to identify strengths and limitations in the implementation of environmental education with the help of eco-pedagogy in the management of organic aquaculture waste in Laguna de la Cocha. The various studies propose an integral and multidimensional approach to achieve a balance between development needs and the conservation of this important ecosystem.

In addition, eco-pedagogy fosters ecological awareness and respect for the natural environment, fundamental

aspects to address the environmental challenges associated with aquaculture in Laguna de la Cocha by promoting a harmonious relationship between humans and nature, laying the groundwork for a deep and lasting cultural change, however, some limitations and challenges to consider are identified the lack of research makes it difficult to evaluate their effectiveness and learning from these eco-pedagogical approaches, Further study of these case studies and analysis of medium and long term results would allow extracting key lessons to strengthen and replicate these initiatives in other similar contexts, thus enriching knowledge about the transformative potential of eco-pedagogy in the sustainable management of fragile ecosystems such as La Cocha Lagoon.

At the same time, studies address the importance of implementing responsible management practices in the economic activities surrounding the ecosystem; in particular, the aquaculture activity has proposed guidelines and strategies for sustainable environmental management for fish farming, such as the efficient use of water and the use of the waste generated. Likewise, innovative alternatives have been explored to valorize these wastes, generating new products and income opportunities for the producing communities, in favor of a more circular economy.

Taken together, these studies reveal that an integrated approach, combining environmental education, responsible management of economic activities, and participatory governance, is essential to achieve the required balance between the demands of development and the conservation of the invaluable Laguna de la Cocha.

Consequently, it is necessary to consider the interrelationship between eco-pedagogy and aquaculture waste management, taking as a reference the works that coincide in pointing out the need to promote greater articulation and coordination among the various actors involved, including local communities, environmental authorities, the productive sector, and academia, who consolidate initiatives such as the creation of ecotourism and eco-pedagogical complexes that seek to harmonize different interests and approaches to achieve truly sustainable development in the region, the productive sector and academia, who consolidate initiatives such as the creation of ecotourism and eco-pedagogical complexes that seek to harmonize different interests and approaches to achieve truly sustainable development in the region, preparing future generations to face environmental challenges with responsibility and knowledge.

VII. RECOMMENDATIONS.

It is necessary to promote research that critically and rigorously evaluates the effectiveness of eco-pedagogical approaches in the management of organic aquaculture waste in Laguna de la Cocha. This will allow the identification of good practices, lessons learned and areas for improvement.

While eco-pedagogy promotes participatory and contextualized approaches, it is also important to explore the integration of innovative technologies that complement these strategies, such as waste treatment systems, and bio-reactors, among others. This can improve the efficiency and sustainability of the proposed solutions.

Environmental authorities and decision-makers must incorporate the principles of eco-pedagogy in the hands of environmental education in policies and programs related to aquaculture and waste management. This will ensure a sound policy framework to support and promote these initiatives in the long term.

Collaboration among key stakeholders such as local communities, environmental authorities, the productive sector, academia, and non-governmental organizations is crucial for the success of eco-pedagogical strategies. These alliances will make it possible to take advantage of diverse knowledge and resources.

It is essential to identify and train community leaders who can act as multiplier agents of eco-educational practices and sustainable management of organic aquaculture waste. These leaders will be fundamental in promoting long-term cultural change.

Incorporating content related to eco-pedagogy and sustainable waste management into school curricula and technical and university training programs will raise awareness among new generations from an early age.

VIII. CONCLUSIONS.

Eco-pedagogy has proven to be an efficient methodology to address the environmental challenges associated with the management of organic aquaculture waste in aquatic

ecosystems, and its educational approach can foster both environmental awareness and collective action within communities, promoting the adoption of sustainable practices that benefit the ecosystem and its inhabitants.

To achieve significant cultural change, it is essential to complement eco-pedagogy with rigorous scientific research, the adoption of innovative technologies, and the establishment of effective public policies. This integrated, multidisciplinary approach will not only allow environmental problems to be addressed more effectively but will also facilitate the long term sustainability economic development of the region.

Finally, local capacity building through the training of community leaders and the implementation of formal education programs is crucial to empower communities. This process will not only facilitate proper waste management but it will also contribute to the conservation of the Laguna de la Cocha ecosystem, ensuring its preservation for future generations and fostering a collective sense of responsibility towards the environment.

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