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ECONOMIC VALUATION OF ECOSYSTEM SERVICES PROVIDED BY WETLANDS IN THE URBAN AREA OF THE MUNICIPALITY OF VALLEDUPAR, CESAR

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Abstract: This study conducted a comprehensive valuation of the ecosystem services of the urban wetlands of Valledupar, Cesar, through the execution of two surveys (pilot and final) applied to 385 residents, with the objective of determining the willingness to pay (WTP) for their conservation. Key findings include an estimated WTP of $65,077.53 per inhabitant, which reflects a high valuation of the environmental impact in relation to the community social component and the relevance of these ecosystems. The results demonstrate a significant commitment of the population towards environmental protection, with 70% of respondents recognizing the benefits of wetlands and 67% aware of their crucial role in climate regulation. The main conclusion underlines the urgency of implementing an integrated environmental management plan aimed at improving hydrological conditions and conserving biodiversity, highlighting the importance of wetlands not only for ecological balance, but also for the preservation of the region's cultural and historical heritage.
Keywords: Valuation of ecosystem services, Urban wetlands, Willingness to pay (WTP), Environmental Management Plan.

INTRODUCTION

The wetlands located in the urban area of the municipality of Valledupar, Cesar, represent ecosystems of vital importance to the region, playing critical roles in climate regulation, flood control, biodiversity conservation, and the preservation of historical and cultural heritage. Deeply rooted in the history and socioeconomic development of Valledupar, these wetlands have been witnesses and key players in shaping local identity. Globally, wetlands are recognized for their ability to act as natural buffers against extreme weather events and for their role in water filtration and purification (Meli et, Al, 2014; Delle and Gill, 2022). However, they face significant challenges derived from increasing human interventions and accelerated urban encroachment, which have resulted in an alarming decrease in their extent and a worrying degradation of their environmental quality.

This degradation trend is not unique to Valledupar, but aligns with a broader pattern observed in Latin America, where urban wetlands are being severely impacted by uncontrolled urbanization, lack of adequate environmental planning, and inadequate waste disposal. Studies in several cities in the region have documented the progressive loss of these ecosystems and the decline in their capacity to provide essential ecosystem services, underscoring the urgency of adopting stricter and more effective conservation measures.

The urgent need to address these challenges is accentuated by the notable lack of up-to-date information and the difficulty in accessing relevant data, a situation that underscores the urgency of this study. Despite these limitations, the research has been strengthened through collaboration with local professionals and experts, who have facilitated access to crucial information and provided valuable on-the-ground insights. Recent studies have shown that the loss and degradation of urban wetlands can have severe impacts on biodiversity and the ability of cities to adapt to climate change, making their conservation essential. This effort not only seeks to fill knowledge gaps, but also to raise awareness among civil society and local authorities about the critical importance of these ecosystems in the urban context of Valledupar.

The economic valuation of ecosystem services provided by wetlands has been a key focus in previous studies, such as that of Pulido L. (2021), who applied economic valuation methodologies to highlight the importance of conserving biodiversity and

ecosystem services in the Humedal El Burro. In a complementary manner, Tibaquirá (2021) linked the economic valuation of the Jaboque Wetland with the preservation of the Tingua Bogotana, managing to estimate a significant monetary value that reflects the community's willingness to pay.

Flórez et al. (2020) expanded this field of work in high Andean wetlands, applying diverse valuation methodologies, which evidenced the importance of an adequate methodological selection for the conservation of these ecosystems. Cadena et al. (2019) and Gélvez (2018) have also contributed significantly to the understanding of the economic valuation of ecosystem services, focusing on specific wetlands in Bogotá, and highlighting the need for effective conservation strategies based on a deep understanding of their economic and ecological value.

In this context, this research is distinguished by documenting and analyzing the current situation and historical importance of wetlands in Valledupar, in order to formulate strategies for environmental management that recognize and reinforce the role of these ecosystems in urban sustainability. In addition, research has shown that wetlands, when well managed, can significantly improve urban resilience, reduce flood control infrastructure costs, and provide crucial green spaces for human well-being. By identifying the economic, cultural and environmental values that the community associates with these natural spaces, we seek to open a path towards the effective conservation of wetlands, based on citizen participation and the commitment of local authorities.

The objectives of this study are to characterize the Sicarare, El Eneal, Maria Camila and El Edén wetlands, comparing their status in periods of their existing historical maximums. In addition, a contingent valuation is proposed to determine the community's willingness to pay for the conservation of these ecosystems, and finally, to formulate concrete conservation measures to ensure the protection and sustainability of these wetlands for future generations. These actions are essential to preserve the ecological balance and the well-being of the community, highlighting the fundamental role that wetlands play in the identity and sustainable development of Valledupar.

THEORETICAL FRAMEWORK

The economic valuation of wetland ecosystem services has emerged as a critical field of study to understand and quantify the value that these ecosystems contribute to human well-being and sustainable development.

Theoretically, environmental economic valuation is based on the need to have an understandable quantification of ecosystem services, which have been studied by FAO and the FSS International Common Classification of Ecosystem Services (CICES). The environmental economic valuation methodology, both for revealed and stated preferences, provides the necessary tools to quantify the welfare value that wetlands provide to human communities.

Decree 2041 of 2014, which defines the Environmental Management Plan, and the Ramsar convention underscore the need for a systematic and evidence-based approach to wetland conservation. The classification and structure of wetlands, as described by Moreno, Garcia, and Villalba (1989), as well as Garcia (2001), provide a basis for understanding their complexity and designing appropriate management and conservation interventions.

The convergence of these studies and theoretical frameworks reflects a dynamic and evolving field of research that underscores the critical importance of wetlands and the need to integrate economic considerations into their conservation and management.

Economic valuation emerges as an indispensable tool for informed decision making, supporting conservation efforts that not only protect biodiversity, but also ensure the well-being of human communities dependent on these vital ecosystems.

METHODOLOGY

This study is framed within the research line called "Sustainability and Environmental Management", specifically in the subline of integrated management of biodiversity and environmental heritage, with a focus on the valuation and use of natural resources. These thematic areas have been formally adopted according to Agreement No. 003 of July 8, 2021, issued by the Council of the Faculty of Engineering and Technology of the Universidad Popular del Cesar (UNICESAR). The methodological approach adopted is quantitative and correlational, with the purpose of analyzing the relationship between variables through the application of surveys directed to the population of Valledupar, which amounts to 459,349 inhabitants, according to the 2018 DANE census.

The study relies on a quantitative approach that includes the application of surveys and the analysis of econometric models, complemented by literature reviews and field studies. This allows for a comprehensive understanding of the disposition of the local community towards the conservation of wetland ecosystems. Through this approach, we seek to determine the economic valuation that the residents of Valledupar give to the ecosystem services provided by these wetlands, and, in turn, to identify effective environmental management strategies that promote their long--term sustainability. The research emphasizes the need for a collective commitment to the protection of these wetlands, given their importance for the ecological balance and quality of life in the region.

The study population comprises ecosystem services for wetland biodiversity, which have been identified and classified into 98 types, including provisioning, regulating, supporting and cultural services, according to the Common International Classification of Ecosystem Services (CICES) and FAO.

THE STUDY METHODOLOGY ENCOMPASSES SEVERAL KEY STEPS

Characterization of the environment and anthropic factors: This stage includes a bibliographic review with requests for information from entities such as the Secretariat of Environment, Economic Development and Tourism of Valledupar, CORPOCESAR and IGAC. In addition, a geographic analysis was carried out using tools such as ArcGIS, widely recognized in the environmental technology field for its capacity to produce high-precision cartographies, using as input digital information from IGAC's "Colombia en Mapas" (Colombia in Maps). The identification of environmental aspects and impacts is carried out following Arboleda's methodology (2008) and the one applied by Empresa Pública de Medellín - EPM.

Determination of willingness to pay: This phase is developed through the construction and application of a pilot survey instrument, followed by a final instrument, which is composed of variables carefully calibrated to reduce research bias, according to the methodology of Jaime and Tinoco-López (2006). This instrument integrates socioeconomic and environmental valuation questions, focused on the measurement of perceived quality and the allocation of voluntary contributions.

A binary Logit regression econometric model is constructed to optimize the statistical and mathematical assumptions, seeking linear estimated parameters with minimum variance (Valdivia et al., 2009).

The willingness to pay is estimated under specific valuation conditions according to Osorio and Correa (2009) and Hanemann (1984).

To analyze the willingness to pay (WTP) and validate the econometric model constructed, a binary logistic regression approach was used. The logistic model was subjected to a statistical validation test using Analysis of Variance (ANOVA), estimating the Sum of Total Squares (SCT), the Sum of Squares of Error (SCE), and the Sum of Squares of Factors (SCF). These calculations were complemented with the evaluation of the Total Degrees of Freedom (GLT), of the Error (GLE) and of the Factors (GLF).

The formula used for the F-test in the ANOVA is:

$$F = \frac{\frac{SCF}{k}}{\frac{SCE}{n-k-1}} \quad (1)$$

Where SCF is the Sum of Squares of Factors, SCE is the Sum of Squares of Errors, n is the total number of observations, and k the degrees of freedom. The F-calculated was expected to be greater than the F-tabulated to accept the proposed econometric model.

The logistic model is represented as follows:

$$\text{logit}_i = \ln\left(\frac{p_i}{1-p_i}\right) = \alpha + \sum_k \beta_k X_{ki} \quad (2)$$

Where,

α = intercept with the axis of the dependent variable.

β = predictor estimation parameters.

X = values of the independent variables involved.

k = number of parameters involved in the logistic model.

Pi = Probability of occurrence of an event.

This model allows optimizing the statistical and mathematical assumptions, ensuring that the estimated parameters are linear and of minimum variance. The willingness to pay is estimated under specific valuation conditions according to the methodology proposed by Osorio and Correa (2009) and Hanemann (1984).

Formulation of conservation measures: This stage contemplates the establishment of measures for the conservation of specific wetlands in Valledupar, accompanied by a follow-up and monitoring plan that defines indicators, goals and resource needs, with a detailed budget, following the guidelines of Arboleda (2008).

This detailed methodological procedure provides a comprehensive framework for addressing wetland conservation and restoration in Valledupar, basing the proposed actions on numerical data, rigorous statistical analysis and a robust methodological process.

RESULTS AND/OR DISCUSSION

This article is based on a literature review that did not yield significant results due to the lack of responses from key entities such as the Valledupar Municipal Comptroller's Office, CORPOCESAR, the Municipal Mayor's Office, IGAC and the Departmental Environment Secretariat. However, the research was enriched through the participation in the elaboration of the Environmental Management Plans of the Urban Wetlands, coordinated by the Temporary Union ASOPROASA, which allowed the collection of relevant data to complement this study.

The Sicarare Wetland (see Figure 1), located in the Parque de la Leyenda Vallenata "Consuelo Araujo Noguera", is of special importance due to its history and its current role in biodiversity conservation. In 1971, this wetland did not exist as such, but a small lagoon functioned as a watering hole. Today, it

has grown significantly thanks to the creation of two large artificial lagoons supported by groundwater, which have become a sanctuary for wildlife. This wetland also maintains a limited ecological connection with Cerro Minakalwa and the lower Guatapurí River Basin, despite the interruption caused by road infrastructure (CORPOCESAR, 2023).

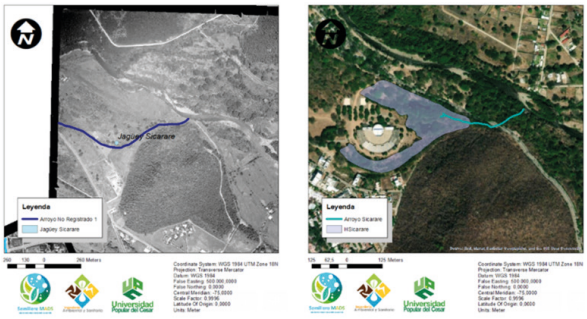

Figure 1. Comparison of Sicarare Wetland Area. Year 1971 versus Year 2023

The El Eneal Wetland (see Figure 2), located within the Artillery Battalion No. 2 "La Popa", is another important ecosystem in Valledupar. Although it has managed to conserve part of its natural structure, in the past it was part of the ecological structure of the Sierra Nevada de Santa Marta. Today, its conditions are semi-clinical, with a predominance of reptiles and birds, and a marked absence of mammals. Despite its isolation, this wetland remains crucial because it is the source of the Arroyo El Mamón de Leche, a perennial water source that flows through the city of Valledupar (CORPOCESAR, 2023).

Figure 2. Comparison of Eneal Wetland Area. Year 1996 versus Year 2023

The Arroyo El Mamón de Leche plays a vital role in the connectivity between three wetlands: El Eneal, Maria Camila and El Edén. Historically, this stream flowed directly into the Maria Camila wetland (see Figure 3), which in its heyday connected to El Eneal. However, urbanization has drastically altered its course, and the stream now diverts towards El Eden Lagoon. Despite these changes, El Mamón de Leche remains a key part of the region's water network, although its ability to sustain the surrounding ecosystems has been compromised (Brochero & Martínez, 2017).

Figure 3. Comparison of Maria Camila Wetland Area. Year 2004 versus Year 2023

The Maria Camila wetland is an example of the serious loss of ecosystems in the region. This wetland has lost 99% of its total area due to urban expansion, leaving it without water sustainability and in a critical state. Frequent flooding in the area, currently controlled by the La Solución Canal and the Las Mercedes irrigation district, is a testimony to the disappearance of this wetland. Despite efforts to restore its ecological functions, Maria Camila is practically unrecognizable and is categorized as a park to remember (Brochero & Martínez, 2017).

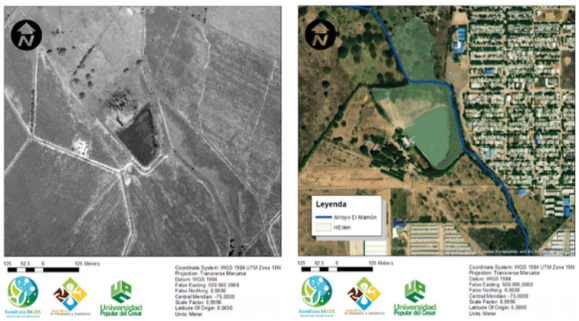

Figure 4. Comparison of El Edén Wetland Area. Year 2004 versus Year 2023

Finally, the El Edén Wetland (see Figure 4), also known as Laguna El Edén, is one of the least known ecosystems by the public and is not officially categorized as a wetland. In the past, it acted as a rainwater buffer, supported by the El Mamón de Leche stream. Currently, it receives all the storm sewer discharges from the southwestern area of Valledupar, but it has suffered significant impact due to the filling in its northern area, an activity that has altered its original ecological function (CORPOCESAR, 2023).

A visit to the wetlands of interest was proposed and permits were obtained for only three of them: Humedal Eneal, Humedal Maria Camila and Humedal Sicarare. In contrast, the visit to Humedal El Edén was denied for unknown reasons and supposedly associated with the degree of environmental impact of this site.

However, through the analysis of digital images and geospatial visualization tools such as ArcGIS, significant changes could be observed in the El Edén Lagoon, showing the inadequate disposal of ordinary and construction waste, the reduction of vegetation cover, and the introduction of agricultural and livestock practices. These findings allowed inferring environmental aspects and impacts, which were corroborated by on-site visits to the other wetlands, while for El Edén, the impacts were deduced based on the available geospatial information.

In this context, an evaluation was applied using the EPM method, whose valuation variables are as follows: Presence of the environmental impact (P), which measures the probability of occurrence: Presence of environmental impact (P), which measures the probability of occurrence; Duration of environmental impact (D), which quantifies the time it takes for the impact to become significant (measured in years); Evolution of environmental impact (E), which evaluates the speed with which the effects and consequences manifest themselves (measured in months); and Magnitude of environmental impact (M), which considers the extent of the impact, regardless of its scale (Arboleda, 2008).

With these variables, the EPM matrix was constructed and the corresponding evaluation was carried out, including the environmental rating (EQ) calculated using the following equation (Arboleda, 2008):

$$CA = C\,[P\times(7\times EM + 3\times D)]\,[P\times(7\times EM + 3\times D)]. \quad (3)$$

According to Arboleda (2008), the Environmental Rating (ER) is classified into four categories: irrelevant (≤ 2.5), moderate (>2.5 and ≤5.0), relevant (>5 and ≤7.5), and severe (>7.5). In this study, 113 environmental impacts were assessed, classified into seven types: natural resource depletion, visual pollution, soil pollution, environmental pollution, water pollution, noise pollution, and air pollution. The results of this evaluation, presented in Figure 5, indicate that 16% of the impacts are considered serious, 32% are classified as significant, 47% as moderate and 5% as irrelevant.

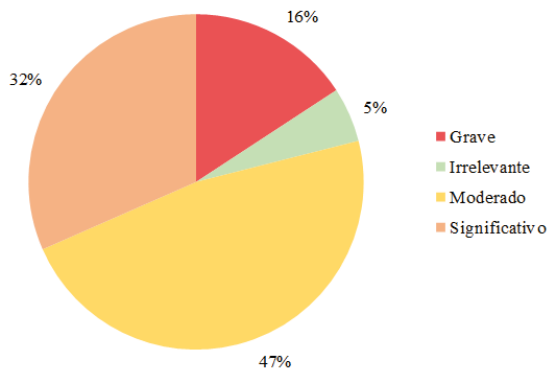

Figure 5. Classification of Environmental Impact Measurement

The ranking of environmental impacts reveals a significant disconnection of ecosystems and a considerable loss of their ecological functions and services, aggravated by the pressure of urban expansion. This has intensified the negative response of the affected ecosystems.

The review of the Environmental Management Plans developed for the urban ecosystems of Valledupar in 2005, compared with the audits and reviews carried out by the Environmental Forum of Cesar during the three-year period 2020-2022, together with other civil societies, shows a notable increase in environmental problems. This study confirms that the environmental situation has evolved from serious to significant, as detailed in the results presented.

As part of the study on the willingness to pay voluntarily for the recovery and conservation of urban wetlands in Valledupar, two key surveys were conducted: a pilot survey and a final survey. The pilot survey involved the participation of 40 individuals selected because of their specific knowledge about the ecosystems, their physical proximity to the wetlands, and their variability in terms of age and gender. These participants were chosen because they were professionals in areas related to the study, and some because of their residence near the wetlands or their historical knowledge of the wetlands. The objective of this preliminary survey was to explore the level of initial knowledge and perception of wetlands. The results revealed that 70% of the respondents recognized the benefits of these ecosystems, and 67% were aware of their role in climate regulation.

Based on the findings of the pilot survey, a more robust final instrument was designed to economically and ecosystemically evaluate wetlands. This instrument was applied to 385 participants, selected from a simple random sampling of the total population of Valledupar projected for the year 2023 (according to DANE census projections, 2018). It is important to note that the initial 40 participants were not considered in this second survey. The questionnaire included detailed sections with questions discriminated into socioeconomic and socio-environmental components, in order to capture a more complete and accurate picture of the community's disposition towards wetland conservation.

The results indicated that respondents showed a positive willingness to contribute financially to wetland conservation. Suggested voluntary contribution amounts ranged from $800 to $11,000, with an average of $5,900. This value represents the average amount that citizens would be willing to contribute to urban wetland conservation. However, it was also observed that respondents were willing to accept financial compensation to allow urban developments in wetlands, with amounts demanded ranging from $10,000 to $94,000,000, averaging approximately $19,000,000. This contrast suggests that while there is an inclination towards conservation, there is also a significant economic valuation of wetlands as potential land for urban development, reflecting a duality in community priorities.

To quantify the willingness to pay (WTP) for wetland conservation, an econometric

model based on multiple regression was developed. This model considered key variables such as contracting opportunity against wetlands (CONTR), responsibility attributed to private companies (EPRIV), community responsibility (COMUN) and the bid price market variable (DAP_R). After four iterations, the model reached a significant and statistically relevant functional expression, represented by the following equation:

$$DAP = 0.923162097 + 0.047260655*CONTR - 0.048551031*EPRIV + 0.101780773*COMUN + 0.00016567*DAP\_R \quad (4)$$

This model demonstrates how each variable influences individuals' willingness to pay for wetland conservation. The variable WTP_R, representing the price offered, remained consistently significant throughout all iterations, underscoring its relevance in determining WTP.

Applying the methodology proposed by Hanemann (1984), the estimated WTP was calculated at $65,077.53 per inhabitant of Valledupar per month, which is equivalent to $16,269.38 per wetland. This value reflects not only the community's willingness to finance conservation, but also the perception of the critical importance of these ecosystems for collective well-being. The overestimation of these values highlights a significant and widespread concern for wetland preservation, which could be interpreted as strong community support for the implementation of more rigorous conservation policies.

For the formulation of the environmental management plan aimed at the conservation of wetlands in the urban area of the municipality of Valledupar, Cesar, several strategic actions have been proposed focused on the conservation of these ecosystems, covering fundamental aspects such as soil and water management, protection of flora and fauna, as well as the integration of the community in awareness and participation processes. These actions seek to prevent, mitigate, correct or compensate for adverse environmental effects, in addition to improving current conditions and ensuring the long-term sustainability of the wetlands, which are essential for the ecological balance of the region.

In relation to the El Eneal wetland, proposals have been designed that include the promotion of good practices in the use of natural resources and the implementation of strict regulations for the protection of the wetland, accompanied by a system of constant monitoring of water quality. Initiatives have also been proposed to improve land management, including the collection and proper treatment of solid and construction waste, as well as the restoration of natural habitats.

The protection of flora and fauna focuses on the creation of nurseries for endangered species and the design of artificial habitats to ensure the preservation of biodiversity.

As for the Maria Camila Wetland, which has experienced a considerable reduction in its area, the restoration of the water roundabout and the creation of infrastructure for the recharge of the wetland through groundwater and rainwater are proposed. Restoration of vegetation cover and effective solid waste management are also among the key measures. In addition, projects to promote passive alternative tourism and the conservation of endangered species are proposed, with special attention to those species that face greater risks due to climate change.

The Sicarare Wetland, located in the Parque de la Leyenda Vallenata, is another ecosystem central to these conservation strategies. The proposals include the evaluation and monitoring of the lagoon recharge model, integrated solid waste management, and the rehabilitation of degraded soils. Also proposed is the restoration of terrestrial vegetation

cover, the creation of artificial habitats for threatened species, and the implementation of ecological corridors to facilitate the safe passage of local fauna.

These conservation measures are designed to be implemented over different time horizons, ranging from 12 months to a maximum of 10 years.

Most of the actions, representing 76.7% of the proposals, have a medium implementation timeframe, estimated at 4 to 7 years. This temporal approach reflects the need to adopt a gradual and sustained action plan to achieve significant results in the preservation of these wetlands, while ensuring their long-term viability.

The total projected cost for the implementation of all these conservation and restoration measures in the El Eneal, Maria Camila and Sicarare wetlands is $21,583,980,000.00. This comprehensive approach ensures that Valledupar's wetlands are not only preserved, but also restored and enhanced, thus guaranteeing their continued contribution to the ecological balance and well-being of the local community. The adoption of these strategies represents a firm commitment to environmental protection, essential for the sustainability of natural resources and the quality of life in the region.

DISCUSSION

The discussion of results in this study critically integrates the historical characterization of the Sicarare, El Eneal, Maria Camila and El Edén wetlands in Valledupar, the economic valuation of these ecosystems and the formulation of conservation measures, highlighting the interrelationships and challenges identified.

The historical analysis of the wetlands reveals a worrisome panorama that is aligned with the general trend of urban wetland degradation in Latin America. The Sicarare Wetland, which has undergone a remarkable transformation due to human intervention, presents an expansion in its area through the creation of artificial lagoons. However, these interventions do not always replicate the complex ecological functions of a natural wetland, which could compromise its long-term sustainability (Moreno et al., 2018). Similarly, the El Eneal wetland, despite conserving part of its natural characteristics, faces problems of isolation and biodiversity decline, reflecting patterns observed in other Colombian wetlands where habitat fragmentation has been a critical factor in the loss of ecological functions (Tibaquirá, 2021).

The case of the Maria Camila Wetland is particularly alarming, having lost 99% of its original area due to uncontrolled urbanization. This highlights the urgent need for stricter urban policies to protect these ecosystems, a conclusion that is reinforced by comparison with other studies in Bogotá, where the need for more robust interventions to mitigate the loss of urban wetlands has been documented (Pulido, 2021). The El Eden Wetland, although less known and not officially categorized, plays a crucial role in water regulation, but has been severely impacted by improper waste disposal, underscoring the complexity of restoring these ecosystems, as has been observed in other similar contexts (Gélvez, 2018).

The economic valuation of wetlands in Valledupar, with a willingness to pay (WTP) of $65,077.53 per inhabitant per month, reflects a significant recognition by the community of the importance of these ecosystems. This valuation, however, must be contextualized in the cultural and symbolic perception of wetlands, which could influence WTP, as has been evidenced in similar studies in other urban areas of Colombia (Gómez-Ballesteros et al., 2019). Furthermore, the community's willingness to accept trade-offs to allow urban developments highlights a duality in local

priorities, a phenomenon also observed in other growing urban regions in Latin America (Hernández-Camacho et al., 2020).

The proposed conservation measures are critical to mitigate wetland degradation, including the restoration of the watershed and the creation of infrastructure for wetland recharge through groundwater and rainwater. These strategies are in line with best practices in wetland restoration, as observed in studies in Valle del Cauca, where water management was identified as an essential component for long-term sustainability (Rodríguez et al., 2018). However, the implementation of these measures faces significant challenges, particularly in terms of financing and continuity in management, which could limit their effectiveness (Guzmán & Vargas, 2019).

The integration of the community in conservation activities is a fundamental aspect of the proposed measures. Experiences in other Colombian cities, such as Bogotá, have shown that community participation is key to the success of conservation initiatives, improving not only the implementation of measures, but also increasing public awareness of the importance of these ecosystems (Jaramillo & Franco, 2016). However, these strategies need to be adapted to the cultural and socioeconomic particularities of the population of Valledupar to ensure their success.

Finally, the limitations of the study, such as the lack of accurate historical data and the reliance on community perceptions, underscore the need for continuous and more detailed monitoring to obtain a more complete and accurate picture of the evolution of these ecosystems. The implementation of a Geographic Information System (GIS) for monitoring is an important advance, but its success will depend on the quality of the data collected and the commitment of local authorities and the community (Rodriguez, 2020). In addition, the effectiveness of the proposed measures will depend on the availability of financial and technical resources, as well as a robust legal framework that guarantees the sustainability of the actions in the long term (López et al., 2020).

CONCLUSIONS

The conclusions of this research underline the critical importance of urban wetlands in Valledupar, Cesar, both from an environmental and socioeconomic perspective. Throughout the study, it has been shown that these ecosystems are not only vital for climate regulation, flood control and biodiversity conservation, but also constitute a fundamental pillar in the preservation of the cultural heritage of the region, with deep historical roots connected to the Asario indigenous communities.

The analysis of the Sicarare, El Eneal, Maria Camila and El Edén wetlands has revealed the diversity of functions that each of them plays in the urban and natural environment of Valledupar. The Sicarare Wetland stands out for its ecological significance, with a considerable expansion that has allowed the creation of a wildlife refuge. On the other hand, the El Eneal wetland, although still functional, shows signs of deterioration due to the decline of key species and its progressive isolation. The Maria Camila Wetland, which has suffered an almost total reduction of its area, is in a critical state, while El Edén has been severely impacted by human activities, particularly the inadequate disposal of waste and the alteration of its natural hydrology.

Economic valuation through surveys of the population of Valledupar revealed a significant willingness on the part of the community to finance the conservation of these wetlands. This finding is a clear indicator of the value that citizens place on these ecosystems, reflecting not only a growing environmental awareness,

but also a recognition of the tangible and intangible benefits that wetlands provide. However, the willingness to accept trade-offs for allowing urban developments highlights a duality in community priorities, which poses a challenge for the formulation of effective conservation policies. This scenario reinforces the imperative need for robust public policies that balance urban development with environmental conservation, ensuring that immediate economic benefits do not compromise the long-term sustainability of these vital ecosystems.

In response to these challenges, an environmental management plan has been formulated that integrates specific conservation measures for each wetland. This plan, which varies in its application from short to long term, proposes detailed actions in soil and water management, restoration of flora and fauna, and promotion of community participation. The measures are designed to be implemented over different time horizons, with a major focus on the medium term, which ensures a gradual but sustained conservation process. Active community participation in these efforts is crucial not only to ensure the effectiveness of the measures, but also to foster a sense of shared responsibility that can endure over time.

The estimated cost of implementing these measures, which amounts to $21,583,980,000.00, reflects the magnitude of the commitment needed to restore and conserve these vital ecosystems. The integration of a Geographic Information System (GIS) for the continuous monitoring and evaluation of the environmental conditions of the wetlands, along with environmental awareness and education programs, are key components of this plan. However, for these initiatives to be truly effective, it is essential to ensure adequate and sustained funding, as well as the existence of a legal framework that supports and guarantees the continuity of conservation policies, beyond administrative and political changes.

Finally, the conclusions of this study highlight the urgency of implementing a coordinated and multifaceted approach to wetland conservation in Valledupar. Lack of intervention could lead to irreversible deterioration of these ecosystems, with severe consequences for biodiversity, climate regulation, and the cultural identity of the region. The high community willingness to participate in conservation suggests that there is a solid foundation on which to build a sustainable future for Valledupar's wetlands. This study establishes a robust framework for action, setting a clear path towards the sustainable preservation of these essential ecosystems.

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