Article

Economic Valuation of Benefits in Freshwater Ecosystems: Complex Wetlands System Belonging to the San Juan River in the Magdalena Medio Region, Colombia

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Abstract: This paper identifies and assesses the economic value of the main natural benefits relating to the complex system of wetlands (CSW) belonging to the San Juan River in the Colombian Magdalena Medio. This is a region rich in biodiversity and natural resources, which in the past was hit by violence and the actions of different armed groups. Benefit estimation takes into account diverse monetary valuation techniques, such as market prices for direct wetland uses and the transfer of benefits, for the assessment of indirect use and non-use values. The results reveal that the most important values relate to ecotourism (60.1%) as a possible future use of the CSW, the benefit of preventing flooding (28.4%), and the biodiversity that inhabits the area (6.7%). All three values represent the total economic value of the CSW. This research also finds that the benefits of the ecosystems currently provided by the CSW exceed the opportunity cost, represented by the total conversion of the area to livestock. Lastly, the net present value (NPV) of 25 and 75 years, relating to the benefits of the CSW, exceeds the income from the conversion of land to livestock, revealing profitable investments in conservation and ecotourism projects.

Keywords: ecosystem services; economic valuation; wetlands; total economic value; Colombia

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1. Introduction

Wetlands are an extension of marshes, swamps, and peatlands, or water-covered surfaces, whether natural or artificial, permanent or temporary, with seasonal or permanent connections to rivers. These ecosystems perform many functions and provide diverse services that contribute to human well-being. Among their contributions are nutrient retention, flood control, habitat availability, climate regulation, water purification, food and timber supply, transportation, recreation, and cultural heritage. Notwithstanding, a few economic actors have associated wetlands with useless or low-value land, which has led to the allocation of other uses such as intensive agriculture, industry, or housing projects. In this context, a significant number of wetlands have disappeared. Davinson [1] warns that, without exception, a loss of wetlands has occurred in all regions of the world during the twentieth and twenty-first centuries, estimating that the global extent of wetlands has decreased by 64% to 71% in the twentieth century. In Colombia, 26% of the mainland and inland area comprised wetlands, collectively spanning 30,781,149 ha, and of these, approximately 24% are transformed [2,3]. Activities associated with the transformation of wetland areas are livestock, agriculture, and deforestation. For Rodríguez, Senhandji and Ruiz [4], the main factors affecting wetlands in Colombia over the past 15 years have been urban planning processes, the pouring of wastewater and solid waste, and agricultural activities. As a result of all the above, it has become necessary to examine in more detail

and identify the ecosystem services that wetlands provide, as well as the economic benefits they generate.

This research aims to identify and economically assess the ecosystem services provided by the complex system of wetlands (hereafter referred to as the CSW) belonging to the San Juan River in the municipality of Cimitarra, in the Santander Department, Colombia. The study area comprises different types of wetlands: permanent, under a tree canopy, as well as temporary, interconnected along the San Juan River, incorporating an area of nearly 8300 ha. We define the area as a “Complex System of Wetlands” on the understanding that wetland clusters of diverse permanence types (permanent or semipermanent, as in temporary or seasonal) comprise a wetland complex [5]. In the same way, several clustered basins of diverse types within a landscape unit comprise complexes of wetlands [6]. In this sense, complexes of wetlands are systems because they include the interactions between ecological, social, and economic systems. These interactions drive the transformation that shaped and reshaped these systems and their organization, resilience, and other system properties, becoming more unpredictable [7,8].

The municipality of Cimitarra is located in the Colombian Magdalena Medio, a region with a history of violence and the presence of different armed groups. This research was undertaken two years after the country signed a peace agreement with the FARC guerrilla group, during which time the municipality has been in a post-conflict situation. Moreover, this research is particularly relevant considering the recent findings by Grima and Singh [9], who show that in biodiversity-rich countries with recently resolved armed conflicts, there is an increase in forest loss in the years following the end of the armed conflict. Acknowledging the benefits of these wetlands and assessing their economic value can help decision-makers prioritize strategies and actions that lead to the sustainability of wetlands over time. Likewise, it also creates a baseline for monitoring these services in the future. In this regard, economic valuation takes into account diverse monetary valuation techniques, such as market prices for direct wetland uses, and benefit transfer for the estimation of indirect use and non-use values. In parallel, it also considers the value of the loss of benefits from wetlands that occurs in its total conversion to livestock, which corresponds to the opportunity cost of these territories.

Despite their importance, there are few published studies regarding the economic valuation of wetlands in Colombia. One of the most important studies on wetlands in the country is the one developed by Vilardy et al. [10], who identified the main ecosystem services by type of wetland in Colombia. These authors constructed a matrix of values of importance for ecosystem services according to type of wetland, in order to indicate which services, within provisioning, regulating and cultural services, were more important in each type of wetland. Even though this research identified the wetlands’ ecosystem services for the whole of Colombia, there is no economic valuation for each of them. In this regard, even though at the national level there are studies on the economic valuation of ecosystems in general (see, for example, [11–13]), there is no particular work on wetlands. Most of the research conducted so far has made significant progress on the biological and ecological characterization of ecosystem services (see, for instance, [10,14]), or in mapping wetlands and analyzing the degree of degradation over time (see, for example, [2,3,15]). This study is significant as it is the first attempt at identifying and assessing the economic value of the ecosystem services provided by wetlands in a region that has historically been hit by armed conflict, such as the Magdalena Medio.

In the next section, this article provides a brief description of the economics of wetland valuation. Subsequently, in Section 3, the article outlines the study area and data, and describes the methods used. The results are presented in Section 4, and the discussion and conclusions from this study are given in Sections 5 and 6, respectively.

2. Assessing Wetlands Benefits

The conceptual framework underpinning the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [16,17] comprises six interrelated elements

that constitute a social-ecological system, which operates on diverse time and spatial scales. These include nature, the benefits of nature to people, anthropogenic assets, institutions and governance systems and other indirect drivers of change, direct drivers of change and good quality of life. The “benefits of nature to people” refer to all the benefits that humanity recognizes in nature, which have also been called ecosystem services. These benefits are classified into four categories, according to their function: provisioning services (food, fiber and timber supply); regulating services (such as water purification and flood protection); cultural services (recreation, esthetic experience, spiritual enrichment); ecosystem support services (photosynthesis, primary production and the nutrient cycle). A systematic literature review has found that provisioning and regulating services are the most studied in Latin America [18–20].

The value of the services derived from ecosystems can be divided into three types: ecological value, socio-cultural value, and economic value [21]. The ecological value is measured using indicators or ecological functions, which mainly describe regulating and support services. Socio-cultural value relates to the benefits to people stemming from wetlands in terms of religious, cultural, and national values. The economic value refers to the monetary values of services produced by wetlands in which people’s preferences are expressed through exchange [21]. The economic benefits of ecosystem services are generally represented in monetary terms [22], because it facilitates the decision-making process of actors and government policy [23], by making benefits and costs comparable in monetary terms. According to Hackbart et al. [24], there is also another valuation category to water ecosystems: ethical valuation, which includes the “moral sentiments” of the population. The latter refers to either any moral obligation that people might have towards wetlands conservation or the moral obligation of conservation in altruism regarding one’s contemporaries or future generations.

Consequently, the concept of total economic value (TEV) is employed to understand the different components of economic value for ecosystem services [25]. The TEV incorporates the values of the direct use benefits of biodiversity (recreational use, timber extraction, fishing, etc.), values that are related to indirect use benefits (CO₂ sequestration, habitat regeneration for animal species, etc.) and option values, which reflect preferences for preserving such ecosystems in order to make use of them in the future. Furthermore, the TEV includes the concept of non-use values, which comprise the *existence* value and the *legacy* value. The former refers to the satisfaction of knowing that there are species or ecosystems, the latter includes the satisfaction that the current generation has in knowing that future generations will still have access to them [26].

This study adopts the TEV to perform the economic valuation of the San Juan River’s CSW, as it provides a good starting point in terms of the economic valuation of ecosystem services (see Admiraal et al. [27] for a discussion about the adequacy of TEV with other research areas). However, it should be noted that the monetary economic valuation captures only a portion of the benefits that biodiversity provides since it does not incorporate ecological values (such as soil formation and nutrient cycles), and socio-cultural values (such as ethnic, religious, spiritual and cultural values). While such attributes contribute to people’s wellbeing, the indirect nature of their benefits often means that they cannot be expressed through monetary valuation techniques [22], and non-monetary methods may be needed to reveal the importance of these benefits.

3. Study Area, Methods and Data Sources

3.1. Study Area

The study area consists of an area covering 8300 ha, corresponding to the wetland ecosystems of the San Juan River in the municipality of Cimitarra, Santander. The study area is interconnected by a series of permanent wetlands under a canopy, as well as temporary wetlands, along the San Juan River which flows into the Carare River (Figure 1). The main wetlands that are permanent are (i) La Duda, with an extension of 21.51 ha; (ii) Ciénaga La Colorada, with 57.06 ha; and (iii) Ciénaga San Juan, with 79 ha. These

wetlands are located in the *veredas* San Juan Riverside and Los Morros in the municipality of Cimitarra, Santander (*veredas* is a term used in Colombia to define a type of territorial subdivision in a municipality. This unit is mainly comprised of rural areas, although sometimes it may contain a micro-urban center). The extension of the CSW is shown in Table 1.

Figure 1. Study Area. Source: adapted from the Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH) [28].

According to the third national agricultural census (3rd NAC), there are 122 agricultural units (UPA) in the CSW area. A UPA is an agricultural production unit under sole management, comprising all types of livestock species maintained for self-consumption and/or commercializing purposes, and all land devoted totally or partially to agricultural purposes. Most of these UPA belong to farmers dedicated to livestock. Regional environmental authorities (CAR) are responsible for the administration of the environment and renewable natural resources in the area of its jurisdiction, including wetlands and rivers. In the case of the CSW, this responsibility relies on the Regional Autonomous Corporation of the Rio Grande of Magdalena (Cormagdalena).

Table 1. Extension of the San Juan River CSW.

Type	Area (Hectares)
Permanent open wetland	306.6
Permanent wetland under a canopy	2474.05
Seasonal wetland	5090.83
Average potential	423.73
Total	8295.24

Note: Typologies were given by Flórez-Ayala et al. [29]. Source: Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH) [28]. Permanently open wetlands are those where the presence of water is constant and there are no trees; permanent wetlands under canopy differ from the former definition by the presence of trees covering the water sheet. Seasonal wetlands consist of areas that exhibit seasonality in flooding with dry periods. The average potential wetland has geomorphological characteristics that identify it with an average probability of being wetland.

The CSW is rich in biodiversity, according to data recorded in the Santander Bio expedition carried out in the municipality of Cimitarra in 2018, where 33 species of birds [30], 41 fish species [31], and 22 species of reptiles [32] were found. Notable species include the blue-billed curassow (*Crax alberti*) and the spider monkey (*Ateles hybridus*), which are in the Critically Endangered category according to the International Union for Conservation of Nature's Red List of threatened species (IUCN Red List). In the study area, there are also Endangered Species such as the striped catfish (*Pseudoplatystoma magdaleniatum*), and Vulnerable Species such as the manatee of the Caribbean (*Trichechus manatus*) and the American crocodile from Magdalena (*Crocodylus acutus*). Throughout the San Juan River, populations of howler monkeys can also be seen (*Alouatta palliata*), Colombian white-faced capuchin (*Cebus capucinus*), macaws (*Ara macaw*), northern screamer (*Chauna chavaria*), alligators (*Caiman crocodilus*) and Magdalena River turtles (*Podocnemis lewyana*), among others.

The municipality of Cimitarra had a population of 47,096 in 2007, and its population is mostly impoverished. According to calculations by Colombia's National Planning Department, the multidimensional poverty index (MPI) for this municipality is very high, at 70.1%. MPI shows the most severe levels of deprivation in dimensions related to education and informal work. In 85.6% of households in Cimitarra, the educational achievement of people aged 15 years and older is fewer than nine years of schooling. On the other hand, 96.5% of households in this municipality have at least one person who holds an informal job.

3.2. Methodology

The starting point for the methodology is the improvements developed by previous studies in Colombia (see, for example, [11–13]). These relate to the comprehensive assessment of biodiversity and ecosystem services, and methodologies suggested by Nhuan et al. [33], and Barbier et al. [26] for economic valuation. The methodological procedure for carrying out the research consists of the following phases (Table 2).

Table 2. Phases for performing economic valuation.

1	Identification of ecosystem services in the San Juan River's CSW.
2	Investigate whether each of the different services offered by the wetland has a direct or indirect benefit.
3	Identify the types of information required to assess each category of value that is being investigated, and plan how to gather this data.
4	Identify the most appropriate methodology for the area.
5	Estimate the economic value of the CSW.
6	Estimate the NPV of the wetland, considering a scenario with the current benefits of the CSW, and its value taking into account the opportunity cost (livestock use scenario).

To carry out the identification of the ecosystem's services within the CSW, we first list the benefits of the wetlands as reported by the literature. Subsequently, semi-structured interviews with biologists, ecologists and Colombia's wetland experts were carried out to establish which of those benefits were present in the wetlands area of study.

We identified as experts those professionals working in positions related to the environmental sector specializing in wetlands. Therefore, we included researchers for NGOs, institutions and the government with projects present in the study area. At the end, we perform nine semi-structured interviews with experts belonging to the Fundación Humedales, Proyecto Vida Silvestre, the Fundación Primates, Cormagdalena, the Nature Conservancy (TNC), the Wildlife Conservation Society, and the Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt. In parallel, we analyzed the information reported by the inhabitants of the *veredas* relating to the CSW in the survey of the third national agricultural census (NAC) [34]. This census provides statistical, georeferenced information on the area's agricultural sector. Therefore, we extracted information from the NAC regarding the ecosystem services of wetlands and rivers (especially provisioning and cultural services) from the population of the area of study. This analysis included information about locations (*veredas*) such as Carare, San Juan Riverside, Los Morros (located in the municipality of Cimitarra), and in the village (*cacerío* in Spanish) of Bocas del Carare in the municipality of Puerto Parra. Afterward, the study area was visited, the different users of these benefits were identified, and the information collected during the previous activity was validated. The identification of users was guided by the main activities that were observed around the San Juan River's CSW and benefited from advice from experts and local leaders on the relevant stakeholders on the study site. After identifying the stakeholders, we conducted semi-structured interviews with different CSW users in order to have both a final list of the CSW's ecosystem services, and the value categories or types of use and non-use that they identify in those ecosystem services (Figure 2).

Figure 2. Steps in the process of identification of ecosystem services present in the study area.

Interviewees were selected following purposive sampling [35]. The purposive sample was chosen because years of armed conflict and a post-conflict scenario in Colombia are still sensitive topics for people in the area of study, and this has affected their willingness to participate in interviews (further information is provided in Section 5). To capture the heterogeneity in the CSW population adequately and achieve representativeness, we selected people from the communities that represent different occupations, such as livestock farmworkers, fishermen, fish marketers, women from community associations, and community leaders. We conducted semi-structured face-to-face interviews with 35 key actors. We relied on the expert interviews to identify individuals or groups that are especially knowledgeable in their occupation, and persons willing to participate in the interview. The study first listed different ecosystem services as reported by the literature. In Step 2, experts were requested to identify the ecosystem services present in the study

area, and their different types of use and non-use value. Interviewees in step 3 were asked to list the benefits and contributions of the San Juan River's CSW to their wellbeing. Since we assumed that benefits from the ecosystem services delivered by the CSW could be represented by different values, we asked actors to identify benefits provided at individual (Why is the San Juan River's CSW important for you?), *vereda* (Why is the San Juan River's CSW important for your *vereda*?), and village levels, in the case of interviewees in Bocas del Carare (Why is the San Juan River's CSW important for your village?). We further asked actors to provide a detailed explanation of the identified benefits. We matched the stated benefits with ecosystem services listed by experts in step 2, and with ecosystem service types: provisioning, regulating, supporting and cultural services (MEA, 2005, TEEB, 2010), and according to the different components of economic value in the TEV approach [26]. Afterward, an analysis of the socio-economic area was undertaken, and sources of information were identified.

4. Results

4.1. Ecosystem Services of the CSW

Ecosystem services of the CSW identified are listed in Table 3.

This research estimated the value of three direct uses of the CSW: fishing, fertile land used for the sowing of grass, and scientific tourism. According to the third national agricultural census, the productive units present in these villages have a livestock vocation, and those that report fishing activities are few: 1 UPA in Carare, 2 in Los Morros, 8 in San Juan Riverside, and none in Bocas Del Carare. The census also reveals that fishing by these production units is carried out for self-consumption purposes only, as a complementary activity to livestock. However, the Bocas del Carare village in the municipality of Puerto Parra has approximately 83 fishermen who benefit directly from the river and nearby wetlands, according to the fishermen's census conducted by the Fundación Humedales [36]. For fisheries assessment, the catch database of the Fundación Humedales for Bocas del Carare was taken, from September 2014 to August 2015. The database has information on captured species, total capture, total sale, self-consumption, and prices (\$/pound). The results show that 97.1% of the fishing goes up for sale, and the striped catfish (*Pseudoplatystoma magdaleniatum*) represents approximately 60% of the total catch in the designated period.

Concerning fertile lands, it was found that areas corresponding to seasonal wetlands and of medium potential (highly fertile due to sediment accumulation), are used mainly for the sowing of grass during summer periods. It can be stated that seasonal livestock farming happens in the area corresponding to this kind of wetland (in Figure 3, the fences that separate the cattle from the La Duda wetland can be seen). The municipality of Cimitarra, located in the CSW of the San Juan River, is predominantly used for livestock breeding. Therefore, it is not surprising that the summer season is used for this purpose. According to the third national agricultural census, the municipality has a considerable inventory of 2200 head of cattle and 5276 head of buffalo. The total number of cattle in Cimitarra corresponds to 20% of the Department, and buffalo accounts for 31%, which makes the municipality stand out for its livestock vocation. In this regard, livestock expansion at the expense of wetlands is one of the major threats faced by wetlands in the region, and corresponds to the opportunity cost or second use of the wetland area.

To assess the use that farmers give in the summer season to the fertile land of the wetlands, the Daily Weight Gain (DWG) for fattening cattle in Colombia from the National Livestock Fund was also considered. The carrying capacity (Large Livestock Units per hectare, LLU/ha) reported by the Colombian Livestock Federation, FEDEGAN, was also employed in the summer periods in the Magdalena Medio region. The average annual price of animal unit equivalent ($\$ \times \text{Kg}$) was also used (according to the Fundación Humedales [36]), the dry periods correspond to the so-called "summer"—December, January, February, and *veranillo*—June, July, August, and its variability is year-on-year). This data estimates the annual and seasonal gross profit obtained from each hectare of temporary and average potential wetland that is exploited for livestock use.

Table 3. Ecosystem services provided by the CSW.

Ecosystem Services		Characteristics/Values
Provisioning services	Direct-use value of the CSW (a) Fish (striped catfish, tilefish, common barbell, tambaqui (cachama), etc.)	(a) Even though the production units present in the <i>veredas</i> that were most related to the wetland complex have a livestock vocation, according to the 3rd NAC, the fishing activity in these production units is carried out for self-consumption purposes. The village of Bocas del Carare in the municipality of Puerto Parra has the largest number of fishermen (83) who benefit directly from the nearby river and marshes. It was revealed that fishers from the other areas also engaged in fishing activities.
	(b) Fertile lands (pasture)	(b) We observed seasonal livestock in the study area.
Cultural Services	Scientific tourism	Due to the great biodiversity of the area (spider monkey, howler monkey, Colombian white-faced capuchin, macaws, northern screamer, squirrels, alligator, and manatee), students, researchers, and consultants visit the area. In addition, the Proyecto Vida Silvestre, and the Fundación Humedales, Fundación Primates and Cabildo Verde Foundations are present in the area for conservation and research projects. Throughout the year, a considerable number of researchers, students, and consultants benefit in terms of economic, as well as social and cultural terms.
	Future use (ecotourism as an option value)	The potential for ecotourism in the future should be highlighted, as there are a large number of bird species, (some endemic, such as the blue-billed curassow). There is also potential to take boat trips on the CSW. Likewise, the biodiversity present today allows the observation of a wide variety of species, such as monkey populations on the banks of the San Juan River.
Regulating services	Indirect-use value Carbon sequestration	Organic matter could be observed in the form of peat. Due to the increase in carbon dioxide in the atmosphere and the resulting global warming, wetlands can help mitigate global climate change. Wetlands absorb the surplus of water in rainy seasons. This regulating function of wetlands results in the decrease of maximum water levels in the San Juan, Carare and Magdalena Rivers, which are important for preventing possible flooding in the village of Bocas del Carare and populated areas in the banks of the Magdalena River.
	Flood control	
Supporting services	Biodiversity conservation (habitat generation for animal species)	In several interviews, the inhabitants of the area reported that a swamp is a place where “fish are born and reproduce,” or that swamps are “the breeding ground” of fish, which is why they must be preserved for the livelihood of future generations. Therefore, the conservation value is reflected in controlled fishing agreements in the La Colorada wetland, to protect the catfish, an endangered species, according to WCS et al. [37].

Figure 3. Fences for cattle used in the La Duda swamp. Source: personal archive.

Among the benefits of direct use is what has been defined as scientific tourism. Throughout the year, there is a constant influx of researchers, consultants, and students, who travel to the area due to the conservation or species protection programs and research projects. One of the most influential conservation programs in the area is the Proyecto Vida Silvestre coordinated by WCS, which aims to safeguard five species present in the study area (*Crax alberti*, *Pseudoplatystoma magdaleniatum*, *Trichechus manatus*, *Ateles hybridus*, and the *perobas* tree (*Aspidosperma polyneuron*)). There are also projects with the Fundación Humedales to conserve catfish, and with Cabildo Verde to protect manatees, among others. The Fundación Primates has had a permanent presence in the region since 2008, and receives national and international resources from abroad to fund research into four different primate species: the howler monkey, the spider monkey, the Colombian white-faced capuchin, and the grey-bellied night monkey. Researchers visiting the region range from students working on their undergraduate projects and doing internships with the Foundation to well-known international researchers. This influx of students, researchers, and consultants to the area benefits the region economically, socially, and culturally. To assess what has been defined as scientific tourism, we took into account the budget for the Catfish Conservation Project from the Wetlands Foundation, which refers to the researchers' annual travel expenses in the study area (inter-municipality land transport, transport to the villages, canoe rental, water-related transport costs, accommodation, food and workshop costs carried out in the study area). Likewise, it was possible to find out from interviews the estimated annual budget of the Fundación Primates in terms of food and accommodation, the cost of boat transport for researchers during their stay at the headquarters of the Foundation close to the San Juan River.

In addition, the indirect-use values estimated for this analysis were carbon sequestration and retention, and flood control. In parallel, the non-use values examined were ecotourism as an option value, and biodiversity conservation. Due to limited resources for carrying out an economic valuation with primary information on the policy site, the benefit transfer method was employed to estimate the above values. For carbon sequestration, the values of the tons of carbon in the soil of flooded areas and air biomass (C(t/ha)) were taken from [23], the only study with primary information conducted in the Colombian Magdalena Medio wetlands. These researchers also analyzed the carbon sequestration/emission capacity of four wetlands located in the *Magdalena Medio antioqueño*, in the municipalities of Yondo and Puerto Triunfo. The values of the study site were chosen because they are representative of the hydrogeomorphic class of dominant riverside wetlands in the Magdalena

Medio region [38]. In addition, the average carbon air biomass of the four wetlands was adjusted to the study site, and the average carbon present in the different soil types present in wetlands (water mirror, water mirror with vegetation, and transitional soils). Likewise, the price of carbon bonds from the European CO₂ Negotiation System was also considered (SENDECO₂), specifically from the certified emission reductions (CERs).

Moreover, to assess flood control and biodiversity conservation, we took into account the values obtained by the meta-analysis of Chaikumbung et al. [39] for those ecosystem services. This research was included, since as far as the authors recall, it is the only one that performs a meta-analysis regression based on studies with primary information about the economic value of wetlands in developing countries. Therefore, the analysis of these authors might offer a more accurate benefit transfer for the San Juan River CSW than one based on developed countries, or one combining data related to different groups of countries. Ecotourism option values and the provision values in recreation and culture were taken from Constanza et al. [40]. In Appendix A, more detail can be found about the methods employed, as well as the variables and data sources used in this study.

Subsequently, two future scenarios were assessed in the CSW, each having a 25- and 75-year period: (1) a scenario in which the flow of benefits of the identified wetland is maintained; (2) a scenario in which the wetland area is lost and replaced by the most important use of land in the Cimitarra municipality—livestock. According to Zarandian et al. [41], scenario analysis is useful since it can support land use planning and decision making. We took this scenario into consideration because livestock is one of the main reasons for the loss of wetland areas in Colombia, according to estimations by Patiño [3], and in the third national agricultural census [34], 79% of the land in the municipality of Cimitarra is dedicated to cattle pasture. Therefore, the second scenario aimed to assess the opportunity cost of the land, compared to the benefits derived from the CSW. Accordingly, it is assumed that in the second scenario, the benefits previously identified for the CSW are lost and the income from livestock is quantified. We evaluated two different periods in the economic analysis: 25- and 75-year periods, to take into account the ecosystem benefits in the near and medium future. To accomplish the above, the long-term effective discount rate was used for projects with an environmental impact for Colombia, suggested by Correa [42]. The author distinguishes the following discount rates: 9.45% (for the yearly horizon 1–5), 6.37% (for 6–25 years) and 3.51% (for 26–75 years). We also used an inflation rate of 4.5%, corresponding to the annual average over the last five years (2014–2018).

4.2. Value of Ecosystem Services of the CSW

By valuing the different ecosystem services (mentioned above) economically, the San Juan River CSW makes an annual benefit of COP 8,394,507/ha, which was approximately USD 2668.7 in 2018 (Market Exchange Rate COP/USD = 3145). From these values, ecotourism contributes to more than half of the total value, followed by flood control (Table 4). In total, non-use values contribute to 67% of the total wetland value, indirect-use values, 30%, and direct-use values, 3.2%. The high value of non-use values reveals the importance of the conservation and protection of the current state of the CSW for future use, either in ecotourism or as a benefit to future generations. Our results are in line with those from Wattage and Mardle [43], who find that non-use values have an important weight in the TEV. Thus, the total economic value of the CSW reached a total monetary value of COP 60,825,997,391 (approximately USD 19,337,281) in 2018. The calculations carried out for the estimation of each of the values are shown in detail in Appendix B.

The 25- and 75-year scenario analysis shows that the opportunity cost of the land, which is represented in the use of land for livestock, is much less than the benefits earned by the San Juan River CSW. The NPV of the current total use of the CSW was estimated to be approximately USD 398.9 million, for a 25-year horizon, and USD 1.43 billion over 75 years, while the NPV of the current total use of the wetland in livestock reached a significantly lower number, around 19 and 70 million USD for the 25- and 75-year horizon, respectively (Table 5).

Table 4. Value of ecosystem services per hectare in 2018.

Wetland Benefits	COP/ha	USD/ha	Share
Fishing	88,195.8	28.0	1.1%
Livestock	173,749.2	55.2	2.1%
Scientific tourism	7616.2	2.4	0.1%
Carbon sequestration	94,671.9	30.1	1.1%
Flood control	2,384,998.3	758.2	28.4%
Habitat-biodiversity	560,190.5	178.1	6.7%
Option value: ecotourism	5,085,085.3	1616.6	60.6%
Total services per hectare	8,394,507.3	2668.7	100%

Note: Market Exchange Rate COP/USD = 3145.

Table 5. Valuation of the San Juan River CSW, according to different scenarios.

Net Present Value	Current Use and Conservation		Use of the Entire Wetland Area in Livestock	
	25-Year Scenario	75-Year Scenario	25-Year Scenario	75-Year Scenario
Colombian pesos	1,255,050,463,096	4,665,501,353,847	59,478,068,063	221,102,668,962
USD	398,994,911	1,483,216,295	18,908,759	70,291,070

As a result, the potential value of the CSW (if public or private investments are encouraged both for the conservation of these wetlands, and to enforce eco-tourism options for the future), reveals a substantial return on investment that is more attractive than the livestock-use option.

5. Discussion

The complex system of wetlands of the San Juan River in the Colombian Magdalena Medio provides important services that contribute to human wellbeing. Quantifying the economic value of these wetlands can help to justify, in economic and financial terms, the conservation option (or sustainable use) against that of the total loss of this resource and its biodiversity (in this case, conversion to livestock breeding).

According to a number of studies, such as Patiño [3], Marquez [44] and Garzón-Yepez et al. [45], large wetland areas in the Magdalena Medio have been transformed for livestock=grazing grassland. Livestock grazing is responsible for 50% of wetland area transformation in Colombia, which accounts for more than 4 million hectares [3]. Furthermore, livestock grazing has been expanded to areas where it is more profitable in the short term than conservation, despite it not being suitable for that economic activity. This implies a major political challenge. Therefore, economically assessing the ecosystem services provided by the CSW, as well as estimating the net present value (NPV) of the medium term (presented here), becomes an important issue for supporting national policy commitments.

We evaluate two scenarios with spans of 25 and 75 years ahead, and include use and non-use values of the CSW, in order to have a realistic idea of what can be lost when moving from conservation (which shows profitable investments in conservation and ecotourism in projects in the long term) towards livestock (which can be highly profitable for farmers in the short term). The economic value per hectare of the conservation scenario, in which the flow of benefits of the CSW is maintained, is 21 times greater than the scenario of conversion. That is, if a total conversion to livestock is introduced, about 45,819 USD/ha would be lost over the next 25 years, and 170,338 USD/ha over the next 75 years. We suggest that the government encourages the farmers in the municipality to reserve an area of their land, adjacent to the forest-shaped wetland, for conservation purposes. This study showed that the fertile land used for the sowing of grass has a value of 55.2 USD/ha in 2018. This value can be the starting point for negotiating payments for environmental services. The local government could use this value as an input to foster tax incentives for wetlands conservation in the region. Another alternative for the government is to ensure the presence and dominion of a competent authority over the CSW. Although national

legislation stated a conservation area of a minimum of 30 m from the edge of rivers and wetlands, the institutional weakness of the state especially at a local level, where armed conflict occurred, makes it difficult to enforce conservation laws.

One of the direct-use values that this research estimated for the CSW is fishing, which contributes an important source of household income to the people from the village of Bocas del Carare. Even though fishing accounted for 28 USD/ha in 2018, only 1.1% of the TEV of the CSW, it represents the main livelihood for fishers and their families in Bocas del Carare and allows for self-consumption among the inhabitants of nearby villages to the CSW, which has a predominantly impoverished population. According to National Planning Department estimates that use data from the 2005 Census, the share of the population that is multidimensionality poor in Cimitarra is around 70%. In consequence, since 60% of the total fishery catch corresponds to striped catfish (an endangered species); the deterioration of the wetland is a major threat to food security and local livelihoods. We recommend that policymakers develop alternative livelihood schemes for the Cimitarra municipality, such as ecotourism. This study shows that one of the most important values of the CSW is the option value of ecotourism, which accounts for 1616.6 USD/ha in 2018. Meanwhile, we suggest that the government implement actions to strengthen the associations of fishermen and farmers, and to work with them in conservation agreements, and additionally, to involve social actors in the processes of the implementation of the basin management plans.

Furthermore, it is also worth noting that scientific tourism has the lowest share of the TEV, since this research only quantifies the immediate impacts of its investments on the income of the local population. The total impact of the interventions of conservation projects goes much further. These kinds of projects also show how to increase the flow of other wetland benefits, such as the value that the population gives to biodiversity or non-use. These have fostered recognition of the relevance of healthy ecosystems for human wellbeing. This recognition is important, because it can enhance the non-use value of the CSW (presented in this study by ecotourism) and may generate economic opportunities for the population in the future. This further suggests that the government should support conservation projects in the area, since it improves local understanding about the benefits of the CSW and understanding of its conservation value.

Some clarification has to be made in terms of the challenges we had to address while performing this study. The Magdalena Medio area is a region with a history of violence and the presence of different armed forces. In the 1980s and 1990s, there was a violent dispute over different territories between guerrilla groups (Popular Liberation Army, ELN, the Revolutionary Armed Forces of Colombia, FARC, and Popular Liberation Army, EPL (Spanish acronyms)) and peasants' self-defense groups. These constant disputes over territory sowed terror with homicides, kidnappings, land-stripping and displacement of the rural population. Among the many negative consequences of so many years of armed conflict is the loss of confidence of the community members (rural and urban). Although we performed semi-structural interviews with different users of the ecosystem two years after the country signed the peace agreements with the FARC guerrillas, the loss of trust is still latent in the community. This post-conflict scenario may have affected their willingness to participate in the interviews. Therefore, we relied on people involved in conservation programs in the study site and followed purposive sampling to choose people from different occupations to facilitate interviews. This ensured the inclusion and transparency of all relevant people. We are aware that this approach could lead to bias. However, we used secondary data such as population surveys of the area (performed by the National Statistics Office) and the fishermen's census (conducted by the Fundación Humedales) to contrast the results of the interviews, which ensure the analysis identified the ecosystem services and benefits of the CSW.

This study has provided preliminary information on the value of ecosystem services and the benefits of the CSW for decision-making. Furthermore, these values should be taken into account to promote collective and joined-up environmental management

between environmental authorities, territorial entities, the local community and other institutional actors.

6. Conclusions

The benefits associated with the San Juan River CSW in the Colombian Magdalena Medio are identified and economically valued in this research. Furthermore, the benefits associated with wetlands outweigh their opportunity cost, which in this region is present in the livestock expansion border at the expense of wetlands.

This research estimated the economic value of three direct uses of the wetland: fishing, fertile land used for livestock on a seasonal basis, and what has been called scientific tourism, which was valued using market analysis techniques. Among the indirect and non-use values, carbon sequestration was valued from wetlands, water regulation, biodiversity conservation, and ecotourism as an option value assessed through a transfer function.

Additionally, ecotourism as a possible future use of the CSW, the benefit from flood control, and the existing biodiversity in the study area revealed the largest shares in the TEV, with 60.1%, 28.4%, and 6.7%, respectively. In this context, the total benefit of the sum of the ecosystem services considered reaches an annual amount of COP 8,394,507/ha, or approximately USD 2668.7/ha, in 2018. In parallel, the 25- and 75-year scenario of the NPV of the CSW, versus a scenario in which the use of wetland is destined for livestock, shows that the former has a much higher value. These results reveal profitable investments in conservation and ecotourism projects.

With regard to policy recommendations, an environmental management plan should be carried out for the swamps of the *Magdalena Medio Santandereano*. This would establish adequate limits for planning for grazing land and planting pasture, or the use of fertile lands of seasonal or average potential wetlands, and in general to achieve the sustainable use of wetlands. The management plan should also develop landscape sustainability indicators, so that each of them can be followed up and monitored.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. The Method, Variables, and Sources used in the Study.

Ecosystem Services of the CSW	Valuation Method	Variables	Data Sources
Fishing	Market prices	(1) The annual average pr/t Kg catch from September 2014–August 2016 in the village of Bocas del Carare. (2) Average annual price of the catch in the same period.	(1) and (2) Bocas del Carare catch database. Wetlands Foundation.
Fertile land (seasonal livestock)	Market prices	(1) Daily weight gain for Colombia (WGG) = 298 g. (2) Carrying capacity for Colombia: great cattle unit (GCU) of 0.7; (3) Dry period time = 6 months; (4) Average process of standing fat cattle \$/kg in 2018.	(1) and (2) From FEDEGAN-FNG [46] (3) Fundación Humedales [36] (4) Statistics from FEDEGAN [47].
Scientific tourism	Market prices	(1) Annual travel expenses for researchers from the Catfish Conservation Project in the study area: inter-municipal and <i>vereda</i> land transport, canoe rental, water transport cost, accommodation, food, and workshop costs carried out in the study area. (2) Estimated annual budget of the Primates Foundation in terms of food, accommodation, expenses regarding boat transport for researchers.	(1) Wetlands Foundation. (2) Primates Foundation.
Carbon sequestration	Benefit transfer	(1) Average C (t/ha) from 4 studies in the Magdalena Medio of organic carbon in water mirror soils, water soil with vegetation and transitional soils. (2) Average C (t/ha) from 4 studies for the Magdalena Medio in air biomass (emerging and floating plants). (3) Certified Emission Reduction in Greenhouse Gas Emissions (CERs)	(1) and (2) from Moreno et al. [38] (3) [48].
Flood control and Biodiversity	Benefit transfer	Related variables to flood control: (1) disturbances regulation, (2) water regulation, (3) water treatment. Biodiversity conservation variable: (4) Habitat-Biodiversity.	From Chaikumbung et al. [39].
Option Value: Ecotourism	Benefit transfer	(1) We used the net present value of the ecotourism project of the study and calculated the values per hectares.	From Pemberton and Mader-Charles [49].

Appendix B

Table A2. Values of Ecosystem Goods and Services in the San Juan River CSW.

Fishing							
Location	Period	kg_total catch	Total Average Annual Fishing Provision Service 2014		Total Average Annual Fishing Provision Service-Adjustment 2018		Total Average Annual Fishing/Ha
Bocas del Carare	Annual Average (2014–2016)	27,028	205,653,887		245,246,085		88,195.81
Seasonal livestock							
Temporary wetland area and average potential (Ha)	Great cattle units (GCU/h)	Daily weight gain (DWG/gr)	Annual weight gain (kg)	Annual meat production (kg) = GCU * Annual Gain (kg)	Animal equivalent unit price (COP/kg)	The total value of 6 months/ha of livestock production (COP 2018)	Total value of livestock production (COP 2018)
5514.6	0.70	298.00	109	76	4564	173,749	958,157,327
Scientific tourism							
Period		The total area of the CSW (Ha)		Total investment service for scientific tourism		The total value of scientific tourism/Ha	
Annual Average (2015–2018)		8295.24		63,177,977		7616.2	
Carbon sequestration							
Permanent wetland area (open and under a canopy)	Temporary wetland area (temporary and medium potential)	Carbon soils of flooded areas *	Carbon air biomass	CER Price (COP) **	Total carbon capture value (COP 2018)	Total carbon capture value (COP 2018)/Ha	
2780.7	5514.6	287,751.47	8383.81	889.0	785,332,027	94,671.9	
Flood control							
Flood Control		Coefficient (Chickumbung et al. 2016)		Significance (%)	Total Average /ha SE	Total Value of Flood Control (COP2018)	
Disturbance regulation		3.6		1.00	1,295,941	7,300,709,437	
Water regulation		2.1		5.00	760,883	4,286,448,009	
Water treatment		0.9		1	328,174	1,848,774,368	
Total					2,384,998	13,435,931,814	
Biodiversity							
		Coefficient (Chickumbung et al. 2016)		Significance (%)	Total average /ha SE	Total value biodiversity (COP 2018)	
Habitat-Biodiversity		1.5		1	560,191.5	3,155,843,484	
Future use (option value: tourism)							
Constanza (1997) averages			USD/ha/yearly			Total value recreation and tourism (COP 2018)	
Provision			1,108,690.56			9,196,920,802	
Recreation			3,976,395			32,985,387,453	
Cultural provision							
Total			5,085,085			42,182,308,255	

* The values of the study site are carbon in terms of air biomass C(t/ha) = 3.01, and carbon in soils of flooded areas C(t/ha) = 103.48. ** CER Euros = 0.25. Market Exchange Rate COP/EUR (2019) = 3556.

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