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Social perceptions of ecosystem services delivered by coastal wetlands: their value and the threats they face in northwestern Mexico

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ABSTRACT

Wetlands are recognized for their socio-environmental value and capacity to provide ecosystem services (ES) and are vulnerable to diverse threats, including those derived from climate change (CC). However, changes in ES delivery may not be recognized by ES users. To determine the extent to which coastal communities in northwestern Mexico are aware of the presence and importance of coastal wetlands, participatory workshops that followed the Metaplan methodology were held in four communities. The effects produced by extreme rainfall events (considered manifestations of CC) on wetlands and their ES were also analyzed. Four coastal wetland types (estuaries, saltmarshes, mangroves, and lagoons) were perceived to be the most important ecosystems, while poor fishing practices, mangrove deforestation, and pollution were identified as their main threats. Climate change, land use changes, and water mismanagement were also perceived as wetland threats. There were a few differences among communities that were mostly related to the number of ES and the ES categories identified. Nonetheless, saltmarshes and mangroves were identified as priority wetlands in the communities included in this study, and their ES were recognized. Most of the participants in all communities agreed on the main threats facing wetlands and their ES, particularly those related to CC and those that affect their livelihoods. Despite this awareness, regional coastal wetlands continue to decline. As such, participatory methodologies are needed to firmly establish the importance of wetlands within communities. In doing so, alternative actions based on traditional knowledge can be integrated into management actions, and novel solutions may be developed at the community level that can be scaled regionally.

Keywords: Climate change, Ecosystem services, Extreme rainfall events, Social perception, Wetlands.

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SIGNIFICANCE STATEMENT

With the aim to understand the extent to which inhabitants of coastal communities recognize the presence and importance of local wetlands and their environmental services, participatory workshops were held in four localities in northwestern Mexico. We used the Metaplan methodology to identify similarities and differences among communities in the perceptions of inhabitants regarding local wetlands. Almost all wetlands included in this study were recognized by the participants. Most participants were aware of the main threats to wetlands, particularly those associated with climate change or those that affect livelihoods, and the services these ecosystems provide. As regional coastal wetlands continue to decline, it is necessary to use participatory methodologies to establish their importance within communities. In doing so, alternative actions based on traditional knowledge can be integrated into management actions, and novel solutions may be developed at the community level that can be scaled regionally.

INTRODUCTION

Wetlands are of great ecological, economic, and social importance. These ecosystems are found throughout the world and are characterized by having substrata that are either temporarily or permanently saturated with water. In addition, wetlands are covered, at least periodically, by aquatic or hydrophilic vegetation, which is a remarkable feature of these ecosystems (Mitsch and Gosselink 2015). Wetlands provide critical foraging, nesting, and nursery habitats for resident or migratory species, such as waterbirds and shorebirds, fishes, frogs, and crustaceans, and play important roles in maintaining terrestrial and aquatic ecosystems (Vernon et al. 2019). Due to their regional importance or geographic expanses, some wetlands have been designated as important national or international sites (e.g., Ramsar sites) that are protected by legal instruments to ensure they are properly conserved and sustainably used (e.g., North American Wetlands Conservation Act; CONABIO-Mexico).

The different wetland types found in inland and marine environments provide diverse ecosystem services (ES), which have been defined as the ecological characteristics, functions, or processes that directly or indirectly contribute to human wellbeing (Costanza et al. 2017). Ecosystem services may be broadly characterized as provisioning, regulating, supporting, and cultural services that promote human safety and welfare (Camacho-Valdez and Ruiz-Luna 2012). Wetland-derived ES include supplying animal and plant proteins, purifying water and ensuring its availability, regulating climate and hydrological regimes, and protecting against erosion (Millennium Ecosystem Assessment 2005). Some wetlands also show notably high capacities to sequester carbon. In fact, 20–30% of all carbon stored in soils worldwide is found in wetland-associated areas (Mitsch 2016). In this context, coastal wetlands supply important ES by regulating climate, sequestrating carbon (i.e., blue carbon), protecting against storms and hurricanes, regulating coastal erosion, and providing refuge to various species of commercial interest (Camacho et al. 2014; Rojas et al. 2017).

Despite their importance, the loss or degradation of wetlands is increasing worldwide, and the remaining wetlands are directly or indirectly at risk due to human activities (TEEB 2013). From the beginning of the 20th century to the present, 64–71% of all wetland cover has been lost (Davison 2014). Mitsch and Gosselink (2015) highlighted wetland losses in the United States (53%), Australia (50%), China (60%), and New Zealand (90%) while reporting relatively minor losses in boreal countries and extreme losses (> 90%) in parts of Europe. These losses have been caused by various anthropogenic drivers such as the development of hydraulic infrastructure (e.g., channels, dams, and dikes), changes in land use, pollution, urban sprawl, and the introduction of exotic species. Overall, the main cause of inland wetland degradation is water drainage for agricultural development, whereas changes in land cover and land use are the main causes of degradation in coastal wetlands (Millennium Ecosystem Assessment, 2005; Clarkson et al. 2013). In some tropical and subtropical coastal regions, the expansion of shrimp farming has also been identified as an important driver of wetland loss (Ottinger et al. 2016).

In addition to the aforementioned anthropogenic factors, global change also threatens the existence and resilience of wetlands. Global change refers to a set of natural environmental changes that are heightened by anthropogenic activities, including the increase in atmospheric CO_2, climate change, and ongoing changes in land use/land cover (Sage 2020). These changes not only have environmental consequences, such as those derived from increasing temperatures or air and water pollution and those resulting from extreme weather events (e.g., droughts, storms, tornadoes, hurricanes, and extreme precipitation), but also generate disease and reduce productivity, which have negative repercussions for human wellbeing and the economy (Duarte 2006). Global change can also alter hydrological and geomorphological features of coastal wetlands and their community structure on local and regional scales, which can affect natural selection, extinction rates, biodiversity, energy flows, productivity, and nutrient cycles in these and other ecosystems (Flores et al. 2010). As such, Carpenter et al. (1992) predicted that the distributions and expanses of coastal wetlands would be modified by climate change.

The Stern Report (Stern and Stern 2007) indicates that climate change tends to increase species extinction rates, reduce water availability, intensify the disappearance of mountain glaciers, and promote a rise in mean sea level, all of which threaten the existence of wetlands. These threats culminate in a greater risk of wetland loss in developing countries when compared to the risk present in developed countries due to the interplay between climate change and the pre-existing social and economic vulnerabilities of each country (Emérit 2008).

In Mexico, there is no precise estimate of the expanse of wetlands within the country. In fact, estimates are notably different among sources, such as those from Olmsted (1993; 33,000 km^2), Carrera and de la Fuente (2003; 45,000 km^2), and the Ministry of the Environment (SEMARNAT 2012; 128,000 km^2). The estimate from the Ministry of the Environment indicates that wetlands cover approximately 6.5% of the national territory. Discrepancies among these and other estimated values have been well documented in some coastal wetlands (e.g., mangroves; Ruiz-Luna et al. 2008) and have been attributed to the absence of a standardized classification system and methodological framework to evaluate and monitor the expanses of these ecosystems. Recently, important initiatives have been put forth to address this issue, and a national standardized methodology for wetland evaluations has been developed, which was led by efforts by the National Water Commission (CONAGUA 2017). However, the results of this initiative have not yet been published. Regardless of the differences among estimates, a clear decline in wetland cover and functionality is apparent. A poor understanding of the roles these ecosystems play in ensuring human well-being by providing and maintaining ES (Maltby and Acreman 2011) has led to the development of insufficient conservation measures at both regional and local scales.

Given the existing inadequacy of management strategies in light of the direct mid- and long-term environmental effects of climate change and the ever increasing risk of wetland deterioration, the present study aimed to identify the perceptions of the inhabitants of coastal communities in northwestern Mexico regarding the importance of their local wetlands. This study also includes an analysis of the ES provided by wetlands and how these ES may have been affected by an increase in extreme rainfall events (ERE). The results of this study serve to improve and support management strategies by elucidating the knowledge held by local communities and encouraging their active participation in future conservation efforts.

MATERIAL AND METHODS

Study area

This study was conducted in northwestern Mexico in four coastal communities in the states of Sinaloa and Baja California Sur (BCS) that border the Gulf of California: Cristo Rey (CR), Isla del Bosque (IB), Las Arenitas (LA), and Loreto (LR), (Figure 1). Both CR and IB are located in southern Sinaloa in the Escuinapa municipality, while LA is located in the Culiacan municipality of Sinaloa, and LR is located in the municipality of the same name in BCS. Each locality is associated with wetlands or wetland complexes that have been designated as Ramsar sites (RS). The wetlands of CR and IB belong to Marismas Nacionales (RS No. 732), and the wetlands of LA belong to the Altata-Ensenada de Pabellones Lagoon System (RS No. 1760). The wetlands of LR belong to the Bahía de Loreto National Park in BCS (RS No. 1358). The study sites are also found within areas classified as priority hydrological, marine, and terrestrial regions by the Commission for the Knowledge and Use of Biodiversity of Mexico (CONABIO 2022).

The population of the Escuinapa municipality totals 61,644 inhabitants, 44.1% of which live in poverty (Coneval 2021). The main economic activities in this coastal area are agriculture (mainly fruits), fishing, and aquaculture. A total of 1,064,328 inhabitants reside in the Culiacan municipality (INEGI 2020), 23% of which live in poverty (Coneval 2021). The economy of this municipality is also based on agriculture, aquaculture, and fishing, although livestock are also raised. The Loreto municipality had a total population of 18,052 inhabitants in 2020, 34% of which lived in poverty, 20.4% of which were employed in commercial activities, 18.5% of which were employed in temporary or seasonal hospitality services, and 12.9% of which were employed in primary activities like agriculture, animal husbandry, forestry, fishing, or hunting (Data Mexico 2021).

Workshops and Data Collection

Participatory workshops were held in each study community with local stakeholders and wetland users. The workshops followed the Metaplan qualitative methodology to structure, manage, and facilitate group communications (Habershon 1993). This methodology allows for problems and possible solutions to be identified with the opinions of participants expressed on small cards (13 x 18 cm). Different co-

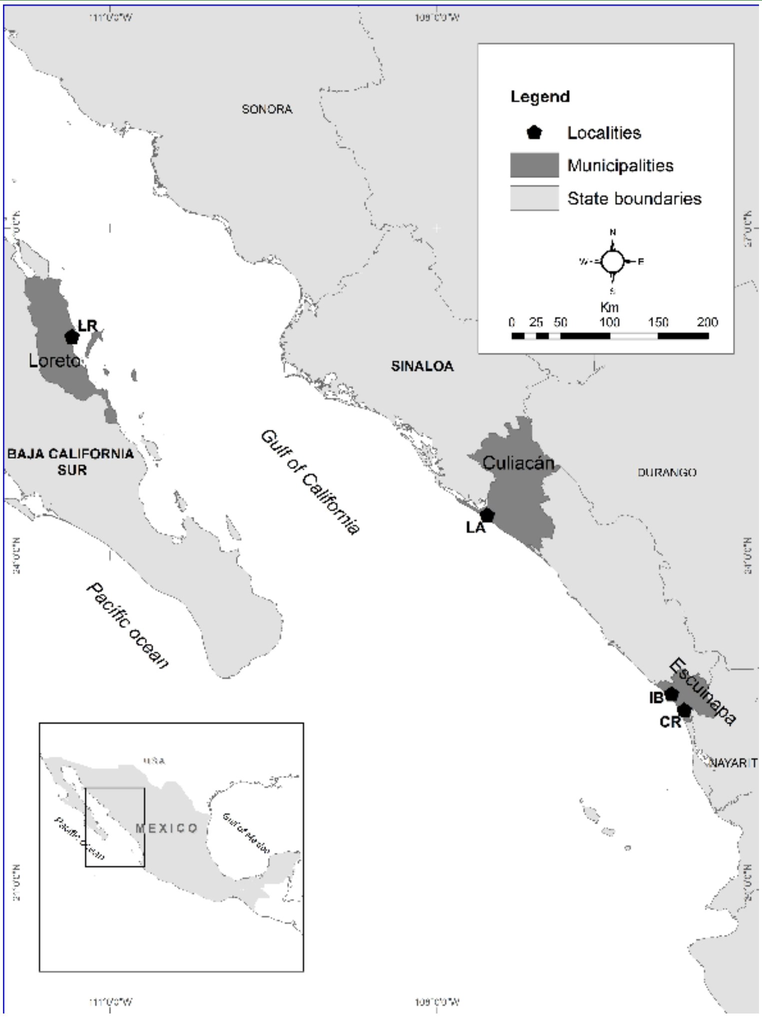

Figura 1. Study area and workshop locations. The workshops were held in four study sites located in four coastal communities in the states of Sinaloa and Baja California Sur (BCS) that border the Gulf of California: Cristo Rey (CR), Isla del Bosque (IB), Las Arenitas (LA), and Loreto (LR).

lored cards were used for each phase of the workshop, which allowed the participants to express and share their own opinions after a phase had concluded by posting their cards on a wall or blackboard. This methodology reduced the number of redundant items, which ensured that the ideas of all participants were properly organized and accounted for at the end of the workshop.

The workshops began by introducing the team of facilitators. This was followed by a brief introduction to the different types of wetlands and ES, which included graphical representations and explanations to establish a common language among participants. The importance of wetlands as ES providers was emphasized, and their classifications according to the Millennium Ecosystem Assessment were explored (MEA 2005). Subsequently, a series of activities were conducted that aimed to determine what the participants knew about the wetlands in their region, their importance, and the possible threats to these ecosystems. After which, the ES offered by wetlands, their local importance, and the possible changes induced by torrential rains or ERE were established.

Based on the Metaplan method, each participant was asked to confirm the presence or absence in the region of ten common wetland types. The participants were also allowed to include additional wetland types from a list provided by the facilitators. Subsequently, the participants were asked to reflect and choose 3 to 5 wetland types whose loss or deterioration would affect them personally and to identify the wetland types that they considered to be important for their community. The first phase of the workshop concluded with the identification of possible threats to the continued existence of these ecosystems (e.g., deforestation, contamination, drying out, or channeling). The threats were collectively listed to record their number by priority wetland type and community and to minimize the effect of sample size in the analysis.

In the second stage of the workshop, the participants focused on identifying the specific ES provided to each community by each priority wetland type. First, the participants identified the ES offered by each priority wetland type (e.g., fishing, the provision of materials, climate regulation, and opportunities for recreation). These were then grouped into one of the following categories proposed by the Millennium Ecosystem Assessment: regulating and supporting (R; joined here in one class for operational purposes) and provisioning (P) and/or cultural (C). Subsequently, the participants rated the importance of the ES based on a four-level ordinal scale: 1) not important, 2) not very important, 3) important, and 4) very important. Finally, the perceptions of the participants regarding the effects of ERE on the capacity of wetlands to supply ES were recorded using the following scale: 1) the capacity to supply ES is lost, 2) the capacity to supply ES decreases, 3) the capacity to supply ES remains the same, and 4) the capacity to supply ES increases.

The workshops were concluded by integrating the information that had been generated with the direct or indirect impacts of ERE on each community. Four types of impacts were identified: floods (Fl), pollution (Po), siltation (St), and water turbidity (Tu). In addition, seven types of change were identified: diminished fishing activities (DF), loss of crops (LC), shortage of food and water (SW), effects on tourism (ET), house damage (HD), health problems (HA), and disruptions to the supply of electricity (E). The participants were asked to classify each according to their experience as either primary (1) or secondary (0).

Data analysis

As part of a wetland prioritization exercise, the votes that each wetland received in each community were ranked in a two-way contingency table to evaluate the homogeneity (independence) hypothesis with an extended Fisher exact test (West and Hankin 2008). A post-hoc pairwise Fisher exact test was then conducted (MacDonald and Garner 2000; McDonald 2014). After the prioritization analysis, information was collected for only the priority wetlands identified by each community. However, discrepancies prevented the response and predictor variables from being ordered in balanced experimental designs, so the subsequent analyses of variance (ANOVAs) were conducted with random incomplete block designs.

The effect of community (factor) on the number of threats identified (response) was analyzed via an ANOVA for a Poisson response (analysis of deviance with the X2 statistic) considering the block effect of wetland type and, inversely, the effect of wetland type and the block effect of community. These analyses were followed by a post-hoc analysis of paired comparisons of the least squares means (lsmeans) with a Tukey adjustment (Agresti 2007; Mangiafico 2015). Similarly, the number of identified ES were analyzed including the factor and block effects of the different ES categories.

The perceptions of the importance of ES and the capacity of wetlands to continue offering them after an ERE were analyzed via ANOVAs for ordinal responses and the factor and block effects of community, wetlands, and wetland categories (provisioning, cultural, and regulating /supporting) in the first case and those of community and wetlands in the second. In addition, responses concerning the importance of the impacts of ERE and the changes they induce were analyzed with ANOVAs for binomial responses with the factor and block effects of the community and the type of impact or change.

RESULTS

A total of 53 people attended the different workshops. The largest workshop hosted 20 participants while the smallest hosted seven people. The participation of women in LR and LA was minimal (1 and 0, respectively), while the number of women was 5 and 12 in CR and IB, respectively. The participants identified 4–8 of the 10 wetlands on the list provided by the moderators. In addition, the participants of the LR workshop also identified oases, which are only present in their region, and designated them as priority wetlands. Overall, five priority wetlands were identified in CR, and four priority wetlands were identified in the other three communities. Lakes and reedbeds were not recognized by participants, although they appeared on the wetland list used in the workshops, while estuaries and mangroves were identified as priority wetlands (Table 1).

In the three communities of Sinaloa, saltmarshes and shrimp ponds were considered priority wetlands, but despite these similarities, the differences were greater ($p < 0.001$ with 10,000 iterations) and were mainly due to the prioritization of saltmarshes with respect to other wetland types ($p < 0.05$) except shrimp ponds ($p > 0.1$). In addition, differences were present with regard to the prioritization of wetland types between IB and LA ($p < 0.01$) and LR ($p < 0.001$) and between LR and CR ($p < 0.01$).

In the communities of southern Sinaloa (CR and IB), threats to wetlands include poor fishing practices, mangrove deforestation, and diverse pollution sources. In LA, the fishing practice of *enyerbado*, which

Tabela 1. Wetlands identified and prioritized in the four coastal communities of northwestern Mexico included in this study: Cristo Rey (CR), Isla del Bosque (IB), Las Arenitas (LA), and Loreto (LR). Symbols: (+) wetland identified within the municipal limits, (–) wetland not identified within the municipal limits, and (p) wetland designated as priority. The number of votes received in the prioritization exercise appears in parenthesis. The colors indicate the prioritization level: from gray for wetlands identified but not prioritized to green for wetlands with the most votes in each community. Brown and pink represent intermediate values.

Wetland type	Description	Community			
		CR	IB	LA	LR
Estuaries	Coastal, brackish water bodies highly influenced by tides and river discharge	+p(3)	+p(1)	+p(6)	+p(7)
Saltmarshes	Coastal wetlands with unconsolidated substrata dominated by herbaceous species	+p(6)	+p(16)	+p(1)	+
Mangroves	Coastal wetlands with unconsolidated substrata dominated by shrubs or trees	+p(2)	+p(5)	+p(2)	+p(7)
Lagoons	Coastal water bodies that are usually shallow and separated from the sea by narrow landforms	+	+	-	+
Beaches	Landforms next to water bodies (sea and lagoons in the present study) influenced by tides with unconsolidated soils	+p(1)	+	-	+p(2)
Reedbed	Vegetation type including diverse plants adapted to growing in wet conditions	-	-	-	-
Oases*	Areas in arid regions where the water table is near or above the surface creating springs or wells	-	-	-	+p(6)
Lakes	Inland water bodies filled mostly with freshwater	-	-	-	-
Rivers and creeks	Channeled water streams	+	+	-	+
Shrimp ponds	Artificial wetlands for controlled shrimp production	+p(1)	+p(2)	+p(1)	+
Dams	Artificial barriers to contain flowing water and create reservoirs	+	+	-	+
Identified wetlands		8	8	4	9

Note: *Wetland type added by the LR participants to the original list of 10 wetland types provided by workshop facilitators.

employs poison, and the construction of shrimp ponds were identified as the main wetland threats. In contrast, the threats identified in LR were diverse and included global change and climate change and their effects (e.g., hurricanes and droughts), land use change for tourism purposes, real estate developments, inefficient water management practices, and pollution.

The number of threats varied from 0 for shrimp ponds in CR to 18 for estuaries in LR (Figure 2). Differences among communities regarding the number of identified threats ($p < 0.001$) were due to the number of threats identified in LR (lsmean = 14.4) with respect to the Sinaloa communities ($p < 0.005$). Four times the number of threats were identified in LR compared to those identified in CR (lsmean = 3.4) and LA (lsmean = 3.6). In addition, the number of threats in LR was double that of IB (lsmean = 6.4).

The differences among wetlands based on the number of threats were not significant ($p > 0.1$) due to the block effect of community. In general, more threats were identified in LR for all wetland types, while the number of threats identified for each priority wetland type in each of the three communities of Sinaloa were similar. In addition, the value of the Spearman correlation between the number of votes received in the prioritization exercise and the number of threats identified per community and wetland type was 0.62 ($p < 0.01$).

The relationship between ES and wetland type varied among sites. In all, 17–39 ES were identified among all wetland types. In Sinaloa, a greater number of ES were associated with saltmarshes, estuaries, and mangroves. The participants of the CR and LA workshops identified 17 ES for each site that were mainly associated with mangroves (35%) and saltmarshes (41%), respectively. In IB, ES were associated with estuaries and mangroves (39% for each wetland type). In addition, 17 ES were identified in the LA workshop, with around 41% of them being linked to saltmarshes. As with the number of threats, a markedly higher number of ES (39) were identified in the LR workshop when compared to those identified in the other workshops. These ES were almost evenly distributed among the priority wetlands identified in LR (Figure 3).

In all four workshops, provisioning services were identified for each priority wetland type with the exception of beaches in CR. These ES represent 25–100% of the services identified in this study and were mainly related to commercial and subsistence fishing (Figure 3). In addition, regulating/supporting and cultural services were recognized as being delivered by the priority wetlands identified in the four workshops. Other ES included protection against storms and hurricanes; oxygen production; carbon sequestration; flood regulation; breeding, nesting, and refuge sites for various species of ecological and economic importance; areas for recreation (e.g., swimming, fishing, and relaxing) and research activities; tourism; scenic beauty; and cultural identity. The ES offered by shrimp ponds were recognized in the three workshops in Sinaloa. In IB, cultural services were also identified for this wetland type, although these were more linked to human well-being and health. Lastly, in LR, the workshop participants acknowledged receiving the benefits from the four priority wetland types that belong to the aforementioned categories.

Intra-community differences in the number of identified ES were detected with the wetland ($p < 0.01$) and ES category ($p < 0.05$) block effects. These were especially evident in the comparison of the wetland evaluation between CR and LR ($p < 0.05$) and in the differences between the category evaluations between the LR and Sinaloa communities ($p < 0.05$). Likewise, discrepancies were found among the participants of the four workshops in the number of services identified for each wetland type when they were grouped in blocks by ES category ($p < 0.01$). These were particularly evident between shrimp ponds and estuaries ($p < 0.05$), shrimp ponds and mangroves ($p < 0.01$), and mangroves and oases ($p < 0.05$) and to a lesser extent, between mangroves and beaches ($p < 0.1$).

About 51% of all participants said that the ES of priority wetlands are very important, while 32% of all participants indicated that the priority wetlands provide important ES. In CR, only 18% of participants considered that the cultural services provided by estuaries and the provisioning services offered by mangroves were not important, although 82% of participants considered that the provisioning and regulation ES provided by saltmarshes were very important. In IB, 71% and 75% of the participants considered the mangrove provisioning and regulation ES to be very important, respectively, whereas 40% and 32% of participants rated the cultural services of shrimp ponds and estuaries to be not very important, respectively. In LA, the provisioning ES of saltmarshes were not very important while mangrove provisioning and regulation ES were ranked very important. In LR, 71% of the participants rated the provisioning ES of oases as very important, while 13% and 17% of participants ranked the same services provided by estuaries and mangroves to be not very important (Figure 3).

Both the wetland type and ES category were considered in each community to assess the importance of ES ($p < 0.001$), and differences were found among communities ($p \geq 0.05$) with the exception of the comparison between CR and LR ($p > 0.1$). In addition, differences were detected in how wetlands were valued when considering the effect of the category ($p < 0.001$). This was mainly due to saltmarshes and oases being valued higher than beaches and shrimp ponds ($p < 0.05$). Likewise, ES were valued differently among communities ($p < 0.001$) due to the greater importance that was assigned to regulating and supporting services ($p < 0.001$).

When evaluating the capacity of the wetlands to continue offering ES after an ERE, 78% of all workshop participants believed that this capacity would change, and 58% believed that it would decrease, although differences were present among communities ($p < 0.01$; Figure 4).

The pairwise comparisons revealed agreement between IB and LR ($p > 0.1$). The participants in these communities tended to think that the capacity of priority wetlands to provide ES would be maintained or even increase after an ERE. In CR and in LA in particular, participants tended to believe that this capacity would decrease or be lost. These differences ($p < 0.001$) were mainly due to participants believing that shrimp ponds had a low capacity to provide ES when compared to the capacity of natural priority we-

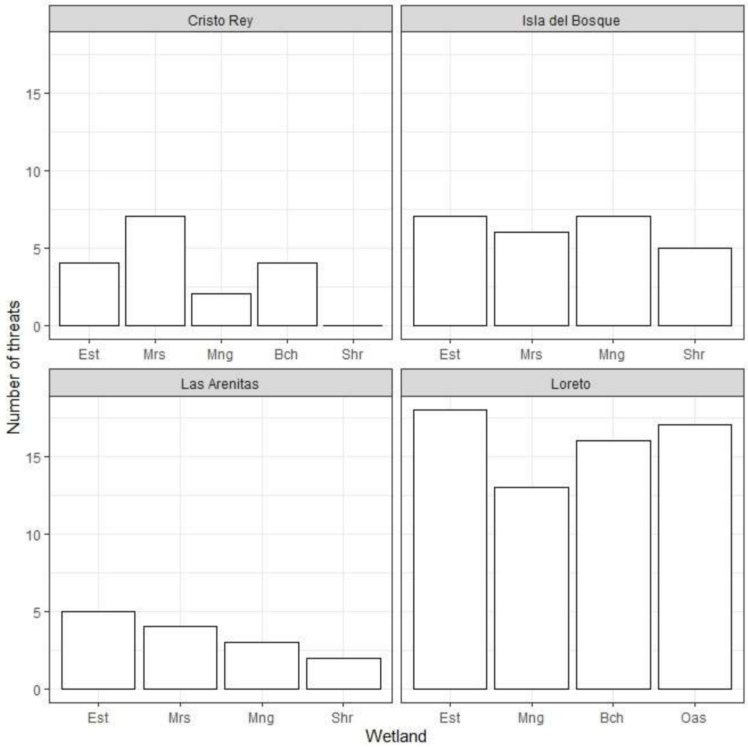

Figura 2. Number of threats identified for the priority wetlands of four coastal communities in northwestern Mexico: Cristo Rey (CR), Isla del Bosque (IB), Las Arenitas (LA), and Loreto (LR). Wetland type: estuaries (Est), marshes (Mrs), mangroves (Mng), beaches (Bch), oases (Oas), and shrimp ponds (Shr).

tlands ($p < 0.001$). In addition, these differences were attributed to the high perceived capacity of oases to provide services, which contrasted with the perceived capacities of estuaries, mangroves, and beaches to do the same ($p \leq 0.01$), although this was not true for saltmarshes ($p > 0.1$).

Finally, considering the impacts and changes induced by an ERE that were identified by the communities, all of the impacts and 80% of the changes were defined as primary in IB. In LR and LA, 75% of the impacts, including pollution and siltation, were identified as primary. In LA, only two changes were considered to be primary, whereas only a food and water shortage was considered to be a primary change in LR (Figure 5). In CR, flooding was the only impact considered to be primary, but five of seven changes were also considered to be primary. This community was the only one to consider health problems and a disruption to the supply of electricity to be primary changes.

Given that the assessment of impacts and changes was collectively conducted, these variables were analyzed with a completely randomized block design that did not include health problems or disruptions to the supply of electricity in the ANOVA, as these were only added by the CR participants. In the analysis of the importance of the impacts among communities (factor) grouped by the type of impact (blocks) and the differences among impacts grouped by community, no differences were identified ($p < 0.1$). However, when analyzing changes, differences between communities and the type of change were detected ($p < 0.01$). Due to the presence of the adjusted probabilities of 0 and 1 in the logistic model, the post-hoc analyses were not able to identify significant differences.

DISCUSSION

This study aimed to determine if community members in northwestern Mexico perceive threats to coastal wetlands that are due to human activities or the effects of global change, including the loss of ecosystem services, beyond those caused by heavy rainfall such as flooding or damage to infrastructure. This study fits within the framework of a broader project that aimed to determine the extent to which coastal communities in northwestern Mexico are vulnerable to the effects of ERE.

To this end, we utilized participatory workshops to collect data from each community. Participatory workshops were considered to be the most suitable format to encourage participants to actively and fre-

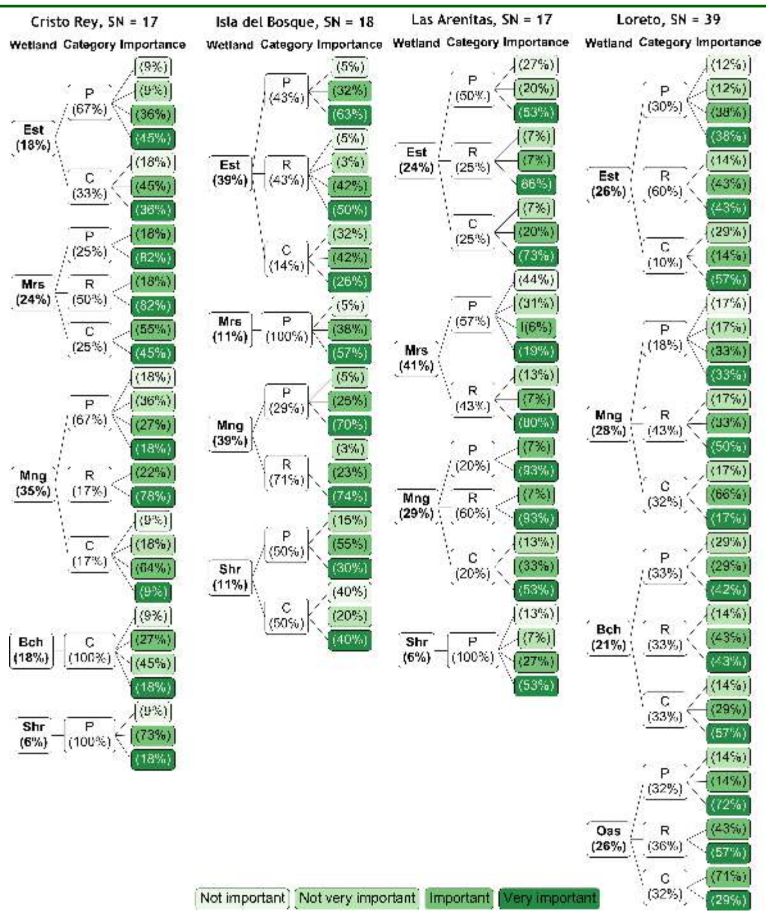

Figura 3. Number and importance of ecosystem services (ES) provided by wetlands in coastal communities in northwestern Mexico: Cristo Rey (CR), Isla del Bosque (IB), Las Arenitas (LA), and Loreto (LR). Wetland type: estuaries (Est), marshes (Mrs), mangroves (Mng), beaches (Bch), oases (Oas), shrimp ponds (Shr). The percentages reflect the number of ES (SN) with respect to the total SN identified by each community. Percentages are shown based on wetland type and ES category and their combination (i.e., importance). The ES categories of provisioning (P), regulating and supporting (R), and cultural (C) are given for each wetland type in each community.

ely express their opinions. However, ensuring that the workshops were properly designed to obtain sufficient information on a variety of topics needed for the subsequent quantitative analysis was challenging. The Metaplan methodology provided the necessary solutions to the challenges associated with designing a productive and participatory workshop. During the workshops, participants utilized cards to help structure their ideas and rank priorities. In the communities of southern Sinaloa (IB and CR), participants recognized many of the wetland types that had been previously identified by the workshop facilitators. Some artificial wetlands were also recognized (Berlanga-Robles et al. 2008; Camacho et al. 2013), whereas two continental wetland types were dismissed, and one wetland type was identified that had not been previously considered. This serves as indirect evidence of the knowledge that workshop participants hold of their regional wetlands.

Between 15 to 20 participants (both men and women) with diverse occupations were expected for each workshop. However, one of the difficulties we encountered was to ensure a sufficient number of attendees for each workshop from diverse backgrounds, including women participants. This was especially important in communities in which vocations exist for specific economic activities. For example, fishing is an important vocation in LA, and there were no other types of users of the wetland or female assistants in this community. Ensuring that the participants of each workshop were representative of their community was important, as gender and occupational inequalities influence results given that perceptions change according to whether or not a resource is exploited or

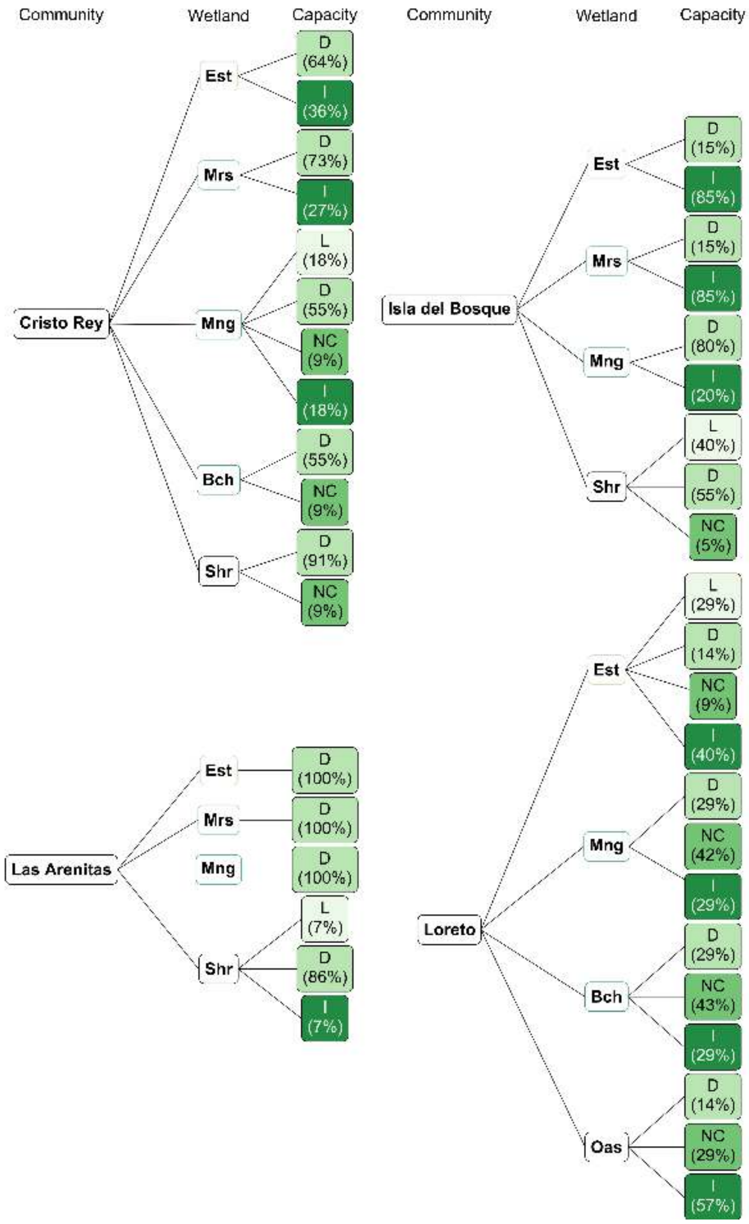

Figura 4. Capacity of coastal wetlands to continue offering ecosystem services (ES) after an extreme rainfall event (ERE) based in the perceptions of the inhabitants of four coastal communities in northwestern Mexico: Cristo Rey (CR), Isla del Bosque (IB), Las Arenitas (LA), and Loreto (LR). Wetland type: estuaries (Est), marshes (Mrs), mangroves (Mng), beaches (Bch), oases (Oas), and shrimp ponds (Shr). Capacity: Loss (L), Decrease (D), No Change (NC), and Increase (I). The percentages in the capacity column reflect the number of individual votes received by each wetland with respect to the total number of votes of each community.

used by individuals or a sector. Carvajal (1994) and Marín-Muñiz et al. (2016) arrived at these conclusions. These authors studied perceptions of changes in land use and the use of wetland resources in Costa Rica and Veracruz (Mexico), respectively. Thus, the benefits derived from wetlands are not seen in the same way by all people. It is therefore recommended that future studies consider differences in gender, livelihoods, and even age to minimize bias.

In this study, the demographics of the workshop participants did not result in notable bias in terms of the number of wetlands or ES they identified. However, there were significant differences between priority wetlands by location, which did not always correspond to the number of ES that each wetland type provided according to the perceptions of the parti-

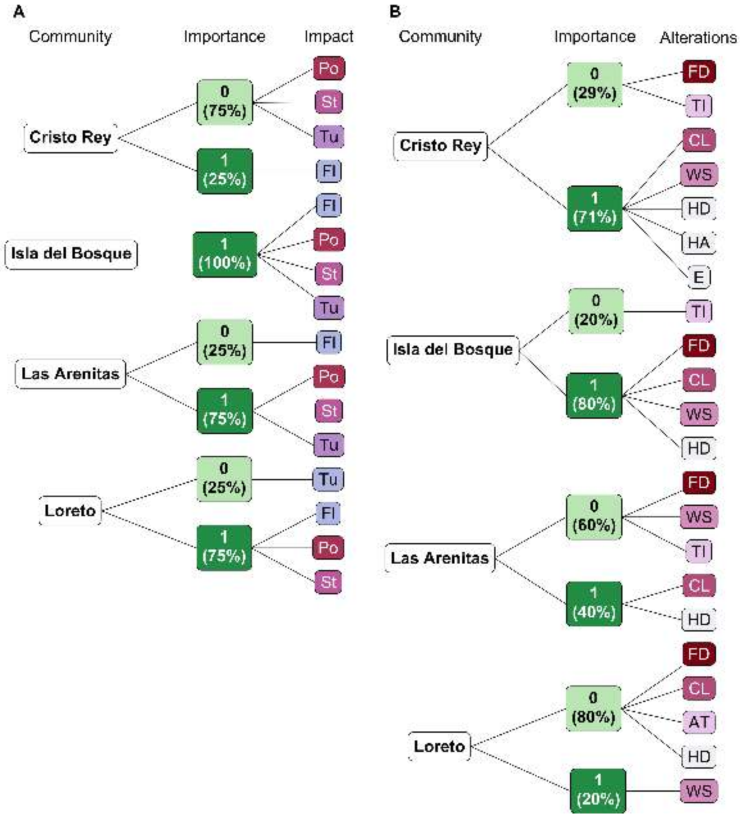

Figura 5. Importance of the impacts (A) and alterations (B) caused by an extreme rainfall event (ERE) in the four coastal communities in northwestern Mexico: Cristo Rey (CR), Isla del Bosque (IB), Las Arenitas (LA), and Loreto (LR). Importance: secondary (0) and primary (1). Impacts: flood (Fl), pollution (Po), siltation (St), and water turbidity (Tu). Changes: diminished fishing activities (FD), loss of crops (CL), shortages of food and water (WS), effects on tourism (TI), housing damage (HD), health problems (HA), and disruptions to the supply of electricity (E).

cipants. This may be because perceptions do not only depend on physical characteristics but also on the properties that each person attributes to any environmental component as a result of their knowledge and experience; hence, it is important to identify the perceptions of people to understand the motivations that determine their decision-making (Marín-Muñíz et al. 2016). This may help to explain why even users engage in activities (e.g., overfishing, cutting mangroves, and dumping garbage) that go against their own understanding of the importance of wetlands.

Wetland abundance can also be a major factor that influences how people value these ecosystems. This hypothesis was supported in this study. Even though saltmarsh ES are largely unknown and underestimated (Lebreton et al. 2019) and although there are few collective benefits to shrimp farming, these ecosystems were classified as priority wetlands in the three communities of Sinaloa, in which the largest wetland expanse in Mexico is located. In contrast, these two wetland types were not considered to be of priority in the community of BCS where these two wetland types are scarce (Berlanga-Robles et al. 2011; 2021). It is important to mention that the LR workshop participants held different occupations to those of the participants of the three communities in Sinaloa and were mainly employees of civil society organizations and the government. As such, these individuals were not direct users of the wetlands like the participants of the three workshops in Sinaloa. It is perhaps not surprising that mangroves were well valued in LR despite their minor presence in BCS (Velázquez-Salazar et al. 2021).

At the national level, mangroves, their associated benefits, and the threats to these ecosystems are some of the most important issues at all levels of the environmental debate within Mexico. Multiple important contributions to understanding this ecosystem type in the Gulf of California (e.g., their extensions, contributions to fishing productivity, and economic valuations) have been produced by researchers (e.g., Aburto-Oropeza et al. 2008, Ruiz-Luna et al. 2010, Hernández-Guzmán et al. 2021) and governmental institutions (https://www.biodiversidad.gob.mx/monitoreo/smmm/extensionDist).

Maltby and Acreman (2011) and Marín-Muñíz et al. (2016) agree that wetland loss and degradation are due in part to a poor understanding of how wetlands function and the roles they play in providing ES to people living within or near them. When considering provisioning and maintenance ES, the results obtained in this study suggest that the participants clearly understood the direct benefits or provisioning services of the wetland types in this study. In contrast, regulating and supporting and cultural services were less recognized. Thus, there is a need to educate the public on the importance of wetlands at the local level. This result may help guide and improve both existing and future environmental education, management, decision-making, and conservation actions. Addressing this need is especially important given that many people do not yet fully recognize how wetland ES help communities mitigate and adapt to the effects of climate change.

The knowledge of the participants in this study of ES is likely connected to their experiences and interactions with neighboring wetlands. Therefore, fishing, food provisioning, and the maintenance of biodiversity (e.g., habitats and refuge areas for various species including those of commercial interest) are the most easily identifiable ES in communities orientated towards fishing and aquaculture. It is important to point out that the wetlands adjacent to the communities included in this study are focus areas of various civil society organizations given their national or international status as protected areas (e.g., Ramsar sites). As such, various conservation activities are conducted in these sites, which may serve to reinforce the understanding of community members of the importance of wetlands and their ES. The perceived threats to wetlands were also similar among the communities in this study, although differences were present between LR in BCS and the three communities of Sinaloa. The threats that were perceived in all communities included poor fishing practices or water contamination, which have been previously documented, and pollution caused by various agricultural sources and untreated urban wastewater discharge (Arellano-Aguilar 2017; Moeder et al. 2017).

It is important to point out that all communities in this study were aware of environmental changes, which were mainly centered around the landscape and climate. Both of these types of change have various repercussions on socioeconomic activities and the environment that vary in intensity (e.g., floods, pollution, sedimentation, water turbidity, reductions in fishing activities, poor harvests, food shortages, and damage to housing). Therefore, preventative actions are required to adapt to future change and thus reduce threats to human health and well-being. These actions should consider regional differences among local livelihoods, resource availability, and consumption patterns (McMichael 2013).

If the flow and supply of ES depends on the integrity of ecosystems and their resilience, then it is critical to implement efficient management measures to conserve and restore wetlands to ensure they retain their functionality even after extreme meteorological phenomena like ERE. For this, resource users must participate in decision-making processes, which must be based on the best available information. In this sense, ES must be recognized and valued to further conservation, resource management, and environmental planning efforts that concurrently generate ecological, social, and economic benefits (De Groot et al. 2010). Social participation has become an internationally recommended component of conservation programs. For example, international organizations such as the United Nations Environment Program, have established strategies to promote the active participation of local communities to ensure environmental protection (Artigas et al. 2014). In addition, Agenda 21 of the United Nations recommends adopting an integrated and participatory approach to conservation and development (Agenda 21 1992). In addition, analyses of attitudes, beliefs, and sociocultural preferences that societies have of ES can be relevant to decision-making and environmental planning processes, as the success of these policies heavily depends on social acceptance and support (García-Llorente et al. 2020). Nevertheless, international recommendations of social participation in decision-making have not yet been embraced in Latin America, in which participation is limited to priority problems in protected areas (Maldonado et al. 2020).

Information on the perceptions and importance of wetlands in Mexico is scarce. To a large extent, this information has been generated as a result of social conflicts due to population growth and territorial expansion, which have traditionally endangered the existence of wetlands and other ecosystems. Therefore, the results of this study serve to fill this information gap and may be used to provide guidelines to structure education, conservation, and resource management strategies in the study region, which may be applied to other communities in different regions. The results of this study also serve to highlight the importance of wetlands and the ES they offer, regardless of their locations or characteristics. Wetlands can be underestimated by societies and communities that remain unaware of their importance. For example, at the regional level in Mexico, the expanse of wetlands in Sinaloa was reduced by $\sim 580\ km^2$ from 1995 to 2019 (Hernández-Guzmán et al. 2021). By educating people at local, regional, and national levels on the importance of wetlands, losses like the one in Sinaloa can be reversed.

CONCLUSION

To conclude, wetland conservation and the wise use of wetland resources requires both technical solutions and the inclusion of resource users in the decision-making process. By initiating and encouraging the participation of resource users in management actions and ensuring continuity to participatory processes, important traditional knowledge can be included in conservation strategies. In addition, community participation and collaboration with management authorities can lead to the discovery of beneficial alternatives to established actions and novel solutions to problems that affect the livelihoods and wellbeing of resource users. These actions can then be scaled from the community level to develop regional management and resource utilization strategies.

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DATA AVAILABILITY

Data collected in this research is available upon reasonable request to the corresponding author.

CONFLICT OF INTEREST

The author has no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: ACE, ARL.
Investigation: ACE, ARL, CABR.
Carried out the data analysis: CABR.
Wrote the first draft of the manuscript: ACE, ARL.
Review and final write of the manuscript: ACE, ARL, CABR.

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