

Strategy for the Ecological Restoration of the Estuary of the River Rancheria (La Guajira, Colombian)

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Abstract

Objective: This research was to formulate the Environmental Action Plan (PAA), as a strategy for the ecological restoration that describes the programs and projects on the basis of the ecosystem goods and services provided to communities living in the area of study; especially the Wayuu indigenous population. **Materials and Methods:** The identification of the stressors, constraints, goods and services, was established through secondary information; which was organized in a matrix of Excel. With the above, it identified and prioritized the issues that affect the estuarine ecosystem of the River Rancheria. The tool implemented for the analysis of causality was the array of Vester. With this we identified the critical issues that present a high level of causality. These include problems: Passive, indifferent, total liabilities and assets. **Findings:** The estuarine system of the river Rancheria is a natural resource that has a variety of living organisms on which they depend as a source of food and shelter. Presents numerous habitats such as mangroves, mudflats, wetlands and permanent and temporary lagoons; which give protection to the coastal areas and shelter for wildlife. **Application:** As a strategy for ecological restoration is proposed programs within the PAA are: Water quality, wildlife management, scientific research, biological monitoring and management and follow-up. In the ecoregion identified the main problems, pressures and threats that are intimately related to the nature of the wetland, and their environments.

Palabras claves: Ecological Restoration, Environmental Action Plan, Estuary of the River Rancheria, The Wayuu Indigenous Community

1. Introduction

The relationship between humans and the environment introduces changes in the coverage and watersheds; the man is a transforming agent of such ecosystems and has strongly influenced the change of the global environment^{1,2}. The assessments of the ecological quality of estuarine systems are part of the research of interest to local communities, governmental authorities, non-governmental organizations, academics and researchers. The biomonitoring of water bodies is essential for authorities; decision-makers and community have reliable information about what is happening in the ecosystems. Through the literature review identified the elements that stress,

limit and degrade the ecosystem in his arms The Riito (ER) and Calancala (BC). In accordance with the problems that affect ecosystem stability identified are the natural origin (herbivory, infestation by parasites natural origin, coastal erosion, storms, strong winds, a shortage of fresh water sources and water deficit), removal (selective logging and intensive), change the hidroperiodo (variation in the hydric dynamics), pollution (solid waste, dumping of sewage, agricultural and livestock products, land-use changes (expansion border unplanned urban and tourism, social conflict: social conflicts and land tenure, deforestation (watersheds, fragmentation and destruction of forests and salinization (increase of the sub-saline and hipersalinizacion)³⁻⁶.

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These problems as identified make the possibilities of development and evolution of the estuarine ecosystem of the river Rancheria are low due to the limitations of natural character, anthropogenic as that in the study area live 2500 people of low economic resources and live in precarious conditions and possibly increase the pollution due to the lack of an efficient system of basic sanitation⁷. Of this, it has been found that the main threat potential of this environment is the proximity of the city of Riohacha, whose growth could be envisaged in this area changes in land use and increased pollution processes^{7,8}. On the other hand, some research in the area of study support the increased uncertainty in the environmental stability and vulnerability caused by climate change, make the estuary of the river Rancheria is not the exception to risks such as environmental variability that affects economic, social and ecological problems⁹. In addition, mangrove forests as functional structure of the coastal areas give answers of accommodation to the variability, due to the fact that they develop a key role in the stability of the coast line, persistence of habitats, biodiversity, ecosystem metabolism, reduction of risk and uncertainty for the sustainable development of resources¹.

The existence of environmental policies that ensure the protection and conservation of coastal areas, contribute to the reduction of the deterioration and destruction of mangroves; which have been accelerated due to the actions of anthropogenic and natural in these. It is necessary to provide general guidelines for the ecological restoration of this estuary zone of the river Rancheria in the Colombian Caribbean, on the basis of the information generated in technical reports, theses and scientific articles and whose emphasis are the ecological research, restoration, conservation and sustainable management of resources⁶. With the array of Vester can know the causes, effects and relationships of a tangible problem and contrast it with the rest of identified problems (one at a time) by assigning a score. These numbers are entered in the matrix and subsequently is the sum of each of the rows (Σ) and columns (Σ Liabilities); the result is plotted on a Cartesian plane, grouping and cataloguing the results according to the causes and consequences of each problem in the quadrant⁵. The Environmental Action Plan (PAA) for ecological restoration of the area of study, proposed was developed from information obtained in field and the review of scientific literature. In the PAA, strategies are proposed solutions and methods for mitigating impacts and tensioners that degrade these

coastal-marine ecosystems in the Caribbean Colombian continental^{16,8,10-13}.

2. Materials and Methods

Initially undertook a review of the literature on the subject and defined the working groups, which took into account the characteristics of the study area and sampling sites. Subsequently, describes the two areas of study and set the coordinates of the sampling sites with a GPS (Garmin H72), as described in **Table 1**.

Table 1. Sampling sites, areas and geographical coordinates. Estuary of the river Rancheria

Áreas	Sampling Site	Geographic coordinates
Arm The Riíto (ER)	Mouth (DB)	11°33'14.6"N - 72°54'80.8"O
	El Mirador (EM)	11°33'90.0"N - 72°54'40.1"O
	Villa Fátima (VF)	11°33'00.8"N - 72°53'51.7"O
Arm Calancalá (BC)	Cangrejito (CG)	11°33'31.5"N - 72°53'22.5"O
	Valley of the Crabs (VC)	11°33'32.7"N - 72°53'36.6"O

The identification of the stressors, Limiting, goods and services, secondary information is collected concerning the area of study; the information is entered in Excel arrays⁵. With the diagnoses are identified and prioritized the issues that affect the estuarine ecosystem of the river Rancheria. The tool used for the analysis of causality was the array of Vester. With this identified the critical issues: Feature a lot of causality, which, in turn, are caused by the majority of other problems. Passive problems: They represent the causes of the problems. Problems indifferent: stand out because the total assets and total liabilities are low; have a low priority within the system of problems analyzed and the active issues: are the primary cause of the central issue, will be the main problems to be addressed.

3. Results and Discussion

With the literature review, described goods and services provided by the study area, as well as the stressors and

global Limiting identified for the Colombian continental Caribbean described in Table 2 and the global goods and services from the “Millennium Ecosystem Assessment”¹⁴, Table 3.

In the estuary of the river Rancheria (Arms The Riño and Calancala) were identified eight stressful and Limiting, which damage the development of the mangrove forests (Table 4) and six goods and services covered under the categories of the “Millennium Ecosystem Assessment”¹⁴, as can be seen in Table 5.

Table 2. Stressful (S) and Limiting (L) global identified for the estuaries to the Colombian continental Caribbean

Nº		Stressful and Limiting	Origin
1	L	Herbivory, infestation by parasites	Natural Origin
2	L	Coastal Erosion	
3	L	Storms winds	
4	L	Bocanas sedimentation and	
5	L	estuarine funds	
6	L	Shortage of fresh water sources, water déficit	
		Forest fires	Extractive
7	L	Selective logging and intensive	
8	S	Clearing of forests for charcoal production	
9	S	Over exploitation of marine resources	
10	S	Inadequate use of fishing gear	
11	S	Extraction of sand and gravel beaches	
12	S	Salt extraction (artisanal and industrial)	Change of hidroperiodo
13	S	Change in the hydric dynamics (hidroperiodo)	
14	S	Pipeline and diversion of water bodies (agricultural and mining)	Land use change
15	S	Change in the use of the ground	
16	S	Construction and shopfitting of springs. Port Infrastructure	
17	S	Construction of road	
18	S	Construction and operation of aserrios	
19	S	Construction and operation of aquaculture and shrimp farming companies	
20	S	Construction and operation of dams, hydroelectric plants	

Nº		Stressful and Limiting	Origin
21	S	Solid wastepollution	Contamination
22	S	Pollution	
23	S	Pollution by dumping of sewage	
24	S	Pollution by dumping agricultural and livestock	
25	S	Contamination by illicit crops	
26	S	Chemical residue contamination miners	Expansion of the use of the soil
27	S	Expansion of the agricultural frontier and livestock (pigs, chickens, ducks, livestock)	
28	S	Expansion border urban unplanned tourism and	
29	S	Mining	
30	S	Expansión of illicit crops	Social conflicts
31	S	Social conflicts and land tenure	
32	S	Conflict and drug trafficking.	Deforestation
33	S	Deforestation of watersheds	
34	S	Fragmentation and destruction of forests	Salinization
35	L	Increase of the wedge salina	
36	L	Formation of salt flats	
37	L	Hipersalinization	Potrerizacion and transport
38	T	Potrericacion, zoning and subdivisión	
39	T	Water Transport	
Fuente: ⁵			

To carry out the recovery, rehabilitation and/or ecological restoration of the estuarine ecosystem of the river Rancheria is necessary to propose guidelines, which serve as a guide and support in a certain way to investigations to identify the problems and system conditions can be highly variable and contrasting⁵. To begin the process of recovery of the ecosystem it is necessary to be identified stressors and limitations that prevent the secondary succession or natural regeneration and prioritize through an analysis of causality. It is possible that, just working out or removing a tensioner system simultaneously to eliminate or mitigate other; having identified the riots, then remove it from the east before undertaking any active restoration strategy. This type of restore shows successful results, in a span of 10 to 20 years, depending on the types of disturbances, the frequency and recurrence of the same^{5,15}. If the system does not reach the desired state

Table 3. Goods and services identified for estuaries of the colombian Caribbean and categorization from the “Millennium Ecosystem Assessment”¹⁴

Nº	Goods and services	Categorization from the “Millennium Ecosystem Assessment
1	Protection coastal	Regulation
2	High biological productivity	Auxiliary/Complementary
3	Source of hydrobiological resources for human consumption and marketing	Supply/Cultural
4	Habitat/shelter/area of nesting, breeding and feeding grounds for migratory and local fauna	Regulation/Auxiliary/Complementary
5	Sink of CO ₂	Auxiliary/Complementary
6	Buffer against flooding (flood plain)	Regulation
7	Water Purifier	Regulation
8	Ethnobotanical Resources Source	Supply/Cultural
9	Capture/sediment trap	Regulation
10	Educational and ecotourism potential	Cultural
11	Dispersal area of fauna and propagules	Supply
12	Accumulation of nutrients	Auxiliary/Complementary
13	Land scape value	Cultural

Table 4. Stressful and limiting factors identified: estuary of the river Rancheria in the Colombian Guajira

Place Name	Stressful and Limiting								
	1	2	3	21	23	27	35	36	37
Armthe Riito (ER)	X	X	X	X	X	X	X	X	X
Arm Calancala (BC)	X	X	X	X	X	x	X	X	X

Table 5. Goods and services identified: estuary of the river Rancheria in the Colombian Guajira

Place Name	Goods and services					
	1	2	4	5	6	7
Arm El Riito (ER)	X	X	X	X	X	X
Arm Calancala (BC)	X	X	X	X	X	X

of recovery, it is recommended that you will carry out an assessment of both environmental and biological factors that may be hindering the recruitment of propagules and natural regeneration of the environment. Therefore, it is

necessary to evaluate the hydrological conditions, physical-chemical gradients in the area and know the ecology and phenology of the species⁵.

With the grant and acceleration of the restoration, it favors the process of natural regeneration through the release of propagules or connection of the affected system with another that is preserved, taking into account aspects such as the hydrology and climate of the east^{5,15–18}. In the event that the ecosystem continues to recover, it is necessary to implement strategies of restoration that is characterized by the recovery of goods and services^{5,17}.

The Plan is structured on the basis of the information in the document which declares the area as Integrated Management District (DMI), which is a category of Protected Area and of the results obtained in the ecological assessment¹⁰. Therefore, there are actions aimed at the management and control of pollution of its waters by mineralization and organic matter (management and control of ocean dumping); control and monitoring of physical-chemical variables in the delta; biological monitoring; scientific research, knowledge generation and dissemination; and finally, management and follow-up (Table 6).

Table 6. Structure of the environmental action plan

Program of water quality monitoring (PMQW)					
Summary: Aims to improve the state of the waters, both of its chemical status and ecological status. Establishment of the monitoring stations					
Goalsproposed	Actions	Strategies	Activities	Measuring the success of the goal	
				Indicators	Measuringscale
The 100% of sources supplying the estuary of the river Rancheria with analysis and monitoring of water quality.	Projects of Water Quality Monitoring (PMQW) and Control and Monitoring of Ocean Dumping (PMOD)	Development of previous studies and terms of reference for the control and monitoring.	Previous studies and activities.	Semi-annual monitoring	High: If there is 1: between 1 and 20% 2: between 21 and 40% 3: between 41 and 60% 4: between 61 and 80% 5: between 81 and 100% Zero: there is no
Program of solid waste (PWS)					
Summary: Count on the service of toilet choose primarily by having the waste to open sky and a very small percentage of the population burn or bury the waste.					
Goalsproposed	Actions	Strategies	Activities	Measuring the success of the goal	
				Indicators	Measuringscale
The 100 per cent of the communities involved in the PWS	Project to Raise Awareness in the Handling of Solid Waste (PWSH) Recycling Project (RP) project of burial Domiciliar (PDB)	Definition of the strategies of Environmental Education. Implementation of the activities	Consolidation of the topics and preparation of the schedule of activities.	Days of training to the communities.	High: If there is 1: between 1 and 20% 2: between 21 and 40% 3: between 41 and 60% 4: between 61 and 80% 5: between 81 and 100% Zero: there is no
Biological monitoring program and scientific research (PMBRS)					
Summary: conducting scientific research to generate the information necessary for the deepening in the knowledge of the characteristics of ecological, social and economic conditions in the study area.					
Goalsproposed	Actions	Strategies	Activities	Measuring the success of the goal	
				Indicators	Indicators
The 100% of the investigations carried out	Applied research projects and experimentation (PRAE) and Scientific Dissemination (PDS)	Research projects.	Execution of the research.	Artículos Libros Informes Socialization of research Dissemination of the results of the monitoring	High: If there is 1: between 1 and 20% 2: between 21 and 40% 3: between 41 and 60% 4: between 61 and 80% 5: between 81 and 100% Zero: there is no
Program Management and Monitoring Systems (PMSM)					
Summary: This is the point of departure for any activity to develop in the estuary of the river Rancheria and its buffer zone.					
Goalsproposed	Actions	Strategies	Activities	Measuring the success of the goal	
				Indicators	Indicators
New research from biological monitoring carried out	Project Management and Monitoring Activities (PMAAM)	Development of the plan of management, monitoring and evaluation of the Environmental Action Plan.	Implementation of the PMSM.	Reports	High: If there is 1: between 1 and 20% 2: between 21 and 40% 3: between 41 and 60% 4: between 61 and 80% 5: between 81 and 100% Zero: there is no
Responsible actors proposed: CORPOGUAJIRA, Department of la Guajira, Municipality of Riohacha and Manaure, Universities, Non-governmental organizations.					
Possible sources of funding: CORPOGUAJIRA, Province of La Guajira, Municipalities of Manaureand Riohacha, Universities, Non-governmental organizations and Private Entities.					

4. Conclusions

At the present time the indices used as indicators of water quality presented as a viable option for the interpretation of the ecological quality based on variables physical, chemical and biological monitoring programs, due to the different variables are combined to generate a value that can be interpreted easily by both experts and the community in general. The impact and frequency of stressors and limitations have degraded a large percentage the estuarine ecosystem, as it relates to the problems associated with land use change, contaminants, extractive and social conflicts encountered and categorized as active for this area of the country. This local reality transcends a negative impact on the supply and delivery of goods and services provided by the estuary of the river Rancheria.

The guidelines of the Environmental Action Plan for the ecological restoration of the estuary of the river Rancheria in area of influence of the indigenous settlements of the Pasito, necessary to recover the ecosystem, is based on the knowledge of the ecology and biology of the system, their goods and services and the identification of the stressors and limitations specific to deteriorate; to engage in spontaneous restoration strategies and promote natural regeneration. But if the system is highly intervened and gradient is recommended to recover it using active restoration actions, which must be clear about their purpose and be participatory in nature, with the community.

Part of the existing information is in the framework of the District of Integrated Management of the delta of the river Rancheria and the results of the ecological assessment of the estuarine system. In the same way, there are actions aimed at the management and control of pollution of its waters by mineralization and organic matter (management and control of ocean dumping); control and monitoring of physical-chemical variables in the delta; biological monitoring; scientific research, knowledge generation and dissemination; and finally, management and follow-up.

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