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COMMUNITY MANAGEMENT PLAN FOR SUSTAINABILITY OF MANGROVE ECOSYSTEM IN NUXCO LAGOON, GUERRERO, MEXICO

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ABSTRACT

Globally conservation of biodiversity and restoration of endangered species (specially the mangroves) has received much critical attention in sustainability studies of regional and tropical ecosystems. Sustainability succeeds when the economy of the region is improved without loss to biological diversity. This work presents a proposal to initiate a Community Management Plan for the sustainability of the Mangrove Ecosystem of Nuxco Lagoon, Guerrero, located in a rural community in the South of México. The objective was to create a proposal with the community called El Veinte, in order to conserve and avail of the environmental services that this ecosystem offers. The project was organized in three phases: Institutional Presentation through a preparatory workshop, Problem Identification, Action Plan. The data included opinions of key informants of the community sampled from municipal public services, staff of schools and individuals involved in key economic activities in the locality. Three topics were determined within the Community Management Plan: Investigation, Education and Preservation and short, medium and long term objectives were assigned to each topic. Through a consensus, the inhabitants of the rural community "El Veinte" identified three priority projects in order to improve the quality of life of the population with an approach of sustainability.

Contribution/Originality: This study documents a proposal for a Community Management Plan for the Sustainability of Mangrove Ecosystem of the Nuxco Lagoon, a rural town in the South of Mexico. This study pioneers in preparing sustainability proposal without any loss to biological diversity and through the consensus of local community.

1. INTRODUCTION

The Food and Agriculture Organization of the United Nations indicates that, globally, the largest losses in the mangrove ecosystems occurred from 1980 to 2005, in countries such as Mexico, Honduras, Panama, USA and The Bahamas (FAO, 2007). The loss of mangrove in the Mexican territory is due to the unregulated logging and the

change in land use caused by agriculture, animal husbandry, aquaculture and tourism (Valderrama-Landeros *et al.*, 2017). The littoral of the state of Guerrero, México, has an area of 484.9 km and in its mangroves are four of the six known species in Mexico, which are in "endangered" category (González, 1993; SEMARNAT, 2010). In 1979, the mangroves surface in the state of Guerrero extended in an area of 16,348 hectares which by the year 2015 was reduced by 41% (Valderrama-Landeros *et al.*, 2017). According to the regionalization of the Mexican mangroves of CONABIO (2016) the Nuxco Lagoon was immersed in a zone denominated in South Pacific which comprises the states of Guerrero, Oaxaca and Chiapas. A need has always been felt of ordering of the coastal zone and a planning under a vision of comprehensive management of different regions, taking into account their particularities. The fundamental objective was to achieve a sustainable development that leads to the governability of the environmental processes and to develop the capacity to manage local problems.

The integral management plan seems to be a permanent mechanism. It contemplates the conservation of important biological communities, restoration of damaged areas (specially the mangroves) and the sustainable use of the region, in order to improve the economy of the region, without loss to biological diversity. Eventually, it could be possible only through a full awareness among the inhabitants about their responsibility in the management and protection of resources, sustainability of the ecosystems and strengthening of their ability to act and accomplish a social base for a sustainable development (Moreno-Casasola, 2000).

The purpose of this study was to determinate an action plan for the preservation of the mangrove ecosystem of the Nuxco lagoon, culminating into three areas within the Community Management Plan: investigation, education and preservation, with short, medium and long term objectives. Also by consensus, the inhabitants of El Veinte defined three priority projects in order to improve the quality of life of population and with an approach to sustainability.

2. LITERATURE REVIEW

México is a country with a very diverse geographical situation where are present different kinds of climatic and biological areas. This has given rise to big habitat variety, including the coastal ecosystems, sand beaches, mangrove ecosystems, swamps, marshes, wetlands, bays, estuaries, lagoons, grassland prairies, halophytes and coral reefs (SEMARNAP-INE, 2000a).

The use, management and preservation of the coastal resources play a key role in the Development strategy of a country, since the coastal strip includes one of the most productive natural ecosystems, because it is considered an area of transition between land and water, where the process of production, consumption and energy exchange take place with extraordinary intensity. Contreras and Zabalegui (1988) therefore, the mangroves constitute the most studied tropical wetland and are considered the most widespread in the tropics.

In the state of Guerrero there are few studies on mangroves, carried out on environments along the coastal zone covering topics such as: systematics and plant taxonomy (Pérez and Mary, 1994; Meza and López, 1997) physicochemical parameters of the lagoons (Delgadillo, 1986; López, 1986; Ramírez, 1988; Román, 1991; Galindo, 2000; Ferrara-Guerrero *et al.*, 2007) relation of fishery resources in mangrove areas; biomass productivity (González, 1993) reproductive phenology (Tovilla and Orihuela, 2002) Establishment of nursery for production of white mangrove seedlings (Castillo, 2007) and like.

In relation to the research works carried out in the area of the Nuxco Lagoon, Vences *et al.* (2016) a loss of the mangrove forest has been estimated in past years, associating it with the encroachment of the area by anthropogenic activities, using the geographic information systems.

Vences *et al.* (2016) in his study called: Perception and environmental knowledge of anthropogenic activities in a coastal community, determined the perception of the residents of three adjoining localities: the Nuxco Lagoon (El Veinte, Los Tarros y Costa Del Sol) in relation to the environmental aspects. The results showed that the

inhabitants perceive strong anthropogenic pressures both in their locality and in the body of water, which is an essential part of their economic activities and the livelihood of their families.

3. PROBLEM STATEMENT

The touristic potential of the state of Guerrero in Mexico, requires an ordering of the coastal zone, a planning under a vision of integral management of such zone and specific management plans for different regions and ecosystems, taking into account their particularities (Moreno-Casasola *et al.*, 2006).

Even when the species of the mangrove are in the category of "endangered" in the NOM-059-SEMARNAT-2010, there is ignorance of this by some residents. There have been no studies on the flora in the Nuxco lagoon, and generally, there is little truthful information about the state of the mangrove ecosystem. The lack of research and ignorance of the inhabitants about the importance of the Nuxco mangrove ecosystem, makes evident the need of this study and the proposal of a Management Plan to impact the whole society.

4. MATERIALS AND METHODS

We worked in the rural locality called Colonia Veinte de Noviembre (El Veinte), located in the municipality of Tecpan de Galeana in the Costa Grande Region of the state of Guerrero in latitude 17° 12´58.16" N and longitude 100° 74´20.09 W, whose altitude is 8 MASL Figure 1. It has a warm sub-humid weather with summer rains and temperature between 14° C and 28°C, and a range of precipitation from 800 to 2500 mm, it has a soil of the type Chernozem (Rzedowski, 2006). In accordance with the CONAPO (2018) this locality has high marginalization rate, where the main activities are fishing, agriculture and animal husbandry.

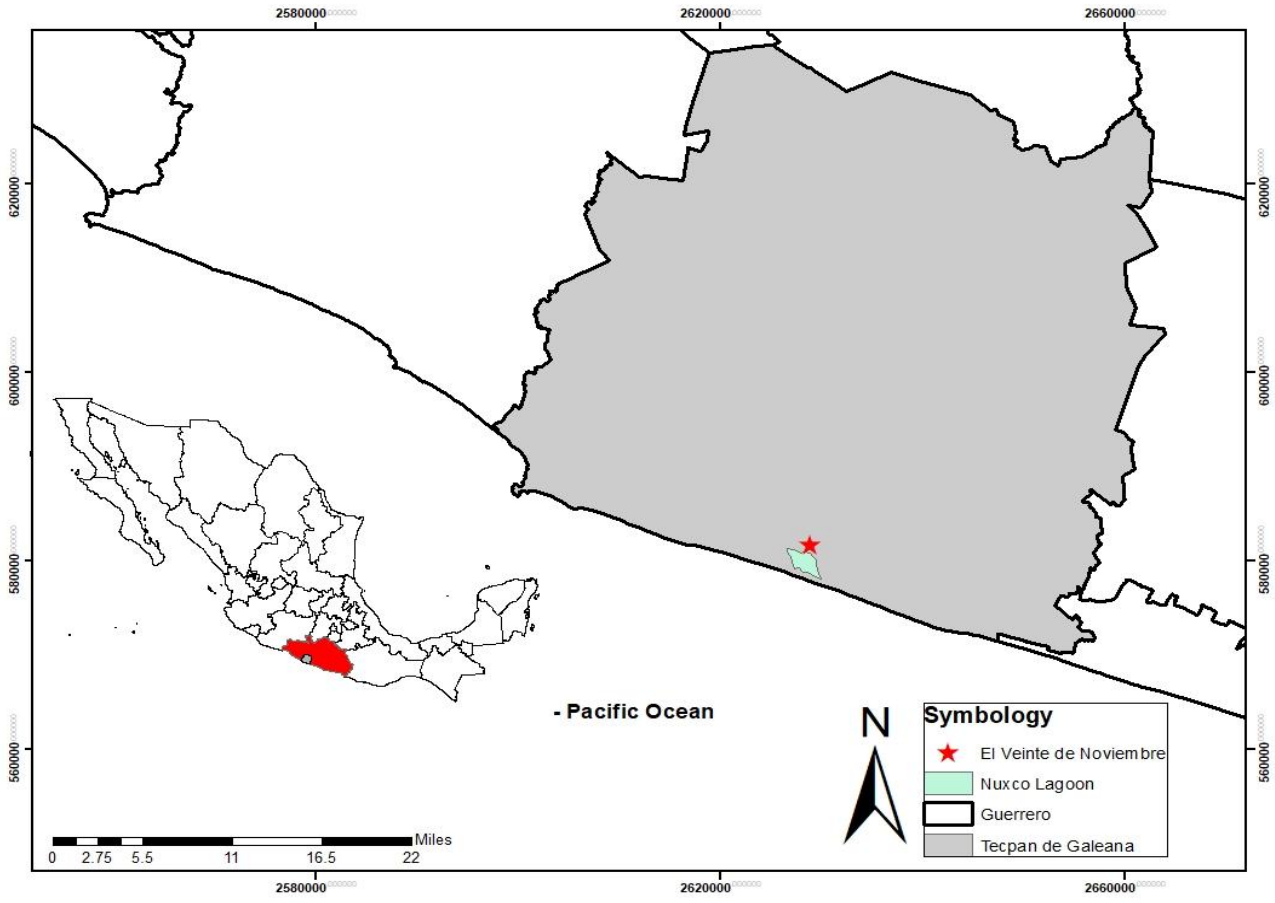

Figure-1. Location of the study area.

Source: Elaborated by the author based on the INEGI 2010, Geoportal Information Geographic. System of coordinate WGS 1984.

A methodology of Participatory Community Planning was carried out (FAO and SAGARPA, 2012) adapted to the study area. The work was organized in three phases: 1) Institutional Presentation through a preparatory workshop, 2) Problem Identification, 3) Action Plan. Two key informants of the locality were interviewed to know the conditions of the mangrove, municipal public service, schools and principal economic activities in the locality. The inhabitants of the locality were convened to attend and participate in the design of the Community Management Plan for the Mangrove Ecosystem of the Nuxco Lagoon (CMPMELN). The participative workshops were developed in different sectors of the community, establishing a schedule with the description of the activities to be undertaken, that were presented to the habitants.

These workshops were attended by approximately 30 people who discussed the environmental issues and the strategies to be agreed by the community to initiate mangrove conservation and sustainability of ecology based in them. All observations and brainstorming of these workshops were recorded in a log.

Stage 1, institutional Presentation lasted 3 hours; the participants were inhabitants of the locality El Veinte de Noviembre (local authorities, municipal commissioner, students, housewives, etc.); the objective of the study was to clarify the functions of each of the members and lay the foundations of teamwork, reaching agreements on the rules and responsibilities that each one must comply for the workshops and make team members familiarize with the participatory approach. As a result, a synthesis of the participatory approach was obtained.

Stage 2, Problem Identification stage was carried out through 6 presentations in which inhabitants of the locality El Veinte participated to conduct these activities:

1. Conferences: with a duration of 10 hours; the objective was to know the importance of the coastal ecosystems, the presentation of research projects that has been conducted in the mangrove ecosystem the Nuxco Lagoon and new productive projects of federal competence related to the lagoon ecosystem.
2. Maps of the resources and expectations of the community: with a duration of 4 hours; the objective was to generally know the natural resources of the community and know how they would like their community to be in the future.
3. Transverse transect: with a duration of 5 hours; the objective was to know the natural resource base, ways and land uses, location and sizes of the agricultural parcels, infrastructure and services and economic activities.
4. Social map of the community: with a duration of 5 hours; the objective was to know the population by gender and age; number and location of the houses according to socioeconomic level, headed by women, ethnic groups, etc.;
5. Venn diagram: with a duration of 4 hours; the objective was to graphically represent the relationship between the organizations or local groups and external agencies and the locality El Veinte.
6. Institutional profiles: with a duration of 4 hours; the objective was to describe the activities that the different institutions develops (Already located in the Venn diagram) and the groups that attend it.

Stage 3, Action Plan, with a duration of 10 hours -- the objective was the elaboration of a community plan that can be molded with the change in the approach of each group and according to their own perspectives. The activities to be performed included the construction of an Action Plan that helps to organize the actions to be performed in order to reach objectives. Responsibilities and commitments were also established for each group.

5. RESULTS

In the first stage, the population consisted of 28 participants: 10 women (36%) and 18 men (64%). All of them belonged to the El Veinte locality. The average age was 48 years old, within the age range of 30 to 90 years old, only 60% had finished the primary school, 32% had droppe4d out in the middle school, 4% had finished high school, and 4% did not attend any school. 58% of the participants were fishermen (within this range is the municipal commissioner and the leader of the fishing cooperative), 36% housewives and 11% performed masonry work. In the

second stage: Problem identification stage, 4 participants were integrated, three men and one woman, who were in the age range of 30 to 50 years old, two of them were fishermen, one housewife and one bricklayer. All four had not finished middle school. In the third stage: Elaboration of the proposal, there were 29 participants in the age range of 30 to 80 years, whose demographics is presented in Table 1 and Table 2.

Table-1. CMPMELN participants.

ID	Range of Age	Stage 1	Stage 2	Stage 3	Average
1	30-40	11	13	12	12
2	41-50	7	9	11	9
3	51-60	7	7	4	6
4	71-80	1	1	2	1
5	81-90	2	2	0	1
	Total	**28**	**32**	**29**	**30**

Source: Prepared by the author based on information gathered in the field research.

Table-2. Occupation of the participants.

ID	Occupation	Stage 1	Stage 2	Stage 3	Average
1	Fishermen	15	17	19	17
2	Housewife	10	11	8	10
3	Masonry	3	4	2	3
	Total	**28**	**32**	**29**	**30**

Source: Prepared by the author based on information gathered in the field research.

According to the key informants of the community, the mangrove coverage has decreased during the last 20 years, particularly after opening of the federal Acapulco-Zihuatanejo highway. Another factor that affected mangrove coverage was the increase in the inhabitants of the region who had gradually settled in this locality, encompassing own zones of the wetland.

In relation to the current conditions of the mangrove key informants commented:

> *"The mangrove was deteriorated due the people who cut down and sold wood without permission, We organized ourselves with some neighbours to look after at least one part of the mangrove and prevent illegal logging, but we could not look after all the mangrove because of its expansion on a large area" (Municipal Commissioner, 65 years old).*
>
> *"People use mangrove wood as firewood and to build huts, but there are people who are not from here but come to cut down and carry away the wood to sell while the government could not do anything. We temporarily organize ourselves to look after the mangrove but sometimes we have not enough time to do it" (partner of the fishing cooperative, 73 years old).*

In relation to the public services the key informants commented:

> *"Most people who live in El Veinte, do not have drainage system, they throw on the street the water they use to wash dishes and clothes; while they use a fossa for bathroom waste water" (Municipal Commissioner, 65 years old).*
>
> *"There is a need for a support from the government to pick up our rubbish on regular basis so that we to don't have to to burn it. Some people suffer because they do not have water supplies, and the ones who have, take a long time to pour" (partner of the fishing cooperative, 73 years old).*

In relation to the main economic activities that are developed in the locality, they commented:

> *"Most of the people have fishing or agriculture as their main livelihood; others to a lesser extent, do the masonry work" (Municipal Commissioner, 65 years old).*
>
> *"Women are engaged in housework, there are three or four that help their husbands in fishing. Fishing is the main livelihood here." (Partner of the Fishing Cooperative, 73 years old).*

In the second stage of Problem identification two scenarios were obtained, "Current situation and desired situation". In the first scenario of Current situation, 8 relevant aspects were identified for the community:

1. Social disorganization: it refers to the formal structures existing in the locality comprising municipality, fishing cooperative, service sector, etc. It presents shortcomings in their organization, which did not permit them to improve and diversify the productivity conditions of their area.
2. Lack of environmental education: it refers to the absence of environmental values resulting in locals losing interest in taking care of the mangrove ecosystem, causing alterations in it and visual pollution.
3. Clandestine garbage dumps: it refers to the lack of control in garbage collection from the locality, which forces inhabitants to opt either for burning or for throwing it in areas that belong to mangrove ecosystem.
4. Land use change: it refers to the cattle grazing that led to the decrease of natural surface of the mangrove ecosystem.
5. Deforestation: it refers to illegal logging of mangrove species for domestic use and rural constructions giving rise to ecosystem decrease and subsequently soil erosion.
6. Messy urbanization: it presents the lack of planning in the territory which caused habitants to settle in each area considered as "federal land" having no public services (water supply and drainage) ending up in making an adverse impact on the mangrove ecosystem.
7. Shortage of drinking water: it refers to the poor supply of drinking water on the part of municipal government affecting the domestic activities of residents and which has been the cause of health hazards.
8. Waste water: it refers to the insufficient drainage system that causes residents to throw their wastewater into the surface currents, which ends in the Nuxco Lagoon, promoting the process of eutrophication, and affecting the quality of fishing resources.

In the second scenario of desired situation, 6 aspects were agreed upon with the community, which seemed to mitigate the current situation:

1. Social organization: it refers to the formal structures of organization that suggest how to achieve progress in production activities in that area without affecting the coastal ecosystem.
2. Environmental education: Residents through the municipal commissioner will request to the municipal authorities to conduct seminars, talks and activities that encourage environmental culture.
3. Efficient management of the waste: The local authority must allocate areas legally regulated for the collection and proper handling of the waste. The period of collection must be done frequently with enough capacity for all inhabitants. Environmental education workshops must also be conducted to reduce waste production and to harness solid waste.
4. Regulation of livestock activities: there was a need to allocate specific areas for livestock grazing, away from the mangrove ecosystem. The desired situation was to request economic support from productive projects in order to modernize farming activities and allow for better breeding of cattle.
5. Production of Mangrove species: A request needs to be sent to the federal government to establish a mangrove nursery, which will allow for reforestation activities and managing areas to undertake mangrove utilization for domestic uses and rural constructions. They will also offer a sale of the mangrove species to local people, government and fishing cooperatives to reforest lagoons in the Region Costa Grande. Last, but not the least, it will foster the environmental education activities, mainly in the surrounding areas of the Nuxco Lagoon.
6. Municipal basic services: A request needs to be sent to the local authority for the regularization of basic services (drainage and drinking water) for the population of the Nuxco Lagoon in order to improve the water quality and health of residents.

In the third stage: Action Plan, three topics were determined within the Community Management Plan: Investigation, Education and Preservation. Short, Medium and Long Term objectives were assigned to each topic.

Objectives for the topic "Investigation":

1. Short Term Period (1-3 years) :
    a. To characterize an area based on distribution of mangrove species and the amount of damage.
    b. To identify the use that the inhabitants of the region make of the natural local resources (agriculture, farming, fishing, among others).
2. Medium Term Period (3-6 years)
    a. To perform inventories of the species of fauna and flora present in the Nuxco mangrove
    b. To identify species that are under a status of protection (SEMARNAT) or which have an economic importance
3. Long Term Period (6-12 years)
    a. To generate information that makes possible the elaboration of productive projects that provides benefits to people and the local communities.
    b. To create and supply a database with information about the natural resources of mangrove in the locality El Veinte.

Objectives for the topic: "Education"

1. Short Term period (1-3 years)
    a. To elaborate and impart capacitation courses and workshops about the management of the resources in the mangrove, in all levels and sectors of the local population
2. Short To Medium Term Period (1-6 years)
    a. To design and implement an environmental education program to raise awareness of the issues in the locality.
3. Medium Term period (3-6 years)
    a. To involve local, regional and state media (press, radio and television) in environmental education programs.
4. Long Term Period (6-12 years)
    a. To manage governmental and nongovernmental support to carry out dissemination activities in favor of the mangrove.

Objectives for the topic: "Preservation":

1. Short Term Period (1-3 years)
    a. To form an effective inspection committee and surveillance of the mangrove ecosystem.
    b. To collaborate with the municipality to establish garbage collect schemes in the region
2. Medium Term Period (3-6 years)
    a. To identify and classify the most damaged areas of the mangrove, in order to develop maintenance and restoration activities.
3. Long Term Period (6-12 years)
    a. To negotiate with the municipal, state and/or federal offices the regulation of the use of the
    b. To monitor with the support of academic institutions the quality of the water and land use in surrounding areas with influence on the mangrove ecosystem.
    c. To manage financial support for the development of activities of preservation in the area.

At the end of this plan, three priority projects were identified for the inhabitants of El Veinte: Mangrove Nursery, Environmental Management Unit (EMU), for the preservation of the wildlife and a Rainwater Collection System.

i. Mangrove nursery: a mangrove nursery to be installed under the charge of Civil association that would be responsible to collect specimens to perform reforestation activities, encouraging the participation of inhabitants and guaranteeing talks of environmental education during these activities.

ii. Environmental Management Unit for the preservation of the wildlife (EMU): An EMU will be installed at the endemic iguana in the community El Veinte, in order to raise awareness among the population regarding the care of the species in the category of endangered (SEMARNAT, 2010) and to permit the sale of the species for edible purposes.

iii. Rainwater Collection System: A rainwater collection system should be designed and established in the locality El Veinte, for the purpose of collecting rain water and stock it for use for the drought season. In this way it will be possible to supply water to inhabitants who currently do not have drinking water and simultaneously it will encourage the use of eco-friendly technologies in the locality.

6. DISSCUSSION

The 8 identified aspects in the scenario "current situation" for the locality El Veinte: Social disorganization, lack of environmental education, clandestine garbage dumps, land use change, deforestation, messy urbanization, shortage of drinking water and waste water, coincide with the problems identified by Moreno-Casasola (2000); Willems *et al.* (2018) and Vences *et al.* (2016) in their investigations of the locality La Mancha- El Llano in Veracruz- Mexico, of a peasant locality in Peru and of three localities bordering the Nuxco lagoon, Guerrero respectively. Vences *et al.* (2016) during his investigation of the environmental perception of three localities bordering the Nuxco lagoon, found that there was a lack of garbage collection, wastewater discharge and mangrove deforestation, which coincides with the current scenario posed by the inhabitants of El Veinte locality. The inhabitants of El Veinte consider that the clandestine garbage dumps and discharge of wastewater into the lagoon were environmental problems that have not been resolved due to the lack of public policies in the government, due to the lack of strategies with low environmental impact and also due to the lack of management plans (Fernández-Tarrio *et al.*, 2009; Barbosa-Guzmán, 2013).

The key members of the community, who were also informants of this study, observed that mangrove coverage has decreased and deteriorated during the last 20 years. They attributed it to the population growth and to the unregulated logging in the mangrove, and matches what was reported by Vences *et al.* (2016) which points that the Nuxco sub basin had a loss of coverage of 296.49ha from 1981 to 2005.

The study accomplished a consensus of the inhabitants of El Veinte in relation with the priority projects for the community taking into consideration. Due to group diversity in age, culture and work differences, it was a complicated process to reach an agreement based on technical criteria and local criteria consistent with Toledo (1997) and Willems *et al.* (2018).

This study articulated and strengthened the links with institutions and organizations that generated information, which had resources that allowed inhabitants to manage support and participate in the formulation and implementation of productive projects of social interest (Willems *et al.*, 2018). This was consistent with the three actions of this study (education, investigation and preservation) in the context of the inhabitants of El Veinte locality. These inhabitants considered it necessary to link and work together with academic institutions and governmental support at all three levels (local, state and federal) to reach a sustainable management of the mangrove area, and simultaneously set up "priority" projects for the locality (e.g. Mangrove nursery, EMU-iguana, and Rainwater collection system). This is consistent with the study by Castillo and Gervacio (2009) who mentioned that establishment of a mangrove nursery was a sustainable alternative to perform actions of reforestation and to achieve the conservation of these ecosystems.

In order to avoid affecting mangrove ecosystem by farming activities, one of the agreed strategies by the inhabitants of El Veinte was to allocate specific areas for livestock grazing activities. This activity was linked with

the established of the Community Management Plan in a peasant locality of Peru, wherein a consensus agreement was reached with the population to counter the issue of overgrazing. The agreement assigned sectorization of sites designed for grazing, with the purpose of having a proper handling of resources and the recovery of natural grass (Willems *et al*., 2018).

The inhabitants of the El Veinte locality also agreed on the need to be trained in environmental matters, responding to the need to develop environmental awareness in children, youth and adults and to avoid further deterioration of the mangrove ecosystem. Such a thing had happened in the in Nuxco locality where "education" was considered an important aspect and borrowed in the current study as small ,medium and long term plans. This is consistent with Linares *et al.* (2004) who affirmed that environmental education was necessary to build awareness about problems faced by the mangroves and also with Vences *et al.* (2016) who mentioned that 61% of the inhabitants bordering the Nuxco lagoon, considered it important to implement environmental education workshops and environmentally friendly projects. This study included these workshops in the three priority projects that the inhabitants of the El Veinte locality defined in a consensual manner, with the purpose of knowing, preserving and exploiting in a sustainable manner the environmental resources that the mangrove ecosystem of the Nuxco lagoon had already offered as a best practice.

7. CONCLUSION

This study attempted an action plan proposing the conservation of the much endangered mangrove ecosystem of the Nuxco lagoon. This Action plan was envisaged as Community Management Plan comprising investigation, education and preservation, with short, medium and long term objectives. The Plan was to be implemented with consensus by the inhabitants of El Veinte locality in the state of Guerrero, Mexico. The study identified three priority projects for the sustainability of the mangrove ecosystem namely Mangrove nursery, EMU-iguana, and Rainwater collection system. These proposals were based on an improvement in the quality of life of the population, under the scheme of a sustainable vision. The inhabitants of the locality "El Veinte" agreed on the need of initiating such an action plan if it aimed at the preservation of the Mangrove Ecosystem. The measures that are reflected in this work are suggestions from inhabitants, and accepted by majority vote. These measures are described in the topics: research, education and conservation.

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