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CONSERVATION OF A MICRO WATERSHED THROUGH SOCIAL PARTICIPATION IN THE NATURAL RESOURCE PROTECTION AREA "LA FRAILESCANA", CHIAPAS, MEXICO

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— Abstract—

The objective of this work was to strengthen social participation in the management of the micro watershed El Pando, taking water as a key resource for the conservation of the ecosystem in the Natural Resources Protection Area "*La Frailescana*". Through the application of qualitative methods and Participatory Action Research to residents of eight communities settled in the micro watershed, the processes of social organization, perceptions about importance, problems and knowledge about natural resources in this area were evaluated. In general (95.4%), the inhabitants think that it is very important to maintain the micro watershed, the water must be protected to conserve the forests because they give various environmental services such as the reduction of threats by floods, food, water and firewood, they also mention that there is contamination of water by inorganic trash and agrochemicals, in addition to logging of forests to establish pastures and agriculture. The inhabitants are willing to participate in actions that promote conservation. Finally, a space of social participation was built with the formation of the Advisory Council of the Reserve to prioritize conservation actions of the micro watershed.

Keywords

Social Participation, Water, Frailescana Chiapas, micro watershed

For a long time water had been considered as an infinite resource, however, estimates of UNICEF and the World Health Organization (WHO) published in 2013 indicate that there are 768 million people in the world who lack access to this vital element (UNESCO, 2003 and 2006). In Mexico, the greatest demand for water lies in the population growth and economic activities of the agricultural sector (Irrigation Agriculture, Livestock and Aquaculture) with a consumption of 61.6 km3, equivalent to 77% of the total national water extraction, (CONAGUA, 2011a) have created areas of high water scarcity, both in regions of low rainfall and in areas where there was a high degree of availability and catchment, because the volume demanded is greater than the supplied one. This generates the search for new alternatives to achieve a more efficient water management, which considers social participation as a right on the part of citizens to express their opinions on issues that affect them directly, such as water, since it has different implications that range from social and economic to environmental (UNDP, 2012). The fact that citizens are involved and contribute their knowledge in the configuration of projects fosters positive and productive results (Osorio & Espinosa, 2001)

The viability in the management of a hydrographic watershed requires that the population involved participate effectively in activities that guarantee sustainability, working with a comprehensive vision of the state and community institutions that allow overcoming partial actions and temporary solutions. Adopting a watershed perspective, leads to the need to work with groups of rural agricultural producers or communities in a coordinated manner and this means understanding the social processes in which their productive activities are inserted, paying attention to social institutions and structures, locals as well as externals who design, implement and direct interventions, so that an adequate environmental management can be achieved, it requires effective social participation, as a fundamental axis of the process (Chávez, 2003).

The concept of social water management is taken as the interaction between a diversity of users, organizations and other institutional actors involved in the use and management of water and the environment in a micro-watershed for the taking of accepted decisions and the coherent implementation of actions regarding access and distribution, multiple use, conservation, as well as shared spaces and infrastructure within its territory. These strengthening actions generate changes in the self-esteem and attitude of the people, which contributes to their involvement and active participation, promoting the development of planning instruments. Among the program's impacts are: empowerment at a personal level, labor insertion and role in water management,

strengthening of user organizations, development at the micro-watershed level, all according to the Regional Process of the Americas VI World Water Forum (Mora and Dubois, 2015).

The Protected Natural Areas (PNA's) provide the spaces for convergence for many actors that are in and around them, from residents to those who are concerned with the conservation and study of ecosystems and biodiversity. That is why the task of protecting these spaces of territory and their resources implicates the active involvement of these actors and there are several moments and stages in which participation takes place in an intense and organized manner. In the reforms of the General Law of the Ecological Balance of Environmental Protection (LGEEPA) of Mexico, social participation is established as an obligation in all phases of creation and management of a protected natural area (SEMARNAP, 2000).

The new social policy of the National Commission of Protected Natural Areas (CONANP) federal government agency in charge of its administration and management; part of recognizing that the conservation of natural resources is possible if you have the participation of the owners and owners of natural resources. The Strategy of Social Participation in Protected Natural Areas has as its objective: to constitute a broad social alliance, placing users and owners in the center of it to generate: a) Social commitment in the conservation of natural resources, b) Shared governance in the use of resources, c) Design of sustainable projects in accordance with the needs of the inhabitants located in the PNA's buffer zone and the potential of the territories and d) Coordinated participation of public institutions and external social cooperation.

The Natural Resources Protection Area (NRPA) "*La Frailescana*", where the study site is located, as in other protected natural areas of Mexico, conflicts between the conservation objectives of natural resources and those of human development of the populations that live in or around them, generating environmental problems such as the change of land use, deforestation, forest fires, hunting, use of agrochemicals and loss of quality, supply and access to water, due to the above, the objective of this work was to strengthen social participation for the management of a micro watershed by taking water as a key resource for ecosystem conservation in communities settled in the micro-watershed "*El Pando*" in the Natural Resources Protection Area "*La Frailescana*", Chiapas , Mexico.

STUDY AREA

This work was developed in the Protected Natural Area "Natural Resources Protection Area *La Frailescana* (NRPA)" specifically in the Micro watershed "*El Pando*", which is part of Hydrological Region No. 30 Grijalva-Usumacinta, in the hydrological Sub-region *Medio Grijalva* or *Grijalva-Tuxtla Gutiérrez* in the Santo Domingo Hydrological Watershed, which contributes its flow to basin 18 "*Chicoasén*" Hydrological Dam between coordinates 15° 45` and 16° 21` North Latitude and 92° 32' and 93° 56' Longitude West (PEOT, 2002). It has a contribution area of 2,053.18 km², it originates near the town of *Raices del Tajín*, Municipality of Villacorzo and its main tributary is the Santo Domingo River that flows into the Grijalva River at the height of the town Cruz de Cupía, Municipality of Chiapa de Corzo It belongs to the Socio-Economic Region called *La Fraylesca* and the Sierra Madre Physiographic Region of Chiapas, composed of an extension of mountains that extends towards Guatemala with altitudinal elevations above 800 meters above sea level. The vegetation includes jungles and forests mainly. Among the Jungles there is the presence of High Evergreen, Low or Middle Evergreen Jungle, High or Medium Sub-evergreen Jungle, High or Medium Sub-deciduous Jungle, and Low Deciduous Jungle. The forests are made up of holm oaks, pine forests and deciduous forest. In addition to these formations, there are Savannas and Secondary Vegetation (*acahuales*) according to the vegetation classification of Miranda and Hernández (1963).

The predominant climate is sub-humid warm with a marked rainfall regime and precipitation in summer. The average annual temperature in the warm zones ranges between 22°C and 26°C, in the semi-warm zones between 18°C and 22°C. The lowest temperatures are recorded in small areas above 2,000 masl, where they range between 16°C and 18°C. During the months of May to October considered rainy, the minimum temperature varies from 12°C to 21°C and the average maximum temperature from 21°C to 34.5°C; the precipitation varies from 1,000 mm to 2,600 mm. For the months of November to April during the dry season, the minimum temperature ranges from 9°C to 15°C and the maximum from 21°C to 37°C. The precipitation during this period fluctuates from 25 mm to 300 mm (CEIEG, 2010).

Image 1.- Location map of the "*El Pando*" micro-watershed and study communities.

Source: self-made

The municipality of Villacorzo, where the total of the micro-watershed *El Pando* is located, is considered to have a high degree of marginalization, where 40% of the inhabitants are in extreme poverty. For the micro-watershed, a total population of 2,299 people is estimated corresponding to eight *ejidos*: February 24, Monterrey, Nuevo Mitontic, Tierra Santa, Bonanza, *La Fraylesca*, La Unión and Nuevo Refugio (Image 1). Within these communities, the main economic activities that are presented are associated with agricultural-livestock production, such as corn, beans and coffee, as well as cattle farming (INEGI, 2010).

Chart 1. Population of the El Pando Micro-watershed, Municipality of Villacorzo Chiapas.

		Ejidos	Number of people
Municipality of Villacorzo	**Micro-watershed *El Pando***	La Unión	44
		El Nuevo Refugio	177
		Tierra Santa	342
		24 De Febrero	158
		La Fraylesca	259
		Bonanza	102
		Monterrey	1,086
		Nuevo Mitontic	131
		Total de población	2,299

Source: INEGI. Population and Housing Census (2010). Corroborated by the Villaflores Health Sector.

Based on the analysis of a satellite scene carried out in 2008, to identify the types of exploitation that are practiced and the bodies of water that are used, it was obtained that the vocation of the soil is basically forestry, corresponding to 91.1% of the territory (106,327.98 hectares), however, 8.9% has been modified by agricultural use (10,407.39 hectares), as well as the development of rural communities. (CONANP, 2008).

The Area presents a great number of currents produced by the ruggedness of the sierra; in the upper parts, the tributaries of the sub-watersheds of Santo Domingo, San Pedro, Presa La Angostura and *Cuxtepeques* drain their waters into the middle watershed Grijalva-Tuxtla of the Hydrological Region 30 Grijalva-Usumacinta. The existence of an exuberant forest cover contributes to the collection and cleaning of surface and groundwater, however, the contamination levels of the rivers and streams present are unknown, since in its interior and in the zone of influence the majority of the populations discharge their domestic wastewater and garbage.

IMETHODOLOGICAL PROCEDURE

Information gathering

For the collection of information between September 23, 2013 and April 30, 2014, the eight communities of the micro-watershed *El Pando* were visited. The survey was used as a technique for collecting data and was divided into three sections with 26 questions.

The first section measured socio-demographic type variables, the second section, assigns measurement to variables such as level of knowledge about the concept of micro-watershed and identification of environmental problems in relation to the water issue, which corresponds to the so-called environmental component and the third section refers to the socio-environmental component which integrates social participation in an environmental issue.

1. Identification of the problems in the micro-watershed *El Pando*.
2. Participation and Evaluation of Problems in the micro-watershed *El Pando*.

For the calculation of the sample size, the following statistical formula was used for a known population N=Z2 Npq/(e2 (N-1)+z2 pq). Where "N" is the size of the total population that corresponds to 2,299 people, "Z" is the degree of confidence established for our case, according to tables of "z" with a value of 1.96, an α=0.05, that is, with a 95% confidence level. The value of

"p", expected prevalence of the parameter to be evaluated or probability of success, it was considered to apply the most unfavorable option (p=0.05), which increases the sample size. The value of "q" that results from q=1-p and the value of "e" or allowed or expected error, which ranges from 2% to 6%, was adjusted to 5%. Finally, a rejection rate (PR) calculated in 10% of the sampling frame was included. The data provided by the calculation were 329 surveys applied.

Obtaining the number of surveys per community was determined based on the percentage obtained from: number of inhabitants-*ejido*/total population x 100, by the total number of surveys to be applied. The distribution of the number of surveys, resulted: 7 people *La Unión*, 26 people *El Nuevo Refugio*, 49 people *Tierra Santa*, 23 people 24 de Febrero, 36 people *La Fraylesca*, 13 people *Bonanza*, 155 people *Monterrey* and 20 people *Nuevo Mitontic*.

The application of the surveys was carried out in each of the *ejidos* with the informed consent of the authorities of each community and the persons interviewed. The surveys were applied to people over 18 years of age and more than 10 years living in the community. Once the application was completed, an identification sheet was assigned to each survey and a capture mask was designed with the Statistical Package for the Social Sciences Statistical Program (SPSS) version 17.

With the information collected and analyzed participatory workshops were applied using the group moderation *Metaplán*, which consists of all members participating in an equitable manner, without influencing individual opinions, seeking to facilitate concentration and understanding of ideas, using "voice, hearing and sight", this participatory tool uses visualization as a method of expanding the spoken word (Cisnado y Avila, S / F). The purpose is to leave blank spaces to give the possibility to add new ideas and contributions. Visualization reduces the danger of going in circles, helps to store ideas; the information is always accessible to all participants.

In these workshops, key players of the micro-watershed participated, among them representatives of the municipality of Villacorzo, ejidal authorities, civil society organizations and academic sector, decision makers and interested in applying actions to conserve water. Key or substantive, supporting or backing, and driving or cooperation factors were identified. Internally, each community of the micro-watershed chose two representatives to attend the workshops. Subsequently, the key factors were prioritized to obtain the most important ones, and were described in a neutral manner avoiding positive or negative trends, finally, the relationships between

the factors were analyzed, future projections were developed for the most determining factors, and necessary measures were identified to guide the factors towards the desired scenarios.

RESULTS AND DISCUSSION

Interviews

329 people were interviewed, of which 53.5% (n=176) corresponded to women and 46.5% (n=153) were men, the average age for the eight communities was 35.7 years ranging from 18 to 69 years, presenting a greater range between 22 to 41 years (48.3%, n=159). With the data obtained in this section of the interview.

Regarding the level of studies, it was found that 40.7% (n=134) had primary education, 22.5% (n=74) did not attend school and only 5.8% (n=19) completed a university degree. With regard to their occupation, all women are housewives and men 84.3% (n=129) work in agriculture and small scale cattle (>10 animals). 80% (n=263) was born or has more than 20 years of living in the community. The majority of the population works in the field from an early age obtaining knowledge mainly by parents and grandparents. This is partly due to the high degree of marginalization of the micro-watershed communities, according to data from the National Population Council (CONAPO, 2010).

For the interviewees, the micro-watershed concept consisted of a river, stream and surrounding stones for its protection, considering that it must be protected because there is a close relationship between water conservation and the forests and that these in turn provide a better quality of life referring to reduction of environmental threats (fire, floods), obtaining resources such as food, water and fuel (firewood). For 60.5% (n=199) there is currently a problem related to water, mainly due to contamination by inorganic waste, use of agrochemicals for agriculture, forest fires and the opening of roads in the area. For those who consider that in relation to water there is no problem, 39.5% (n=130) indicated that there is enough water and not contaminated since the forests are in good condition. 89.3% (n=294) of the inhabitants indicated that they are aware that community participation is important in order to plan activities related to the conservation of natural resources in the long term, which will allow them to maintain them in good condition and therefore a better quality of life.

The contamination of the water resource associated to the intensive agricultural activity, with the excessive use of agrochemicals, was one of

the most frequent responses, since it affects the health and well-being of the inhabitants of the Micro-watershed, a fact that is corroborated by a local study carried out in 2015, to know the water quality within the area, through the measurement of the *Índice de Calidad de Agua* (ICA), proposed by Brown, modified version of the WQI (Water Quality Index). In this analysis, it was identified through indicators such as phosphorus and chromatographic sweeps that surface water runoff have been affected by industrial fertilizers, agrochemicals and pesticides (CONANP, 2015). The intervention of *ejidal* actors through the application of their internal, municipal, state, and federal regulations regarding the application and compliance with laws and regulations related to natural resources could reduce the pressure that the use of agrochemicals causes to the environment.

In general, the majority of the surveyed population (95.4%) considers it of the utmost importance to conserve the micro-watershed *El Pando* as a producer of fresh water, and is willing to participate in actions that promote its conservation. The answers show a certain degree of environmental sensitivity, and certain values such as solidarity, would allow detonating processes for the rational and sustainable use of the resource, which guarantees the satisfaction of future generations. The reasons for protecting it range from the enjoyment of it, health aspects, economic and ecological benefits and specifically the valuation of water as a source of drinking water and for the development of productive activities.

Workshops

Five participatory workshops were held between the months of September and December 2014, attended by 17 people on average (n=136) in a proportion of 45.5% (n=61) women and 54.5% (n=75) of men, interspersing headquarters in different communities.

The topics addressed were:

- "*La Frailescana*", background and zoning
- "*La Frailescana*", scenario 2040 (Water theme was addressed)
- The Advisory Board, Structure and Functions
- Process for appointing directors
- Internal Rules of the Advisory Board

The term scenario was conceptualized, this in order to put in context those attending the workshop in the construction of a vision for the micro-

watershed for the year 2040, in such a way that the following questions were answered: Where do we want to go, where do we see ourselves in the future?

STAGE

It represents something high, more visible, something important, activity (drama, representation), let's see something (balcony), see the mistakes that were made and do better.

At the workshops it was discussed the environmental problems of the micro-watershed, the organizational relationships that exist within it, the conflicts generated both by the access and by the availability of water resources and the regulation of state entities, individual and collective actions for the management of the micro-watershed and the institutional framework surrounding natural resources in the area, as a result nine factors were identified, ten attributes and 14 processes and obstacles in relation to the management actions of their natural resources for the micro-watershed *El Pando* (Table 2, 3 and 4).

Chart 2.- Favorable and unfavorable factors identified in the workshops in relation to natural resources management actions in the *El Pando* Micro-watershed, municipality of Villacorzo Chiapas

Favorable factors	Unfavorable factors
Have a dialogue (Communication between communities)	Clandestine forest clearing
Unification	Forest fires
Obey the rules between peers	Fires without measure
Being responsible	Plagues and diseases
Work together	Litter anywhere
Organization of all as a single team, to achieve our purpose.	Continue as we are
Organize to reforest the clearing areas, conduct controlled burning reduce agrochemicals, collect garbage.	Not wanting to work
	Not having interest
	Do not taking it seriously
	Do not take us into account
	Not value what we have
	Not loving nature
	Not supporting ourselves

CONANP counseling for the communities	The government's lack of interest in the project
Conduct workshops or courses.	Carelessness of the authorities
Have love for nature, be better trained and know more	Not receiving resources fro government institutions
	Lack of counseling
Increase awareness	Disorganization
Awareness of each member of the residents of the NRPA "La Frailescana"	
Working together to care for the environment and reforest	
Do not litter in streams and rivers. Avoid destroying with hunting.	
Apply regulation	

Table 3.- Attributes they have and that they wish to acquire in relation to the management of natural resources in the El Pando Micro-watershed, municipality of Villacorzo, Chiapas

Attributes they have	**Attributes they wish to acquire**
Training	Manage the payment of environmental services and productive projects
Government Advisory especially from the National Commission of Natural Protected Areas (CONANP)	Projects and economic supports
	Nursery and coffee projects
	Resources for the renewal of coffee plantations, pests and diseases
We have different animals (jaguar)	We need temporary jobs and productive projects
We have water, basins, springs	More government support
We have flora	To have resistant seeds
We have well-kept forests	Resources to achieve our goals
	We need resources to get ahead
Coffee projects	Have more coffee machines (toaster, reclaimer, pulper and drying yard)
Tourism approved projects	We need a dryer
Unit for the Sustainable Management of Wildlife	Infrastructure, pasture chopper
UMA´s forest exploitation	Infrastructure, yard, tank. Machinery
	A sawmill to machine the wood
Training on land use	Recognized marketer
Knowledge in oraganic product management	Incorporate ourselves into the productive chain for a better life condition
Knowledge Biological Control	
Organic certification	

Organization of coffee production Legal organization Organization and planning	We need training; we need economic resources, we need productive projects so our economic situation improves and people can be encouraged to take care of the environment Soil conservation in coffee plantations Technical assistance Training for exportation Training, coffee (certification) counseling and follow-up
Brigades against forest fires Equipped and trained community brigades Trained brigades	We need interest in ourselves Transportation

Table 4.- Processes and obstacles identified in the workshops in relation to the management of natural resources in the El Pando Micro-watershed, Villacorzo municipality

Processes and obstacles
Lack of information
We are not being taken into account
The institutions do not give us any real answers to our petitions
A lot of stationary
A lot of requirements are needed for government dependencies
A lot of paperwork for projects
Government responsibility
Window times
On time dissemination of the projects in *ejidos*
Not have a qualified technician
Abuse of officials
Rip-off technicians (thieves)

Social participation

Thus, from the analysis of the scenarios, factors and their relationships, it was determined that the social management of water is the theme and axis generating other aspects of sustainable local development, and those factors that contribute to the inhabitants of the micro-watershed El Pando managing what is necessary to make an adequate use and management of water, improve decision making, execution and evaluation of the same that will be determined in the attention of the following four factors in order of priority:

1. Project development
2. Development of capacities for water management in the micro-watershed (Organization)
3. Water management and development research (Conservation of forests)
4. Counseling with less bureaucracy

Finally, as an area of participation, an "Advisory Council" was created for *La Frailescana* Reserve, which was legally based on the General Law of Ecological Equilibrium and Environmental Protection in Article 159, giving it legal certainty and thus strengthening it with governmental participation and of Non-Governmental Organizations (Aguilar *et al*., 2009). This council will be the facilitator and counselor of the processes, in charge of promoting and guiding the critical analysis and reflection of the participants, of promoting dialogue, without interfering in the decisions that the group makes, of providing information about the most relevant aspects of the external environment and the problem to be treated, as well as the way to achieve it, interpret it and use it, which indicates that it is sustainable over time. The strengthening of local capacities and organization are fundamental to contribute to the socioeconomic and environmental development of the study population. The most important thing is the investment for the creation of competitive human capital through education and the creation of more remunerative work opportunities that allow fulfilling the 2040 vision for the micro-watershed *El Pando*.

The micro-watershed in this study is proposed as a planning area for natural, material, human and financial resources for the Natural Resources Protection Area "*La Frailescana*", which occupies a considerably large area for the staff of the National Commission of Protected Natural Areas that attends directly. From the operational point of view, the planning of the area considers that it is important to work at the micro-watershed level, since the area has limited resources; so it is important to know where the money, the hours and the effort invested can lead to the greatest impacts. This is the fundamental reason for prioritizing the goals and, mainly, the areas of intervention within a watershed. Taking the micro-watershed as an area for planning actions aimed at introducing changes in production systems, seeking to reconcile and integrate the objectives of production and protection of natural resources, is a technical and strategic option dictated by the nature of the interactions between these resources.

The size of this micro-watershed is defined by its nature and by certain operational adjustments based on the capacities of government and non-government institutions linked to its management and development. In this

case, "*El Pando*" will also be attended by the Advisory Council, which is made up of representatives of each of the eight *ejidos* that comprise it, that is, they will be the ones who generate skills to manage what is necessary to develop their local capacities, research and development projects.

CONCLUSIONS

It is concluded that the planning for the integral use of micro-watershed facilitates the perception of individuals and the community about the interactions between production (use and management of resources by humans) and the behavior of natural resources used to production (soil, water, forests). In this way, a greater awareness of the need to promote changes in one's own way of acting is favored.

The Social Management of water in the *El Pando* micro-watershed should guide its actions based on a participatory process through the Reserve Advisory Board that helps identify and prioritize its main problems, and participate in the preparation of an action plan that try the resolution of them.

The female gender, showed an active and enthusiastic participation in this research process, which infers an important role in decision making, so its participation is paramount. Enabling the empowerment of women will enable the participation of all actors in the development of the region. In this sense, the use of land that is currently being carried out is not favoring the management or sustainable use of water resources, nor are there any incentives that encourage the adoption of sustainable agricultural practices and permanent protection of water resources, which is why it is proposed to participate in programs for payment of environmental services.

In short, the integral management of the soil and water resources of the micro-watershed *El Pando* should take advantage of the participatory potential of the social actors living in the study region by inserting primarily small producers through the formulation of initiatives aimed at conserving, regenerate and make sustainable use of natural resources.

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