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Improving Sustainability Concept in Developing Countries

# Permaculture, a tool for adaptation to climate change in the communities of the Laguna Oca Biosphere Reserve, Argentina.

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## Abstract

The Laguna Oca y Herradura del Río Paraguay Biosphere Reserve, have a Formosa City, as a part of the plain alluvial system and ecosystems, being observe serious issues to socioeconomic, cultural and environmental levels.

According to the above, it was suggested that the habitants lifestyle from Biosphere Reserve, are unsustainable within the sustainability paradigm and by permacultural practices sustainable livelihoods will be generated.

The study focused in assembling a database, about the reality experienced by these communities and the lifestyle of its habitants, was analyzed within the sustainability paradigm.

The methodology used, was based on the territory diagnosis and model Survey Evaluation Sustainability Community, with a multivariate analysis information.

It was found that the habitants living conditions of the communities Reserve are unsustainable, observed that by incorporating permacultural practices, these conditions will change in favor of sustainable development and it will provide capacities to climate change adapt.

The study provides theoretical contributions, for conducting future research or prescriptive studies, on the basis of this study.

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*Keywords: Permaculture, Climate Change, Biosfer Reserve, Sostenibility Paradigm.*

## 1. Introduction

The Biosphere Reserve “Laguna Oca” is located on the right bank of the Paraguay River as part of the Formosa city, in the Formosa province, Argentina. The Biosphere Reserve “Laguna Oca del Río Paraguay”, was appointed in 2001 and comprises approximately 13,000 hectares of riverine wetlands adjoining the Formosa City. (Directorate for Scientific Technical Coordination Biosphere Reserve Laguna Oca y Herradura del Río Paraguay, 2013). This study focuses on the neighbourhoods that are part of the Reserve at its limit with the city’s environment and part of the Transition area. The neighbourhood are: Laguna Siam, Santa Rosa, Villa Hermosa, San José Obrero and Bernardino Rivadavia.

The special case of the Biosphere Reserve Laguna Oca y Herradura del Río Paraguay (RBLOyHRP) is that it has the city of Formosa as part of the system of floodplain ecosystems and observed serious problems both socioeconomic, cultural and environmental level concerning regulations preservation of nature and the level of human intervention in the ecosystem of the Reserve.

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The life conditions from the resident’s area are not sustainable in terms of nature conservation, economic

development, social equity and healthy conditions. This problem is the trigger of many problems that contribute to global warming and not have any kind of adaptation processes to climate change, becoming the communities of the studied place, highly vulnerable.

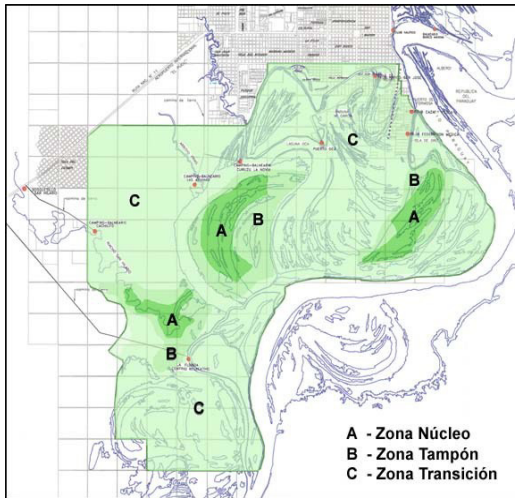


Figure 1. Biosphere Reserve Laguna Oca. 2013.  
\* Source: Scientific Technical Coordination of the RBLOyHRP.



Figure 2. Areas that make up communities  
\* Source: Image provided by the PROMEBA III. Formosa. 2014.

In June of 2014, an event that is naturally likely, turned serious like in 1983, the Paraguay river and stream, they began to grow their level, generating a state of alert in flood areas, one of them, the Biosphere Reserve. The issue is that the living conditions of communities in the Formosa city, located in the peripheral or transition zone of the Biosphere Reserve Laguna Oca y Herradura del Río Paraguay, are unsustainable within the paradigm of sustainability.

Climate Change and its overall context, it is a problem that affects small and large scale, undermining any attempt at development, United Nations [1], the sustainability paradigm, Larrain [6] proposes, based on a vision from the complexity, different alternatives to direct development towards sustainable goal, a sustainability vision and as part of what the researcher considers sustainable lifestyle, is Permaculture, Holmgren [5].

A more current definition of Permaculture is proposed by David Holmgren in 1978, "The conscious design of landscapes which mimic the patterns and relationships in nature, while supplying food, fiber and abundant energy to satisfy local needs." People, their buildings, the way they organize themselves, are fundamental to permaculture. Thus the permaculture vision as a permanent sustainable agriculture has evolved into a vision of permanent sustainable culture.

In relation to the scene in which find the communities Reserve, it is considered that permaculture practices may be an alternative solution to several problems faced by these communities living within the sustainability paradigm; for this, the study focuses on the assembly of a data base. The research faced the study, based on cultural and geographical dimensions that arise for Sustainable Development as an alternative way, analyzing the different options for implementation of permaculture as a tool of adaptation for climate change and sustainable alternative development in communities of RBLOyHRP.

The Hypothesis proposed is:

"The life style of the communities habitants, placed in the RBLOyHRP, are unsustainable from the sustainability paradigm".

The objectives for this study were:

General objective:

- Analyze the way of life of the communities habitants located in the RBLOyHRP, from the paradigm of sustainability.

Specific objectives:

- Characterize communities (neighbourhoods that are part of the RBLOyHRP into analysis units.
- Identify environmental problems of the communities Reserve.

- Establish indicators of sustainable development in the human settlements Biosphere Reserve.
- Identify the presence of permaculture practices in the communities Reserve.

## 2. Materials and methods

According to the hypothesis and research objectives, the following methodological design scheme is as follows:

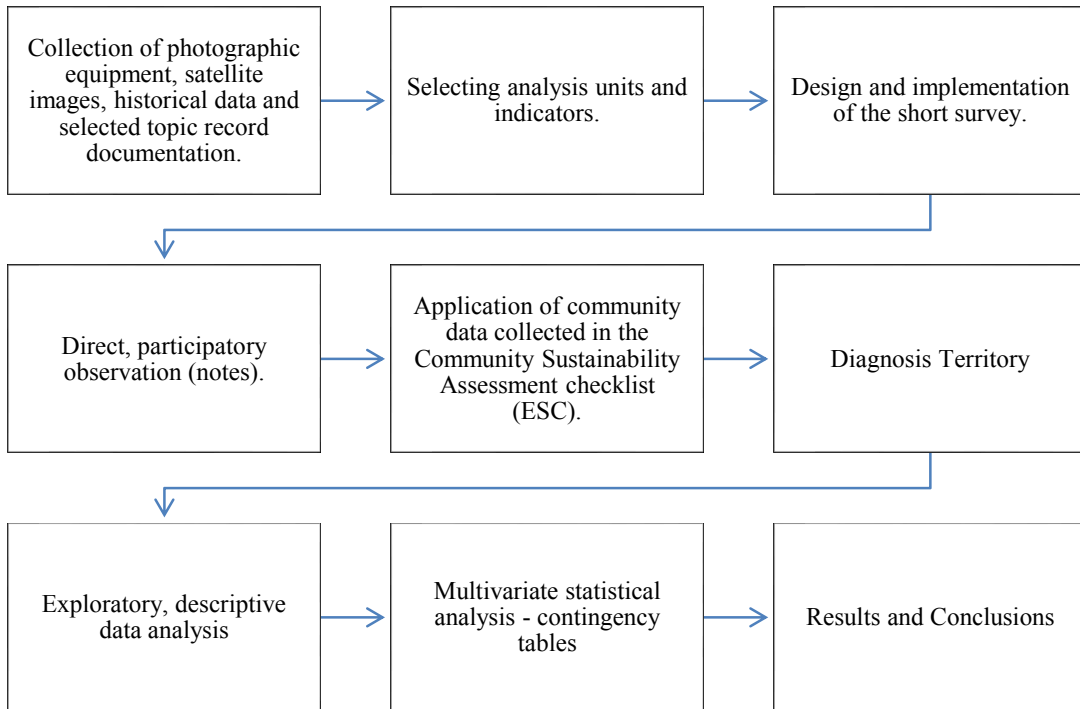


Figure 3. Schematic Design Methodology

The methodology consists, of an exploratory research is aimed at obtaining a general understanding of reality; then proceed to the descriptive fact-finding events and their implications. Finally, explanatory research with which it seeks to verify the variables with reality, using a hypothetical deductive scientific method. The research is not experimental.

The study objective, are the communities neighbourhoods of the Formosa city, which are located in the RBLOyHRP, in its transition zone. The procedure for sample selection was based on criteria of possibilities and research resources available, these being limited, the sample size is small, but can be descriptively representative, noting that the selection criteria it consisted of individuals with longer residence time in the neighbourhoods.

This approach considered individuals over 30 years. The characteristic of the length of residence may favour the wealth of data to collect quantitatively and qualitatively to the achievement of the objectives. The sample consisted of 190 individuals, including in the five neighbourhoods of the Reserve. The study was conducted based on information collection techniques through direct observation, the brief survey, the ESC and analyzing qualitative and quantitative data provided by the diagnosis of the territory, document analysis and content analysis.

### 2.1 Direct observation

It was performed a photographic survey of the areas in question, allowing give an overview of the social, economic and environmental context of communities. Five analysis units were determined for the survey:

1. Environmental or ecological
2. Social

3. Economic
4. Cultural and spiritual
5. Institutional

The indicators were identified through the PEI/ ER Model, Ministry of Environment of Peru [7] adapted to the local context.

#### 2.2 Interviews

Individual interviews with the subjects of greater representation in government institutions were performed depth to provide information. The analysis of the data obtained, was through the interpretation and description of the information in analog way.

#### 2.3 Environment Observation

The systematic observation, it was made with direct characteristics and passive participation. Registry items were photographs, maps and notes, to identify the presence or absence of permaculture practices, by the survey methodology, could not be captured in full and by the method of observation took shape. For the interpretation of an analog data analysis, it was performed and triangulated, exposed to pair consultation, through a comprehensive description and systematic contrast among partners and information agents.

#### 2.4 Surveys

For the development of the short survey and the evaluation, was considered a descriptive design with qualitative ordinal variables, based on the analysis units and selected sustainability indicators. For the analysis of the survey data, was conducted descriptively in the first instance and explanatory by multivariate analysis, for this, was applied variables of the correspondence to each neighbourhood using contingency tables, with data collected from the short survey applied individuals from the communities.

The survey structure has two types of questions: a) questions designed to capture attributes or objective responses of the interviewee, referring to himself or his environment, and b) questions designed to capture perception psychological aspects and subjective representations of respondents with respect to their surroundings. The aim of the survey was to collect data from the communities, ergo from neighbourhoods, to characterize them. Secondly, the checklist selected for this study Community Sustainability Assessment (ESC) is conducted, and its descriptive analysis, comparing the levels of sustainability community among neighbourhoods studied, contemplating suggested by the System Assessment Ecovillage Network. The ESC was selected, corresponding to the first version by the Global Ecovillage Network, considering that covers most of the proposed indicators for the present study.

The rating system checklist consists of a series of values assigned to each option and divided into three main sections, each one with seven sub sections. After completing the list, adding the values assigned to each item, that gives a value for each major section (range stipulated by the Ecovillage Network). After having the total for each section are added together and the total will correspond to the degree of sustainability community, suggested ranges from the following assessment:

333+ Indicates excellent progresses toward sustainability

166-332 Indicates a good start toward sustainability

0-165 Indicates that required to take action to embark on the sustainability road.

The interesting thing about the ESC is contemplated variables considered in the Permaculture principles, that way they can identify permaculture practices in the community. However, by not having any reproducible methodology to select the valuation ranges, this tool is only to make the descriptive comparison between them.

For the information analysis of short Survey and ESC, Excel and IBM-SPSS Statistics program was used as a tool.

#### 2.5 Territory Diagnosis

With the territory diagnosis, where identified the main water bodies of the Reserve in its transition zone bordering neighbourhoods studied, infrastructure and access embankments type were also identified, in addition to define the neighbourhoods. Diagnosis evaluated two images corresponding to Google Earth Area RBLOyHRP study, which were georeferenced; an image belongs to a catch of 2004 and the other in 2014, data from the sites in question, by gvSIG 1.11.0 extrapolated program.

### 3. Results and discussion

The results have been very useful for verifying the compliance with the objectives in the first instance and to corroborate the hypothesis. By charting percentages, made with data collected from the short survey, were identified the main problems of the community in general and the lack of public services (sewer system,

potable water system, electricity, garbage collection, community centers). Even though the government are starting public works, do not cover all the neighborhoods and their basic needs.

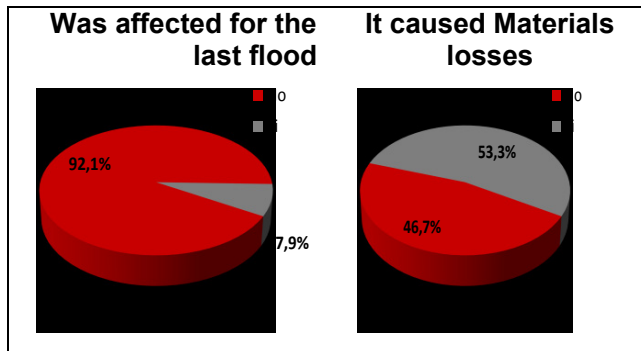


Figure 4. Flood affectation.

Respect to the analysis Vulnerability and Risk indicators in the Figure 4, the vulnerability is reflected, to natural extreme events such as floods; considering all the neighborhoods studied, a very small percentage represents the population that is at risk.

Also it shows that those who suffered these events, a less more than half of people suffered material losses, despite knowing the risk of living in that place, they are still there. This shows that the grade of construction risk is important, not reflecting resilience capacity.

One also interesting relationship is reflected in Figure 5, you can see that the neighborhoods have a Solid Waste (SW) collection, make less handicrafts those without service.

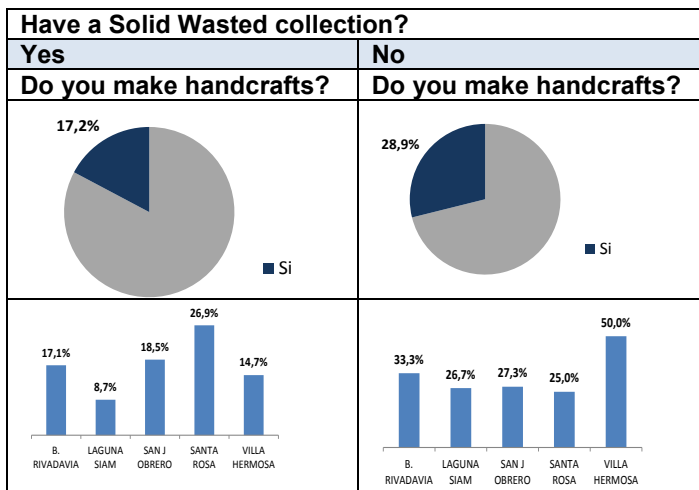


Figure 5. Relationship between provision of SW collection service and production of handicrafts.

The phenomenon based on the assumption above, with respect to the environment is closely related to man and it is a determining factor that generates the creation, according to Turok[10]. For these people, this is not a problem, but it is an opportunity. This is of resilience case. Permaculture is also a tool, which is projected on the maximization of available resources, in a way that is guided by one of the ethical principles of it and not to produce waste, which is a principle design.

Therefore, places where there is not waste collection, considerate thereof as a raw material.

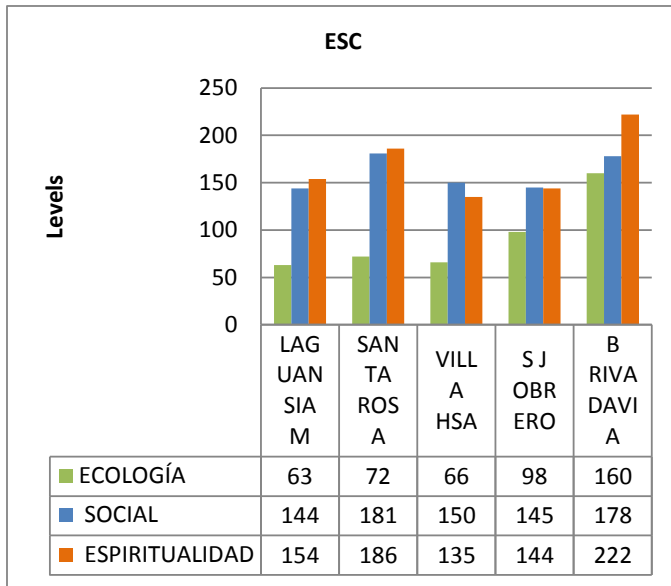


Figure 6. Five neighbourhoods ESC.

In Figure 6, we see that among the five neighbourhoods, Bernardino Rivadavia, indicates a result "a good start toward sustainability", while the rest of the communities achieve "is required to take action to embark the sustainability path ", suggesting an advance in the implementation of sustainability strategies.

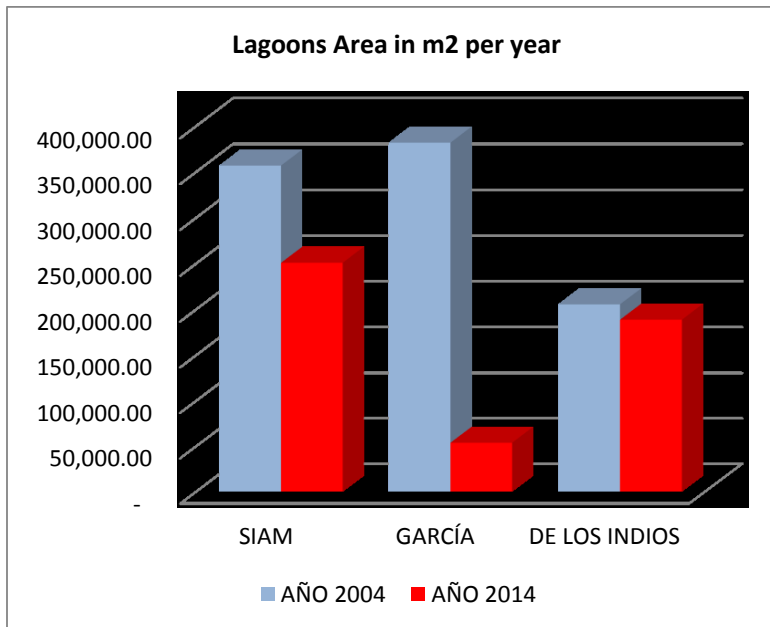


Figure 7. Lagoons area per year

In Figure 7, you can see that there is a major setback for the waters of the García lagoon, and by the photographic record and image analysis adding embankments, which left it completely locked with the rest of visualized chained lagoons, being dependent on the volume of water precipitation falling in the year.

Furthermore, Indian and Siam lagoons, also being enclosed, despite its decline is less than the García, this

occurs because they are bordering the city and dumped them storm drain waters, maintaining a constant volume, also depending of the rains, but feeding by water collected of the city drainage system. This factor, combined with extreme rainfall, produce floods of low-lying areas that are habited, despite being on the side of the barrier that protects against floods of the Paraguay river.

Also observed landfill construction large area is in the natural and urban area reserve, showing that building infrastructure activities that are performed by the State in the Reserve –Cloacals Effluent treatment Plant - and progress continues of urban settlements in areas that are at hidric risk.

Through the process of direct observation and photographic survey, environmental problems of the communities, confirmed the unsustainability in them, where identified as living conditions in relation to health, there are vulnerable for not presenting any type of management of sewage, or not possess knowledge to handle from Permaculture, also the management of solid waste presents a serious problem, especially for the environment that impacts negatively on the anthropic environment, generating infectious vectors.

It was also noted that there is a zone of settlements in flood-prone areas which represent a group of people with marginal characteristics Besada & al [2], that look for spaces near the city center, setting in those spaces not authorized to live (Figure 8). These people are generally unemployed, PROMEBA III [8], searching better opportunities, settle in those ignoring in most cases, the risk of coming there.



Figure 8. Santa Rosa settlements



Figure 9. San José Obrero settlements

However, there is a certain group of people, with the above figures that set in these areas, with speculation being assisted and provided free housing.

Prior to the study conducted, were no specific data on population studies of communities of RBLOyHRP, there was no analysis of the characteristics of these communities, there were no studies on water bodies Reserve in its transition area with respect to decrease its size, nor on public infrastructure that is done in the area of Reserve and its relationship with the communities of neighbourhoods; nor any relationship was performed with permaculture as a tool for adaptation to climate change, nor is there any record of specific study on the Reserve on climate change and the vulnerability of the population related. Even recently they are conducting census work by government agencies and the Formosa Municipality and the Neighbourhood Improvement Program (PROMEBA III), as they had not these data statistically.

However, since different areas of government, has been working on improving the quality of life of the habitants of these neighborhoods, these areas (PROMEBA and Ministry of the Community of the province) are working in the zone on issues the installation of basic services (water, electricity, sewage, community health), which are introducing some permaculture practices in population indirectly (without notion of Permaculture), but as any introduction of new habits or customs, has long and these works are very recent.

So also it considered important public works such as the laying of the sewer and water network, and that through this study, it was observed that the water connections network are clandestine type, especially in the "under area" of the neighbourhoods studied. This situation is based in the water service that cannot provide

outside the construction area. The results obtained demonstrate the situation of the communities studied, allowing data to know that until now were unknown and were not measured in any way.

The results are consistent with the objectives, however show the importance of the political sector in decision-making and its activities, in the zone Reserve. These results prove the unsustainability of the communities Reserve, as well as the state of vulnerability of the same.

On the other hand, allow finding permaculture practices, by analyzing the data, to appreciate the description of the survey and multivariate analysis; those practices are the orchards, community meetings to improve the quality of life for residents, resilient activities such as the reuse of waste by making crafts. Also, with respect to food production, it can be inferred that habits are rural practices survivors they did in the past, before the city take the natural space in the area, worthy feature of rescue and foster.

#### 4. Conclusions

In the present study, was analyzed the living conditions of the community population of the Biosphere Reserve, reaching the empirical finding which are unsustainable in the sustainability paradigm.

The causes of this unsustainable lifestyle, were seen coming from the lack of public services, lack of knowledge of the environment and environmental education, the lack of campaigns or programs that encourage sustainable lifestyles and lack of policy implementation public to take charge of the named above. Theoretical contributions were obtained, providing a database validated and can reproduce in the new sections of the Reserve, in the course of this research and broaden the possibility to be applied in other communities.

The detection of permaculture practices in communities and identifying the causes of socio-environmental issues, they can generate permaculture designs to each community and environment. Gradually introducing practices so as to reproduce themselves over time. Measuring the sustainability of communities is an issue that requires work and experimental application. While there are cases of sustainable cities or trying to be, the same indicators have not yet been accepted by all cultures application, this issue being an issue that is still working in the world to solve. For this reason, it is interesting to develop test cases with the application of permaculture principles, to establish measurable parameters that can be tested and reproduced in other communities with similar characteristics.

The research aims plays an attractor role, considering that the system changes, referring Complexity Paradigm Romero Pérez, [9] and as a contribution of the ecosystemic thinking in the sustainability paradigm and permaculture principles.

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