



EVALUATION OF THE SUSTAINABILITY CRITERIA OF FOREST MANAGEMENT IN THE MUNICIPALITY "PALMA SORIANO", SANTIAGO DE CUBA PROVINCE

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ABSTRACT

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The monitoring of the criteria and indicators carried out in Cuba to a municipal level and management areas are limited to a valuation according to the established methodology, making an inadequate evaluation of the same ones, what does not allow to obtain results on scientific bases that guarantee a correct valuation to define if the Forest Management is sustainable. This work carries out an evaluation of the criteria and indicators in the municipality "Palma Soriano" Santiago de Cuba province. The indicators were valued by means of a scale that allows judging their behavior using the approved and implemented methodology in Cuba. With these valuations there were carried out the graphs of sustainability, as tools to evaluate the performance of the criteria and indicators during 10 years. It concludes that the evaluation of the acting for each criteria was of "weak", "Excellent", "Extremely weak", "Weak" and "Favorable", for the criteria Forest Covering, Health and vitality of the Forest Ecosystems, Contribution of the Forest Ecosystems to the environmental Services, Productive functions of the Forest Ecosystems and Multiple Socio-economic benefits to cover the necessities of the society respectively.

Contribution/ Originality: The contribution of the work is to provide information, used as a tool by the local Government in the formulation of effective policies for forest management, the evaluation of development projects and the investigations of the Universidad de Oriente in methodological proposals to measure local development in the municipalities.

1. INTRODUCTION

Nowadays, the importance of the sustainable development of the forest resources is recognized to assure the well-being of the local populations and the national economy that is why the challenge of facing the degradation of forests resources, at world level will depend on the answer that is given to this phenomenon at local level.

The sustainability indicators are measuring of scientific base that allow evaluating and monitoring in a coherent way the progresses achieved in the Sustainable Forest Management (SFM) and communicate them to a wide range of interested parts and institutions: governments, the private sector, Non Government Organizations, donors' organizations, researchers and the public. In accordance with the report Evaluación de los recursos

forestales mundiales (FAO, 2016) the sustainability indicators can be also useful to identify the necessary changes in the management practices, in order to maintain and improve the health and vitality of the forests.

The changes carried out in Cuba starting from the implementation of the upgrade of its economic pattern, have generated the growing opening of the tourism and the private productive sector. Consequently, there been an increment in the demand of lumbermen and non lumbermen products of the forests, by making a strong pressure on these, which at the same time derives negative consequences for other resources, as the water and the floor.

Although in Cuba there have been carried out investigations related with the evaluation of the Criteria and Indicators of Sustainable Forest Management, defining them and establishing the methodologies and scales of valuation to evaluate them and monitor them annually. Generally the results of their monitoring and evaluation in the municipalities are neither exposed, nor analyzed for the makers of the agro forest sector. That is why, at local level the municipal governments neither use, nor value this information for the elaboration of the strategies of local development and the territorial order, as a necessity in the upgrade of the economic pattern of the country.

The analysis of the results of the monitoring carried out in the last years defined as problem to innovate or to solve that: the inadequate evaluation of the criteria and indicators don not allow to obtain results on scientific bases that guarantee a correct valuation of the behavior of the same ones to define if the forest management is sustainable, that is why the objective of the work is to evaluate and value correctly the behavior and performance of the sustainability criteria and indicators in the municipality "Palma Soriano."

2. MATERIALS AND METHODS

2.1. General Characterization of the Study Area

The municipality Palma Soriano is located on the center of Santiago de Cuba province. For its extension it is the third in the province with 928.4 Km² that represents 13, 67% of the provincial territory and it is located inside the basin of the Cauto river, which is the one of more extension in Cuba. The forest patrimony has 22793.30 ha, from them 21927.70 are covered of forests, where the natural forests (17921.20) represent 82%. It possesses a forest index of 25.4%.

The characterization of the municipality and the cartography was obtained from the Plan of Territorial Classification, facilitated by the Municipal Office of Physical Planning. The information to elaborate the database was obtained of the statistical models of production and the Forest Dynamics from the State Forest Service of the municipality Palma Soriano and Santiago de Cuba province.

2.2. Methodological Foundation

For the selection of the criteria and indicators and verifiers was revised the methodology proposed by [Herrero \(2005\)](#) from which were used for this research 5 criteria, 14 indicators and 22 verifiers, the same ones were monitored for a 10 year period.

To value the performance of the criteria and indicators was used the qualification chart proposed by [Gómez \(2012\)](#) and it was used as tool the sustainability graphs recommended by [Picado and Sepúlveda \(1998\)](#) and [Masera et al. \(1999\)](#).

3. ANALYSIS AND DISCUSSION OF THE RESULTS

3.1. Evaluation of the sustainability behavior and performance of criteria and indicators in the municipality of Palma Soriano

3.1.1 Criterion I. Forest Covering

In the analysis of the monitored indicators is observed that the total covered area shows a tendency to be increased, however it is not possible to cover the potential surface, the percentage relationship between the total

covered area and the potential surface in every year was above 95%, the range of the total covered area that did not reach the potential surface oscillates between 347, 7 ha in the year 2005 and 976, 6 ha in the year 2011. Also the planted and achieved surface in the evaluated period was below of the planted surface, the best percentage of effectiveness, was in the year 2011, with 78%.of achievement.

The achievements are related with the survival of the plants. In this period the biggest value belonged to the year 2011 with 79,6%. In the same way, the percentage of survival in other years showed values below 80%, evidencing the drop quality of the plantations. Keeping in mind that the regulations of the forest State Service, starting from the made counts of survival, the plantations are evaluated to grant the allowance, which is assigned in the measure that bigger percentages of survival are obtained.

The main causes that originated the low achievements in areas and survivals of the plantations were: intense periods of droughts, the uncontrolled shepherding and the conflicts with the owners of the forest areas. These indicators are outstanding because they define the areas that incorporate to the forest patrimony of the municipality as established plantations.

Figure 1 shows that the Total Area Covered (TAC), Third Count Achievement (TCA) and Third Count Survival (TCS) indicators have not been sustainable over time, these indicators obtained a weak performance evaluation. The Forest Index (FI), shows an outstanding performance evaluation.

The evaluation of the performance of the criterion Forest Covering in the period was weak, it is recommended to make an analysis of the Forest Program of the municipality, to order the forest patrimony and to carry out an objective planning of the reforestation areas.

The analyses show that it is insufficient the quantity of young plantations that incorporate, which could contribute to diminish the exploitation of the natural forests of the municipality. According to [FAO \(2016\)](#) the natural forests contribute to the conservation of the diversity of the genotypes and the maintenance of the natural composition of the arboreal species, to the stability of their structure and the ecological dynamics. The planted forests usually settle down as production forests or with the purpose of protect the floor and the water. Appropriately negotiated, these can provide several products, services and to contribute to reduce the pressure on the natural forests.

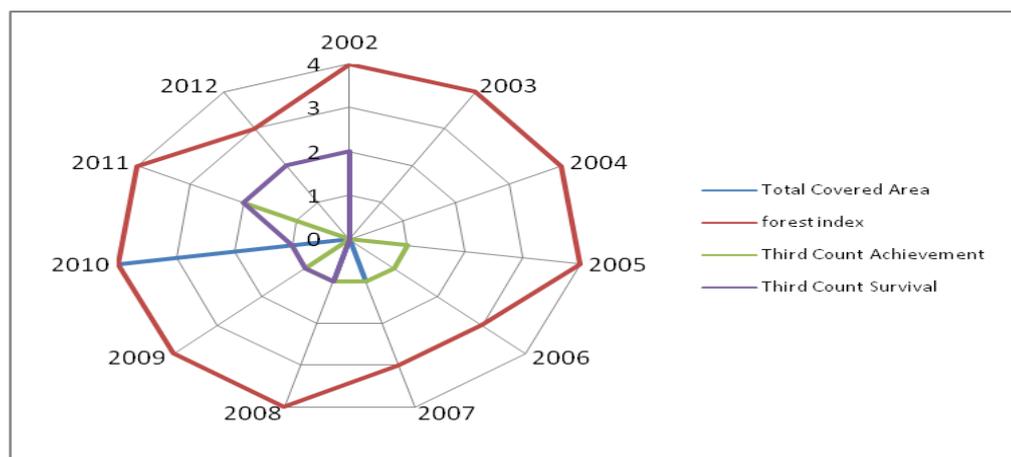


Figure-1. Graph of sustainability of the indicators for the criterion Forest Covering.

Source: Own elaboration.

3.1.2. Criterion- II. Health and Vitality of the Forest Ecosystems

The affectations caused by the forest fires only happened in the years 2004 and 2010, however although the number of fires is not significant, the traveled and damaged surface is above 2 ha, for each 1000 ha of covered surface with forests, being affected 97 ha in this period. The figure 2 shows that all the indicators have an evaluation of excellent performance.

The use of the fire in the agro forest activity is one of the factors that generates a significant number of fires, nowadays its prevention, depends on a correct application of the techniques and prescriptions of burning, an appropriate application of the Forest Law and an opportune control by the forest rangers.

Other indicators as: necessity of silvicultural management in the forests show that the application of the silvicultural treatments (silvicultural clean, prunes, thinning, reconstruction or enrichment of forests) behave in a satisfactory way, during every year, because its execution is carried out according to the planning and the annual necessity of the Forest Program.

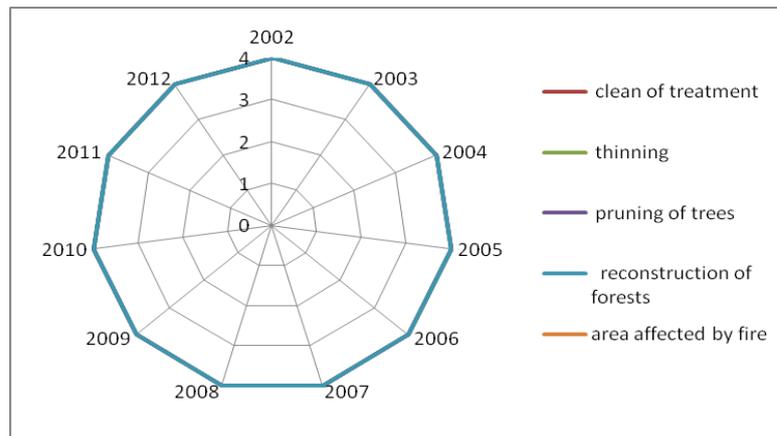


Figure-2. Graph of sustainability of the indicators for the criterion: Health and vitality of forest ecosystems.
Source: self made.

The evaluation of the criterion Health and vitality of the forest ecosystems in the period was excellent.

3.1.3. Criterion-III. Contribution of the Forest Ecosystems to the Environmental Services

The evaluation of the indicator: Protection of the bodies of water for the case of the dams, showed that the protected surface of the reservoirs during eight years stayed below the tendency line, in the last two years it is increased, being achieved until 97% of the surface to protect of the dams, lacking to reforest 44,2 ha, however the protected surface of micro dams, only reaches 4,8%, being very below to the plan in regard with the surface to protect of micro dams.

In the case of the surface to protect of rivers, stays during several years below the tendency line, starting from the year 2010 an increment is appreciated until reaching the 92% of the surface total to protect, lacking 67,2 ha to reforest.

The protected surface of rivers and dams obtained an evaluation of favorable performance; however the protected surface of the micro dam obtained an evaluation of extremely weak performance. Therefore the protection indicator of the bodies of water showed an evaluation of extremely weak performance. Considering the importance of the indicator to the performance evaluation of the criterion: Contribution of the forest ecosystems to the environmental services (figure 3), showed an evaluation of extremely weak too.

The micro dam of the municipality is located in the areas of the patrimony of the livestock enterprises and agricultural crops, these protection areas have suffered a drastic reduction because of their pruning and fire.

Historically the farmers, peasants or small producers show an incompatibility between the forest component and the agricultural one, to change this perception can be a slow and difficult process because the traditional use of the earth and the management of the natural resources are firmly established and socially ingrained in these communities. This situation requires motivating the environmental education and the agrarian extension to introduce technologies of systems of agro silvopastoral production. Thus, promoting the importance that has the protection of the micro dams as source of supply of water for the livestock and the self-consumption of the farms as

well as the necessity of reforesting them to avoid that the erosion and the sedimentation diminishes its capacity of storage of water.

In the long process of deforestation through which the island of Cuba traveled for more than four centuries, the most affected areas were undoubtedly the river banks. Some of the reasons were: good soil fertility (for agricultural use), proximity to the water, cutting of trees of first quality, among others. In this way thousands of hectares of forests disappeared, mainly the riparian forests, surrounding to the bodies of water. In the case of the municipality Palma Soriano, in the river bank of the Cauto River and its secondary tributaries, develops all the economic, social and cultural life of the municipality and in particular of the city of Palma Soriano. The rivers in the mountainous and urban area constitute its main source of water supply.

Nowadays, the supply of water to the population has become one of the priorities for the local government, the extensive periods of drought, the contamination of the waters; make every day to be more difficult to supply water to a growing population, the industries and the agriculture. Therefore it should be considered the valuation of this indicator to give the evaluation of the performance of the criterion III.

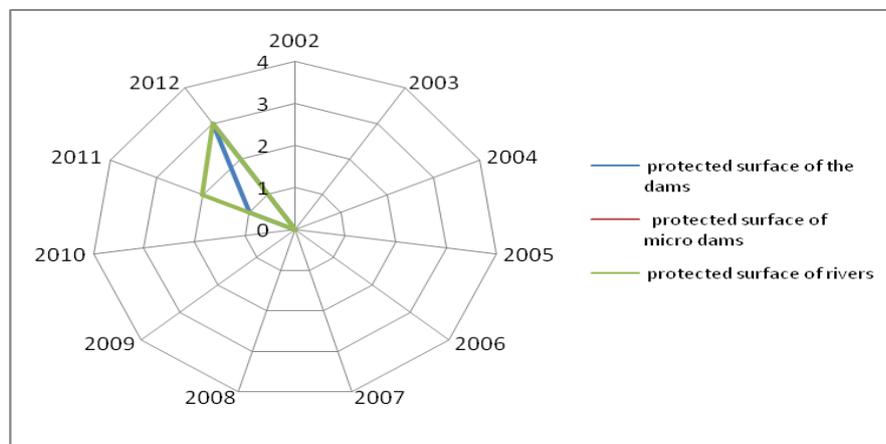


Figure-3. Graph of sustainability of the indicators for the criterion: Contribution of the Forest Ecosystems to the Environmental Services.
Source: Own elaboration.

3.1.4. Criterion- IV: Productive Work of the Forest Ecosystems.

The indicator: Executed Annual Pruning (EAP), overcomes the Permissible annual Pruning (PAP), its tendency is to diminish, but in every year the executed pruning was above the sustainable exploitation, therefore the index of total sustained yield was above one. The sustainable forest management requires defining the cutting of trees and the investment to replace them.

The extracted wooden volume of the natural forests manifested a tendency to the increment, although in the year 2005 show a decrease, with 2,9% of the extracted volume. In next year increases the percentage registering the biggest values in the years 2006, 2007, 2011 and 2012 with 54,8; 58,5; 63,2 and 71,5% respectively.

In the same way, the managed surface as Agro silvopastoral Systems shows an increment, however it is below the existent potential surface because the managed surface of Forest farms is bellow of the potential surface.

The forest farms are the only type of agro silvicultural systems in the municipality, most of them do not fulfill the principles that regulate these systems, neither are controlled, nor evaluated the productive results, nor the environmental and social impact of these farms where they are located, to know its state and to recommend new management. The agro silviculture can be the best option before the deterioration caused by the migratory agriculture, very used in the mountainous areas of the municipality and that affects the coffee production systems.

Although the tendency of the number of forest farms is to increase discreetly in the municipality, it is clear that it does not exist a strategy that allows reaching sustained yields. The potential of existent surface in the municipality to manage all its diversity in the different agro silvopastoral methods does not take advantage, what

does not allow the investigation of auto sustainable combinations under local conditions, the rescue of conservation practices ; the diversity of production of foods and the maintenance of the linking from the man to their forest property. In this way, men could protect and take care of the forest resources to sustain their environment.

In the report *El estado de los bosques del mundo* (FAO, 2014) data are analyzed about the socioeconomic benefits of the forests. The data gathered by the OIMT and the FRA make reference to the local population's rights and the forms in which they participate in the administration of the forests. Nevertheless, the same as with the distribution of the benefits, most of the proportionate information is qualitative and not quantitative, and it follows a focus centered in what should happen more than in measurable results.

The figure 4 shows that the Index of Sustained Yield (ISY) had an extremely weak performance and the extracted wooden percentage of the natural forests obtained an evaluation of satisfactory performance. The indicator: agro silvopastoral systems presented an evaluation of the weak performance. In general the criterion Productive Functions of the Forest Ecosystems was evaluated with a weak performance.

To achieve a sustained production and to maintain the forests of a certain territory, it cannot intersect a bigger wooden volume to the equivalent of the annual increment; this is known as Sustained Yield. The "permissible annual cut of trees " or sustainable volume is the equivalent to the annual total increment of the forests of a certain territory, expressed in m³ per year. Equally the extracted wooden percentage of the natural forests should not exceed 60%, In the case of this municipality this topic charges bigger importance because the biggest wooden quantity that is planned to extract comes from the categorized forests as protective and in its majority they are natural. The Index of Sustained Yield (ISY) had an extremely weak performance and the extracted wooden percentage of the natural forests obtained an evaluation of the satisfactory performance. In this case the criterion is evaluated by the smallest performance; therefore it is proposed as extremely weak the evaluation of the criterion Productive Functions of the Forest Ecosystems. The evaluation of the performance of the criterion Productive Functions of the Forest Ecosystems was weak.

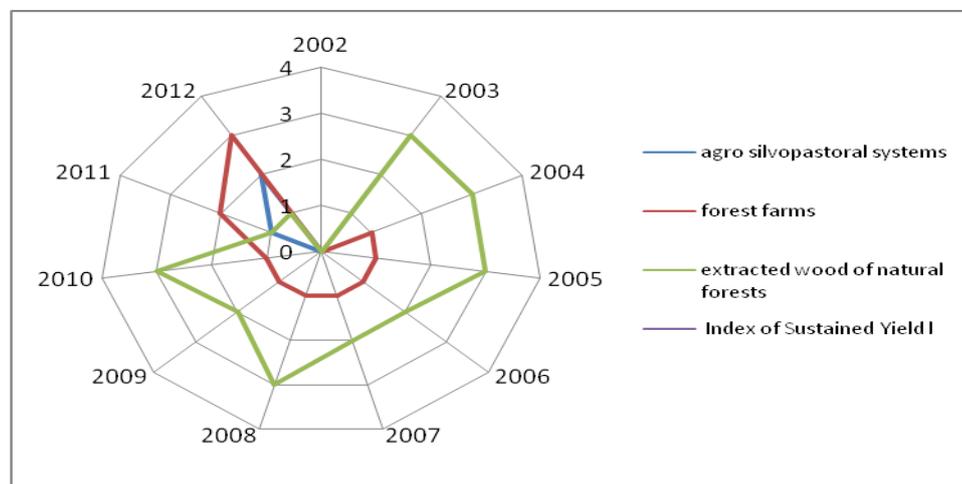


Figure-4. Graph of sustainability of the indicators for the criterion: Productive Functions of the forest ecosystems.

Source: Own elaboration.

3.1.5. Criterion-V. Multiple Socio Economic Benefits to Cover the Necessities of the Society. Its Maintenance and Improvement

The figure 5 shows that the indicator: accidents of the work in a general way showed an evaluation of the favorable performance. The evaluation of the performance of the criterion: Multiple socio Economic benefits to cover the necessities of the society. Their maintenance and improvement in the period were favorable, although it is not taken into account, neither the behavior of the half wage, nor the value of the forest production, for not having scale of valuation. However it is recommended to study and research to value them, because they are fundamental

indicative to define the sustainability of this indicator. According to [FAO \(2014\)](#) although it is gathered information systematically on the environmental and economic aspects of the forest administration, the measurements of the social or socioeconomic benefits that are obtained of the forests is much more complicated due to the shortage of data and to the lack of a clear definition of what exactly should be measured.

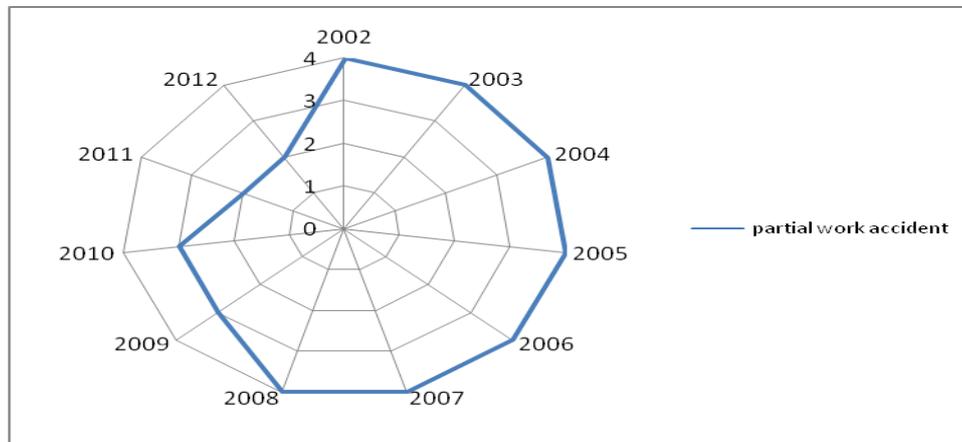


Figure-5. Graph of sustainability of the indicators for the criterion: Multiple socio Economic benefits to cover the necessities of the society. Its maintenance and improvement.
Source: Own elaboration.

In accordance with the previously raised and keeping in mind the evaluation of the performance of the C&I in the municipality "Palma Soriano", Santiago de Cuba, is inferred that a SFM has not been reached, that's why it makes necessary according to [Caswell \(2014\)](#) to facilitate a mark or base:

- To establish a common conceptualization of SFM at world level and, in turn to catalyze better politicians, programs and forest strategies.
- To increase the information and appreciation of the benefits and values of non timber of the forests.
- To improve and to enlarge the control processes and forest evaluation.
- To elaborate plans and norms of forest management and to supervise their execution.
- To communicate the tendencies registered under the conditions from the forests to the leaders and the general public.
- To begin communication and dialogue with the interested actors.
- To improve the databases, inventories and forest systems for the summary, administration, obtaining, upgrade and analysis of data.

In Cuba, similar studies have been carried out in different municipalities and at national level for the State Forest Service. The investigations referred to the topic of criteria and indicators have been directed to the methodological proposals to evaluate them. Their evaluation at local level (municipality), constitutes a tool for the Council of the municipal Administration, providing them a format of the management of their forest resources, for the formulation of effective policies, by the local governments in the municipality. It also offers elements to evaluate the projects of non farming cooperative and private sector which should have an appropriate environmental focus, to guarantee the sustainability of the same ones.

These results have been used as tool in the elaboration of the methodological proposal to measure the indicators of local development in the municipalities of Santiago de Cuba province, in its environmental dimension. This investigation is carried out by the Universidad de Oriente and the Municipal University Centers of the province

4. CONCLUSIONS

The valuation of the behavior and performance of sustainability of the criteria and indicators in the municipality "Palma Soriano", allowed defining:

1. The criteria Forest Covering, Health and vitality of the forest ecosystems, Contribution of the forest ecosystems to the environmental Services, Productive Work of the Ecosystems Forest and Multiple socioeconomic benefits to cover the necessities of the society. Their maintenance and improvement, showed an evaluation of performance "weak", "excellent", "extremely weak", "weak" and "favorable" respectively.
2. The evaluation of the criteria and indicators of the Forest Management In the municipality "Palma Soriano", Santiago de Cuba province has not been sustainable.

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