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Research Paper

Evaluation System Proposal for Sustainable Forestry Development in Mexico

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Abstract: Sustainable development is an ecological process that meets the needs, desires and interests of the community, and at the same time achieving conservation of natural resources and an improvement in the condition of the environment. The objectives of this study were: a) to design a hierarchal system of criteria and indicators in order to evaluate the sustainable development at the basin level in cold-temperate forests, and b) to evaluate the actual level of sustainable development in the Chihuahua Basin, which will serve as a basis for later evaluations at the national level and as an international reference. The proposed model is based on three fundamental characteristics: strategic thinking, holistic focus, and democratic participation. From the review and analysis of experiences generated at the state, national, and international levels, the basis for the criteria and indicators hierarchal system for the evaluation of sustainable forestry development in the Río Papigochi Basin, Chihuahua, Mexico was determined. The hierarchal system of criteria and indicators consists of four areas of study and evaluation: Socio-economic, ecology and environment, institutional policy, and culture and self management. Each area has diverse number of principles, criterions, indicators and verifiers. For the acquisition of the final quantitative structure of the ideal ratings, real ratings, and contributions, software was developed using Delphi programming. The information generated by the hierarchal system structure was entered into the database, the ideal rating decided upon during a participatory workshop, and finally, the rating was obtained from the verifiers in the survey and from direct feedback.

Key words: Sustainable development, evaluation system, criteria and indicators, hierarchal system, forest management, community development.

Introduction

Since the 1990s, the international community has searched for solutions to the problem of accelerated environmental deterioration. Due to this situation the Earth Summit, United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro, Brazil in 1992. This conference was the largest gathering of world leaders up until that time for the purpose of discussing the relationship between the environment and development, what is now called sustainable development (SD). In this context, UNCED focused the world's attention for the first time on the development of sustainable forestry as a fundamental component of sustainable development (Wijewardana et al., 1997).

After UNCED, a working group about criteria and indicators (C&I) for the conservation and sustainable management of temperate and boreal forests was formed in Geneva in June, 1994, now known as the Montreal Process. The proposal of the development work was centered on the development of internationally accepted C&I applicable at the national scale for the conservation and sustainable development of temperate and boreal forests (Wijewardana et al., 1997). After this event, the formulation of C&I was replaced by the more commonplace definition of the evaluation of sustainable forestry of later internationally celebrated processes, for example, the Santiago Declaration, 1995; the Tarapoto Proposal of Criteria and Indicators for Sustainability of the Amazon Forest, 1995; the Dry-Zone Africa Process, 1995; the Near East Process OAM, 1996; and the Lepaterique Process of Central America, 1997.

Some of the experiences related to the evaluation of sustainability through criteria and indicators in Mexico are: the Indicator-based Framework for Evaluation of Natural Resource Management Systems (MESMIS - *Marco para la Evaluación de Sistemas de Manejo Incorporando Indicadores de Sustetabilidad*), the Monarch Butterfly Model Forest in Michoacán, the evaluation system for sustainable development in the Chihuahua Model Forest (CMF), and the use of the CIFOR methodology in the *Ejido El Largo* and *Anexos municipio de Madera, Chihuahua* among others.

Objectives

a) Design a hierarchal system of C&I in order to evaluate the SD at the basin level in cold-temperate forests.
b) Evaluate the actual level of SD in the Chihuahua Basin, which will serve as a basis for later evaluations at the national level and as an international reference.

Background

Sustainable development. Sustainable development "is a continuous, dynamic socio-ecological process that meets the needs, desires and interests of the community, and is characterized by its search for ideal future development with a holistic focus and, at the same time, achieving conservation of natural resources and an improvement in the condition of the environment. In this process, the community must be the principal player - actively participating in the decision-making process for the design, implementation, and control in the development plans, projects, and programs since they live with the consequences and effects of whatever action undertaken in their community" (Luján and Magaña, 1999).

Another definition associated with the concept of sustainable development is Sustainable Forest Management (SFM). This is not a new concept, its origins date back to 15th century in Europe. The concept of SFM and well-managed forests has been adapted to the ideas and needs of society throughout its history. Its real significance at this time is the result of discussion and compromise among interested parties. Historically the concept of SFM has evolved from sustainable timber production to its present meaning, which denotes sustainability in all forest functions (Groot, 1994).

Philosophical basis of the evaluation model. The philosophy of the sustainable development strategic evaluation model focuses on three fundamental characteristics: strategic thinking, holistic focus, and democratic participation. The model considers the community, i.e., the people who live and interact with the natural resources, to be the principal players in sustainable development.

Components of the hierarchal system of evaluation. Principle: The fundamental law or rule serving as a basis for reasoning and action. The principles can be an objective or an attitude relating to the function of an ecosystem, or can refer to the forest as a relevant aspect of the social system that works reciprocally with the ecosystem. The principles are the explicit elements of the goal.

Criterion: The state or phase of the dynamic process of the forest ecosystem, or the state of the interacting social system that acts reciprocally and should be in place as a result of adhering to a principle. The way that criteria are formulated should give rise to a verdict in relation to the level of compliance in an actual situation (Lammerts van Bueren and Blom, 1996). A criterion is considered as a second order principle that incorporates direction and operationality of a principle that without itself would only be a direct measurement of behavior (Prabhu et al., 1996).

Indicator: An indicator is a qualitative or quantitative parameter that can be evaluated in relation to a criterion. It objectively and unambiguously describes the characteristics of an ecosystem or related social system, or the elements of management, the policies in force and the processes directed by man, and indicative of the eco-social situation (Lammerts van Bueren and Blom, 1996). It is whatever variable or component of the forest ecosystem or the management system utilized in order to infer the status of a particular criterion (Prabhu et al., 1996).

Verifier: A verifier is a source of information for the indicator or for the referential value of the indicator (Lammerts van Bueren and Blom, 1996). Verification constitutes a piece of information that improves the ease of measurement of an indicator. In reality, a verifier is used to measure indicators in the field (Prabhu et al., 1996).

The National Context of Sustainable Forest Development. The Undersecretary of Ecology was created in Mexico in the 1980s. The General Law of Ecological Equilibrium and Environmental Protection (1988) and the National Water Commission were established as decentralized organisms of the federal government. Environmental policy was unified with the 1992 creation of the National Institute of Ecology (*Instituto Nacional de Ecología*, INE), the Environmental Protection Federal Office (*Procuraduría Federal de Protección al Ambiente*, PROFEPA) and the National Commission for the Knowledge and Use of Biodiversity (*Comisión Nacional para el Conocimiento y Uso de la Biodiversidad*, CONABIO). Additionally a new Forest Law was created that same year; which for the first time incorporated the concept of sustainable forestry management.

Within modern long term policy, the federal government has declared the forest and its interrelation with water, as a primary matter in national security. Due of this, the Strategic Forest Program for Mexico 2025 was created (*Programa Estratégico Forestal para México 2025*, PEF 2025). In addition, there is the National Environment and Natural Resource Program 2007-2012 actualizar 2007-2012?? (*Programa Nacional de Medio Ambiente y Recursos Naturales*, PNMARN) whose principle purpose is constructing new environmental policy for Mexico, fulfilling the expectations of the changing population. As a result of this, Mexico approved the General Law of Sustainable Forestry Development in 2003. This law brought about the favorable establishment of sustainable management for Mexico's forest resources.

Evaluation of sustainable forestry development

Experiences at the international level. There are various experiences at this level; among these are some that stand out: "Social criteria and indicators for sustainable forest management – a guide to ILO texts," (Poschen, 2000); criteria and indicators of the Center for International Forestry Research (CIFOR) (Prabhu et al., 1996); the Helsinki Process (Leal, 1997); criteria and indictors and pan-European general directives (Third Ministerial Conference on the Protection of Forests in Lisbon 1998); the Montreal Process (Buchanan, 1999); the Santiago Declaration (Buchanan, 1999); the criteria and indicators for the African Dry Zone, Near East, the African Timber Organization (Wijewardana et al.,1997); the Tarapoto Proposal for the Amazon (Wijewardana et al., 1997) the Lepaterique Central American Process (Salas 1999). In any case, there are operational processes such as forest certification by the Forest Stewardship Council (FSC) (Lammerts van Bueren and Blom, 1996) and the international standards promoted by the International Organization of Standardization (ISO) (Lammerts van Bueren and Blom, 1996).

Experiences in Mexico. Various experiences have been created such as the MESMIS methodology (Masera and López, 2000); the evaluation carried out at Ejido el Largo, municipality of Madera, Chihuahua (Narváez et al., 2004) and those created at the Chihuahua Model Forest (CMF) in the state of Chihuahua (Luján et al., 2004; Alcalá, 2002).

Frame of reference for the study area. The area of the Basin that pertains to the state of Chihuahua is 14,994.1 km^2 of the total 71,776 km^2 that make up the Yaqui River Basin. For this study, the area of the Basin that begins in the east central part of the Ocampo municipality and the highlands of the Guerrero municipality where runoff is generated to create the Río Papigochi are

being evaluated. In this area, development includes agricultural and forestry activities such as wood production (in the high part of the sub basin), cattle growing, seasonal agriculture, and fruit growing (in the Irrigation District 083) (INEGI and State government of Chihuahua, 1999).

Martial and Methods

Study description

The hierarchal system of criteria and indicators consists of four areas of study and evaluation: Socio-economic, ecology and environment, institutional policy, and culture and self management. This study was funded by CONAFOR – CONACYT.

Design of the hierarchal system

Basis of the Criteria and Indicators Hierarchal System. From the review and analysis of experiences generated at the state, national, and international levels, the basis for the criteria and indicators hierarchal system for the evaluation of sustainable forestry development in the Río Papigochi Basin was determined, principally by the criteria and indicators developed by Luján et al. (1999) for the Chihuahua Model Forest.

Additions, modifications, and redefinitions of criteria and indicators of the hierarchal system. First, an Access database was developed where a selection was made of all of the principles, criteria, indicators, and verifiers that were found in the process of identification of experiences generated at the state, national and international levels, and those which could make a contribution to the hierarchal system. Later, the principles, criteria, indicators, and verifiers were analyzed in accordance with the distinguishing features of the hierarchal scheme of vertical and horizontal congruence. Through these process additions, modifications, and redefinitions of the hierarchal system that shaped the first hierarchal system of criteria and indicators in agreement with the conditions in the Río Papigochi Basin were identified. The hierarchal system obtained was then introduced in a participative consolidation workshop.

Consolidation/strengthening of the hierarchal system

Consolidation workshop participants. *Ejidos*, communities, small property holders, non-governmental agencies, representatives from municipal, state and federal government, educational institutions and others that participate internally or externally in sustainable forestry development in the Río Papigochi Basin.

Ideal and actual assessment of the hierarchal system

Methodology of ideal assessment of the hierarchal system. According to Luján et al. (1999), for sustainable forest development to adapt itself to the environment, it is necessary that the most important element - the community – participates in decision making and that they participate in the evaluation of the environment by contributing their own criteria. In order to facilitate the process, a participative workshop was carried out in the city of Guerrero, Chihuahua. The objective of the workshop was to consolidate the proposed hierarchal system, giving it an ideal assessment in accordance to the criteria set by the participants.

Areas and principles. This exercise consisted of a planning session that created a percentage rating for each of the four areas, according to the importance of each area's contribution to the attainment of sustainable forestry development according to the criteria of the participants in the workshop. In that respect, the sum total of the percentages given for each area must be 100%. This assessment dynamic repeats itself for each of the principle levels with the condition that the sum total of the principles for each area represents a 100% rating to be established (see example in Figure 1).

Criteria, indicators, and verifiers. The methodology for the assessment of criteria, indicators, and verifiers was developed in accordance with the assessment dynamic for areas and principles. A rating of 100% was established for all criteria pertaining to each principle and so on for all of the indicators of a criterion and all of the verifiers for an indicator. This was brought about through the use of working groups, which relied on the support of a facilitator.

Methodology of real assessment of the hierarchal system. Two actions were orchestrated in order to determine the real assessment of the hierarchal system. First, surveys were designed as a basis to the quantitative elements that form the hierarchal system at the verifier level. Verifiers, by their very nature, cannot be assessed through a survey, particularly in the environment and ecology area; therefore an investigation of official statistics from diverse federal institutions was carried out. Also there was an analysis made of the information generated by the ecological and environmental components and of the information generated from studies of forestry management programs of the properties located within the study area.

Design and implementation of the surveys. The first step in the design of the surveys consisted of incorporating all of the questions used in the surveys carried out in the Chihuahua Model Forest (CMF), in accordance with the verifiers retained from this process in the hierarchal system. After this step, their suitableness was determined according to the modifications to the base structure CMF of the hierarchal system. In the case of the verifiers whose origins were not from the CMF and were assessed by survey, a draft of the rating questions was created according to the nature of the verifier. The final surveys were obtained from this process.

The required number of surveys was established according to the formula:

$$n = \sqrt{N} + 1,$$

Where n = sample size and N = the finite population (Magaña, 2000, cited by Carrillo, 2004), resulting in a total of 153 surveys. With the information obtained from the surveys, information processing proceeded.

Real rating of the different components. The real rating criteria varied according to the nature of the verifier and from where the information was gathered. For example, in the environment and ecology area results based on the statistics from national (CONAFOR, SEMARNAT, PROFEPA, and CONABIO) and international (FAO) institutions were found, such as those generated by the environment and ecology component. Additionally information obtained from the interview process was used.

Software design for the quantitative identification of the hierarchal system components

For the acquisition of the final quantitative structure of the ideal ratings, real ratings, and contributions, software was developed using Delphi programming (Figure 2). The information generated by the hierarchal system structure was entered into

the database, the ideal rating decided upon during the participatory workshop, and finally, the rating was obtained from the verifiers in the survey and from direct feedback.

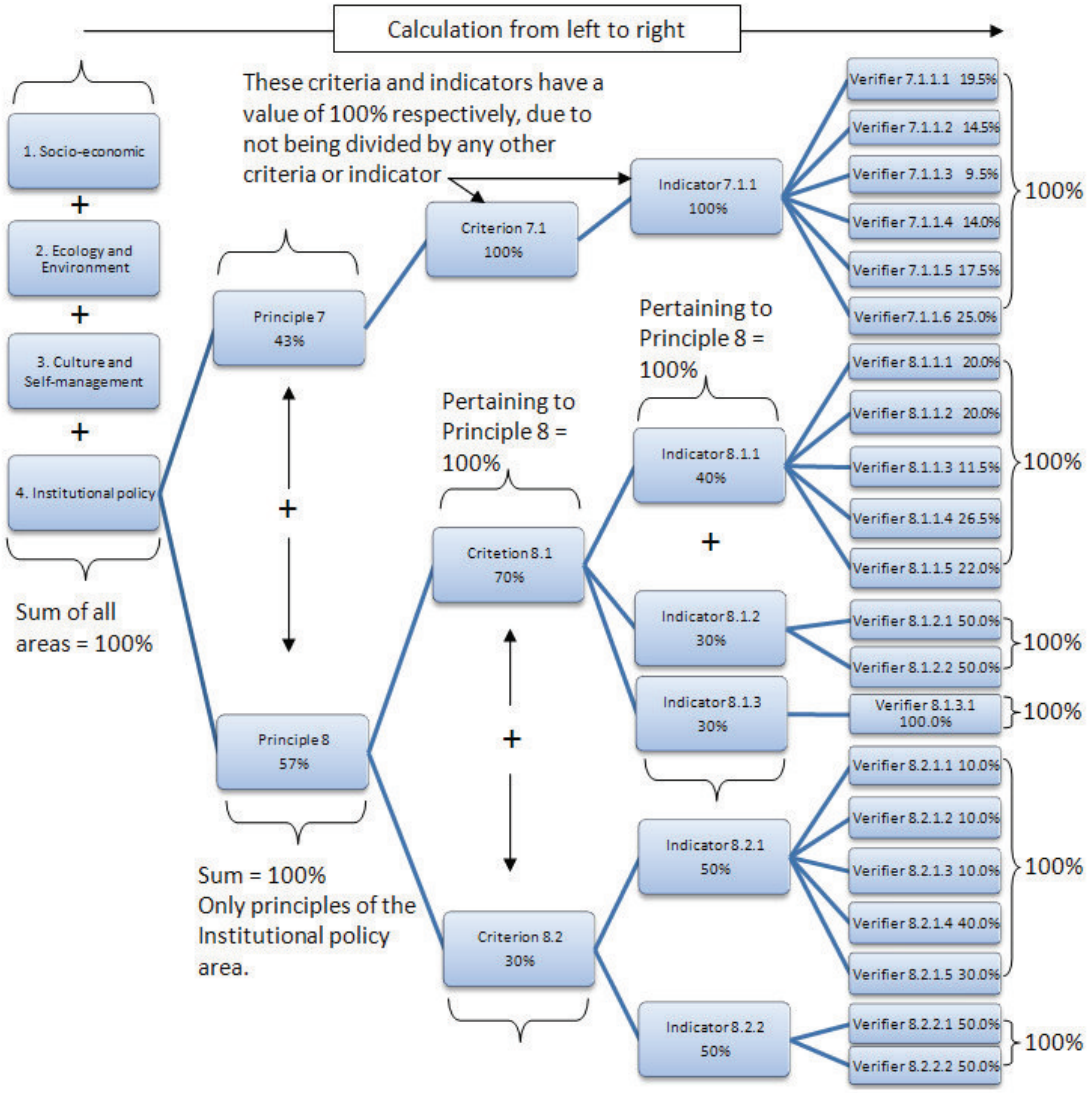

Figure 1. The integration and contribution of the different levels of standards for the sustainable development strategic evaluation

Measurement criteria for the sustainable development level

After obtaining the ratings of the verifiers, indicators, criteria, principles, and areas, the evaluation scale generated at CMF was utilized. (Table 1)

Table 1. Sustainable development valuation scale (CMF)

Sustainable Development type	Range (%)
Optimum	90-100
Good	80-90
Average	65-80
Poor	50-65
No development	<50

Results

With the goal of achieving the objectives presented in this study, a hierarchal system of criteria and indicators was established for the area of study: the sub-basin of the Río Papigochi. These criteria and indicators were designed to evaluate the sustainable forest development consistent in the four areas, eight principles, 23 criteria, 48 indicators, and 110 verifiers.

The Profile of Sustainable Development

The hierarchal system of criteria and indicators define the profile of sustainable development through a scale that identifies the ratings of sustainable development (Figure 1) according to the ratings obtained from the four areas and their sustainability

principles, which determine the context of the system (area of influence) and environment. The areas are: socio-economic, ecology and environment, culture and self government, and institutional policy (Figure 2).

It was observed that in general, the rating obtained in the study area within the sub-basin of the Río Papigochi shows that its sustainable development is in a "poor" condition. This is explained due to the socio-economic area receiving a contribution rating of 57% which means that the economic and social activities for development in those communities within the study are "poor." There is little harmonious development between the human dimension and the environment. According to testimonial evidence, the community is not responsible for the management of natural resources in respect to their integrity. In addition, low indices were identified regarding quality of life (employment, malnutrition, and housing). This situation does not contribute to community development.

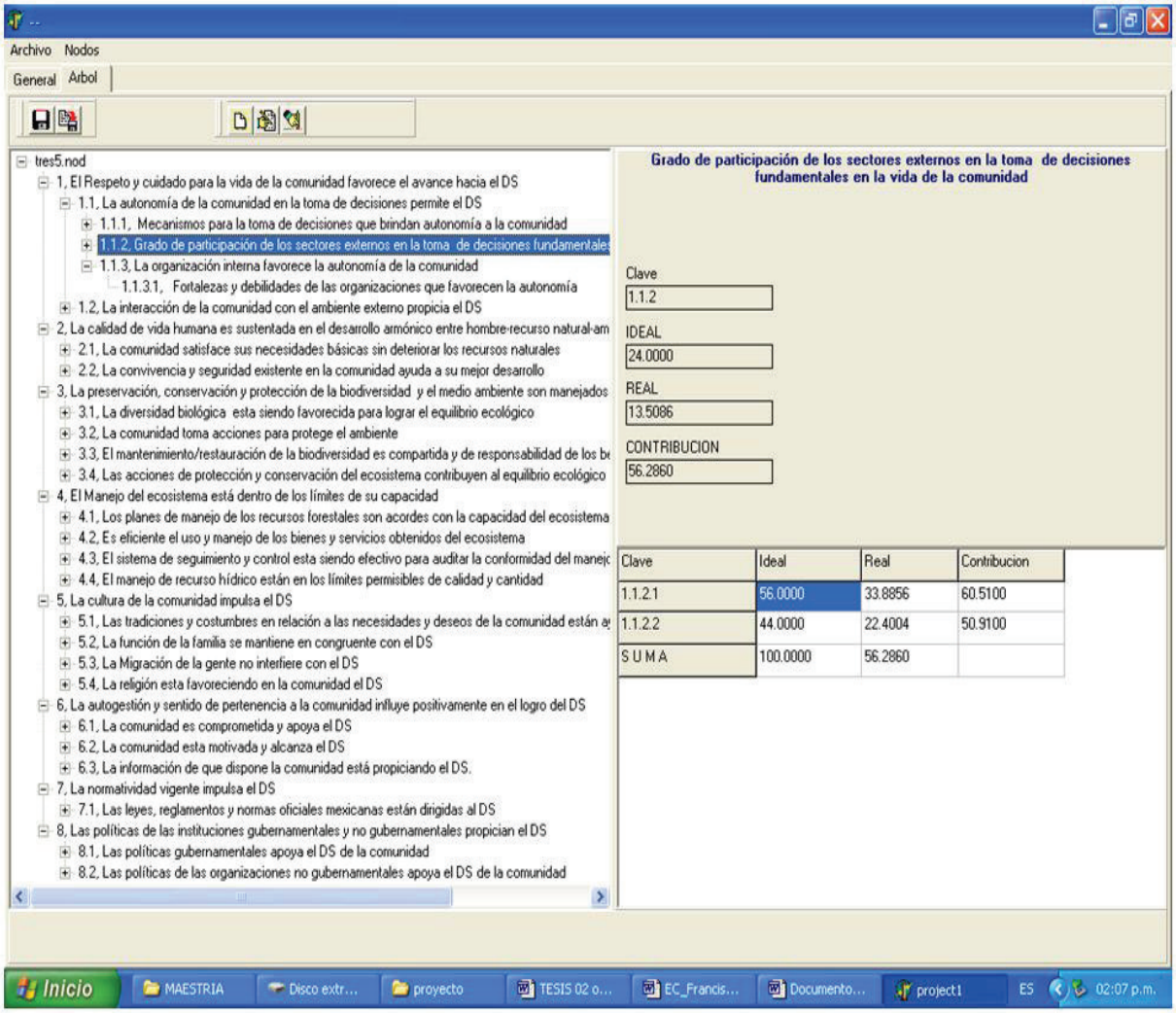

Figure 2. Software screen shot of the quantitative component of the hierarchical system; form for the structure of areas, principles, criteria, indicators and verifiers

In the case of the institutional policy area, a contribution rating of 13% was obtained. This rating falls into the "no development" range, which is to say that the policies and programs that are intended to benefit the communities within the Río Papigochi Basin are not well directed or at least that is the opinion of the inhabitants. The community evidenced a lack of knowledge of the legal ordinances – laws, regulations, and standards – in environmental matters. This is the reason why the policies and programs from governmental and nongovernmental agencies are not contributing in agreement with the communities within the area under study.

The ecology and environmental area, according to the evaluation, had a rating of "poor." This situation such as this constitutes a 59% contribution (Figure 2). Principle 3, "The preservation, conservation, and protection of biodiversity and the environments are managed satisfactorily by the community" and principle 4, "The management of the ecosystem is within the limits of its capacity" define the rating of sustainable development in question as "poor." Respectively, principle 3 shows a "no development" rating and principle 4 has an "average" rating. This is owing to the decrease in vegetative cover, the presence of soil erosion, and the endangerment of wildlife. The actions undertaken to stabilize and improve the previously mentioned environmental conditions have not had the desired effect. This represents an intermediate state on the scale of the sustainable development profile.

The culture and self management area has a sustainable development rating of "average." Principle 5, "The culture of the community promotes sustainable development," and principle 6, "The community's self management and sense of ownership positively influences the success of sustainable development" have a contribution rating of 67.11% ("average" development) and of 63.88% ("poor" development) respectively. As previously inferred, principle 5 determines the average tendency for the level of sustainable development in the area. Due to the community's self management and sense of ownership does not positively influence the success of sustainable development because the current organizational structure is not facilitating community participation due to lack of legitimacy (individual decision-making). Moreover, the community is not motivated to work with philosophy of sustainable development due to lack of information.

Table 2. Profile of sustainable development of the four areas that make up the Río Papigochi, Chihuahua sub-basin

Area					Principle				
_____	Ideal %	Real %	Contribution %	Sustainable Development Rating %	___	Ideal %	Real %	Contribution %	Sustainable Development Rating %
Socio-Economic	24.00	12.90	51.00	Poor	1	45.00	25.03	55.62	Poor
					2	55.00	30.38	52.24	Poor
Ecology and Environment	23.00	14.00	59.00	Poor	3	42.00	18.90	45.00	No development
					4	58.00	40.10	69.10	Average
Culture and Self-Management	31.00	20.00	65.50	Average	5	50.00	33.55	67.11	Average
					6	50.00	31.94	63.88	Poor
Institutional Policy	22.00	3.80	17.00	No development	7	43.00	3.11	7.24	No development
					8	57.00	14.18	24.88	No development
Total	**100.00**	**50.70**		**Poor**					

Conclusion

1. In general, the hierarchal system of criteria and indicators developed identified the study area of the Río Papigochi Basin as being in a "poor" state of sustainable development.
2. The ecology and environment area is identified as having a poor state of development. This was determined mainly because the preservation, conservation and protection of biodiversity are not being managed satisfactorily by the community.
3. The actions undertaken to stabilize and improve environmental conditions (decrease in vegetative cover, increased erosion, and endangerment of wildlife) have not had the desired effect of stopping the deterioration of the natural resources.
4. The present forestry management programs do not unite the components needed to support sustainable forestry development. The dimensions in which these studies are concentrated show that the technical and economic aspects are pushing aside the socio-cultural, ecology and environment, and institutional policy dimensions.
5. The different coefficients of the processing of wood raw materials encountered highlight a deficient technological level for the tools utilized for the forest land uses.
6. The level of compliance with management programs shows incomplete function of the proposed forestry system; authorized uses are not observed and the official regulations are not being followed.
7. Diverse studies about water resources and the establishment of management and administration planning are included.
8. The area of culture and self management has an average rating of development; it is defined by the cultural values and the role of the family in order to attain sustainable development.
9. The community in general does not understand the concept of sustainable development due to a lack of information.
10. The mechanisms for sharing benefits – assemblies and neighborhood meetings – are not contributing positively to facilitate community participation in the decision making process.
11. The level of influence of the type of possession of land in development of a community is moderate. Border conflicts between *ejidos* or small properties were identified.
12. The information obtained through the survey presented the difficulty of understanding of the drafting of the questions, and in some of the occasions, in the difficulty of responding to the questions administered.
13. Software was designed and applied which has the function of performing automated quantitative identification of the hierarchal system of criteria and indicators (proportional ratings of ideal and real contribution), thus determining the profile of sustainable development of the hierarchal system. In this way, the software has the flexibility to increase or decrease the structure (areas, principles, criteria, indicators and verifiers) of the hierarchal system as appropriate to each case, so that it can be used in subsequent sustainability evaluations, adapting to the needs of each location.

Recommendations

1. It is suggested that the present evaluation model for sustainable development be applied to areas other than the Río Papigochi Basin at the state and national levels.
2. It is recommended that for future evaluations using criteria and indicators, this methodology should be used as a basis, and the possibility of simplifying the quantity of criteria and indicators to be analyzed in addition to the use of the simple language in terms of implementation of the hierarchal system, with special attention to the levels of criteria, indicators, and classifications.

3. In future evaluations of sustainable development where this hierarchal system of criteria and indicators is used as a basis, it is recommended that the rating structure in the area of ecology and the environment is perfected using this mechanism to give greater support to the rating scale.
4. Commitment is a requirement, conforming to the philosophical basis of the sustainable forestry development macro-project in the Río Papigochi Basin, and furthermore that the communities and *ejidos* involved participate in the process of the macro-project and that in the future become the principal participants in the evaluation process.
5. The inclusion of science and technology is recommended for future evaluations of sustainable development where the hierarchal system of criteria and indicators is used.

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