

Editorial Manager(tm) for IWA Conferences  
Manuscript Draft

Manuscript Number: IWA-3706R1

Title: Evaluation of the Mexican Program of Payment for Environmental Hydrological Services

Article Type: Full Paper

Keywords: Environmental Hydrological Services, Payment Program, Mexico, systemic analysis.

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Manuscript Region of Origin: MEXICO

# Evaluation of the Mexican Program of Payment for Environmental Hydrological Services

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## ABSTRACT

In the present work we intend to evaluate in systemic form the implementation process of the Mexican program of Payment for Environmental Hydrological Services (PSAH in Spanish abbreviation). During the period of its implementation of 2003-2008, it was seen that the program has not got either its environmental objectives (to stop the deforestation), or socio-economic objectives (to make the program self-sufficient and efficient). It could be possible to detect the main advances and failures of the Mexican program by the adoption and application of the four analysis criteria (operation, legislative, institutional and economic frames). In the final part it is speculated about the future of the program in Mexico and about following steps for this study, including proof interviews with decision-makers involved in the implementation process and benefits analysis to verify the real social and environmental impact of the program.

**Keywords:** Environmental Hydrological Services, Payment Program, Mexico, systemic analysis.

## INTRODUCTION

As it is known, the population growth and the urban expansion in recent years have brought about the environmental impact that is reflected in: the contamination of air, water and soil; the loss of biological diversity; the imbalance of natural cycles; the change of land use (mainly by the deforestation); with the secondary effects present, such as erosion, soil salinity and desertion. In this case it is possible to emphasize what the consequences of deforestation entail to the modification and loss of entire ecosystems and to the loss of their environmental functions and services (SA in Spanish abbreviation) that they provide to the society.

It is possible to mention that although Mexico occupies only 1.5% of the world territory, it concentrates on its territory up to 10-12% of native species of flora and fauna, many of which are endemic. Due to this it was catalogued as a mega-diversity country, becoming one of the 17 countries that lodge 70% of the total biodiversity of the planet. According to the Forest National Recount of the 1994, 29% of the territory is occupied by forests and wetlands, 54% of which are temperate zones forests and a 46% are dry and tropical wetlands. Non-wood resources that are taken advantage of for the development of the country reach 32% from arid zones and a 54% from the temperate climate (CONAFOR, 2009).

Although it is understood that it is important to preserve the natural environment for the preservation of life-cycles, both biological and hydrological; the forest sector faces a serious problem in the form of deforestation on the national and international scale. In particular, according to the data of the United Nations' Food and Agriculture Organization (FAO in Spanish) for the year the 2005, the loss of forests was of about 13 million hectares per year on the world-wide level. In Mexico these numbers vary between 200 thousand and 1.5 million hectares per year according to the data of the CONAFOR (2006). Among others problems that characterize the present situation of the forest sector in Mexico there are deforestation, degradation and loss of the forest ecosystems; low competitiveness of the timber industry at the international level; the insufficient investment and improper use of the forest resources; the Environmental Services markets are not developed.

Among the principal causes of the continuous deforestation in Mexico it is possible to detect: I) the change of land use (owing to the population growth, urban expansion and greater demand for natural resources; also due to the public policies that foment large-scale farming and livestock farming, bringing about the expansion of the agricultural border over the surface with natural vegetation); II) the illegal felling and over-exploitation of the forest resources; III) the plagues and diseases of the vegetation; IV) forest fires. Among the consequences of these, there are: a) high risk of forest fires; b) erosion and soil degradation (due to the loss of physical, chemical and productive soil properties), for example, in Mexico, about 45% of soil is degraded; c) reduced water infiltration and change of the hydrological cycle components; d) the deterioration of the habitat quality (at the moment there are 338 dangerous invading species registered and 897 endemic species are at risk of extinction, 261 of plants); e) socio-economic consequences (poverty, migration, economic losses).

In order to fight the situation of deforestation in Mexico different environmental public policy programs and actions have been implemented. Among those there are on the Federal level the following:

1. Program of Payment for Environmental Services, PSA (divided in three big categories: hydrological, carbon capture, conservation of biodiversity and scenic beauty); carried out by the National Forest Commission (CONAFOR in Spanish) from 2003.
2. Plans of Territorial Ordering and Plans of Territorial Ecological Ordering (POT and PEOT); executed by the Secretariat of Social Development of Mexico (SEDESOL) from 2000.
3. Different projects/programs/actions for restoration and ecological preservation, such as reforestation and/or river basin management; supported by the Secretariat of Environment and Natural Resources (SEMARNAT).
4. Implementation of hydrographic river basin management; within the objectives of the National Water Commission (CONAGUA).

Nevertheless, as it has been seen, the deforestation in Mexico continues in spite of the development and the implementation of these programs, including the program of the interest of this study, Payment for Environmental Services, PSA (CONAFOR, 2006). The hypothesis considered here to explain this situation, refer to the implementation of the PSA program in Mexico, specifically, PSAH, that have not managed to fulfill their objectives neither in environmental terms (reflected in the diminution of the rate of deforestation), nor in socio-economic terms (to make the program self-sufficient and efficient), during the period of their implementation - 2003-2008; because it was applied based on the international experience, in this case, one of Costa Rica, and the social, economic, politico-institutional and legislative aspects specific to the country were not considered. In particular, such aspects as social organization of the communities, land tenure, environmental regulation and political and institutional frame in Mexico are very different from other countries.

Based on this, the general objective of this work has been to evaluate in systemic form the process of implementation of the PSAH in Mexico (like instrument of environmental policy on the federal level), with detecting the main advances and failures of the program, considering the legal, institutional and economic structure of the country.

## **THEORETICAL FRAME**

The concept of sustainable development and integral ecosystem management of natural resources was adapted as the theoretical frame of the present study. This concept refers to promoting of the new vision for natural resources management the terms of the equilibrium between the economic development interests of the countries and the physical function of the nature for conservation of life-

cycles, - hydrological, carbon and biodiversity. In the specific case of this investigation, it refers to promotion, discussion and acceptance of the concept of Environmental Services (SA in Spanish) and the establishment of the SA markets between benefits and offers of SA. It is very important to comment that this process has had a long trajectory on the world scale that, in summarized form, appears to the continuation (Ochoa, 2009).

- Stockholm Declaration, 1972. United Nations Conference on Environment, where for the first time the environmental dimension was included into the world-wide political agenda, accepting an ecosystem's vision through its importance for the human development. The recommendations were made regarding the promotion of ecosystem conservation and preservation, including the species in extinction.
- Brundtland Report, 1987. World Commission on Environment and Development, where the central point was the adoption of the concept of sustainable management of natural resources. The new model of the development considers that "The humanity must take care of the needs of the present without impairing the possibility of the future generations to realize their needs too".
- Declaration of River, 1992. United Nations Conference on Environment and Development, where it was agreed that the participant countries had to adopt an approach of sustainable development, assuring the economic and social development. The idea of the Environmental Services was planted.
- Earth Summit +5, 1997. Where the execution of the Program 21, agreed on in the Declaration of River, 1992, was analyzed. International legal objectives, related to the development of concrete programs for the reduction of the GEI, were adopted.
- Kyoto Protocol, 1997. United Nations Framework Convention on Climate Change, with the aim of greater commitment of the countries to approach the problems of climatic change and decreasing GEI emissions for 2008-2012 by 5.2%. Specific mechanisms were introduced and the market of carbon capture was opened, giving the way to implementation of the different programs of Payment for Environmental Services (PES).
- Johannesburg Declaration on Sustainable Development, 2002. World Summit on Sustainable Development, where the declarations on the Sustainable Development and the eradication of poverty with base of the protection and conservation of the natural resources were presented. The objectives of reduction of poverty were incorporated in the presentation of the PSA programs.

Some of the determinations of the Environmental Services (SA) are: a) "a benefit in the form of biological and physics-chemical processes and functions that the natural environment (ecosystems) gives to the life, especially to the human population" (Towers, 2006); b) "All those benefits that the people obtain from the ecosystems...". These include services of provision, services of regulation, and cultural services (SEMARNAT, 2006). This way the SA can be determined as services of provision that are used for the soil formation, biogeochemical cycles, the primary production and that includes: I) services of provision (food, water, fuel, fibers); II) services of regulation (regulation of the climate, disease transmission and contagion control, regulation of the water); III) cultural services (spiritual and religious, recreation and eco-tourism, aesthetic). These services produce certain environmental products that are used by the man, such as fruit, crafts, medicines, etc. It is a tangible natural resource that used as raw materials in the production or the final product, and used and transformed in this process (Millennium Ecosystem Assessment, 2005).

The recognized modalities of SA are:

- Hydrological Environmental Services (maintenance of the capacity of aquifers' recharge, maintenance of water quality, reduction of river basin sediments, reduction of floods during

extreme precipitation events, conservation of springs, major volume of superficial water available, reduction of the risk of floods).

- Biodiversity and Landscape (biodiversity and ecosystems protection, soil protection and recovery, beauty landscaping and the recreation).
- Carbon Capture (oxygen generation, damping of the impact of the natural phenomena, modulation or climatic regulation).

The main idea of implementation of schemes of Payment for Environmental Services (PSA in Spanish abbreviation) is to try to give environmental, social and economic values to the SA and to create markets through the proportion of payments from funds (international, federal and mixed) to the properties of forest zones to conserve the forests in different benefits (Pagiola *et al.*, 2003).

There is a great amount of the publications (scientific articles, documents of work, spreading, protocols, technical information of evaluation, etc.) that on international level have risen questions about the topic of Environmental Services in the last the years. Mainly in the countries like Costa Rica, the USA, Spain and Brazil (Rojas y Aylward, 2003; Rosa *et al.*, 1999; ONF, 2004; Pagiola *et al.*, 2003; Mertz *et al.*, 2007; Kosoy *et al.*, 2007; Heal, 2005; Postel and Thompson, 2005; Ochoa, 2009; Batabyal *et al.*, 2003; Benett *et al.*, 2005; Wunder, 2005; Sánchez-Azofeifa *et al.*, 2007; etc.). Nevertheless, at national level there are very few published academic works on the subject, and the technical documentation and information publications stand out more (INE, 2005; Pagiola *et al.*, 2003; INE-TCCCR-CONAFOR, 2007; Colegio de Posgraduados, 2005, 2008; Collado, 2006).

It is necessary to mention that there is an ample range of the topics of realized studies. From the bibliography analysis of the environmental services markets in Costa Rica (Rojas and Aylward, 2003); where it is referred to the great amount of existing literature on the theme. Nevertheless, the lack of studies of evaluation of PSA program are stressed, including the monitoring of the benefits of the SA, analysis of the implications of the program and integral evaluation of this. In other works, like of Mertz *et al.* (2007), it is spoken of the necessity to count on the effective evaluations of the relation between biodiversity and human population in the context of the SA provision, just as with the long term studies and the system of monitoring. In the study by Kosoy *et al.* (2007) three cases of applications of the programs of payment by Hydrological PSA in Central America (Honduras, Costa Rica and Nicaragua) in terms of the analysis of the socioeconomic context and the cost of opportunity of the conservation of the forests are compared. The lack of clear determinations of the relations of environmental market and the lack of investigations on the cost of opportunity of the SAH clearly stand out.

Heal (2005) in his article makes a reference to the importance of the development of justice economic and environmentally markets. He accentuates the fact that the economic incentives are crucial for the ecological conservation and that market probably has the best average to provide the populations with these incentives; and recognizes that in this case the integral evaluation of the programs is essential for the correct determination of these instruments. Postel and Thompson (2005) add in their work the experience acquired during the application of the programs of payment by SAH, their economic attributes and benefits, discussing three particular cases, of Quito (Ecuador), Costa Rica (Costa Rica) and of New York (the USA). The understanding of the process and importance of the determination of the hydrologic services underlines the lack of ability to mitigate the risk in urban zones related to the lack of the hydrological resources apt for the human consumption; concluding on the necessity to develop the evaluations of the SAH on regional and local scale to support to the decision making. It is why the present work is dedicated to the analysis of the Mexican PSAH program implementation process.

## METHODOLOGY

The methodology adopted in this investigation was used to realize an analysis of the process of implementation of the PSAH programs in Mexico, based on four criteria. For which the most important factors that lead to the exhaustion of the ecosystems and consequently to loss of the Environmental Services are determined; the theoretical frame that founds the concept of Environmental Services and determines the appearance of the schemes of Payment by Environmental Services, in specific of PSAH, was structured; the legal, institutional and economic structure that supports the scheme of PSAH in Mexico were analyzed; and the opportunities and failures were determined.

In the present study the practices of the cabinet and field studies are combined by means of application of diverse quantitative and qualitative techniques. It was developed in several stages: I) Bibliographical revision, with determination of the conceptual frame, space and temporary aspects; II) Realization of field work, with application of interviews, and search for complement information; III) Systemic analysis of the study cases and elaboration of conclusions. In order to be able to realize systemic analysis of the implementation process of the PSA and PSAH program of study case of Mexico, the following four criteria were determined: 1) Operational aspect (rules and foundations of the program), 2) Environmental regulation (legislation), 3) Political and institutional frame (institutions), and 4) Economic aspect (funds and market initiatives).

## RESULTS

Based on the four criteria determined in the methodology, four principal aspects of the Mexican PSAH program have been analyzed.

### Foundations of the PSA

The PSA program in Mexico was initiated in 2003 in modality of Hydrological PSA (PSAH in Spanish abbreviation), with the example of the experience of the Costa Rican PSA (Rosa *et al.*, 1999); in this form contributing to the positioning of the subject of Environmental Services in the Mexican Public Agenda and demonstrating the importance of the forest for the urban population in terms of conservation of water quality and quantity and other services, same as the complexity of the problems referring to the social, natural and economic aspects involved (Hernandez, 2009). But, apparently this process was carried out without consideration for the specific conditions of the country, because of this it did not contain necessary social and environmental impacts during this period, and because of this it could not achieve its environmental and social objectives.

The initial objectives of the program focused on the reduction of the deforestation and the minimization of poverty in the country. A hypothesis appeared that the payment for conservation of the forest could contribute to the improvement of the environmental situation, as well as to increase the population's quality of life. The agreements to execute the payment were signed for 5 years at MXP300 and 400 by hectare for the payment of conservation of the forest in the estates located in critical zones for charge of water-bearing and declared as zone of hydrologic disasters; located within the mountain list determined by National Forest Commission (CONAFOR); tied to the supplying of the population centers of more than 5 thousand inhabitants; and with the forest cover more of 80% per hectare.

In Tables 1 and 2 the evolution of the modality of the program during the period of 2003-2008 (with the numbers of the surface incorporated, properties and the amount of PSA payment) are presented.

**Table 1.** Evolution of the modality of the PSA program in Mexico.

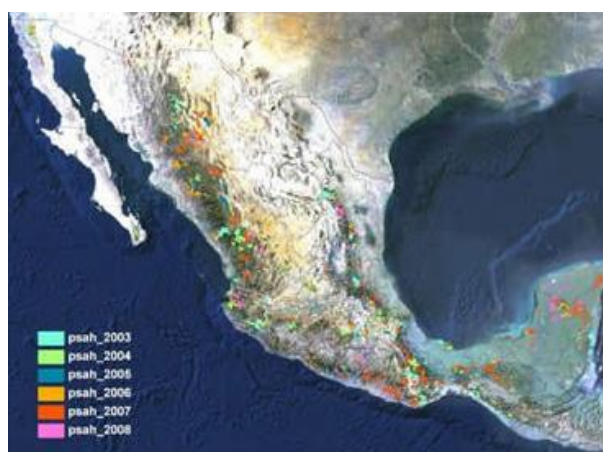
2003	2004	2005	2006
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Creation of the Environmental Hydrological Services Program, PSAH	Creation of the Environmental Carbon Capture Services Program and the Derivations of Biodiversity as Agroforest Services, PSA-CABSA	Project of Environmental Forest Services, PSAB	ProArbol Program integrates four modalities PSAH, Biodiversity Conservation, Agroforest Systems and Project of Carbon Capture, CAB
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**Table 2.** Main statistics of PSA application in Mexico in the period of 2003-2008.

Year	2003	2004	2005	2006	2007	2008	Total
Surface incorporated, Thousands of ha	126.8	184.2	169.1	127	545.6	324.1	1,476.80
Properties	272	352	257	241	816	727	2,665
Amount of PSA, Millions of pesos	192	288	257.8	204	925.9	570	2,437.70

In Figure 1 the location of the zones that receive payment through the PSAH program in the same period can be appreciated. There is a clear growth dynamic of the territory and the number of involved properties.



**Figure 1.** Location of the zones of PSAH Program application (CONAFOR, 2009).

Presently, the objectives of the PSA program have been reformulated, being the following: I) decreasing of the poverty indexes in forest areas, by means of the induction to a handling and sustainable use of the natural resources; II) promotion of the development and the economic expansion from valuation, conservation and viable advantage of the forest resources; III) stimulation of planning and forest organization, increase of production and productivity of the forest resources, its conservation and restoration; for contribution to the improvement of quality of life of Mexicans.

According to the data of CONAFOR (2009), it is important to mention that the eligibility criteria for the zones for application of PSA program although have varied in period 2003-2008 too, and finally in 2009 have been subdivided in three main groups:

- Technical (location of overly-exploited aquifers - for the application of PSAH and the percentage of vegetation cover up to 50% for all PSA modalities).
- Social (location within the zones identified as territories with high index of marginality, presence of the indigenous population, and in the communal or small proprietary land tenure).
- Environmental (location within the Natural Protected Areas, with high deforestation risk).

#### Legislative frame

The Program of Payment for Hydrological Environmental Services has been implemented in Mexico with the support of Forest National Program 2001-2006, derived from the Forest Strategic Program for

Mexico 2001-2025; based both within the legal framework determined by the Political Constitution of Mexico, the National Program of Development, of Natural Environment and Resources, the Statutory law of the Federal Public Administration, the National Water Law, the Federal Law of Rights and the Rules of Operation of the PSAH. The first Rules of Operation for the granting of the payment for the SA were published in the Official Newspaper of the Federation the 3 of October of 2003. In these the norms and procedures of application were determined that would be due to consider in the operation, assignation and execution of the federal support in charge of the Forest National Commission (CONAFOR, 2009).

Until 2005 diverse programs of the CONAFOR, including the PSAH were operated independently, each with their own rules of operation and procedures of distribution of economic resources. In 2006 some of these programs were diversified and perfected, operating as of 2009 under an innovative scheme of management that tries to simplify and speed up the proceedings for the management of resources, being determined by a single scheme of Rules of Operation for the Programs of Forest Development (Ochoa, 2009). Currently the programs of the CONAFOR are grouped in four categories: Forest Development, Commercial Forest Plantations, Conservation and Restoration, and Competitiveness; all under the lineaments of the governing program titled ProÁrbol. The Program of Environmental Services is in the category of Conservation and Restoration; and it includes four modalities: I) Hydrological SA; II) Conservation of biodiversity; III) Agroforestry systems with culture under shade; IV) Development of the idea of the project of carbon “kidnapping” (for which not yet the execution is planed).

#### *Institutional frame*

From second half of the past century important institutional changes have appeared in Mexico to be able to form the institutional base for the implementation and development of PSAH (Ochoa, 2009). the following are among the more important milestones: A) 1982, a new Forest Law for the environmental protection and the Secretariat of Urban Development and Ecology were created (SEDUE); B) 1988, the National Institute of Ecology (INE) replaces to the Undersecretary's office of Ecology, and based like a decentralized organization; and it is formulated the General Law of the Ecological Equilibrium and the Environmental Protection (LGEEPA); C) 1994, at the Ministry of Environment, Natural Resources and Fishing (SEMARNAP) is created, which represented an effort to systematize the programs that had responsibilities to the preserve natural resources and the biodiversity.

With the establishment of the National Plan of Development 2001-2006 the approach of sustainability the founding of national development strategy was determined. One of the modifications to reach the proposed objective, was the creation of National Forest Commission (CONAFOR) in 2000, as a decentralized public organism of the Ministry of Environment and Natural Resources (SEMARNAT); with the aim of developing, encouraging and impulsing productive activities, of conservation and restoration of forests , as well as to participate in the formulation of the plans and programs, and in the application of the federal policy of viable forest development. Within the first activities realized by this institution are the National Forest Program the 2001-2006 is the Strategic Forest Program for Mexico, 2001-2025, that was determined as the first document of political strategy for the forest sector of the country. Under the approach of sustainable development and precedents in the Forest Programs in the short and long term, in 2003 of the PSAH program appears.

#### *Economic frame*



The resources available to administer the program in 2003 were constituted through Mexican Forest Base, where, according to the operation rules, MXP192 million included were destined for direct support of the beneficiaries, of which up to 10 million were designated for the payment of hydrological environmental services with forest management and 8 million were spent on operation, evaluation and monitoring of the program (CONAFOR, 2003). In 2004 the amount designated for the same base, counted a total of MXP288 million; and for the following year MXP273 million were destined (UACH, 2006). At the end of 2005, with technical assistance and financial support of the World Bank and the Global Environmental Found the Government of Mexico through the CONAFOR, began to develop the Project of Environmental Services of the Forest, approved at the end of 2006, with a financing of USD45 million granted by the World Bank and a grant from the GEF of USD15 million (CONAFOR, 2009).

In order to promote the joint responsibility in the scheme of the payment for environmental services between the users and benefits, the CONAFOR implemented the program of Concurrent Bases and the program of Patrimonial Base of Biodiversity. The program of Concurrent Bases received an investment of MXP36 million in the 2008, granted by the users, and MXP36 million, granted by the CONAFOR; resources that were managed to execute the payment for the SA in 25 thousand hectares of the country. The program of the Patrimonial Base of Biodiversity, was initiated with the base of a total of MXP130 million to promote a capitalization of USD200 million with the purpose of the generating financial products destined to the permanent payment of the biodiversity conservation (CONAFOR, 2009a). Nevertheless, in spite of the constant increase of the incorporated surface, the program of PSAH in Mexico has worked as a program of subsidy to the beneficiaries and has not been able to boost the creation of self -sufficient markets.

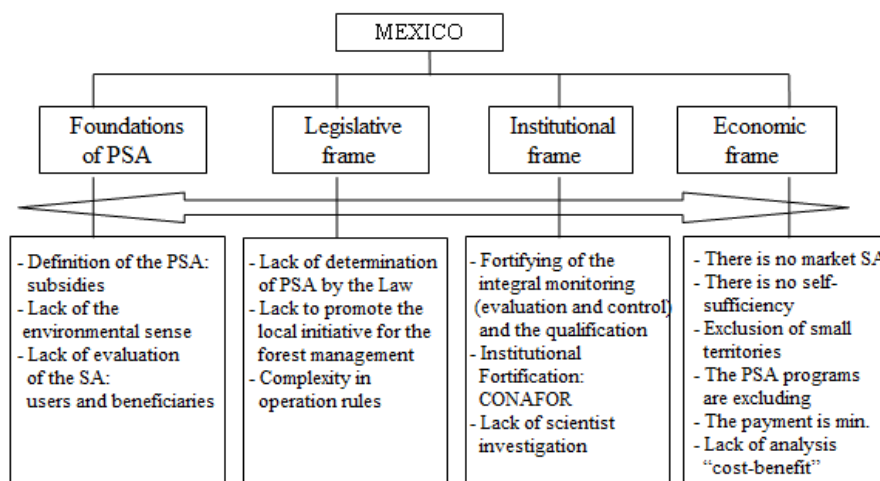
As the result of the systemic analysis of the implementation process of PSAH in Mexico, It is necessary to mention the following strengths of the program in Mexico:

- ❖ Attempt of new schemes for mitigation of the loss of forest cover.
- ❖ Integration of social, economic, environmental aspects in environmental preservation.
- ❖ Effort for soil protection and related natural resources, on which the water quality and the quality of the associate vegetation and/or complete ecosystems depend.

As the limitations of the program, also recognized by several studies and authors, as School of Postgraduates (CP, 2005, 2008), Autonomous University of Chapingo (UACH, 2006), Ochoa (2009) and Hernandez (2009), the following points could be possibly detected:

- PSAH has operated as federal subsidies.
- Lack of scientific understanding and studies to determine the SA, specifically, SAH.
- Lack of monitoring of water quality and quantity to determine the real benefits of the PSAH (before and after the application of program, including zones of recharge and discharge).
- Lack of legal determination of the PSAH program and its demand mechanisms.
- Lack of establishment of the self-sufficient, local markets.
- Lack of the citizen consciousness about the cultural and economic value of SA.
- Lower environmental interests in comparison with the social ones in the scheme of the PSAH.
- Excluding programs in the same territory (hectares).
- Disregard of aspects of land tenure that it is a very important issue, because about 70-80% of the forests are under the administration of 7-8 thousand of and communities.

In graphical form the limitations and the challenges of the program are presented in Figure 2, subdivided by the four criteria of analysis.



**Figure 2.** The limitations and challenges of PSAH program in Mexico (based on Ochoa, 2009).

During the constant discussion at public forums (as National Forest, National Environmental Services and National Technical Committees) about limitations detected in the process of implementation of PSA, in specific of PSAH programs in Mexico; since 2009 it was decided to adopt a new national strategy for the change the PSA-CABSAs for the Program of Reduction of Emissions by Deforestation and Forest Degradation (REDD in Spanish), trying to become a hybrid scheme, based in the knowledge constituted by the previous generations of the PSA, with the rights of the turn and the forest properties created and the promoted responsibility to maintain the incentives in a comprehensive frame of policy (Hernandez, 2009; Iglesias, 2009).

## CONCLUSIONS

As the result of the analysis of the process of implementation of the PSAH program during period 2003-2009, many limitations of operative, legislative, institutional and economic character have been discovered. These are the reason why it was not able to achieve its environmental and social objectives, established initially, such as the reduction of the loss of the forest cover and the benefits of the hydrological cycle and of the poverty rates by means of protection of the forests and formation of self-sufficient SA markets. The opportunities for the development of the program in the future could be: I) establishment of local markets (self-financing, based not only in CONAFOR Forest Fund, with concurrent funds and long term contracts); II) development of "service packages" (as eco-tourism); III) reinvestment of resources (stimulus for the local initiative). Also, it is important to be said that the transformation of the program in the last years towards a hybrid scheme indicates a big and complex issue in the implementation process of the PSAH program and a high political and social potential and interest in this.

Limitations of this study consist in the lack of the analysis of the impact of the program and analysis of its function on the local scale. This way the second stage of this work includes the application of the proof interviews and questionnaires for all levels of authorities at federal and regional scale involved in the application of the program; and for benefits at local scale. On the other hand it is detected that it's necessary to realize the modeling of the social, economic and environmental flaws for a better understanding of the functioning of the environmental services. Thus, it is necessary realize the hydrological modeling, as in the work of Cheng *et al.* (2006) and Chen and Zhao (2010).

## ACKNOWLEDGEMENTS

Acknowledgement to the CONACYT for financing the field work by the project "*Instrumentos de Política Pública Ambiental y expansión urbana: los casos del Pago por servicios Ambientales, las UMA's y los FOCOMDE's en el contexto de la expansión urbana de la Zona Metropolitana de la Ciudad de México*", 80848, Basic Science, 2007-1.

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