MECHANISM OF PAYMENTS FOR HYDROLOGICAL ECOSYSTEM SERVICES IN THE WATERSHED OF THE PIRAY MINÍ STREAM

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ABSTRACT

To promote the conservation and forest hydrological restoration of the ecosystems located in the watershed of the Piray Miní stream, which supplies water to Eldorado, economic compensation mechanisms are required for the owners of the properties that provide environmental services to society. The objective of this work is to analyze the situation of environmental and socioeconomic factors, related to the watershed of the Piray Miní stream, and to propose a scheme of payments for hydrological ecosystem services for the conservation and restoration of ecosystems. Regarding the materials and methodologies, background analyzes and interviews were carried out; and their own reflections on the subject. The survey of reference watersheds was carried out with the Geographic Information System and land inspections were carried out. As results, environmental, social and economic factors and compensation mechanisms for ecosystem services in force in Argentina were characterized; proposing the assessment and implementation of a compensation scheme for ecosystem services for the watershed of the Piray Miní stream. It is concluded that it is very necessary to implement the proposals to achieve the conservation of the properties that provide hydrological ecosystem services.

KEYWORDS: Conservation; Restoration; Valuation; Compensation.

INTRODUCTION

The situations of environmental degradation in the watershed of the Piray stream, located (See Figure 1) between the parallels of 26º10 '- 26º30' South Latitude and the meridians of 53º40 '- 54º40' West Longitude, in the Province of Misiones, Argentine Republic , of approximately 150,000 hectares, which supplies water to the city of Eldorado, requires the development of a plan for the conservation and restoration of ecosystems that provide ecosystem services to society, within the framework of the territorial ordering of the watershed and the Sustainable development in the economic, social and environmental aspects, to promote the improvement of the quality and availability of water for the well-being of the

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population in harmony with the environmental quality of the ecosystems located in the territory.

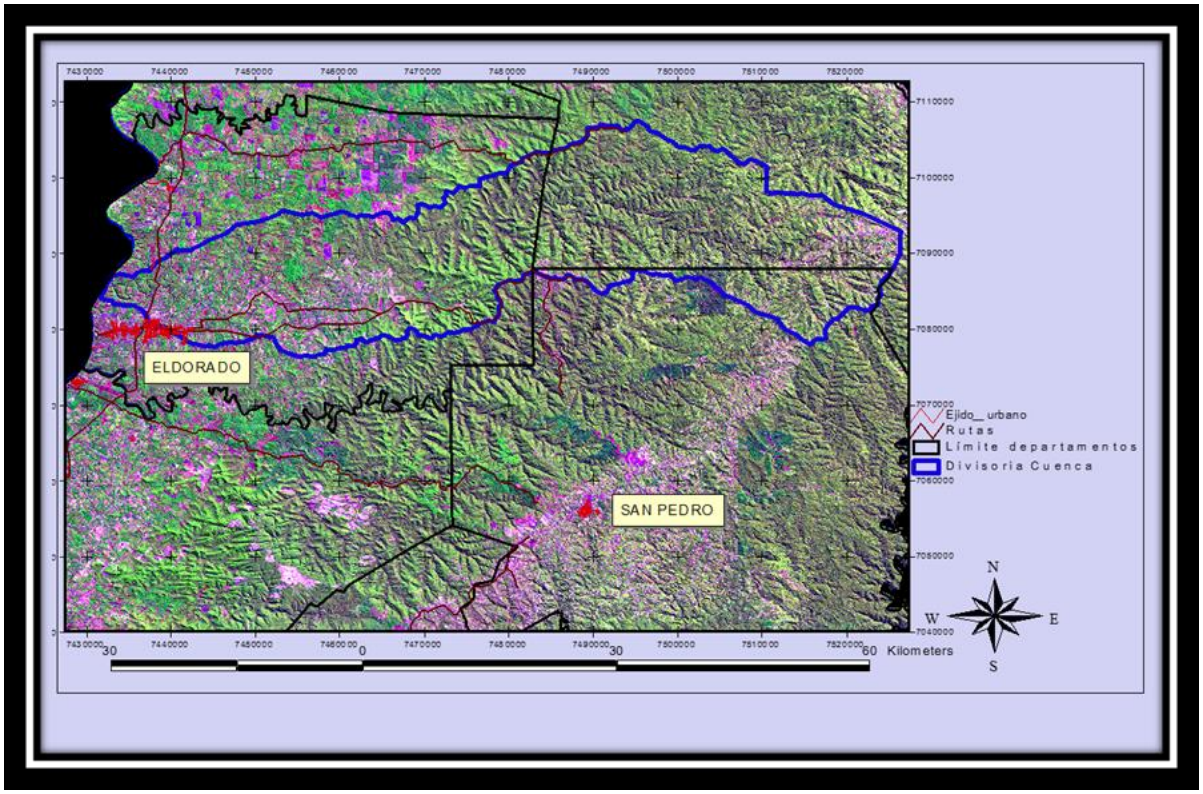

Figure 1. Image with the relative location of the Arroyo Piray Miní Basin.
Source: Landsat satellite scene

The Piray Miní stream basin constitutes a hydrographic system of exceptional value and social, ecological and economic importance, which has supplied and may continue to supply the inhabitants of the municipality of Eldorado and other municipalities located there with rainwater. The territorial area that covers the watershed is part of the Eldorado, San Pedro and General Manuel Belgrano departments, with the municipalities of Eldorado, 9 de Julio, Santiago de Liniers, San Pedro, Pozo Azul, Bernardo de Irigoyen, Colonia Delicia and Colonia Victoria; the soils are used for agricultural, industrial, urban activities, and despite being subjected to environmental impacts of anthropic origin, it still has natural and rural ecosystems with high environmental quality.

Regarding the subject, Rodríguez Vagaría, A. et al (2012) affirms that: The inadequate management of natural resources causes problems that seriously affect the productive capacity of agricultural systems and finally have an impact on the quality of life of the inhabitants. The agro-hydrological restoration encompasses, in a unified plan of action, the problems of soils, water and vegetation of the wathersheds in an authentic process of natural resource management.

On the climate of the study area, Eibl et al. (2001) describe that: The climate is classified as Cfa in the Köppen system, which corresponds to a humid subtropical climate without a dry season, with an average annual rainfall of 1700 mm, distributed equally throughout the year and an annual average temperature of 21oC, with absolute maximums of 39 oC (January) and absolute minimums of -6 oC (July)".

According to Wanderer et al. (1997), the maximum monthly average flow of the Piray Miní stream, of 165 m3 / second, occurs in the month of April; and the quality of the water in the intake of the public water supply system of the city of Eldorado, indicates that the waters of the Piray Miní stream belong to type 2 according to the World Health Organization (WHO): Bacteriological quality that the application requires of the usual methods of coagulation, filtration and disinfection.

Martínez Duarte, JA et al (2019), studied the state of conservation of the soil protection forests of cartographic unit 6B, in the restitution sheets of the edaphological map of the Province prepared by the Argentine Company of Topographic and Aerofotogrammetric Surveys (CARTA , 1962), and the possibilities of its conservation or restoration.

Protective forests have their antecedents in National Law No. 13273 of 1948; and in 1977 the province of Misiones sanctioned its own forest law under No. 854, currently XVI No. 7, which declares protective forests to those that protect soils, river banks, hydrographic basins, among others; then Law No. 3426, currently Law XVI No. 53, in its article 1, subsection d, declares as protective forests those that occupy the soils of class 6B. Subsequently, with the sanction in the Province of Misiones of Law XVI No. 105, the slope threshold of 15% is established with an even more restrictive criterion to consider the forests that cover it as protectors. Likewise, the aforementioned legal norm establishes this type of forests as permanent, by categorizing them as category II, in accordance with the classification made by National Law No. 26,331 on minimum budgets for the conservation of native forests.

According to the Argentine Company of Topographic and Aerofogrammetric Surveys (C.A.R.T.A.), cartographic unit 6B of the hydrographic basin of the Piray Miní stream covers 53.85% of the total area (80,483.5 hectares). In addition, 27.5% of the surface of the basin (40,705 hectares) belongs to cartographic unit 6A; 27,433 hectares (18.5%) correspond to cartographic unit 9; and there are small areas with soils from Cartographic Unit 3 and 8 (Figure 2).

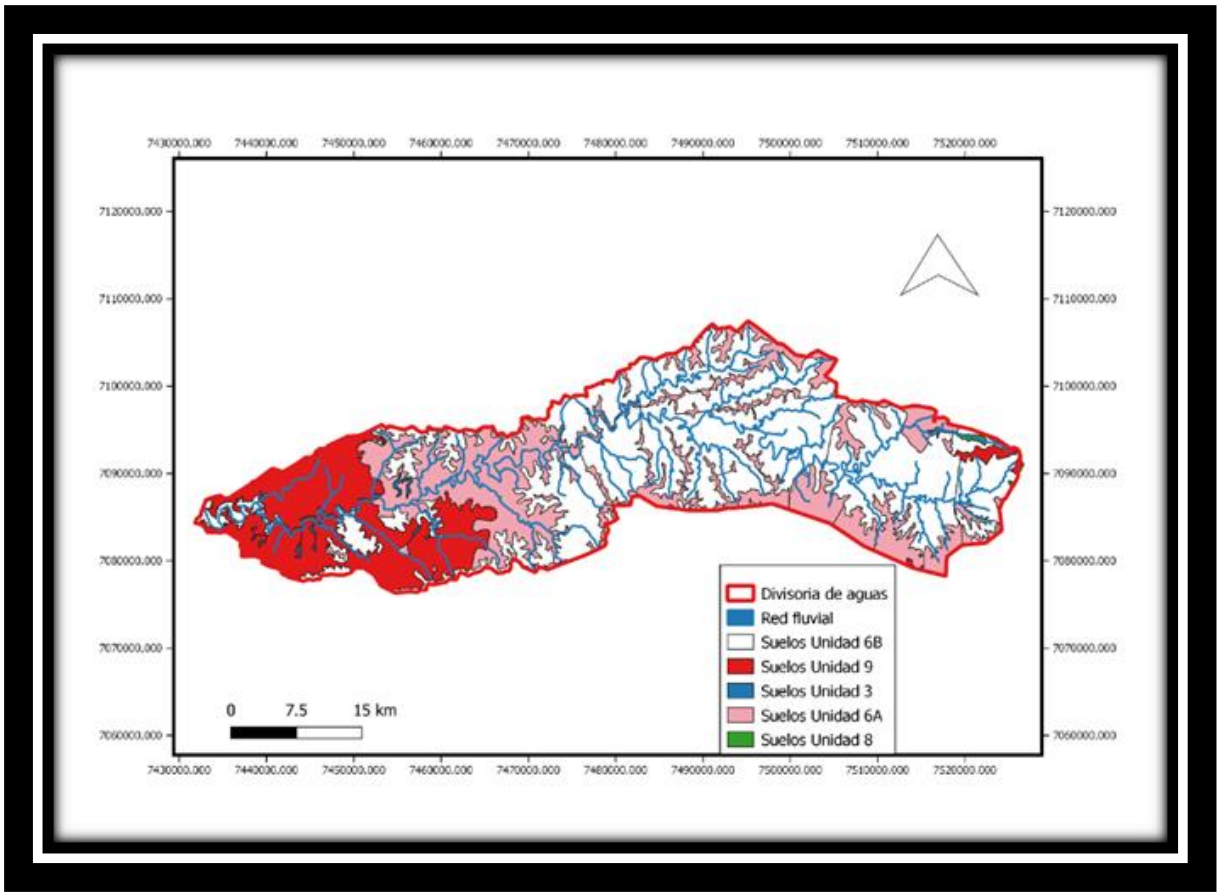

Figure 2. Soil cartographic units in the catchment basin of the Piray Miní stream

Source: Based on C.A.R.T.A, 1962

Also, analysis of satellite images of the time series 1990-2015 classified for the basin under study has been carried out, determining the variations of the surfaces of the areas of protection of water courses covered by native forests, and agricultural and forestry crops.

Regarding the legal framework, in light of the worrying decrease in ecosystem goods and services, the Provincial Government sanctioned Provincial Law XVI - No. 60 (Before Law 3631) in November 1999, which creates the integral area of conservation and sustainable development corridor green of the Province of Misiones of more than 1,000,000 hectares that covers most of the upper and middle watershed of the Piray Miní stream, and connects the protected natural areas of the province. The Law highlights and seeks to recognize the importance of the environmental services that the forests of the upper basins naturally offer, such as: the production of clean water, the maintenance of biodiversity and the fixation of atmospheric carbon and the contribution to the improvement of the quality of life of local people.

It should be noted that article 41 of the 1994 National Constitution establishes the right of all inhabitants to develop in a healthy environment. The General Environmental Law No.

25,675 of 2002, defines the minimum budgets for environmental protection and establishes the need for the sustainable management of natural resources.

Likewise, the Law of Minimum Budgets Regime of Environmental Management of Waters Nº 25,668 of 2003, defines to the watershed like unit of management of the natural resources. National Law No. 26,331 of 2007 on minimum budgets for the environmental protection of native forests, in article 1 establishes the minimum budgets for environmental protection for: enrichment, restoration, conservation, use, and sustainable management of native forests and the conservation of the environmental services that these forests provide to society. In the 5o article it states: Environmental Services are considered to be the tangible and intangible benefits, generated by the ecosystems of the native forest, necessary for the concert and survival of the natural and biological system as a whole, and to improve and ensure the quality of life of the inhabitants of the Nation benefited by native forests. Among others, the main environmental services that native forests provide to society are: Water regulation; Conservation of biodiversity; Soil and water quality conservation; Fixing greenhouse gas emissions; Contribution to the diversification and beauty of the landscape; and Defense of cultural identity. Article 30 states: Create the National Fund for the Enrichment and Conservation of Native Forests, in order to compensate the jurisdictions that conserve native forests, for the environmental services they provide; generating the possibility of financing the conservation of native forests that provide hydrological environmental services, by improving administrative procedures that facilitate payments to property owners.

On 10/29/09, the Legislature of the province of Misiones sanctioned Law No. LAW XVI - No. 103 (Before Law 4520), which proposes to regulate payments for environmental services that generate native forests or established forest plantations.

The Provincial Water Law No. Law XVI - No. 15 (Before Decree Law 1838/83), in its article 1 establishes: This Law and the regulations that are consequently issued, govern the study system in the Province of Misiones, use, conservation and preservation of water resources belonging to the public domain. The waters belonging to the private domain are subject to the control and restrictions established by the Enforcement Authority in the exercise of police power in the public interest.

Provincial Law Nº Law XVI - Nº 37 (Before Law 3231) of soil conservation, in article 9 determines that: The operational planning units will be the watersheds in their different levels of magnitude; and in article 12 it states that: The management of surface runoff waters in order to avoid soil erosion, must be carried out in accordance with the planned management of the watershed, independently of the cadastral limits of the properties that the constitute.

The Organic Charter of the city of Eldorado 2018-2038 (2018), in the subtitle Environmental management, Article 44, determines that "Environmental management policies on natural resources must be carried out in order to mitigate the effects of climate change, by whose reason, in the regional or global order, will tend to favor the integration of the municipality into networks, agreements and regulations that govern the aforementioned subject. The municipality, with the participation of residents, implements actions aimed at ensuring: Environmental education in all modalities and levels, promoting activities that implement mechanisms for community participation in the matter and raising awareness of the role of citizens in caring for the environment".

Regarding the institutional, the Faculty of Forest Sciences (FCF) of the National University of Misiones is an important scientific and technological ally for the study of this ecosystem and its management. The FCF maintains long-term agreements with several national and international academic institutions. This institution has developed within its work areas research projects in watersheds in the area, always concluding on the importance of the availability and quality of water for the health of the people who inhabit the watersheds and for the sustainable development of the province. One of these basins under study is the Piray Miní stream basin, considering that it supplies water to Eldorado located in the lower basin, and that the well-being of the population is related to the quality and availability of fresh water; and the current generation and those to come depend on sustainable development, with pure and abundant water being the indicator of good management of natural resources.

Environmental management as a general administration tool indicates that the planning, management and integration of the watersheds of the province will promote sustainable development; and we must consider environmental issues in our decisions and assume our status as environmental administrators, admitting that we are responsible for incorporating ecological aspects into plans and actions, to enable socially responsible management. The concept of planning and management of watersheds is one more part of all good planning of the use and sustainable development of the land. When it comes to the practical implementation of such planning, it is important that it is applied to sufficiently homogeneous areas in terms of their physical, economic and social characteristics, so that they offer an appropriate basis to undertake a management and land use planning program. Such a unit is provided by the watershed and each basin works as a system and the modification of one part influences the whole unit.

The interest shown by local actors in carrying out a sustainable management of their natural resources; the strategies implemented by the Provincial Government aimed at causing a cultural change in the way of conceiving the use of the jungle; the forest policy of the National

Government, which incorporates the issue of payment for environmental services as a component of the National Forest Plan; and the support of the Faculty of Forest Sciences of the National University of Misiones to deepen the research projects carried out in this important watershed, constitute a context that favors actions for the conservation and restoration of ecosystems.

The valuation of the environmental services that the forests provide to the Piray Miní stream basin should consider their importance in regulating the water cycle, in conserving biodiversity and fixing carbon. Uclés Aguilera (2006) stated that: Environmental economics has developed a multitude of valuation systems and methodologies that allow at least to achieve approximate values that 'make visible' the economic utility of environmental assets and serve to achieve their long-term sustainability.

It should be noted that the environmental services provided by natural and rural ecosystems are increasingly of vital social importance, and require the design and implementation of new effective schemes that promote the conservation and restoration of the ecological systems located on the properties that make up the watersheds; and payments for environmental services have proven their validity worldwide for the conservation and hydrological restoration of watersheds.

In a recent publication, Salzman James et al (2018) have stated that “In recent decades there has been a considerable increase in payments for ecosystem services (PES), with more than 550 active programs around the world and between 36 to 42 US $ 1 billion in annual transactions”. Likewise, Montagnini Florencia et al (2010) have stated that “Payments for environmental services (PES) can encourage projects that improve restoration, production and rural development”. “Payment systems for environmental services (PES) constitute a novel solution that allows reversing a situation of environmental degradation through the logic of the market, and transforming areas of high value and environmental risk due to demographic pressures in areas where there are achieve sustainable development ”(Martínez de Anguita, P. et al 2006).

As local theoretical and methodological antecedents, the research works can be mentioned: "Methodology for the formulation and environmental economic evaluation of watersheds management plans in the province of Misiones" (Martínez Duarte, 2006) and "Environmental economic evaluation of alternatives action in the watershed of Schwelm stream, Eldorado, Misiones, Argentina” (Martínez Duarte, 2003).

The report of the consultancy in which we have participated, on sustainable forest management and community, prepared for the National Secretariat for the Environment and Sustainable Development, on: "Proposals for promotion and compensation mechanisms are

also relevant theoretical background for this topic. economic services derived from native forests "and" Proposals for continuation of case studies of the Futaleufú basin and Los Pericos - Manantiales basin "where it was proposed: To carry out feasibility studies for the application of payment systems for environmental services in the Futaleufú Basin and carry out a similar feasibility study in the watershed of Piray Miní stream, whose upper basin is located in the San Pedro Model Forest, Misiones Province; (Montagnini et al, 2010).

It should be noted that a research project was also carried out called Economic Assessment of the Hydrological Environmental Service of the Native Forest in the watershed of Schwarzenberg Stream, Eldorado, Misiones; where the research problem was to determine the economic value that the Eldorado people assign to the hydrological services of the native forest. The general objective of the project was to assess the hydrological environmental services that native forests provide to the watershed of Schwarzenberg stream, for a forest restoration project. Landowners and institutions are willing to conserve the remaining native forests, and even restore areas of soil protection forests and water courses, requiring the support of society through their institutions, mainly in relation to technical advice and financing of projects for the conservation and restoration of soil vegetation cover.

The information provided by the work can contribute to the planning and implementation of actions to restore the environment with hydrological and forestry practices and, especially, the conservation and restoration of native vegetation that protects the water and soil of the watershed.

The people of Eldorado assigned a monetary value of 2,025 pesos per hectare and per year to the environmental service, and it was concluded that without protective forest, the maximum flow and the torrential state of the basin increase. Families are willing to pay for the hydrological environmental services that native forests provide to the watershed; Further studies were recommended to design a system of payments for environmental services, considering that the hydrographic basin of the Schwarzenberg stream drains into the Piray Miní stream, a short distance upstream from the intake of the public water supply system of Eldorado (Mantulak et al, 2013).

The objective of the present work is to analyze the situation of the socioeconomic and environmental factors, related to the watershed of the Piray Miní stream, and to propose a scheme of payments for hydrological ecosystem services for the conservation and restoration of ecosystems.

DEVELOPMENT

Materials and methods

Analyzes of the primary and secondary antecedents were carried out, and interviews were carried out with key informants; and their own reflections on the subject. The survey of reference watersheds was carried out with the Geographic Information System and land inspections were carried out.

Results

It was possible to characterize the conservation status of the protective forests in the watershed of the Piray Miní stream, verifying the existence in the middle basin, of extensive continuous areas of primary native forests in different degrees of exploitation and secondary native forests in various stages of succession ecological, evidencing the need to formulate a plan for the conservation of the remaining native vegetation, the restoration of the protective forests of water courses and the enrichment of degraded native forests.

The Tables in Figure 3 contain the complete annual sequence of analysis of the evolution of land use and cover 6B exclusively, and of the total watershed, highlighting the one corresponding to the year of the map; and indicating with light tones the areas transformed for agricultural activities and with dark tones the areas with forests. The sectors located in the lower basin, and to the east and south of the middle and upper basin, have been the most affected by the transformation of the protective forest cover of the soil to agricultural uses.

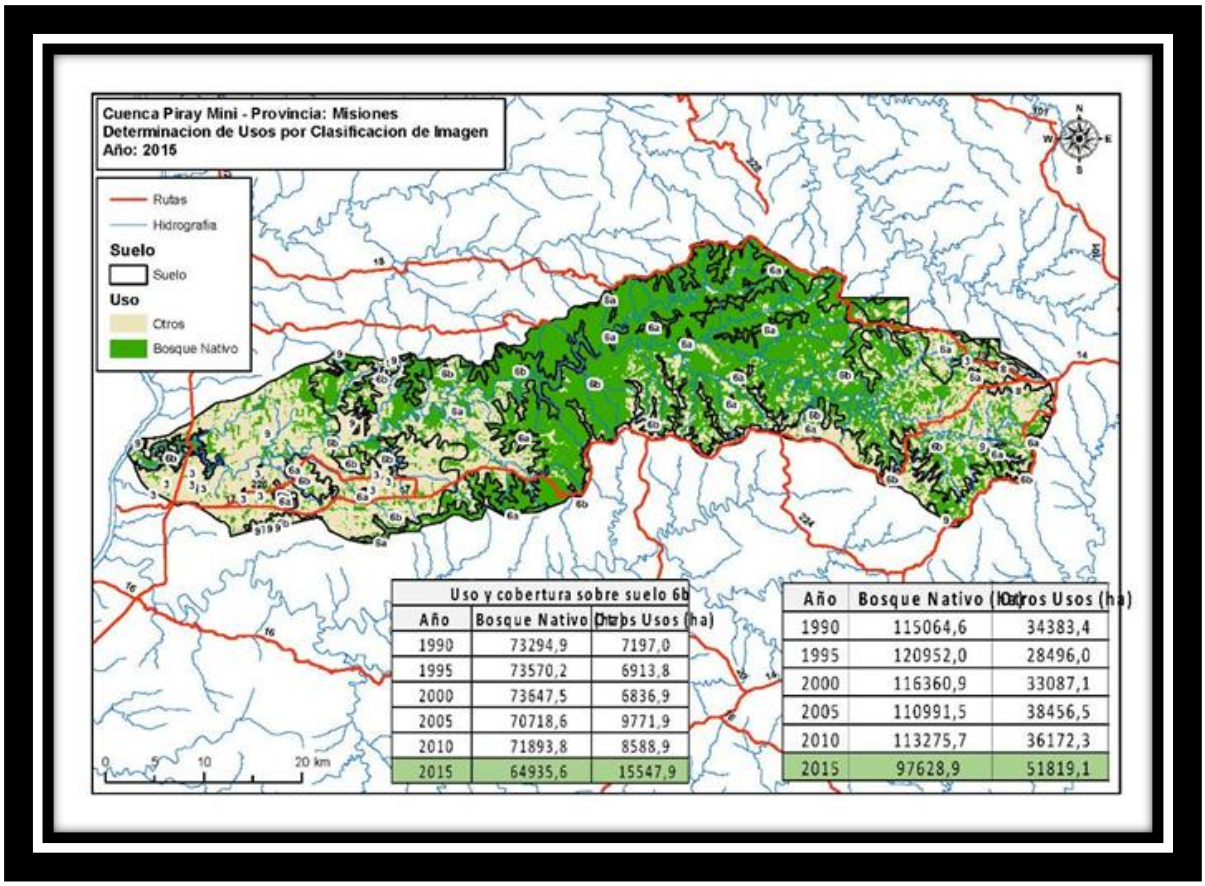

Figure 3. Use and land cover in the watershed of the Piray Miní stream

Source: Based on C.A.R.T.A, 1962.

The relief indicated by the percentage of average slope of the surface, reveals that the slopes are higher than 20% in sectors of the upper and middle basin mainly; meaning that the native forests that cover these areas, with soils of cartographic unit 6 B and the riparian forests of the river network, must be conserved and restored as protective forests.

The soils of the watershed are: In 60.75% of the total surface, stony and sloping, on basaltic bases, moderately deep and deep. 20.91% of the surface of the basin is made up of stony soils, on a basaltic base, almost flat with variable but not very pronounced slopes; free drainage. The soils with undulating surfaces on basalts, very deep with free drainage, cover an area of 27,125 hectares (18.34%), predominantly in the lower zone of the basin.

Landowners and institutions are willing to conserve the remaining native forests, and even restore areas of soil protection forests and water courses, requiring the support of society through their institutions, mainly in relation to technical advice and financing projects for the conservation and restoration of soil vegetation cover, through payment schemes for ecosystem services and other forms of compensation.

In relation to Eldorado, it is the largest municipality in the northern area of Misiones in terms of commercial activity, establishment of industries, various commercial establishments,

health infrastructure, education, justice, banks, among others. According to the 2010 Census, the population of the department of Eldorado is 78,152 people. According to the Provincial Forestry-Industrial Information System - SIFIP, Ministry of Agriculture and Production, 2010: The Department of Eldorado has 53,424 hectares reforested with: 49,694 hectares of conifers, 2,488 hectares of Eucalyptus and 1,242 with other broadleaf. The municipal organization chart includes the Directorate of the Environment, dependent on the Secretariat for Social Action and the Environment.

With regard to drinking water, the urban area is supplied by the water purification plant of the Cooperativa de Electricidad de Eldorado Ltda., which provides the service. In more remote neighborhoods the water supply is carried out through drilled wells. Solid urban waste is collected and transported to the existing transfer station in the municipal garbage dump, to later be transferred to the Aguas Blancas landfill in the municipality of Caraguatay. Only part of the garbage is transferred to the sanitary landfill and the rest is deposited under the open sky along with the waste from the other municipalities that is deposited in this place.

The management of waste considered hazardous remains in the hands of the companies and no further information is available on them. The biopathological waste is collected by a company that provides this service and is transferred to the Fachinal landfill in the south of the province of Misiones.

Figure 4 indicates the relative location of the open-air midden in the municipality of Eldorado, in the upper sub-basin of the tributary Faubel stream that drains upstream of the city's water intake into the Piray Miní stream, and also indicates the location of the watershed of Schwarzemberg stream of approximately 955 hectares, which also empties into the Piray Miní stream approximately 4,751 meters upstream from the intake of the public system that supplies water to the residents of the city of Eldorado. These streams have an irregular hydrological regime and their waters are polluted by: sewage drains, other effluents from anthropic activities such as service stations, workshops, car washes, and sediments from soil

erosion.

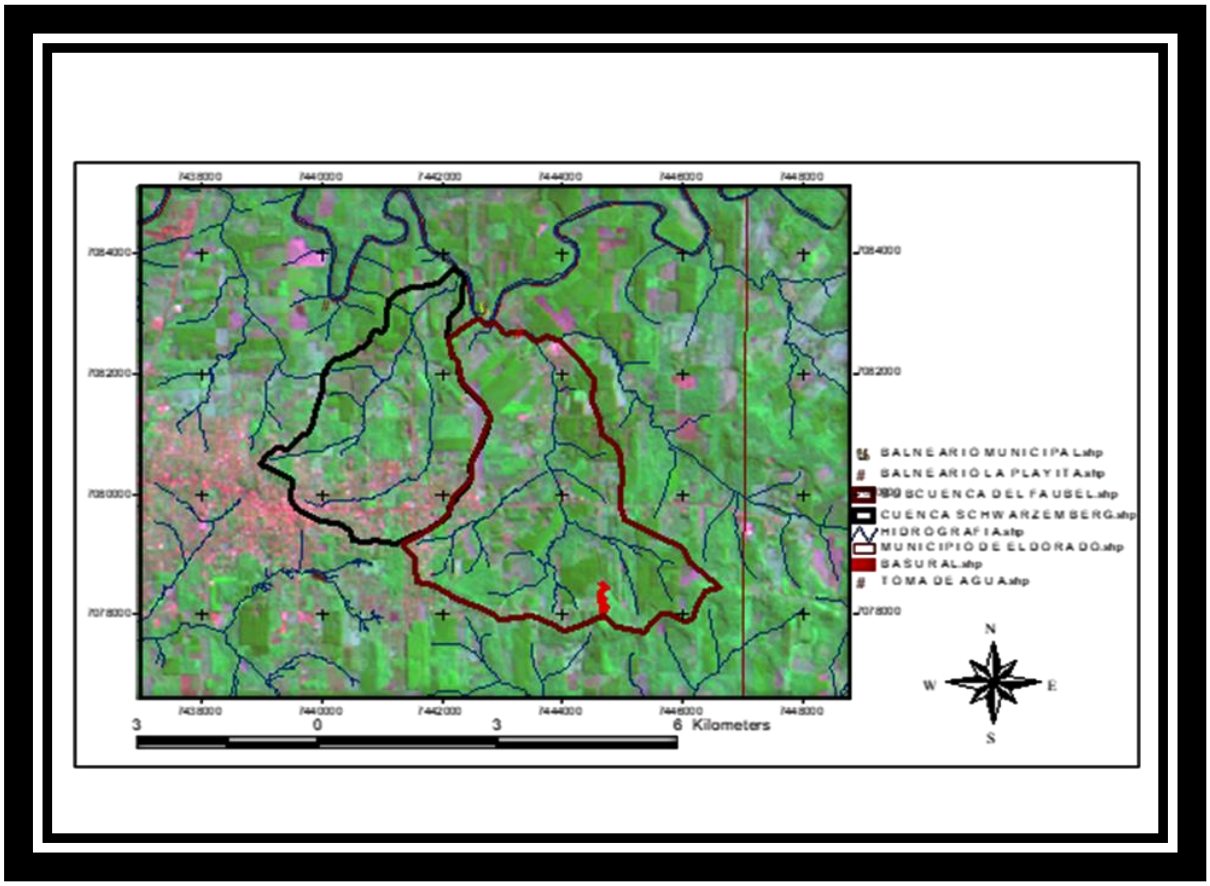

Figure 4. Location of the Faubel and Schwarzenberg stream basin.

Source: Elaboration based on Landsat satellite image

A key referent interviewed stated that: “In the municipality there is a lack of culture, there is a lack of teaching incentives, it is necessary to know how serious a pollution is, the time it takes for a pollutant to break down, and that makes people throw waste into the environment and do not collect the garbage. “And in relation to water, precisely because of the lack of conscience, the citizen of Eldorado does not take care of his environment, and especially the basins such as the Schwarzenberg and the Faubel. Luckily, the Pomar does not drain into the Piray Miní, because there it would be disastrous, because all the sewage contamination of Eldorado goes to the Pomar. So there is a lack of awareness, it is terrible. Today, even if there are ordinances, if people are not trained or taught and do not change their consciences, it is useless. Because you are going to see so many fines that it will be uncollectible”. "You have to solve the underlying problems, correct the causes that generate pollution, because remedies, such as water purification, are becoming more and more expensive and sometimes they are no longer enough." "We would be willing to inter-institutional integration to address these socio-environmental issues, because it is the way to find solutions in our relationship with the environment and its consequences."

Analyzing this situation and reviewing the background with a person from Eldorado who is a Hydraulic Engineer, it appears that the Piray Miní stream has water quality problems, which can be corrected with the implementation of actions included in a Management Plan for the watershed with the aim of improving the hydrological regime. There is also the possibility of building small dams that serve as water reservoirs for the lower flow months of the summer. It is considered, then, that the best alternative is to implement a forest hydrological restoration plan including the implementation of water reservoirs. Also, the aforementioned alternative would result in the improvement of both the environmental quality of the watershed and the ways in which the people of Eldorado relate to the environment.

Regarding education, the municipality of Eldorado has 62 common educational centers offering initial, primary and secondary education. The Faculty of Forestry Sciences of the National University of Misiones offers undergraduate and graduate degrees.

In the city, water for daily home consumption comes from the drinking water network managed by the Cooperativa de Electricidad de Eldorado Ltda., And most of the population is connected to the electricity network of the same cooperative.

The diagnosis made determines the direct relationship between the sociocultural process and the environment in the municipality of Eldorado. The settlers, mainly of German origin, their descendants and farmers in general, modified the original cover of the soil of the basin, replacing the Paraná jungle with agriculture of annual and perennial crops, livestock and urbanization. Said transformation of land use was carried out without applying conservation guidelines, generating negative impacts on water, soil, biodiversity, and on the socio-environmental situation in general.

The applied development model is the classic prevailing at the time of the colonization of Eldorado (as of 1919) and that basically remains today, prioritizing immediate economic benefits without assessing the externalities of the actions applied on the environment.

The accelerated qualitative and quantitative deterioration of the native forest mass and the environment in general was verified in the field. Agriculture is being carried out on soils expressly prohibited by the Provincial Protective Forest Law, on unsuitable land due to: the steep slope, erodible soils, and without biological or structural measures to prevent torrential activity.

Another serious consequence of the aforementioned torrential activity is the frequent flooding and flooding suffered by the populous neighborhoods, especially those located in the sectors of lower elevation, in relation to sea level, of the watersheds.

Undoubtedly the contribution of Law 26,331 / 2008 of minimum budgets for environmental protection of native forests, is significant; where it is defined, among others, that the main

environmental services that native forests provide to society are: Water regulation; conservation of soil and water quality; conservation of biodiversity; contribution to the diversification and beauty of the landscape; fixation of greenhouse gas emissions and defense of cultural identity. This law considers a system of payments for environmental services as a whole, that is, it promotes the conservation of native forests so that it simultaneously provides all the benefits detailed above in an equitable manner without privileging some in relation to others. It is considered that this modality of taking the set of environmental services allows an adequate payment to the owners of natural forests, reforestations and other forest uses of the land, for all the environmental services that these ecosystems provide; requiring for the most adequate implementation the drafting of detailed manuals of procedures by jurisdictions, containing the technical, administrative and legal specifications to be applied for each particular case in each jurisdiction for the conservation and restoration of ecosystems; specifications that must be permanently updated, foreseeing that the same owner can have in the same property a sector with native forest in conservation and in another part in restoration. Likewise, it is very important for the credibility and the consolidation of the system, the strict fulfillment of the contracts on the part of all the actors; that is, payments in time and form by the State that represents the applicants or users of environmental benefits, as well as by the owners who represent the suppliers of ecosystem services.

Although currently the amounts to be paid to owners are calculated based on forest areas, the costs of silvicultural treatments required for each situation must be taken into account to calculate the necessary payments for environmental services for each land use. That is, in addition to the prohibitions and regulations established by law, it is necessary to adequately compensate the owners for the expenses they incur to conserve and restore the ecosystems of their properties, plus a benefit for the environmental services they provide to society.

Of course, each of these activities must be detailed in the management plans prepared by the Forest Engineer, or Agronomist Engineer, and once approved, their compliance on the ground must be evaluated and monitored.

It is necessary to design and implement a unified database of free access to the public, with all the information related to the development of the program. This information must reflect significant data for a good monitoring of the impact of the compensation mechanism for ecosystem services that is applied, to facilitate its management and permanent improvement.

In summary, it was possible to characterize the environmental and socioeconomic factors, and the compensation mechanisms for ecosystem services in force in Argentina;

proposing the assessment and implementation of a compensation scheme for ecosystem services for the watershed of the Piray Miní stream.

CONCLUSION

Analyzing the influence of the ecological factors described on the torrential state of the hydrological system, it turns out that: The climate favors the abundant availability of rainwater and if the surface runoff is not adequately regulated, it has enough energy to generate erosion, causing loss of soil and muddying the water of the river network. The characteristics of the relief also favor torrential activity, a phenomenon that is regulated by the geological factor through faults and joints that facilitate subsurface and underground runoff as well as by the hardness of the basalt rocks that resists water erosion, but the soils are erodible.

Therefore, we can affirm that the basin of the Piray Miní stream has a torrentially incipient state, and it is mainly the protective forests that regulate the torrential phenomenon by providing hydrological ecosystem services to society.

The Piray Miní stream has the capacity to continue providing water to the people that make up the population of the city of Eldorado, in the quantity, sufficient regularity and adequate quality, through the public water supply system. It is vitally important for the health and quality of life of the people that the corresponding authorities make the decision to continue using the waters of the Piray Miní stream as a safe source of water supply to the city. Said decision will allow, in addition to the regular availability of water of known good quality, the development of the watershed system within the framework of the principles of social, environmental and economic sustainability.

The existence of supply and demand for hydrological ecosystem services has been diagnosed, as well as good institutional and governance conditions in the locality, as well as good prospects for capacity development, all very favorable conditions for the development of a scheme of payments for ecosystem services.

The contribution of Law 26.331 / 2008 of minimum budgets for environmental protection of native forests, is undoubted when establishing the bases for economic compensation of ecosystem services, and must be updated and improved permanently since it is already valid for more than 10 years. Administrative transparency and good governance are essential elements for the success of compensation programs for ecosystem services.

Although the legal framework so determines, it has been observed in the current scheme, that in the implementation of payments for ecosystem services, the environmental functions of native forests are not adequately considered in relation to the functioning of the watersheds to which belongs.

After analyzing the situations of the socioeconomic and environmental factors, related to the watershed of the Piray Miní stream, and the compensation schemes in force in Argentina, it is considered that the conditions required for the development of a payment scheme for ecosystem services are met, therefore it is proposed: 1) That the competent authorities promote the management of the Piray Miní stream basin through the implementation of a plan with programs for conservation, restoration, environmental sanitation and improvement of the hydrological regime, and promote the valuation and design compensation schemes for ecosystem services, 2) Formulate a plan for the conservation of the remaining native vegetation, the restoration of the protective forests of water courses and the enrichment of degraded native forests, 3) Support research and extension activities , in order to deepen knowledge about natural ecosystems and services that they provide to society, and achieve social awareness about the vital importance of these ecosystem benefits, 4} Support research and extension activities, in order to deepen knowledge about natural ecosystems and the environmental services they provide to society, and achieve social awareness of the vital importance of these ecosystem benefits, 5) That the State promote private payment schemes for environmental services, in which companies interested in receiving the benefits of environmental services can contribute financially to the promotion of land uses that contribute to providing those services. For example, the company that provides water to the population may pay individual owners or associates for the conservation and restoration of forests located upstream from the public drinking water supply service to the city of Eldorado. This institution can collect a monthly environmental cost from water users to invest in the protection of the watershed; and the State must intervene to order anthropic activities throughout the territory of the hydrographic basin to avoid environmental impacts that nullify or diminish the economic benefits of the ecosystem service.

REFERENCES

Please refer to articles in Spanish Bibliography.

BIBLIOGRAPHICAL ABSTRACT

Please refer to articles Spanish Biographical abstract.