Environmental awareness at the protected area of Brilhante, Brazil

Martin S. Lassen and Thomas Panagopoulos

***Abstract*—**Human occupation in rural tropical watersheds has been contributing to a steady degradation of water and other natural resources. Agricultural expansion, deforestation and a lack of sound sanitary equipments to treat wastewater are conditions that threaten the environmental quality of the Environmental Protection Area of Brilhante (APA Brilhante), located in Santa Catarina, South Brazil. The area, being largely covered by native Atlantic Forest, holds a number of natural springs, important for the overall quality conservation and distribution of water in rural parts of the municipality. In APA Brilhante land use is permitted, but must be done in accordance with the principles of sustainability. To understand the socio-environmental conditions, the possible threats to water quality and to highlight the potential for alternative land uses, a field survey was done based on interviewing families that all lived inside or near the protected area. Results show that degradation of soil and water combined with pollution are the main concerns for the population. If no alternative land use practices are applied, the environmental conditions will continue to degrade. Thus intelligent management, based on socio-environmental understanding, education and effective stakeholder collaboration is needed to protect the landscape and secure the environmental benefits that people can derive from working with nature. The population requests information on how to conserve water, soil and vegetation to protect nature and continue farming for food production. For this reason the study concludes that the Brilhante community possesses great potential for the adaptation of suitable land use practices. This will help APA Brilhante to become a good example of sustainable management for similar protected areas.

***Keywords*—**Conservation behavior, Brazil, Atlantic rainforest, Environmental awareness.

I. Introduction

THE recent environmental history of Brazil was characterized by the severe destruction of its ecosystems [1]. The deforested area total 2.7 million km2 or roughly 31.7% of the national territory and this country is one of largest consumers of biomass energy in the world. To answer to the large demand on wood fuel, timber and pulp, Brazil has developed a vast forest potential. The large scale forest plantations (basically of *Pinus* and *Eucalyptus* species) occupy around 5 million ha or around 1% of the national territory [2].

Fresh water is a prerequisite for life on earth. Human occupation in rural tropical watersheds has been contributing to a steady degradation of water and other natural resources. During the last decades the concern about how to maintain water quality good for future generations has become a priority issue in global development [3]. It is an essential natural resource for basic human needs. In the coming decades, humanity will face important challenges, not only to meet these basic human needs but also to ensure that the extraction of water from rivers, streams, lakes and aquifers does not affect freshwater ecosystems to perform their ecological functions [4]. Important environmental and social indicators such as climate change, an increase in erosion, pollution through intensified agriculture and a growing population density in river basins suggest that in many parts of the world freshwater problems will magnify [5].

At the present time, the production of biomass for food and fibre in agriculture requires about 86% of the worldwide freshwater use [6]. An increase of demand for food in combination with a shift from fossil energy towards energy from biomass puts additional pressure on freshwater resources. For the future, all production must come from the natural resource base currently available [7] requiring a process of sustainable intensification by increasing the efficiency of the use of land and water [8]. The current and future economic development causes a continued need for natural resources, such as fresh water. A shift towards biomass energy, as promoted to decrease the impact of fossil energy on the climate system [9], will bring with it a need for substantially more water, which will raise a conflict between 'water for food' and 'water for energy' [10].

Brazil, holding around one third of the worlds remaining rainforests, keeps 12 % of the world's water resources stored in rivers, lakes and underground aquifers. In many natural areas having open public access, but lacking proper environmental law enforcement, the resources can be easily overexploited. Because of this deforestation and unsustainable land-uses continue to cause serious degradation and contamination of freshwater [11], [12]. Forest plantations covered 187 million hectares in year 2000, with a current annual planting rate reaching 4.5 million hectares globally, South America accounting for 11% of the annual rate.

In Brazil, the largest country in South America, forest

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plantations are believed to be expanding at a rate of 2.2 to 2.3 thousand square kilometers per year [13].

Such contamination makes the rural inhabitants lack viable remedies to treat water for domestic use. They become reliant on sustainable alternatives solutions to conserve the available water and natural resources. For this there will continue to be a growing demand in the coming decades [14]. A question arises to a socio-environmental planner confronted with a range of negative outcomes caused by human occupation in rural areas of high natural value: How is it possible to conserve water resources in areas of good environmental quality with the condition of allowing a sustainable use of water and other natural resources for the common benefit of the people and physical environment?

Santa Catarina State is a south Brazilian state located in a corridor of the Atlantic Rain Forest that extends from the northeast to the south of Brazil. The state possesses a rich natural heritage of forested areas with numerous natural springs, but human pressure has made it necessary to establish a network of protected areas to preserve the water resources that have not yet been polluted or degraded. Traditionally, the purpose of establishing protected areas has been to solely protect the biodiversity and natural value of a landscape, but recently focus has been given to traditional agriculture as means of conserving natural and cultural values in human impacted landscapes [15]. Many conservation projects in Santa Catarina have already been realized and in 1993 the Itajaí Municipality established their first area of environmental protection in the rural suburb of Brilhante.

This conservation area was created with the aim of protecting the remaining parts of the Atlantic Rain Forest, within which the municipality's best quality freshwater resources are being generated. Protecting an area of high natural value can create a buffer against pollution and degradation for the supply of fresh water to the rural inhabitants living inside or near the protected area [16]. In the case of APA Brilhante the aim has been to reach a socio-environmental equilibrium where a positive interaction between people and environment is created resulting in improved quality of rural life. This means that nature will provide ecological services for the people which will sustain a healthy society and help nature recover its ecological diversity [17]. Ensuring a sound management of the protected area is therefore an essential key to obtain environmental sustainability and as [18] mention good environmental management can be realized by making good use of the people already living within the area.

In Brazil the different types of protected areas that can hold human populations are classified as "units of sustainable use", and APA Brilhante is classified as such. The inhabitants are generally permitted to live within the designated area by applying a more environmentally friendly land use practise. But converting into a sustainable land use can be a great challenge to farmers not yet familiar with alternative cropping methods that can save both soil and water resources [19]. To obtain the necessary knowledge about the potential for local inhabitants to adapt a sustainable land use practice in protected areas, we need to analyze and evaluate the contemporary land use pattern and its environmental impacts on soil, water and vegetation.

Performing a field survey that unveil the social conditions, the present environmental challenges and the economic needs that rural inhabitants are facing will have a great importance for projects dealing with community-based water management in river basins of any size. Many previous studies view the preservation of water and natural resources as a result of a minimum influence of human activity, but fewer studied have considered including populations as a dynamic force that can shape and sustain an environment which helps the coming generations for a healthier future.

The objective of the present study is to analyze and evaluate the socio-environmental conditions in a small protected area with the purpose to strengthen the willingness and capacity of the local population for good water resource management and sustainable use of the Environmentally Protected Area of Brilhante, Santa Catarina, Brazil.

II. Description of the Study Area

The study area is located at the protected area of the Rio Itajaí watershed at Santa Catarina (fig. 1), which is one of Brazil's 26 states. With an area of 95.400 km² Santa Catarina State holds a large variety of natural landscapes and many different ethnic groups, mainly as a result of late European colonization. Is located in the southern part of Brazil and borders Argentina to the west. The state capital is Florianópolis, located on Santa Catarina Island. Along the Atlantic coastline, about 90 km north of Florianópolis, at Latitude 26°54'28" and Longitude 48°39'43", the coastal Municipality of Itajaí can be found. Rio Itajaí Mirim, being the main tributary of Rio Itajaí Açu, provides most of the freshwater-supply for the City of Itajaí.

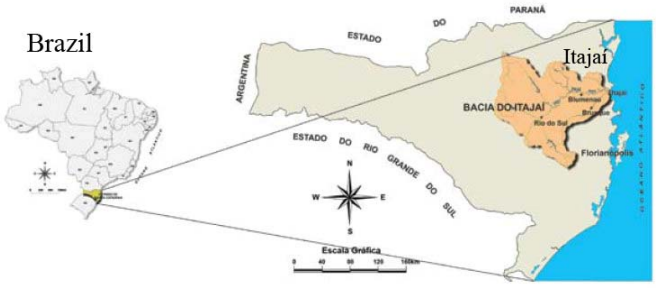

Figure 1- Location of the State of Santa Catarina in Brazil and the study area of the Rio Itajaí watershed.

The river provides possibilities for transportation from inland to coast, but has been highly contaminated from input of untreated domestic wastewater, intensive agriculture, effluents from industries and salt-water intrusion from the Atlantic Ocean. The Area of Environmental Protection "APA da Serra Brilhante" created by a Municipal Law at 1993 and house 621 families. The total area encompassed 2015 ha of

which 41% was covered by native forests maintained mainly along watercourses and valleys.

The purpose of creating the APA Brilhante was to protect the most important hydrological resources in the municipality and to guarantee a sustainable use of the natural resources in the area. According to SDR Itajaí [20] and [21], many natural springs and water courses within the Municipality of Itajaí have been degraded partially or in their full course as a result of lacking riparian forest, unwise water management and changes in land use. Degradation usually starts from the point where human settlement starts having impacts on the freshwater ecosystem (fig. 2).

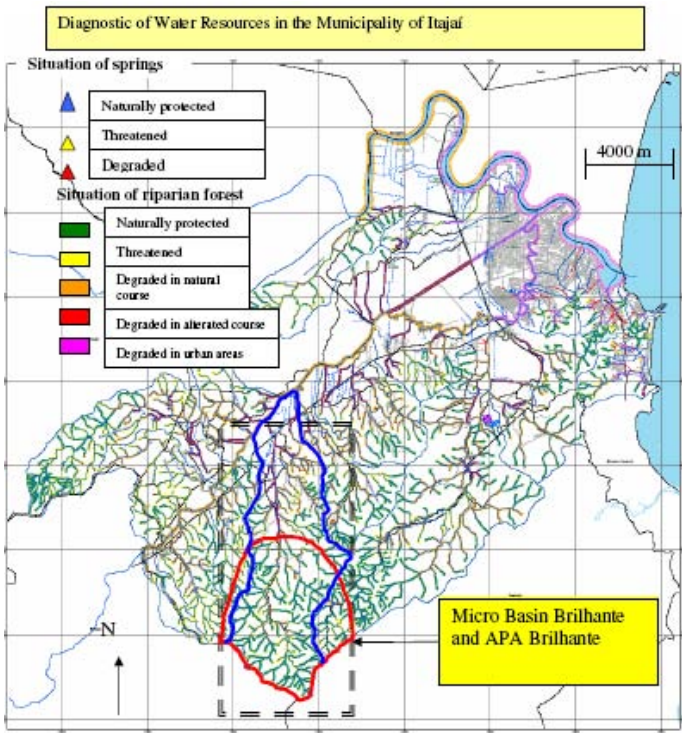

Figure 2- Diagnosis of the environmental condition of natural springs and riparian forests within the Municipality of Itajaí (modified from [20]). On the map are shown the limits of the micro-basin and APA Brilhante.

The climate in Itajaí is classified as Subtropical (mesothermic humid with an annual average temperature of 21°C). The summers are warm, rarely over 37°C, and the winters are mild, rarely under 10°C. Rainfall is more intense in the summer period and less intense in the winters, and Itajaí receives an annual precipitation of between 1400 and 2000 mm. The high amount of rain gives an elevated humidity to the air – equivalent to 84 % in average with an average air pressure of 1010 Mbar [21]. The Brilhante area is made up of two valleys with hills rising to 200-300 m above sea level and at the source of the Brilhante River they rise to 400-600 m. The forests of Brilhante are classified as native Atlantic Rain Forest of the type *Ombrófila Densa* which grows widespread across Santa Catarina, and the introduced *Eucalyptus* spp. plantations.

Ombrófila Densa is composed of dense ferns, arborescents, terrestrial orchids, bromelias retaining water in their flower trunks, palm trees from which palm heart can be extracted for human consumption, moss carpets working as sponges to conserve water and an innumerable number of lianas. Many species have been classified as epiphytes and live in symbiosis with other species. According to some scientists, the Atlantic Rain Forest is said to hold the largest number of tree and plant species per hectare ever found on the planet. The large numbers of tree-species give shelter to high diversity of mammals, bird and insects, all living in or near the forest. Many of these species are endangered in other parts of the Atlantic rain forest. It has been estimated that around 357 tree species thrive in the area of the Rio Itajaí watershed.

The remaining vegetation comprised planted stands of *Pinus* spp., *Eucalyptus* spp., and *Araucaria angustifolia*. Only planted forests were harvested, either for timber, energy biomass or cellulose extraction. Non-native stands were harvested at intervals of approximately seven years during which time there was a substantial growth of underbrush, and a clear fell was carried out in the third interval (i.e. after 21 years).

III. Methodology

To investigate the socio-environmental conditions and the use and management of natural resources in the Brilhante area, a questionnaire containing 50 questions was prepared. The questions were prepared as a geographical description of the area, containing specific questions related to the use and management of water and other natural resources. In the following weeks, 60 families, living in 60 different houses in Brilhante were visited and the questionnaire was performed as an interview with one or more of the family members at each house. Each interview could typically last from 30-60 minutes and at times develop into a conversation. This facilitated the interview as many of the local inhabitants provided the questionnaire with supplying information that couldn't have been obtained elsewhere.

The location of field interview was selected randomly. Families may be farmers or landowners and with different education levels (fig. 3 and 4). Two recreational sites were selected for interview to highlight the importance of tourism in the area. Some of the interviews were recorded with a Sony IC Recorder (Dictaphone) to remember exactly what was being said at each of the sites.

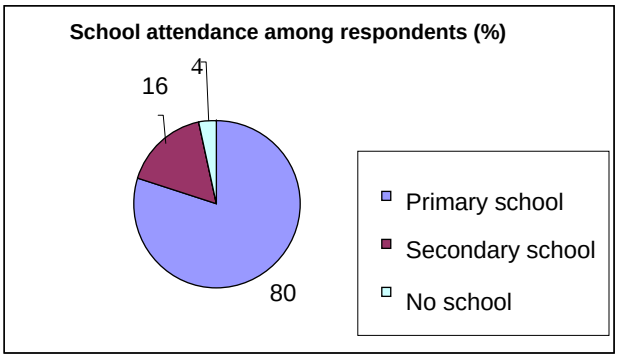

Figure 3- Pie diagram showing the education level of people interviewed.

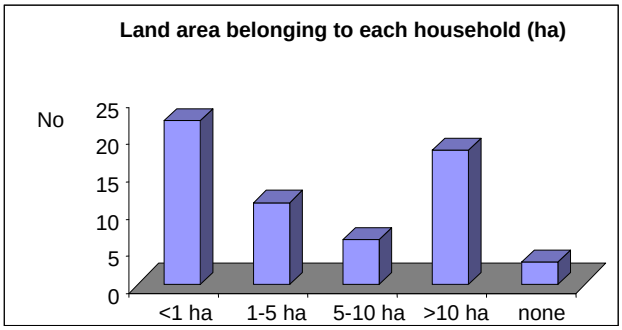

Figure 4- The size of land area belonging to the interviewed households.

Additional information was collected from local stakeholders. During the "Semana do Meio Ambiente" more information was aquired as a result of the meetings being held in different parts of Itajaí. At the local school at Brilhante II, a project of recuperating the riparian forest along the local stream was initiated with the help of the school students on the first day of the "Semana do Meio Ambiente". Prior to or during the interviews each of the interviewed persons would be informed of the ongoing plans of applying the "Area of Environment Protection" to the Brilhante area – this would also demand a responsibility of the inhabitants living in the area further down the valley.

Once all the interviews were made, a digital map of the area indicating all the 60 locations of the interviews would be produced. This map, combined with other thematic maps would form the base of the analysis of the area and evaluation of its characteristics (problems and potentials).

Results of the interviews were categorized in a table showing the number of responders having choisen – to determine whether the inhabitants of Brilhante would be in favour of or against changes in the environment – using the application of the "Area de Proteção Ambiental" as tool to stimulate a sustainable development in the area. The maps, answers of the interviews, additional information and photos from each site would form the base of the analysis and evaluation given in the following section.

No previous announcements of the arrival of the interviewer would be given, and the questionnaire should therefore be regarded as having been performed spontaneous [22]. In respect to the availability of people that could answer to the questionnaire, the persons being willing to answer would be questioned, without preferences.

IV. Results and Discussion

All the results of the socio-environmental analysis among the 60 families in Brilhante are resented below. As the questionnaire turned out to be very extensive, not all the questions would be answered by all the interviewed persons. Depending on the person's willingness to answer and comment upon the questions, the replies reflect the broad view of insight and different positions regarding the caretaking and future sustainability of the local environment.

The interviews of the few farmers still existing in Brilhante, show that they are facing many of the common economic and biophysical challenges that globalization and climate changes are giving to the tropical areas (fig. 5). Due to climate changes, some regions of Brazil, especially the semi-arid Northeast will suffer from a diminution in water availability [23]. These changes can set forth a search for alternative land use systems to cope with environmental and socio-economic pressures [23].

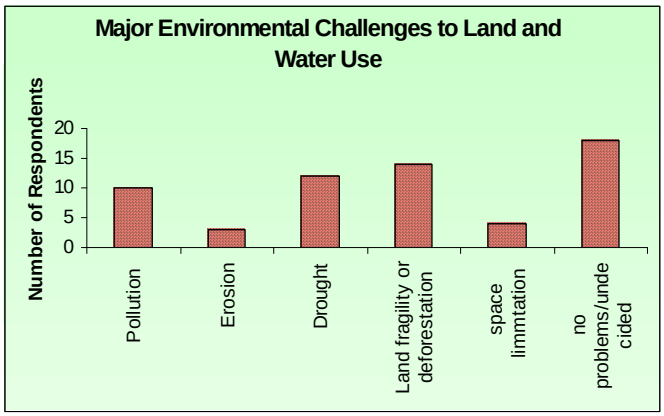

Figure 5- Histogram showing the number of respondents highlighting specific environmental challenges to land and water use (respondents had to give priority to one problem).

The natural Atlantic Rain Forest that surrounds the Brilhante Valley is a precious resource for the local inhabitants, because they protect and generate the natural springs from where 75 % of the households receive their drinking water. A high amount of rainfall and the effective retention and filtration of water that the soils perform in the forest bottom is responsible for this. The majority of the families that had access to spring water answered that the water is so clean that it can be drunk readily, when it flows through the hoses that connect the springs to the water tanks that most of the houses had installed in the gardens.

"We shouldn't disturb the natural forest, because it provides us with water. If it wasn't because of the native forest, still surrounding Brilhante, we would be without clean water now." (Citation, housewife – Brilhante I).

This view on the forest is reflecting the perception that many locals have after seeing much of the native forest having been converted into pasture or Eucalyptus plantations. All the households having access to spring water from the forest expressed their gratitude for this, but at the same time they were worried if this situation would last. The future of the native forest is therefore much dependent on the demand for space to expand the agricultural activities practiced in the area. At the same time it is possible to combine agricultural activities with sustainable forest management [24]. What is still lacking in Brilhante is a deeper knowledge of the resources hidden in the forest. This could help the local population to benefit from the forest resources as an economic alternative to agriculture/cattle ranching. The forest itself, besides giving shelter to wildlife, provides a variety of readily exploitable products and services. And most important for Brilhante is that it also plays an essential role in maintaining the watershed that supplies much of the available drinking water for the community [25].

In the work by Campi [26] it is shown that the evapotranspiration and water uptake from Eucalyptus trees in fact doesn't differ from that of the native Atlantic Rain Forest, but according to Ferreira [27] the unsaturated overland flow is increased by plantation of Eucalyptus spp. in dry periods of the year. After drying out, the soils become water repellent. Water repellence can lead to erosion during short periods of heavy rainfall [28].

Within the group of farmers that have specialized in cultivation of Eucalyptus, we have also included the cultivation of Palmito Juçara (Euterpe edulis) that plays an important role in the food production economy of some farmers, but in the last decades this specie has suffered from illegal over-extraction and become threatened.

Wastewater is considered the most important source of pollution affecting the water quality of the Brilhante River. From the survey having been performed among the inhabitants in Brilhante I and II, it was found that the problem of wastewater discharge into the river is a common concern that needs sustainable solutions. Half of the questioned families have not yet received any cesspit installation kit for wastewater treatment.

From the field survey it was found that the practice of burning the fields before or after cropping is hardly being practiced in contemporary land use throughout the community. Only 10 out of 60 households stated that they practiced field burning. Formerly, the need for fertilizers was one of the great challenges for the farmers, a need which could be partly covered by burning the fields before and after cropping to release the inorganic nutrients, which are bound to the organic material covering the field. This practice has been related to the "slash and burn" agriculture which has been practiced for centuries in areas of Brazil covered by tropical forest. Today's environmental law has enforced strict rules concerning the practice of burning fields.

In relation to the actual pollution of the nearby river and the losses of numerous water springs as a cause of deforestation, the conscience of preserving the dense natural forest areas has increased in the last 10 years. Most families referred to the environmental conditions in the Brilhante area as it was 10 years ago. The river was full of water and the forest supported enough natural springs to create natural ponds which were frequently used by the local inhabitants for leasing and as a secure water supply in times of drought (personal communication, interview 43). Even the youngest members of the families refer to the landscape as it appeared 6-10 years ago and comment upon the recent changes that have occurred in the recent years.

A large majority of the individuals responded that deforestation and the plantations of eucalyptus has dried out the soils and caused many natural water springs to disappear. This has led the respondents to suggest a number of important counteractions against environmental degradation (fig.6). Another large scale factor influencing the recharge of the groundwater table is the instability and lack of rainfall that the area receives:

"We are feeling the effects of the big changes going on in Amazon, where the mighty are controlling the land…if the deforestation in Brilhante would continue like that; we wouldn't have more water in 10 years, so of course we have to take care" (citation: pineapple-farmer, Brilhante II).

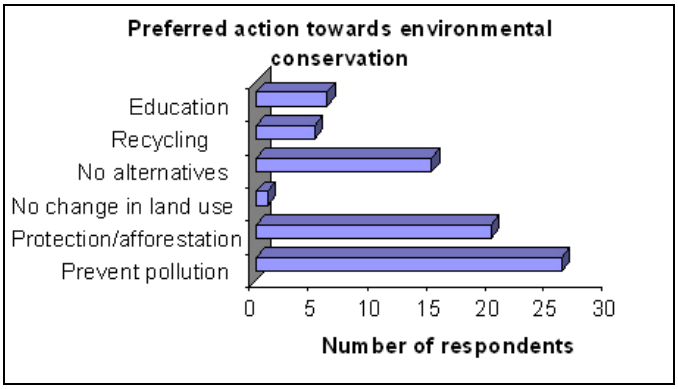

Figure 6- Histogram showing the preferred action towards environmental conservation in the Brilhante area.

The deforestation rates in Brazil are alarming and this country is one of largest consumers of biomass energy in the world (Fig. 7). In order to respond to this scenario, Brazil has developed a vast forest potential that has contested by environmental groups that struggle to reduce the establishment of large-scale exotic species plantations.

When asked, what the families can do as individual households, most families responded that much could be done, for example in regards to collection and separation of rubbish. Most of the interviewed families admitted that it was wrong to throw rubbish in the river, but they ignore alternatives.

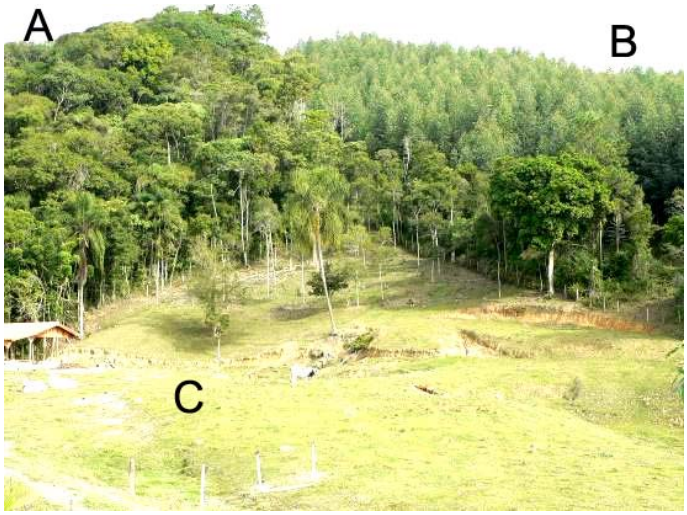

Figure 7. Rainforest of native *Ombrofila densa* (A) has been recently cleared to give way for *Eucalyptus* plantations (B) and pasture (C). (Used by permission of Sebastian Lassen ©2008, all rights reserved).

Figure 8- Students from the community school participating in reclamation project and replanting native species along the bank of the Brilhante river. (Used by permission of Sebastian Lassen ©2008, all rights reserved).

A small fraction of the interviewed farmers tried to explain their dilemma in terms of economical value. How were they to survive on a long term scale if they were not allowed to expand their area of arable land? This question would lead to a discussion about fragility of the soils and the probable return they would get from each hectare.

Interestingly, it was clearly felt that the local inhabitants were satisfied living in an area so blessed with peace and scenic nature. Among the questioned families were a young couple, having moved from the city to the countryside, because they considered Brilhante to be a healthier environment for children and their family life. For the youth "variety is the spice of life" and in a certain way they try to convey this viewpoint to the elderly generation. Changes should come from within, but "the first steps come from the youngest in the society".

Public participation and environmental awareness were promoted mainly to younger. The "Project a Greener Itajaí" is a municipal environmental project aimed at giving continuity to the actions of reclamation of the riparian forests around streams and natural springs in the Municipality of Itajaí generation (Fig. 8).

In the local school, the first steps to rehabilitate the riparian vegetation along the Brilhante River have already been taken, and this has shown to be of great attraction and interest to the school students, who voluntarily took part in the fist plantations of native tree species along the part of the river that passes the school. From such initiatives the youngest members of the society can see that their contribution, as small as it may be, actually helps and the changes create joy and satisfaction among those who see the value in making the environment greener.

Among rice farmers, the opinion showed to be quite different. They cannot afford to offer 30 meters of their rice fields for the benefit of the riparian forest to be rehabilitated. For them it is difficult to see any benefits in having trees instead of rice on their fields and believing that the municipality tries to take part of their cultivated land they quickly discard any considerations of participating in the project "Itajaí Mais Verde".

Another problem is the spreading of pesticides with airplanes in rice plantations. The families were interviewed in regard to this matter and they all expressed their fears of heath damage for them, plants and animals. In figure 9 it can be seen that water quality is the most important indicators of sustainability according to the opinion of the Brilhante inhabitants.

Sustainable landscape management in environmentally sensitive areas should be based on traditional social stewardship. Solutions to alleviate the environmental degradation ought to build on creative and dynamic applications designed to meet the needs of the specific areas, such as the foundation of river basin committees and local projects of environmental education [29].

The initial aim of having designated Brilhante as Environmental Protection Area has been to achieve a sustainable use of the area. According to Liitig and Greißler [30] 'human needs cannot be sufficiently met just by providing an ecologically stable and healthy environment, but if a society is indeed omitted to sustainability, the equally legitimate social and cultural needs ought to be taken care of as well'.

The results indicate that the residents have limited awareness and a poor understanding about sustainable development and the rules of the environmental conservation area. However, they hold a positive attitude toward water conservation while people's awareness of the conservation

program has a positive correlation to their educational level, whereas their pro-environmental and resource conservation behavior has a positive correlation to the age of the respondents.

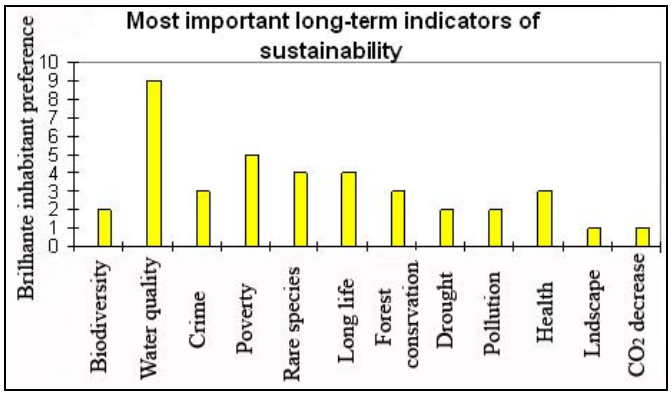

Figure 9- The indicators of sustainability as chosen by the Brilhante households.

V. Conclusions

The main objective of this study was to create a better understanding of public awareness and performance in the promotion of environmental protected areas in Itajai, Brazil. It was found that the residents in Brilhante have limited awareness and a poor understanding about sustainable development and on which are the rules at the environmental conservation area. While the government sets an ambitious goal and takes more responsibility in promoting rainforest conservation and reclamation, the public does not have basic information on what role they should play. Most residents are not involved in the promoting conservation.

The older population and mainly the farmers of the study area do hold a substantial amount of knowledge about the resources around them, although, they request in general more information on how to conserve water, soil and vegetation and how to strengthen their self-sustainability in food production. Brilhante inhabitants consider that badly managed agriculture and the Eucalyptus plantations having substituted the native forests dried out their soils. A general concern for the community is to preserve the remaining sources of freshwater and keep the water quality as good as possible. For this purpose to be fulfilled, wise stewardship should be taken all the way through the Brilhante Micro-basin.

Analysing the social, economic and environmental conditions it can be concluded that degraded areas within APA Brilhante can be reclaimed with: adaptation of sustainable land use practices, increase of small farm productivity, biodiversity preservation, on-farm water conservation and a supply of diverse ecosystem services.

The municipality has the responsibility to show the direct benefits of converting parts of arable land into riparian forest by actual examples and in direct communication with the farmer [31]. The study concludes that the Brilhante community possesses great potential for converting into more sustainable land management practices and could become a good example of sustainable land use among similar protected areas.

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References

[1] E. Ceccon, “El paraíso casi perdido: historia breve de la deforestación en Brasil” Revista Ciencias. UNAM. México. Vol. 64, 2001, pp. 22–29.

[2] M. Varmola, A. Del Lungo, (Eds.), “Tropical Forest Plantation Areas Data Set”. Forest Plantations Working Papers. Forestry Department Food and Agriculture Organization of the United Nations, 1995.

[3] UNESCO, Water, a shared responsibility. The United Nations World Water Development Report 2. 2006

[4] S. L. Postel, “Entering an era of water scarcity: the challenges ahead”. Ecological Application Vol. 10 (4), 2000, pp. 941–948.

[5] C. Revenga, J. Brunner, N. Henninger, K. Kassem and R. Payne. “Pilot Analysis of Global Ecosystems: Freshwater Systems”. World Resources Institute. Washington DC. 2000.

[6] A.Y. Hoekstra and A. K. Chapagain, “Water footprints of nations: water use by people as a function of their consumption pattern”. Water Resources Management Vol. 21, 2007, pp.35–48,.

[7] P. Oliveira and T. Panagopoulos, “Post-fire Landscape Rehabilitation at the Protected Area of Montejunto, Portugal”. In: New aspects of Landscape Architecture. T. Panagopoulos, J.Burley (eds.) WSEAS Press, Faro, Portugal, 2008, pp 157-161.

[8] L.O. Fresco, “Biomass for food or fuel: Is there a dilemma?” The Duisenberg Lecture Singapore September 17, 2006

[9] C.Y. Kao, “Development of Biomass Energy in Taiwan: Current Status and Prospects”. In: New aspects of energy, environment, ecosystems and sustainable development. T. Panagopoulos, T. Vaz, M.D. Antunes (eds.) WSEAS Press, Faro, Portugal, 2008, pp 126-129.

[10] FAO, “Introducing the International Bio-energy Platform.” FAO, Rome, Italy, 2006.

[11] D.L. Johnson and L.A. Lewis, “Land Degradation: Creation and Destruction.” Blackwell, Oxford UK & Cambridge, USA, 1995.

[12] J.D. Restrepo and J.P.M. Syvitski.. “Assessing the Effect of Natural Controls and Land Use Change on Sediment Yield in a Major Andean River: The Magdalena Drainage Basin, Colombia.” Ambio, The Royal Swedish Academy of Sciences vol. 35, no. 2. 2006, pp. 123-134.

[13] C.J.C. Bacha and A.L.M. Barros, “Reflorestamento no Brasil: evolução recente e perspectivas para o futuro.” Scientia Forestalis Vol. 66: pp. 191-203, 2004.

[14] UNEP. “Challenges to International Waters – Regional Assessments in a Global Perspective.” United Nations Environment Programme, Nairobi, Kenya: 125 p. 2006.

[15] S.R. Harrop, “Traditional agricultural landscapes as protected areas in international law and policy.” Agriculture, Ecosystems and Environment, Vol. 121, 2007, pp. 296-307.

[16] R. Abell, D. Allan, J. and B. Lehner, “Unlocking the potential of protected areas for freshwaters.” Biological Conservation, Vol. 134, 2007, pp. 48-63.

[17] Estação Experimental de Itajaí and Centro de Treinamento de Itajaí. “Apostila do Curso Profissionalizante de Agroecologia: Agroecologia Para Todos.” Governo do Estado de Santa Catarina. Florianópolis, 2001.

[18] R.Y.M. Kangalawe, and E.T. Liwenga, "Livelihoods in the wetlands of Kilombero Valley in Tanzania: Opportunities and challenges to integrated water resource management." Physics and Chemistry of the Earth, Vol. 30, 2005, pp. 968–975.
[19] M. Elbakidze, "Implementing sustainable forest management in Ukraine's Carpathian Mountains: The role of traditional village systems." Forest Ecology and Management, Vol. 249, 2007, pp. 28–38.
[20] SDR Itajaí, "Plano de Recursos Hídricos da Bacia Hidrográfica do Rio Itajaí: Construindo o Futuro da Bacia." Projeto Piava. Santa Catarina and Agência da Água do Vale do Itajaí, Blumenau, Brazil. 2006.
[21] SDR Itajaí, "Caracterização Regional. Secretaria de Estado de Planejamento, Orçamento e Gestão." Itajaí, Brazil. 2003
[22] T. Panagopoulos, M. Vidic and B.R. Ramos, "The Impact of Golf Course Development on a Constantly Changing Mediterranean Landscape." Proceedings of the 3rd Conf. on Energy, Environment, Ecosystems & Sustainable Development, July 24-26, 2007 Agios Nikolaos, Greece, pp: 110-115.
[23] T. Geiser, "Global Change and Regional Impacts." Water Availability and Vulnerability of Ecosystems and Society in the Northeast of Brazil, Springer, 2003.
[24] J. L. Vivan, "Agricultura e Florestas: princípios de uma interação vital." Agropecuária, Guaíba, Brazil, 1998.
[25] T. Tietenberg, "Environmental and Natural Resource Economics." HarperCollins College Publishers. New York, 1996.
[26] A. Campi and J.V. Soares, "Comparação entre uso de água em plantações de Eucalyptus grandis e floresta *Ombrófila Densa* (Mata Atlântica) na Costa Leste do Brasil." Arvore, Vol. 27, 2003, pp.159-170.
[27] A.J.D. Ferreira, C.O.A. Coelho, R.P.D. Walsh, R.A. Shakesby, A. Ceballos and S.H. Doerr, "Hydrological implications of soil water-repellency in Eucalyptus globulus forests, north-central Portugal." Journal of Hydrology, Vol. 231, 2000, pp. 165–177.
[28] C. Giardina, R. Stanford, I. Dockersmith and V. Jaramillo, "The effect of slash burning on ecosystem nutrients during the land preparation phase of shifting cultivation." Plant and Soil, Vol. 220, 2005, pp. 247-260.
[29] A.C. Beaumord and F.L. Diel, "Environmental Threats in the Central and Northern Coast of Santa Catarina State: an Owerview." Journal of Coastal Research, Vol. 39, 2006, pp. 1017-1020.
[30] B. Liittig and E. Greißler, "Social Sustainability: a catchword between political pragmatism and social theory." International Journal of Sustainable Development, Vol. 8, 2005, pp. 65-76.
[31] I.L Basic, A.K. Bregt and D.G. Rossiter, "A participatory approach for integrating risk assessment into rural decision-making: A case study in Santa Catarina, Brazil." Agricultural Systems, Vol. 87, 2006, pp. 229–244.

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