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"Water Use and Conservation at the Environmental Protection Area of Brilhante, Santa Catarina - Brazil"

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Martin Sebastian Lassen

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NOME / NAME: Martin Sebastian Lassen

DEPARTAMENTO / DEPARTMENT: Química, Bioquímica e Farmácia

ORIENTADOR / SUPERVISOR: Thomas Panagopoulos – Faculdade de Engenharia e Recursos Naturais, Universidade do Algarve

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JURI: María del Mar Delgado Serrano – Universidad de Córdoba

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RESUMO

A ocupação humana nas bacias hidrográficas rurais tropicais tem contribuído para uma constante degradação da água e de outros recursos naturais. A expansão agrícola, o desflorestamento e falta de equipamentos sanitários em boas condições para tratamento dos esgotos são as condições que ameaçam a qualidade ambiental na Área de Protecção Ambiental do Brilhante (APA Brilhante), situado no Estado de Santa Catarina, no Sul do Brasil.

A área, em grande parte coberta por floresta atlântica virgem, possui inúmeras nascentes naturais importantes para conservação da qualidade da água e a sua distribuição nas zonas rurais do município. Na APA Brilhante o cultivo da terra é permitido, mas tem de ser feito de acordo com os princípios de sustentabilidade. Para compreender as condições socio-económicas, as possíveis ameaças à qualidade da água, e realçar potenciais alternativas ao cultivo da terra, foi feito um levantamento baseado em entrevistas às famílias que viviam dentro ou perto da área protegida.

Os resultados mostram que a degradação do solo e da água, combinada com a poluição, são as principais preocupações da população. Se nenhuma prática alternativa de cultivo do solo for aplicada, as condições ambientais continuarão degradar-se. Deste modo, a gestão racional baseado numa percepção sócio-ambiental, na educação e na colaboração eficiente dos grupos/organizações interessadas, são indispensáveis para proteger a paisagem e garantir os benefícios ambientais que o povo pode obter da interacção com a natureza. A população solicita informações sobre como conservar a água, o solo e a vegetação para proteger a natureza e continuar o cultivo para produção alimentar. Por este motivo, o estudo conclui que a comunidade de Brilhante possui uma grande capacidade em adaptar práticas sustentáveis de cultivo, o que ajudará Brilhante a tornar-se um bom exemplo de planeamento sustentável para outras áreas protegidas semelhantes.

Palavras-chaves: Consciência ambiental, minifúndio, cultivo sustentável da terra, qualidade da água, Área de Protecção Ambiental.

WATER USE AND CONSERVATION AT THE ENVIRONMENTAL PROTECTION AREA OF BRILHANTE, SANTA CATARINA - BRAZIL

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 practises. This will help APA Brilhante to become a good example of sustainable management for similar protected areas.

Keywords: Environmental awareness, small scale farming, sustainable land use, water quality, Environmental Protection Area

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1. Introduction

During the last decades the concern about how to protect the worlds remaining freshwater resources and maintain water quality good for future generations, has become a priority issue in global development (UNESCO-WWAP, 2006; Millennium Ecosystem Assessment, 2005). Important environmental and social indicators such as climate change[1], an increase in human impacted sediment erosion, pollution through intensified agriculture and a growing population density in river basins suggest that in many parts of the world, future problems with supply of clean water will magnify (Revenga et al. 2000).

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, eutrophication and unsustainable land-uses continue to cause serious degradation and contamination of freshwater and soils (Restrepo & Syvitski, 2006; Johnson et al. 1995).

Such contamination makes the rural inhabitants lack viable remedies to treat water for domestic use. They become reliant on sustainable alternative solutions to conserve the available water and natural resources. For this there will continue to be a growing demand in the coming decades (UNEP 2006). Being a socio-environmental planner confronted with a range of negative outcomes caused by human occupation in rural areas of high natural value, the question arises: How is it possible to conserve water resources in areas of good environmental quality with the condition of allowing a

[1] For climate change was used the definition given by UNFCCC, 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods' (Joint Science Academies, 2005).

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 Forest that extends from the northeast to the south of Brazil. The state possesses a rich natural heritage of forested areas holding numerous natural springs of good quality, but human pressure has made it necessary to establish a network of protected areas to preserve 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 values of a landscape, but recently focus has been given to traditional agriculture as means of conserving natural and cultural values in human impacted landscapes (Harrop, 2007). This opinion is shared by Abell et al. (2007) suggesting that areas designed to protect freshwaters are managed most effectively by combining the most innovative ideas in different fields of science ranging from biology to social science. Local inhabitants must therefore take actively part in developing best environmental conditions in their area.

Among the many conservation areas having been designated in Santa Catarina State (Annex 1), in 1993 the Itajaí Municipality established their first environmental protection area in the rural suburb of Brilhante, named "Área de Protecção Ambiental da Serra do Brilhante", or simply APA Brilhante.

This conservation area was created with the aim of protecting the remaining parts of the Atlantic Forest, within which the municipality's best quality freshwater resources are being generated. Studies have shown that protecting an area of high natural value can create a buffer against pollution and degradation for the supply of fresh water to rural inhabitants living inside or near the protected area (Dudley and Stolton, 2003).

Fig. 1 gives an example of how an Environmental Protection Area can fit into a watershed, purposely being designated within a micro basin. Upstream protection of tributaries can help to safeguard a good environmental quality of the river when it enters the estuary coastal zone.

In the case of APA Brilhante the aim has also been to reach a socio-environmental equilibrium where a positive interaction between people and environment is created - ultimately resulting in improved quality of rural life. This means that nature can provide a range of ecological services for the good of community life and strengthen its ecological diversity (Gerência Regional de Itajaí, 2001).

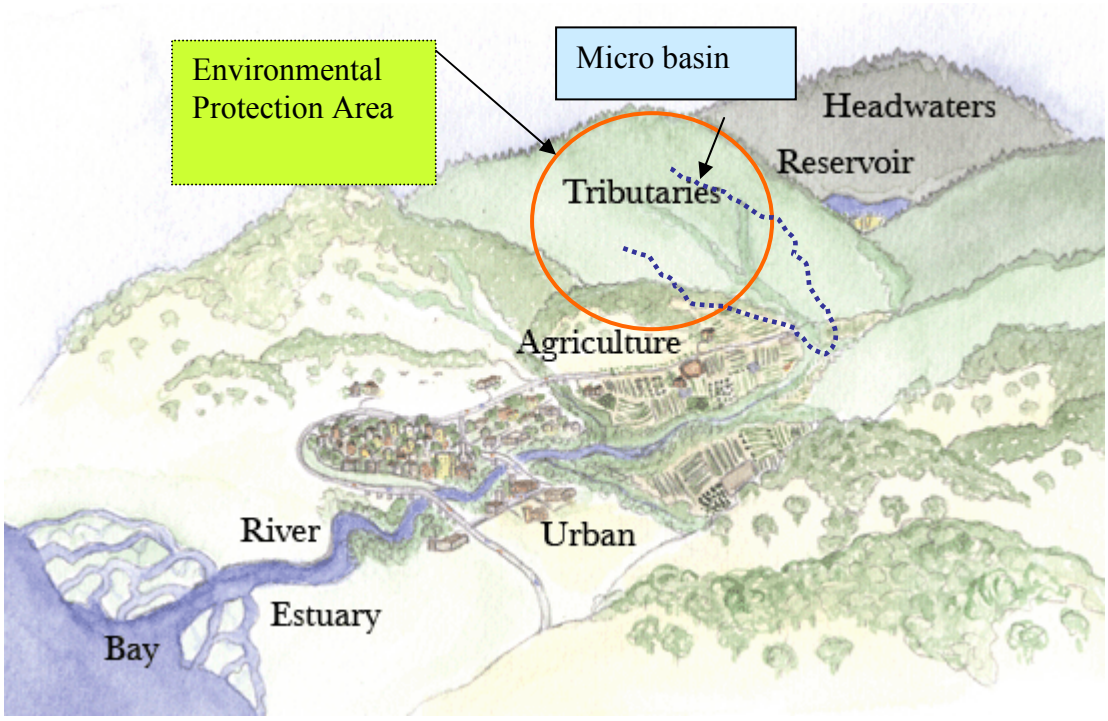


Fig. 1: Drawing of a typical watershed linking rural upland to urban areas at the coastal zone. Within a minor tributary, delimited as micro basin an Environmental Protection Area has been designated. (Modified after: Watershed Information Centre and Conservancy of Napa County)

Ensuring a sound management of the protected area is therefore an essential key to obtain environmental sustainability and social improvements (ICEM, 2003; Scherl et al., 2006). And sustainable environmental management of source waters originating in these protected areas can be realized by making good use of the people living within the area

and strengthen the institutional arrangements for land use planning (Kangalawe et al., 2005; Timmer et al., 2007; Ivey et al., 2006).

In Brazil, a specific group of protected areas that can hold human populations are classified as “units of sustainable use” (Reserva da Biosfera da Mata Atlântica, 2002). APA Brilhante is classified into this group. The inhabitants are generally permitted to live within the designated area by the sole condition of applying a more environmentally friendly land use practise. However, the pressures from man’s activities have turned many such areas into battlefields between environmental preservation and economic development.

From fig. 2 it can be seen how a watershed, even though having been protected by law, can be threatened by human occupation like deforestation, uncontrolled settlement, agriculture etc. This is unfortunately happening to many protected areas in Brazil (Ministerio do Meio Ambiente, 2006; Fantin et al. 2007). Therefore Secretaria de Estado do Desenvolvimento Sustentável (2007) point to the watershed as the basic unit for planning the use, conservation and recuperation of natural resources.

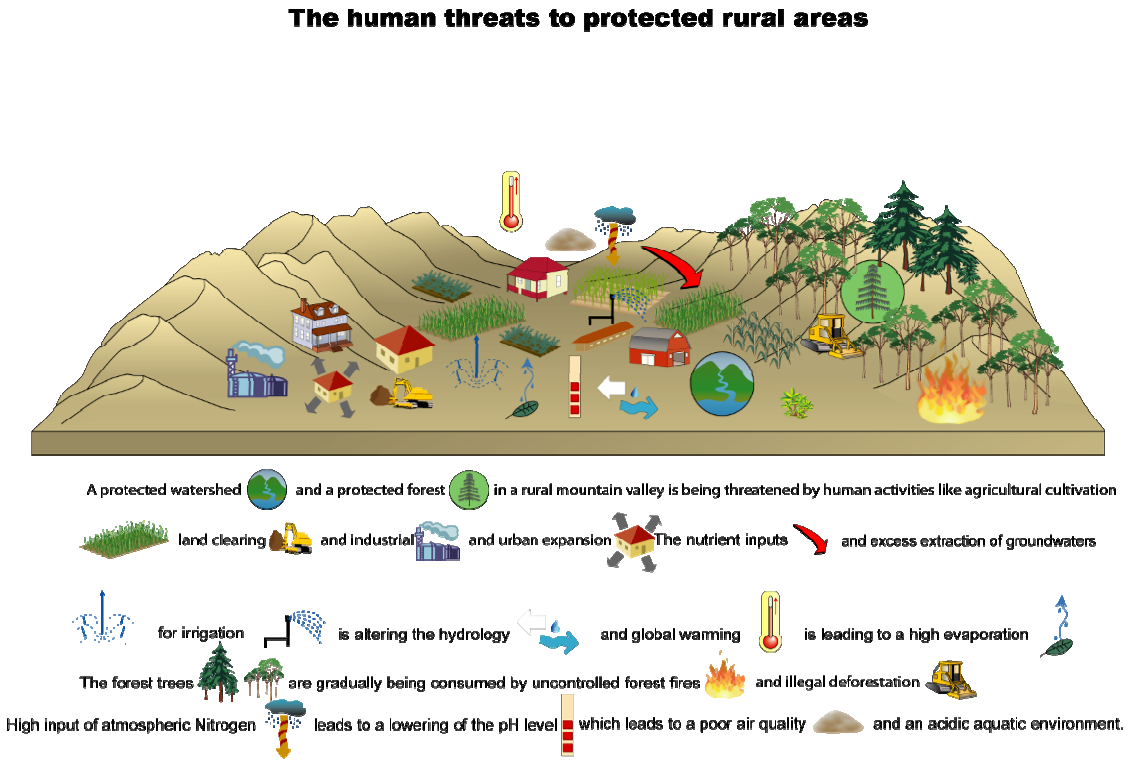


Fig. 2: Conceptual diagram showing some of the common human threats to protected rural areas – in this case, a mountain valley in rapid economic development.

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 (Elbakidze, 2007). To obtain the necessary knowledge about the potential for local inhabitants to adapt a sustainable land use practice in protected areas, we need to analyse and evaluate the contemporary land use pattern and its environmental impacts on soil, water and vegetation (Mori, 1998). 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.

The Rio Itajaí Hydrographical Region is divided into 58 municipalities which all possess a part of the total number of tributary rivers that drain into the Rio Itajaí Açu (Comitê do Itajaí, 2006). Most of the tributaries of Rio Itajaí Açu originate in areas that have been protected by environmental law. After having received waters from all its

tributaries the Rio Itajaí Açu finally drains into the Atlantic Ocean. Thus a link can be drawn between the protection of headwaters and improved environmental quality in estuaries when rivers enter the coastal zone (UNEP/MAP/PAP, 1999). That however is not the case if cities and agriculture further down the stream in areas which are not protected by environmental law pollutes the water.

Many municipalities in the region have designated a certain percentage of the municipal area as being protected by law, but little attention has been given to divulge knowledge and inform the public about how to protect the waters originating in their respective area (Pfeilsticker, 2007). A management plan can be elaborated within each minor river basin when the stakeholders living in the area are involved in decision making. Achieving good management in a river basin can stand out as an example for other areas to follow, meaning that environmental protection calls for collaboration and individual responsibility towards the actions taken.

This study does not merely consider preservation to be a result of minimum human activity. It suggests using the local community as a lively force that shapes and sustains the environment; which can help coming generations to a healthier future. The objective is to evaluate the use of water and conservation at the Environmental Protection Area of Brilhante through a description of present social and environmental conditions. A challenge for this area is to strengthen the capacity of local inhabitants, implying that they aim for good management of water resources. It is hoped that this can lead to a sustainable use of the area.

2. Description of study area

Santa Catarina is one of Brazil's 26 states, located in the southern part, below the State of Paraná and above the State of Rio Grande do Sul. It borders Argentina to the west (fig. 3). With an area of 95.400 km² Santa Catarina State is equivalent to the size of Portugal. Although it occupies only 1,1 % of Brazil's total 8.5 million km², it holds a large variety of natural landscapes and many different ethnic groups, mainly as a result of late European colonization. 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. It lies within the Rio Itajaí Açu drainage basin which has been highlighted in fig. 3. Itajaí is a municipality of 165.950 inhabitants (Secretariado de Desenvolvimento Regional de Itajaí, 2003). The total area is 304 km² with 78 km² in 17 urban suburbs and 226 km² belonging to 18 rural. The city was founded in 1860 and through decades of economic development it now holds one of Brazil's most important shipping ports (Município de Itajaí-info).

Two major rivers crossing the Municipality of Itajaí are the Rio Itajaí Açu and the Rio Itajaí Mirim – they are also the main rivers draining the Rio Itajaí Açu Drainage Basin, denominated as "Micro-Região Vale do Itajaí" (Comitê do Itajaí, 2006). Only the Rio Itajaí Açu is navigable from Blumenau, located 70 km inland, to the coast, but in recent decades it has been highly contaminated caused by untreated domestic wastewater, intensive agriculture, industrial pollution and salt-water intrusion from the Atlantic Ocean (SEMASA info).

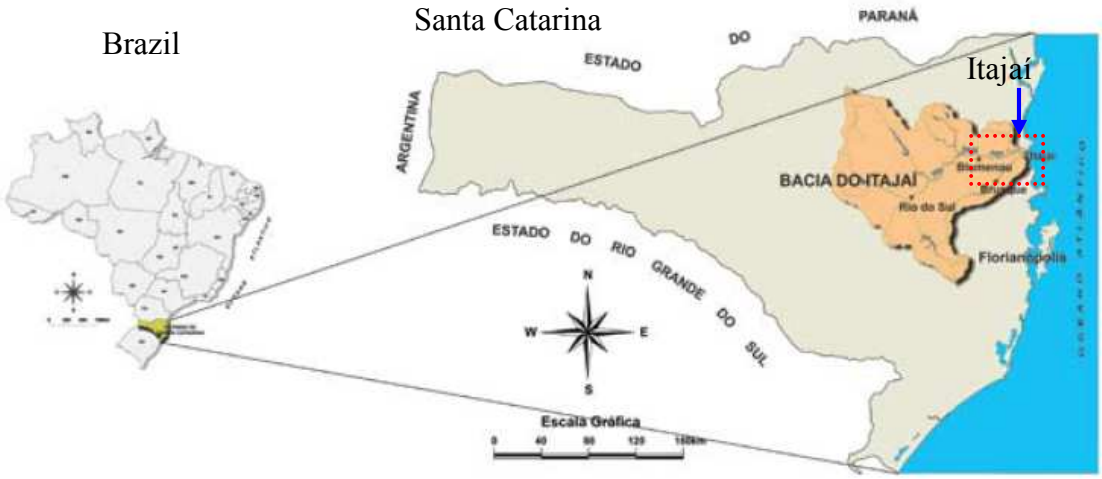


Fig. 3. Map showing the location of the State of Santa Catarina in Brazil and the specific location of the Rio Itajaí Drainage Basin, also denominated "Micro-Região Vale do Itajaí". Adapted from Comitê do Itajaí (2006).

Rio Itajaí Mirim, being the main tributary of Rio Itajaí Açu, provides most of the freshwater-supply for the City of Itajaí (Estado de Santa Catarina, 2005). Though having better quality than Rio Itajaí Açu, water being taken from the Rio Itajaí Mirim is being treated before it can be distributed for domestic use (SEMASA-info). The confluence between Rio Itajaí Mirim and Rio Itajaí Açu happens at the outskirts of the City of Itajaí. Hereafter the Rio Itajaí Açu flows into the Atlantic Ocean at the Port of Itajaí.

Navegantes, Itajaí's neighbour city, is located on the north bank of the Rio Itajaí Açu river mouth. It has an international airport with connections to the main Brazilian cities and countries such as Argentina, Paraguay and Uruguay.

With easy access to the BR 101 Highway the City of Itajaí continues to develop as a service centre. As a coastal municipality, Itajaí offers diverse economic activities attracting a high migration to the urban and semi-urban areas. Fringing the outskirts of the city are fractions of Atlantic Forest, and the economic activities in the rural suburbs are based on agriculture. Nevertheless, the natural landscapes and ecosystems of the

area are continuously being threatened by irregular human occupation, industrial development and extraction of natural resources.

According to Beaumord and Diehl (2006, p.1019) 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 conducted by UNIVALI, the city's main centre for higher education.

2.1 APA Brilhante

Brilhante I and Brilhante II are two rural suburbs of Itajaí, located in the southwest corner of the Itajaí Municipality, shown on fig. 4. According to Secretaria de Agricultura (2007) both Brilhante I and Brilhante II house a total of 621 families, giving the suburbs a total population of about 2000 inhabitants. In fig. 4 the red circle indicates the Brilhante area, and the Environmental Protection Area Brilhante is limited by a white line. Urban areas are marked in grey, cultivated areas are white and forested areas have been marked with green.

The Environmental Protection Area of Brilhante "APA da Serra Brilhante" was created by the Municipal Law 2832 of 22'nd of September 1993, with a total area of 2015 ha. This protected area starts within the limits of the village church and the school. It then continues upstream, covering all Brilhante II and its woody hillslopes until it reaches the limits of the neighbouring watershed.

The purpose of creating the APA Brilhante was to protect the most important hydrological resources in the municipality and to promote a sustainable use of the natural resources in the area. APA Brilhante constitutes one of two protected areas in the Itajaí municipality, the "Area de Protecção Ambiental Atalaya" being the other

protected area, being smaller and less populated with a scenic location along the Atlantic coastline.

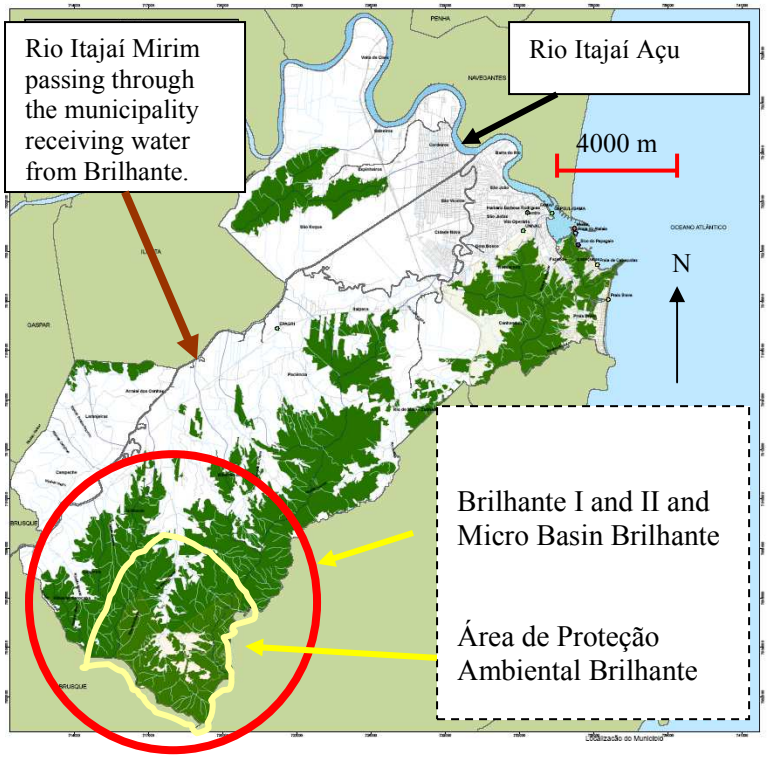


Fig. 4: Environmental map of the Itajaí Municipality. With red, the Brilhante area and with yellow, the Environmental Protection Area Brilhante. Modified after (Plano Diretor de Itajai, 2005).

2.2 Climate

The climate in Itajaí is classified as Subtropical (mesothermic humid with an annual average temperature of 21°C). This climate has the code CFa after Köppens climate classification (Estado de Santa Catarina, 2005; SDR Itajaí, 2003). The summers are warm, rarely over 37°C, and the winters are mild, rarely under 10°C. On fig. 5 it can be seen that rainfall is more intense in the summer period and less intense in the winter. Itajaí receives an annual precipitation of between 1400 and 2000 mm, enough to supply most water needs for agriculture, household water provision etc. 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 (Perfil de Itajaí 2005, SDR Itajaí 2003).

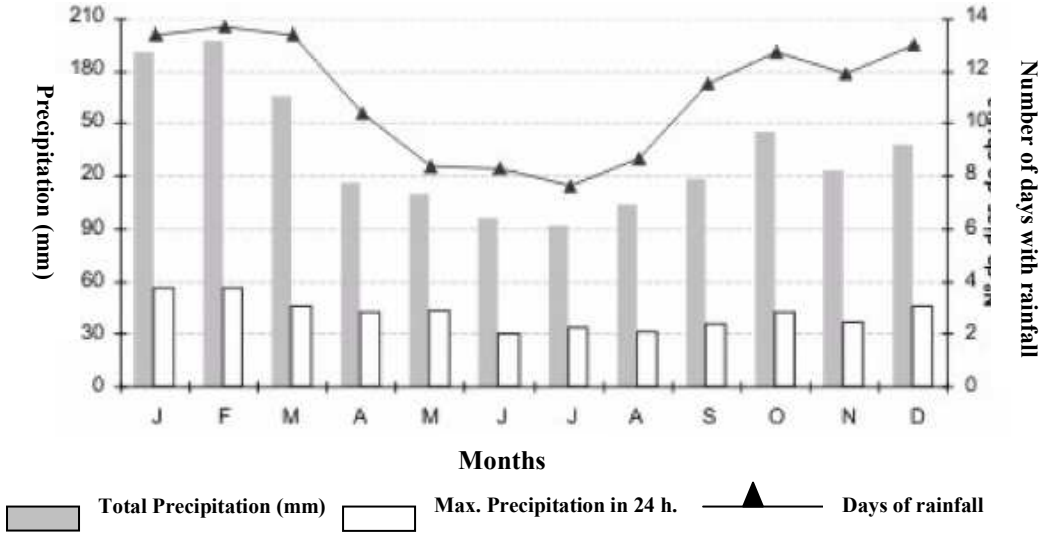


Fig. 5: Diagram showing the total precipitation, the max. precipitation in 24 h and days of rainfall at the meteorological station of Camboriú, SC – INMET, in the period between 1912 and 1983 (source: Plano Diretor de Itajaí – Mapa Ambiental).

2.3 Geology and relief

The Brilhante area is made up of two valleys, one valley leading to the Brilhante II and another leading to Brilhante I. On both sides of the main road that connects Brilhante II with the Itajaí-Brusque road, the hills rise to about 200-300 m above sea level. At the source of the Brilhante River, in the interior parts of the valley, hills rise to 400-600 m. According to Dos Anjos and Hildebrand (1996) the lithology of the Brilhante Valleys makes part of the "Brusque Metamorphic Complex", which is classified as a group of Cambrian magmatic rocks that form the oldest geological complex in the Municipality of Itajaí. Inside the magmatic rocks of Brilhante, portions of meta-sediments composed of fine sediments (silts and mud) along with sandstones, phylite, schist and quartzite can be found.

The predominant orientation of this lithological complex is NE. In the most southern part of APA Brilhante occur granitoids of the “Suite Valsungana”. Covering the oldest geological sequences there can be found Cenozoic sediments – principally composed of Quarterian sedimentary deposits that accompany the main stream channels in the area (Plano Diretor de Itajaí - Mapa Geológico). The magmatic formations are exposed to constant physical and chemical weathering by the high amount of rainfall that the area receives.

2.4 Hydrology and water resources

In the entire Brilhante area, there exist about 100 sources of water, all forming small creeks and streams that supply the Brilhante River (Estado de Santa Catarina, 2005). The confluence of the creeks with the river happens in the valley, as water runs from the mountain slopes towards the lower points of the Brilhante Valley. Thus the Brilhante River takes its form in the upper valley and widens gradually downstream as it flows all the way through Brilhante passing many of the houses that are scattered along the stream. The river then it continues to flow downstream, passing Brilhante I, until reaching the Rio Itajaí Mirim flood plain, where it finally finds its confluence with Rio Itajaí Mirim.

The groundwater table in Brilhante fluctuates with the amount and duration of rainfall. After long intense rainfall, the groundwater table automatically replenishes. It happens that the discharge exceeds the flow capacity of Brilhante River which can make the loamy flood plain soils oversaturated with water.

Rainfall also supplies the wells and ponds from where many local inhabitants in the lower valley can extract water. People living at the hill foot can benefit from artesian groundwater. Artesian groundwater is generated where the gravity flow of water in

confined aquifers is directed downhill towards the lowest points in the landscape. This process results in a spring flow from where water wells up from the ground by its own force.

According to many older inhabitants of the Brilhante community, the groundwater table has been falling through the last few decades. These changes have been tracked by observing fluctuations of the water level in the Brilhante River and in private wells. Due to falling water levels, the Brilhante River should rather be classified as a small stream or a creek, but because it remains the principal recipient of water from the Brilhante watershed it retains its denomination as river.

By looking at the difference between the present levels of water in the river compared to the height of the old river bank (fig. 6), the inhabitants claim that the water level in the Brilhante River has been falling. This can have many reasons. It may be due to normal seasonal fluctuation following a period with less rainfall. However FAMAI (Enio Sales-personal communication) suggests that, an important reason for the loss of water discharge is to be found in the change of land use and vegetation in the Brilhante Valley.

Fig. 6: Left, showing the Brilhante River overlooking Brilhante I downstream from the Brilhante Valley. Right, the water level in a typical private well from where many of the inhabitants in the lower Brilhante extract their water for domestic use.

Through the 20'th century, since the valley was colonized by European settlers, most of the native vegetation covering the valley and its smooth hillslopes has been cleared to liberate land for cultivation and pasture. In recent decades, native forest cover or poor agricultural land has increasingly been substituted by fast-growing exotic tree species like *Eucalyptus spp*. and *Pinus spp*.

This development has resulted in a loss of many natural springs from which the Brilhante River receives its water. Furthermore Forman and Godron (1986) have shown that natural vegetation, primarily the forests, acts as a sponge to the water that falls on the ground. When rain falls, the forest soils keep the water in the depth of the soils because of the high content of organic matter. In general natural forests can therefore be considered to have a water-preserving function (Miller, 1994).

On fig. 7 the area of the Micro Basin Brilhante I and Brilhante II is highlighted by a thick blue line in the black dashed box and the APA Brilhante by a thick red line. Other micro basins are shown by thin blue lines. Notice that there are micro basins with natural springs which cross the municipal borderline. These waters are shared between Itajaí and its neighbour municipalities. Main water courses with or without fringing riparian forest are shown by coloured lines and natural springs are marked with triangles.

The Brilhante River is the main water course that drains the entire Micro Basin Brilhante. The environmental condition of springs and riparian forests has been classified as being naturally protected (green), threatened (yellow) or degraded. With orange is shown riparian forest having been degraded in the natural course of the river. Red dash indicates the riparian forests that have been degraded in a river courses that have been modified and violet indicates riparian forests which have been degraded in consolidated urban areas.

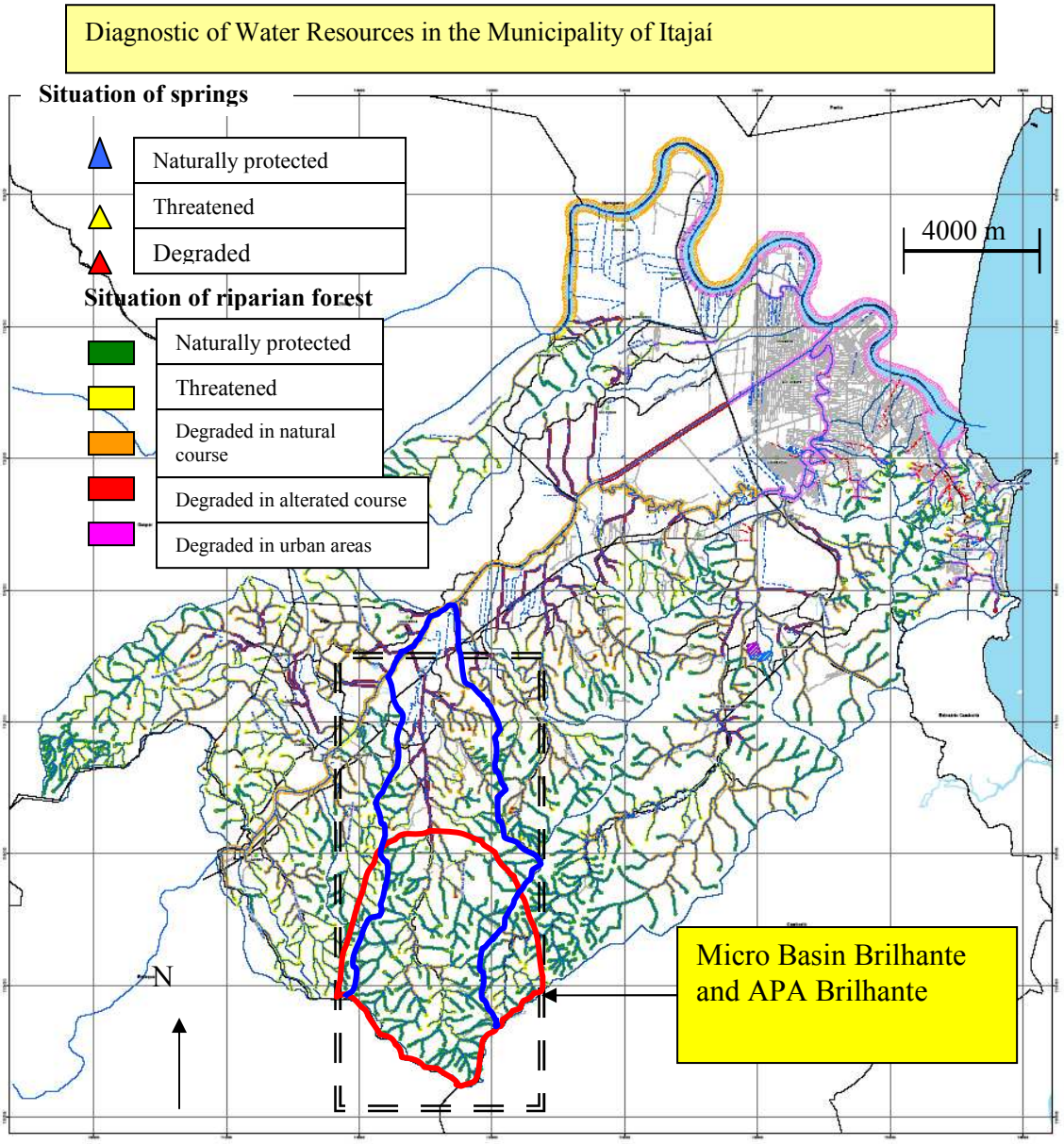


Fig. 7: A diagnostic of the environmental condition of natural springs and riparian forests within the Municipality of Itajaí. On the map are shown the limits of the micro-basin (blue) and APA Brilhante (red). (Modified after FAMAI-Diagnóstico de Recursos Hídricos de Itajaí)

According to FAMAI, 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. Waste-water drainage, application of fertilizers, spreading of pesticides and removal of riparian forest are all important threats to the aquatic environment (Troeh et al., 1980). However, a considerable number of naturally

protected springs are located within the Micro Basin Brilhante. This gives the designation and protection of APA Brilhante a certain importance in securing the most important water resources in the municipality.

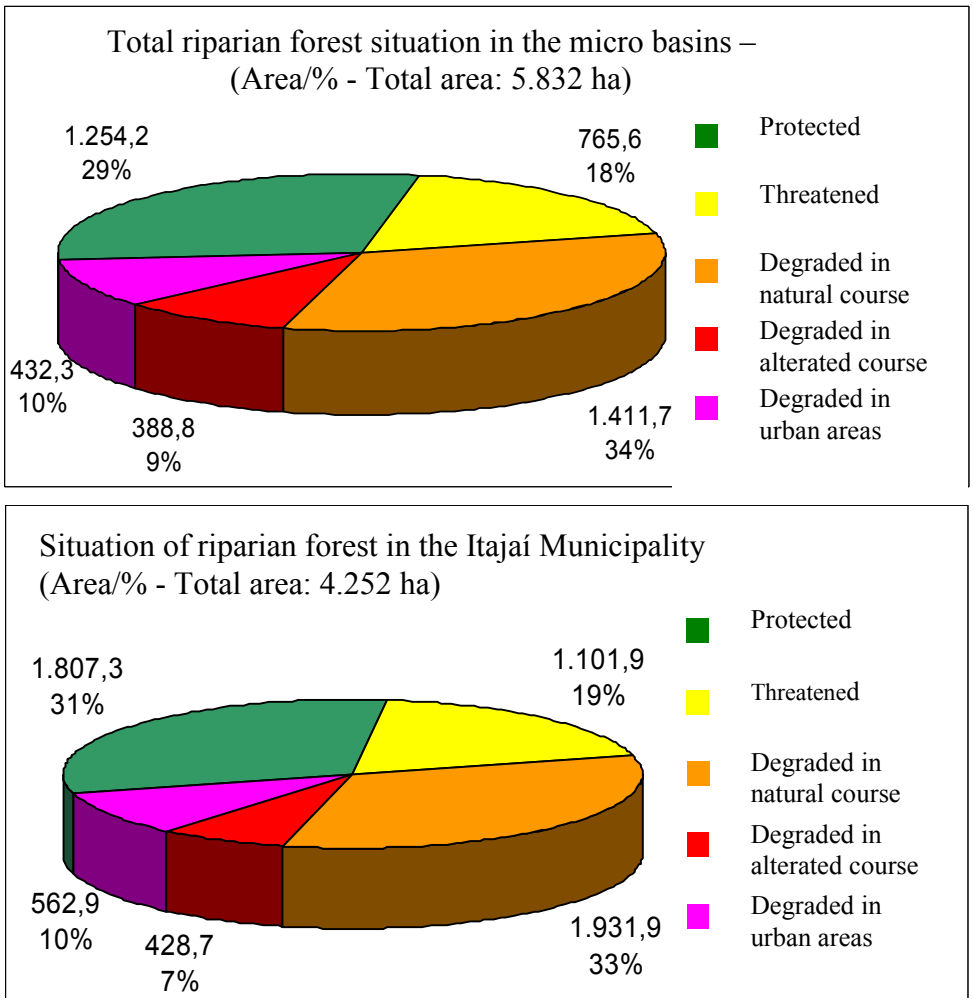
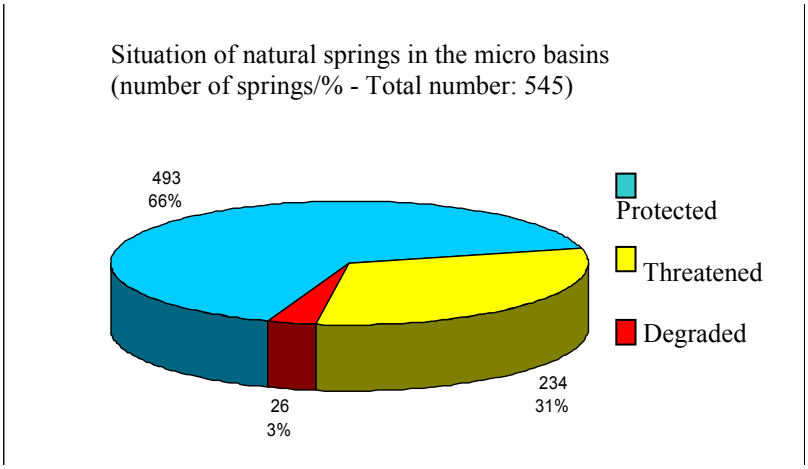


Fig. 8: The environmental status of riparian forest within the Micro Basins and within the whole Itajaí Municipality. (Modified after FAMAI-Diagnóstico de Recursos Hídricos de Itajaí)

An overview of the environmental situation of riparian forest and natural spring is given in fig. 8 and fig. 9. Evaluating the environmental situation of the riparian forests (fig.8) we estimate that rivers are at risk of further degradation, because only 30 % of the total area of riparian forests has been protected, whereas one third on the riparian forest cover has been degraded in the natural river course. Alternation of rivers has also

contributed to further degradation. The situation is better when looking at natural springs (fig. 9) where about two-thirds of the springs are classified as protected whereas only 3% are degraded. Hence there is a need to protect and recover the surface water resources as well as the riparian forests, because riparian vegetation makes the only buffer zones that can protect the water course against pollution, not only in Brilhante but in the rest of the municipality as well.



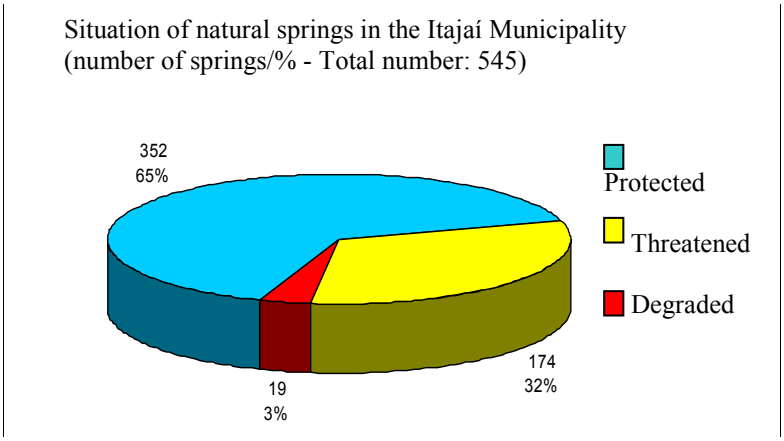


Fig. 9: The environmental status of natural springs within the Micro Basins and within the whole Itajaí Municipality. (Modified after FAMAI-Diagnóstico de Recursos Hídricos de Itajaí)

2.5 Soils

The soils in the Brilhante area have been formed as a result of a constant chemical and physical weathering of the underlying crystalline bedrock. The two dominating types of soils found in the Brilhante Valley, classified according to the FAO soil system are (Plano Diretor de Itajaí – Mapa Pedológico):

1. Cambisol Haplic – primarily in the lower Brilhante Valley
2. Argisol Alic, Red-Yellow – primarily in the upper Brilhante Valley

As the soils have been supporting native Atlantic Forest prior to cultivation, the soil humidity and content of organic material in the upper horizons has fallen after land clearing (Troeh et al., 1980). To maintain the humidity of the topsoil, increase the microbial activity and bring the content of organic matter back to normal, it is important to minimize evapotranspiration by keeping the soil covered by vegetation. By a combination of residue retention, mulching and minimum soil tillage, organic matter will be decomposed into humus as a cause of a healthier soil with diverse micro-flora and microbial fauna (Govaerts et al., 2008; Doran and Zeiss, 2000).

According to local farmers (Pedro Lira and Valerio Girardi, Brilhante I – personal communication) the lower valley Cambisol Haplic soils are the most favourable for agriculture (fig. 10), whereas on hillslopes covered with soils of the type Argisol, Alic, great care must be taken in respect to the risk of soil erosion. Because both soils are clayey, they become plastic when saturated by infiltration of rainwater, whereas in periods of drought, they can become very hard and difficult to till.

Throughout Brilhante, fertile soils constitute a precious natural resource to farmers being faced with the challenge of cultivating increasingly fragile land. An important rule of landscape management in areas where soils are exposed to erosion is to keep the

soils covered by beneficent vegetation to a certain degree all through the year. This precautionary practise can prevent the smallest soil particles from being lost from the soil surface during periods of intense precipitation (Eastmond and Faust, 2006; Isabirye et al., 2007).

Fig. 10: Left, a clayey Cambisol supported by grass in Brilhante I. Right, a closer look at the rich clayey texture of this soil.

2.6 Flora and fauna

The forests of Brilhante can be classified in two main types - the native Atlantic Forest (Mata Atlântica)[2], growing widespread across Santa Catarina, and the introduced genus of *Eucalyptus spp* and *Pinus spp.* having been planted for production of wood.

Natural vegetation covering the hillslopes of Brilhante is of the type *Ombrófila densa* of sub-mountainous formation (Klein, 1980) - a vegetation group that makes part of the humid coastal rainforest, named the Atlantic Forest, growing as a dense vegetation in a corridor relatively parallel to the Atlantic Ocean from Rio Grande do Norte in northeastern Brazil to Rio Grande do Sul in south Brazil (Santa Catarina State - info). The growth of Atlantic Forest is determined by the varied temperature regime and the amount of precipitation. In N Brazil the temperature varies very little – here the average annual temperature stays around 24°C. In S Brazil, the temperature is lower and

[2] The Mata Atlântica (Atlantic Forest) has been identified as one of the worlds most important biodiversity hotspots for conservation, partly because it serves as habitat for a high number of endemic species found nowhere else on the planet (Myers et al. 2000)

occasionally drops below 0°C. When winds from the Atlantic Ocean bring a high humidity towards the continent and reach colder altitudes in the coastal mountains, they finally condense in the form of rain. During early hours of the day at spring and summer, the precipitated rainwater re-evaporates and produces a dense fog, which can be seen above the humid *Ombrófila densa*.In fig. 11 it is shown how almost 93 % of the Atlantic Forest has been completely devastated. Since the colonization of Brazil started around the year 1500, increasing population density along the Atlantic Coast has driven a constant need for arable land – land which has been liberated by clearing the forested valleys and hills (Ambiente Brasil-info). Shown in light brown are the lands where the forest has been cleared and land cover has changed into agriculture, pasture, secondary forest, urban areas etc.

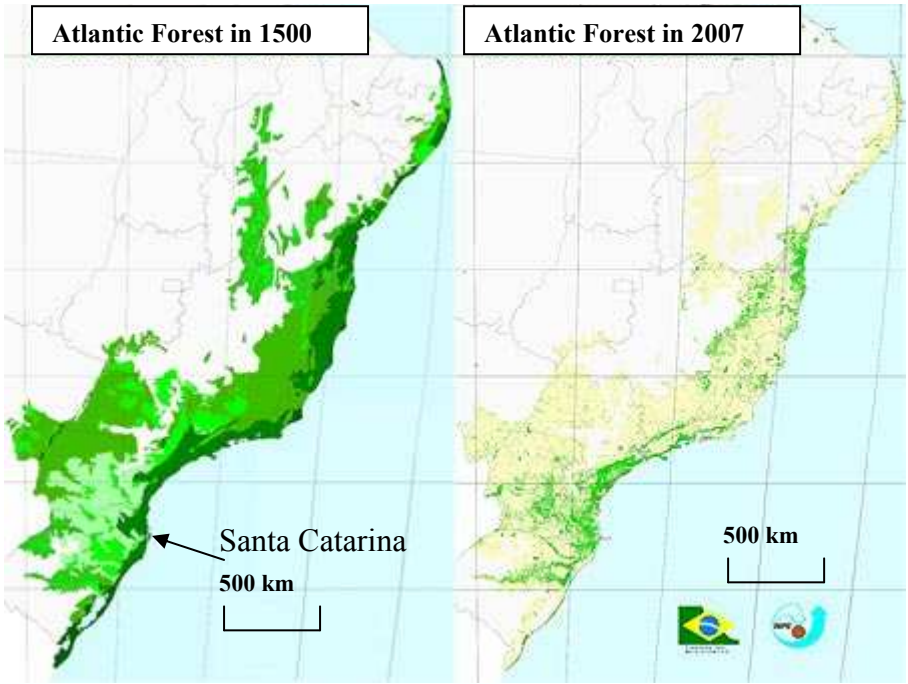


Fig. 11: Map showing the Atlantic Forest cover in year 1500 (left, in green), and the present area (right, in green) covered by the same type of forest in year 2007. (Source: http://static.hsw.com.br)

Historically deforestation of the Atlantic Forest has been most critical in the NE of Brazil, where the remaining Atlantic Forest is most fragmented. In the states of Paraná and Santa Catarina, a few large patches of the forest still remain intact making the regions of Serra do Mar most representative of this highly diversified forest (Mesquita, 2004: Serra do Mar Paranaense - info).

The Atlantic Forest is exceptionally diverse. Among others, the sub-mountainous *Ombrófila Densa*, characteristic for the forest zonation of the Brilhante Mountains, is composed of dense ferns, arborescents, terrestrial orchids, bromeliads that retain 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 (fig. 12). Many species have been classified as epiphytes that live in symbiosis with neighbour species.

The large variety of tree-species gives shelter to an innumerable diversity of mammals, bird and insects, all living in or near the forest. The latest studies (ACAPRENA-info) have revealed that in nearby areas of the Itajaí Hydrographical Basin, there has been discovered 220 bird species (constituting 68 % of all the known bird species of Santa Catarina), 56 species of mammals (constituting 38 % of the known species of mammals in Santa Catarina) and 40 species of amphibians (40 % of all the species in SC). Many of these species are endangered in other parts of the Atlantic forest. It has been estimated that around 357 tree species thrive in the area of the Rio Itajaí Hydrographical Basin, which is equivalent to 47 % of all the existing species of trees in SC.

According to ACAPRENA (2007) some of the most common wood species that can be found in the forests covering the Itajaí Hydrographical Basin are:

- Canela Preta (*Ocotea catharinensis Mez*) is the most common tree species, making up about one third of the volume of wood in the *Ombrófila Densa* forests of SC.

- Palmito Juçara (*Euterpe edulis*) is a palm tree that produces the eatable palm heart. It has been seriously threatened by commercial over extraction.

- Embaúba (*Cecropia sp*.), also called the Trumpet Tree, is a fast growing tree that grows in humid localities of the Atlantic Forest and along riverbanks. Here it makes part of native riparian vegetation. Its leaves have been widely used by indigenous tribes for their anti-inflammatory properties (Rain Tree Nutrition-info).

Fig. 12. Left, a Brown-Throated Three-Toed Sloth (*Bradypus variegates*). Right, a look into the rich variety of flora found in the native *Ombrófila densa of Brilhante*. (Picture on left – source: www.ambiente.sp.gov.br/ppma/mataatl1.htm)

One of the most threatened mammals of the Atlantic Forest is the Brown-Throated Three-Toed Sloth, seen on fig. 12. This sloth feeds on tree leaves and of the fruits of the pioneer tree Embaúba (belonging to the genus *Cecropia*), widely distributed within the dense tree cover of the Atlantic Forest (see picture on right).

Common species of birds, mammals and amphibians found in *Ombrófila densa* include:

- The Dusk Legged Guan (*Penelope obscura*), a large bird in the family of Cracidae, similar in appearance to a turkey. It feeds on fruits, insects and worms found in tropical moist lowland forests and subtropical or tropical moist montanes[3](IUCN Red list-info).

- The Howler Monkey (*Alouatta guariba clamitans*) is one of the largest primates inhabiting the Atlantic Forest in South Brazil. Its characteristic howl, which can sometimes be heard coming from the forest at dawn, is used to communicate with relative howler monkeys. It preferable meal consists of leaves, fruits, seeds and small animals which it manages to catch occasionally. It is considered as critically threatened by IUCN as a cause of a reduction of its natural habitat, the dense Atlantic Forest (ACAPRENA-info).

- The Lagarto-teiú (*Tupinambis teguixim*), also called the Common Tegu, is the largest of the lizards of Brazil. Attaining up to one meter in length its preferable habitats is a firm warm soil, near to water. It feeds on eggs, fruits, leaves, insects and small forest animals.Laying its eggs in ants' nests and termite holes, it draws advantage of the heat found in these biological niches. This reptile has long been chased for its meat and skin, which has made it threatened as native specie throughout the Atlantic Forest (Ambiente Brasil - info).

Along with the native Atlantic Forest species, a selection of exotic species, principally the geneses *Eucalyptus spp*. and *Pinus spp.*, have been planted in large scale throughout Santa Catarina. In the Brilhante Valley notably the *Eucalyptus spp*. now cover around half of the forest area. Information obtained from farmers of Brilhante

[3] Montane: a biogeographic term which refers to highland areas located below the tree line. Montane regions generally have cooler temperatures and often have higher rainfall than the adjacent lowland regions, and are frequently home to distinct communities of plants and animals (Forman and Godron, 1986)

indicates that both of these tree geneses have a fast growth cycle compared to the native species. Because they are considered exotic in Brazil, lacking an evolved immunity to herbivores, monocultures of *Eucalyptus spp.* are very vulnerable to pests. They are usually grown in rows and thus give a monotonous appearance to the landscape. The fragmentation of native forest caused by plantations of eucalyptus makes it difficult for flora and fauna to disperse. Biological diversity is also reduced as result of lacking plant species richness found in the under storey forest bottom and the lacking horizontal and vertical stratification of trees found elsewhere in the native Atlântic Forest (fig. 13).

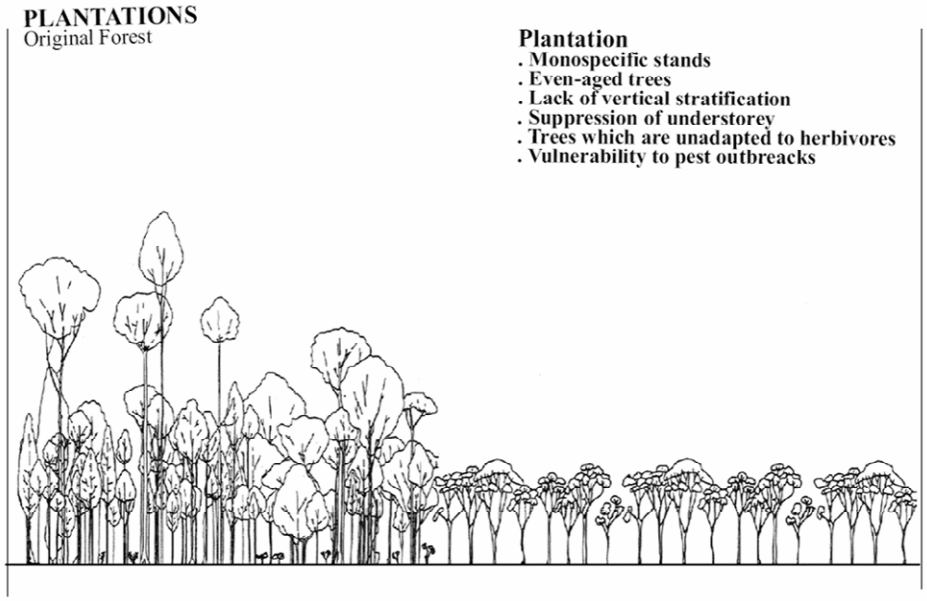


Fig. 13. Profile of rain forest (left) showing some of the consequences of replacing it with a plantation of *Eucalyptus spp.* (source: Majer and Recher, 1999)

From these facts Majer and Recher (1999) have shown that the ecosystem functions of forests change radically when native forest cover is converted into plantations of *Eucalyptus spp.*

2.7 Socio-economic characteristics

According to the former numeration performed by the "Secretaria de Agricultura", the communities of Brilhante I and Brilhante II consist of 621 families, giving the total number of inhabitants in the two suburbs to be around 2.026. This number should be taken as an estimate, as many of the houses existing in the area have not been officially registered in the municipal cadastre.

As the region was traditionally characterized as a migration frontier, immigration started in the late 19'th Century. Since then, a progress in agricultural activities has slowly shaped the landscape to become how it looks like today.

Initially it was necessary to clear the forest in the valley to liberate land for agriculture, and in 1862 the first road was opened to be able to transport and extract resources to and from the area. According to the oral and written memory depicted by Sr. Júlio Patissi, one of the oldest living inhabitants in the community, settlement began by the Italian immigrants Antônio Nicoletti and Antônio Patissi who brought their families to the area.

Their wives were of German origin, giving present-day inhabitants a blend German and Italian family heritance (Estado de Santa Catarina 2005).

According to Noble (1967), one of the most outstanding characteristics of agriculture in rural Santa Catarina is that, compared to the rest of Brazil, most farmers in Santa Catarina operate their own farms. The strong attachment between the farmers and their private land holdings is considered an advantage, because it has led to a great diversification of the farm economy.

In Brilhante many years of cultivation have had consequences. Among these was the loss of soils by erosion, which then forced farmers and cattle breeders to liberate new

pastures for grazing and cropping. Farmers started looking for alternative crops that could be grown on the hillslopes.

Today pineapple is one of the main crops being grown in patches on slopes facing the upper Brilhante Valley (fig. 14). In the lower valley Palmito, Palmeira, rice and other types of vegetables are being cultivated.

Fig. 14: Left, a newly planted pineapple field on a steep hillslope, Brilhante II. Right, a plantation of Palmeira along a river bank working as riparian vegetation.

A rising number of settlements creating space limitations, reduced soil fertility and the introduction and the search for alternative jobs are factors that have made the number of families being directly dependant on agricultural activities to decline.

For most farmers, the yield of agricultural crops can only supply the basic needs of the household and as the prices for agricultural products have been falling, the economic benefits of being a farmer in Brilhante today are low. Since Brusque became a centre for textile production, tailors (mainly women and younger family members) have supplied the agricultural activities by assembling clothes as the principal alternative source of income in Brilhante, just as shown in fig.15.

Another source of income for many of the local inhabitants consist in production of hardwood and pulp from the many Eucalyptus plantations that now occupy around half of the present forest cover.

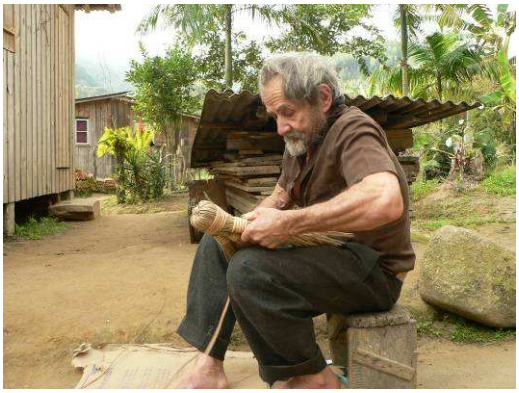


Fig. 15: Left, children supplying the family economy by making clothes, often done in a part of the private home. On right, a farmer in the upper Brilhante Valley supplying his family income by making brooms from Cipó, a type of fern originating in the Atlantic Forest.

Wood has always been an important natural resource in the Brilhante area, but following the law on native forest protection, it has been prohibited to cut any parts of the native forest cover. As a response to this some farmers have started making use of alternative forest resources for artisanal handicrafts (fig. 15). To cover the demand for wood, plantations of *Eucalyptus spp.* started to occupy many of the formerly deforested areas. An advantage for the farmers having combined the cultivation of pineapple with plantations of *Eucalyptus spp.* is that once planted, the eucalyptus wood will be fully mature in a period of 10 years, ready to cut and sell as hardwood, pulp or cellulose. The interest for converting unproductive soils or areas of virgin forest into plantations of eucalyptus trees is therefore still high (fig.16).

Fig. 16: Left, showing a hillslope pasture with replantations of Eucalyptus next to native *Ombrófila densa*. Right, riparian vegetation has been recently cleared to give way for pasture, making the stream very vulnerable to erosion and nutrient pollution.

Once having cut the native forest, the first settlers in the area started to introduce cattle into the area. To avoid erosion the pastures would be let to fallow after some years of grazing - the hillslopes would then revive with a new cover of grasses, shrubs and herbs. Milk and meat would be produced along the cultivation of potatoes, corn and other nutritious vegetables, supplying the families as subsistence cultivation.

Mechanization made it possible for some farmers to shift from extensive agricultural cultivation into a more intensive cultivation of a few profitable crops like pineapple or rice.

Nowadays, the field patches of Brilhante are mostly covered by one crop, and in a few instances, a mix of different crops. Multiple crop systems and crop rotations are mostly seen in Brilhante II, inside the APA.

In spite of the apparently intensive cultivation of crops like pineapple, maize and rice, the overall agricultural economy in Brilhante can still be characterized as subsistence agriculture, supplying the families, but giving small lucrative profits. Many houses possess gardens where the families produce vegetables and roots like mandioca, potatoes, sweet potatoes, cará, taiá etc. (Estado de Santa Catarina 2005).

These roots supply the diet by adding important vitamins and minerals to the meat or fish dishes that are commonly eaten by people of South Brazil. Besides mandioca, the cultivation of beans and maize are significant for traditional agriculture, because these crops constitute principal ingredients in daily Brazilian cooking.

As source of meat and milk products, many farmers have specialized in the breeding of cattle, this being the animal taking up most space in the landscape. For subsistence cultivators, the cultivation of chicken is important because they require little space and are easy to handle on a small farm.

Another popular source of proteins comes from cultivating freshwater fish like Tilapia. These fish are being raised in fish ponds mostly placed in gardens next to the house. Cultivating fish requires an input of prefabricated food, and concern has been raised about this type of aquaculture, because aquaculture is contributing an increased nutrient-input to the river ecosystem. For small scale farmers pig breeding can be an alternative to cattle breeding. Pigs are typically placed in separate wooden shelters next to a meadow, which gives the opportunity for the pigs to move around freely.

2.8 Legislation in Environmental Protection Areas

To avoid the destruction and misuse of public or private areas of high natural value, Brazil has constituted a law defining the areas that need to be protected. According to Brazilian environmental law number 9.985, of 18 July 2000 SNUC - Sistema Nacional De Unidades De Conservação (the National System of Conservation Units), a unit of conservation is defined as:

"Conservation Unit: A spatial territory with its environmental resources, including its juridical waters, with relevant natural characteristics, legally instituted by Public Power with the objectives of conserving, and defined limits of which a special administration regime and adequate guaranties of protection are applied".

Within this definition there exist two groups of conservation units, each with specific characteristics:

I. Units of Integral Protection

II. Units of Sustainable Use

The SNUC chapter 3, article 15, § 1-5 classifies Environmental Protection Areas into the group of conservation units for sustainable use (Table 1). They are constituted by the following specific conditions:

§ 1 An area of environmental protection is constituted of public or private land

§ 2 In respect to the constituted limits, there can be established norms and restrictions for the use of a private property located in an area of environmental protection.

§ 3 The conditions for the realization of scientific research and public visits in areas of public dominion should be established by the management organ of the protected unit.

§ 4 In areas of private property, by means of the proprietary, there can be established conditions for scientific research and public visits by observing the uses and legal restrictions covering the area.

§ 5 The Area of Environmental Protection is set under a presidential counsel by the organ, responsible for its administration and is constituted by representatives of the public organs, of organizations from the civil society and by the residing population, according to the disposal of the regulations in this law.

As seen from table 1, special emphasise is given to secure the sustainability of the use of natural resources in the APA. This requirement exists from the fact that many such areas have been occupied by uncontrolled settlements which in large extend have degraded natural ecosystems through bad land use.

Category	Objectives	Characteristics
Environmental Protection Area	To protect the biological diversity, discipline the process of human occupation and secure the sustainability of the use of natural resources.	Area, generally widespread with a certain degree of human occupation having many abiotic, biotic, aesthetic or cultural attributes, important for the quality of life and the well-being of human populations; constituted by public or private land.

Table 1. Objectives and characteristics of APA as conservation unit for sustainable use according to SNUC. (Modified after Marenzi, 2004)

Besides the general designation of Brilhante as APA, there exists another law that covers water sources and streams where vegetation is protected as being vital for the preservation of the water quality. The law on Areas of Permanent Preservation, APP is defined by Resolução CONAMA no. 303 of 20'th March 2002 and summarized in table 2 below.

Width of river	Minimum width of Riparian Forest
Less than 10 meters	30 meters at each bank
Between 10 and 50 meters	50 meters at each bank
Between 50 and 200 meters	100 meters at each bank
Between 200 and 600 meters	200 meters at each bank
More than 600 meters	500 meters at each bank
Natural springs	50 meter radius around the spring

Table 2. The minimum width of riparian vegetation required as Area of Permanent Preservation around water courses and springs. (Modified after Fendel, 2006).

Together with the law that covers the APP and the definition of the Area of Environmental Protection, APA Brilhante should be treated by a "management plan".

A management plan is a technical document that serves to define the zonation and practical norms indicating the possible use of the area and the management of its natural

resources (Marenzi, 2004). It describes how to implement the physical structures such as roads etc. which are necessary for the management of the area. For serving the community, a management plan requires public participation as an important decision making tool for achieving best management of the natural and cultural resources existing within the area.

Taking into consideration the important aspect of human occupation in Environmental Protection Areas, the management plan should specify how the local community can be more directly involved in spatial planning and formulate a "utilization plan". Specific for Environmental Protection Areas the utilization plan is made to describe the options for sustainable use of the area (Milano, 1993). In the case of APA Brilhante and many similar protected areas in Santa Catarina (Wegner, 2000) such management plans still await elaboration. It requires that the necessary information regarding the sustainable use of natural resources and conservation of biodiversity be collected and evaluated. Because APA Brilhante has only been protected by municipal law, and is not classified as a Federal- or State- Protected Area, it has not yet been given the necessary attention by the local government. This is one reason why the area still lacks a proper management plan.

3. Methodology

To investigate the socio-environmental conditions for use and conservation of water in the Environmental Protection Area Brilhante, a questionnaire was prepared at Universidade do Vale do Itajaí. This questionnaire was used as the instrument for interviewing local inhabitants living inside or near to the protected area during the months of June-July 2007 (Annex 2).

Conforming to the principles given by FAO (Sheng, 1990) both the biophysical and socio-economic-, environmental conditions of the micro basin were analysed through direct observation and through the elaboration of a field questionnaire.

Questions were designed to present a general geographical description of the area, with specific questions related to the use and management of water and other natural resources.

Taking into account the differences in educational level among the respondents, the questionnaire attempted at using a conventional language that could be understood by everybody. In some cases, abbreviations and technical terms had to be explained by the interviewer, e.g. the meaning of "erosion" "sustainability" as well as the significance of "APA". Before going into the field, a preliminary study was performed based on the principles given by Hill and Hill (2002) to verify the quality of questions and duration of each interview. The final questionnaire (in Portuguese - see ANNEX 2) consists of a mix of questions giving open and closed answers together with some questions demanding multiple answers, similar to the methodology used by Buechler and Mekala (2005). The use of open questions provided the respondents with the chance of giving qualitative answers based on the need of explaining certain opinions and ideas (particularly when the choices of answers were unknown to the interviewer), whereas the use of closed questions made the date easier to rate or rank.

Open questions giving answers that had similar characteristics are presented as verbal citations in the results. In other cases, responses are presented individually, as suggested by Fink (1995).

A visit to the local school, Escola Básica Professor Martinho Gervasi preceded the interviews – as many of the local inhabitants were frequently attending informative classes at the local school. A general overview of the project and the joint field survey

was presented to a group of students – all living in the Brilhante I and Brilhante II villages.

In the following weeks, 60 households in Brilhante I and II 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 min. and at times develop into a conversation where additional information, not necessarily linked to the questionnaire, was given by the respondents. Because of this not all answers have been presented in the results. For presentation of results a selection was made to only include the answers/comments having most relevance for the purpose of the field survey.

After calculating the frequencies, the results were presented as pie diagrams and histograms, similar to the presentation of results in a study done by Panagopoulos et al. (2007). These diagrams show the frequency of every category in the variable; e.g. the variable access to drinking water has two categories, natural springs or wells, and the frequency tells how many households have access to either springs or wells.

The households were selected randomly. For the field survey and interviews 60 households were randomly selected. A sample population of 60 was regarded as sufficient, representing about 10 % of the total number of families living in Brilhante I and II. Both households with and without arable land were selected according to the assumption, that not all the inhabitants would be farmers and share the same opinion about preservation of natural resources.

Two recreational sites were intentionally selected for interview to investigate the importance of tourism in the area. Most interviews were recorded with a Sony IC Recorder (Dictaphone) to remember what was being said at each of the sites. As the interviews were done in Portuguese, the citations presented in the results have been translated into English to be as close as possible to the original answer.

The geographic location of each household was obtained from measuring with a handheld GPS (fig. 17). Then the latitude and longitude was uploaded in a map using the software ArcGis 9. This map shows the specific location where each of the 60 interviews was done (Annex 3). Additional information was collected from personnel of the local "Secretaría de Agricultura" and EPAGRI – being responsible for the project "Microbacias II". The community had formerly been visited by technical personnel from EPAGRI, recently having initiated a project of installing biological wastewater cesspits for protecting the water quality in the Brilhante River.

Fig. 17. Interviewing a local inhabitant of Brilhante II and mapping the position of the household with a handheld GPS.

During the Environmental Week of Itajaí a number of public workshops were elaborated. These focused on local participation in environmental protection, which gave the ideas for recommendations on environmental capacity building in Brilhante. On the first day of this "Environmental Week" a project of recuperating the riparian forest along the Brilhante River was started with help from students at the local school. Additional information about earlier research in Brilhante was collected from FAMAI, which has continued monitoring the area with cadastral numeration of the houses starting in August 2007.

Once all the interviews were made, maps, answers of the interviews, additional research information and photos from each site would form the base for the analysis and evaluation of problems and potentials that is given in the following section.

4. Results and discussion

Given below are the graphics showing the results of the socio-environmental analysis among the 60 families in Brilhante.

As the questionnaire turned out to be very extensive, not all the questions were answered by the respondents. This depended on each person's willingness to answer and comment upon the questions. These answers reflect a broad insight and present different opinions regarding environmental caretaking and future sustainability.

4.1 Socio-economic characteristics

Among the 60 individuals having been interviewed, there was a small majority of women (35 out of 60). As the time of arrival at each household varied, we mostly found women and infants staying at home, while husbands and older children were working or going to school.

Fig. 18 shows that 48 out of 60 individuals had attended primary school to some level, whereas only 10 had passed on to secondary school. While two respondents had never gone to school, none of the respondents had reached university.

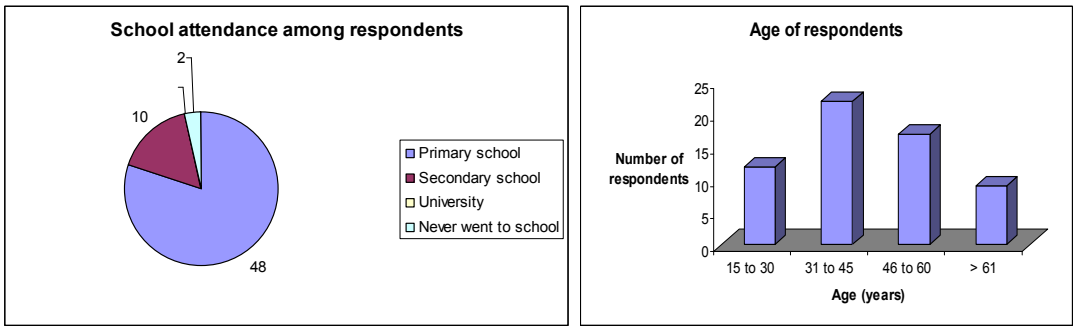


Fig. 18. Pie diagram showing the number of people interviewed having attended school, classified in three levels, primary- and secondary school and university. To the right: Histogram showing the number of respondents in each age group.

The age of the Brilhante population is close to follow a normal distribution as seen in fig. 18. In some cases it was found that the oldest members of the community were the ones possessing most land.

In other cases the social distribution of land goods depends on the family heritage. It was often found that land belonging to young farmers has been passed on by parents and grandparents, and has therefore been cultivated for at least two generations. Future farming in Brilhante therefore depends on the willingness of younger farmers to keep the heritage of their antecedents despite constrains that the environmental regulations and economic conjunctures hamper on contemporary agriculture.

An economic dilemma facing contemporary farmers is that low market prices given on conventional known crops make it unprofitable for farmers to initiate a sustainable production that avoids the use of chemical fertilizers and pesticides. Fearing that this might result in lower harvest output, they choose to abandon sustainable land use practices that might be helpful to the environment (O'Rourke, 2006). As stated by a rice- farmer in Brilhante I:

"If it wasn't for our agriculture, what would there be left for us to do in Brilhante"?

Lack of job opportunities is a common challenge for building sustainable livelihoods in populated protected areas. This has been debated by Cihar and Stankova (2006) showing that job opportunities in protected areas do not merely come from outside investments, but are frequently linked to the initiatives taken by the public.

To get a picture of the economical characteristics in the community a distinction was made between the professions of the individual interviewed persons in fig. 19. The service sector includes other types of jobs such as lorry driver, sawmill worker etc.

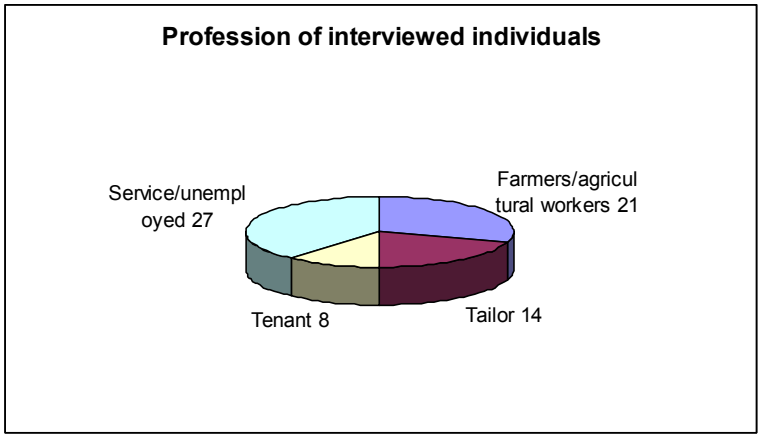


Fig. 19: Pie diagram showing the number of interviewed individuals being employed in individual sectors.

It was found that 45 % of the interviewed persons possessed other occupations than farm work, whereas 48 % of the people considered themselves as farmers or tenants, working for a landlord. Even though farming is a common activity in Brilhante, very few farmers work full-time as their only source of income. This fact could be interpreted as having been influenced by land degradation that has made it difficult to maintain a high agricultural production – thus today the community does no longer consider agriculture as the most important life-sustaining activity in Brilhante.

As discussed previously, making clothes gives an important domestic supplement to farm work with 23 % of the interviewed being tailors. Manual labour is necessary, but

the salary is low, meaning that among families with children, it was seen that the children contributed to the domestic work.

Because the selection of household for interviewing was done randomly the land area belonging to each house was different from household to household, as shown in fig. 20. Among the families, 37 % possessed less than 1 ha of land area, many of them being small scale farmers or having vegetable/fruit gardens for subsistence agriculture.

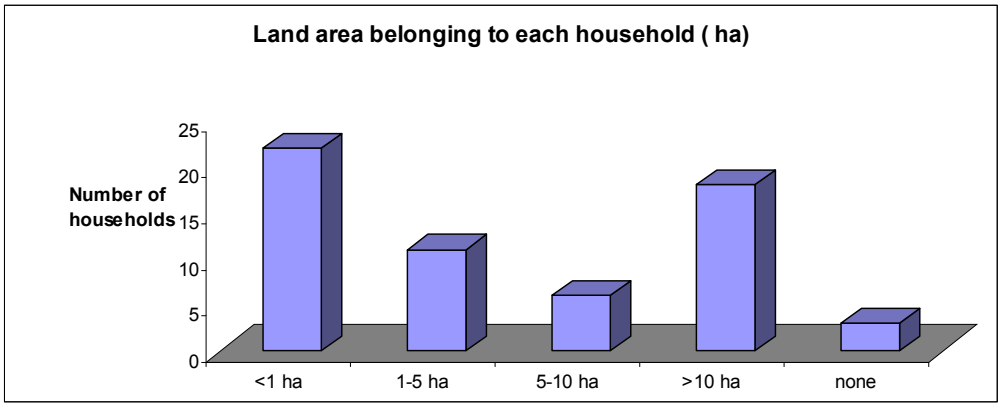


Fig. 20. The size of terrain belonging to each of the 60 households.

Size of terrain was seen to be an important constrain for developing environmental sustainability. Many families wanted to change their land use pattern or develop more environmentally friendly livelihood activities, but felt unable to do so because of space limitations. Consequently these inhabitants didn't feel they had any influence on the current appearance of the landscape, but directed attention towards the negative environmental impacts caused by other types of land use:

"We only have our house and a small arable area to produce vegetables and fruits for our own use, and we are feeling the negative environmental impacts of the actions being taken by the big farmers that cultivate Eucalyptus or rice, using pesticides and larges quantities of water". (Lorry driver – Brilhante I)

The families that did not have possession of any arable land, besides the garden that surrounded their house, were interested to partake in the common management of natural resources in Brilhante, but were limited to improve their use of basic domestic resources such as water, electricity, waste etc. As emphasised by Kangalawe et al. (2005), a land use plan, showing the existing and potential land use can help a community to direct spatial development efforts and minimize the potential conflicts over resource use. This idea has been complimented by Milder (2004) that suggests to strengthen the public participation process in creating an Ecological-Economic Macro Zoning of the APA. This will alleviate future conflicts by benefiting many different interests at the same time.

In fig. 21 we get a picture of the existing types of land use being practised throughout the Brilhante Valley. Of the households that possessed an area suitable for agricultural production or other types of land use, we found that about half of the questioned households had chosen a mixed type of land use.

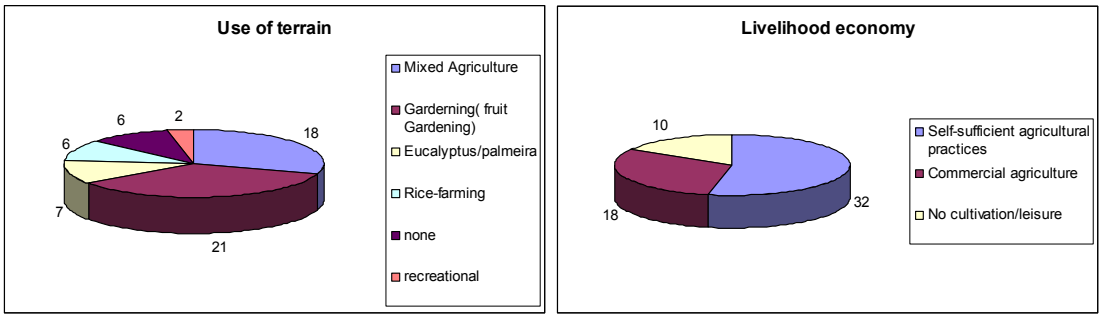


Fig 21. Left, pie diagram showing the number of households practising different agricultural activities in Brilhante, inside and outside the APA. Right, a diagram showing the source of livelihood economy for each household.

Here, the production had been diversified between livestock grazing and small scale horticulture based on growing vegetables and fruits, mostly for proper use. A typical example of horticulture being practised within the protected area can be seen on fig.22. As seen in other protected areas, favourable climatic conditions can give excellent

opportunities for local farmers to diversify their agricultural production to a level where ‘a year-round flow of goods and services for both subsistence and sale can be obtained and risks associated with external disturbances are minimized’ (García-Frapolli, 2007, p.138).

Considering that only 30 % of the households had dedicated their agricultural production for wholesale, Brilhante seems to be fit for improvements in land use and future continuation of subsistence farming. Today, the main commercial products are rice, beef and eucalyptus for timber production. If small scale farmers dedicated more time to cultivate high quality organic vegetables, there would be potential for establishing a fair to open up a market for local products (Bellé et al., 2005).

Fig. 22: Left, view of a typical mixed horticulture practised on small scale around wooden houses, Brilhante II. Right, a closer look at maize as important subsistence crop.

The seven households that held plantations of eucalyptus were all occupying a large terrain. When questioned about the impact of eucalyptus trees on the water resources, six of these farmers claimed that the trees had a negative impact on quantity of soil water. Only one farmer was convinced that the eucalyptus plantation didn’t affect the soil water balance and that eucalyptus trees could even benefit the available amount of groundwater stored in the soil. In the work of Almeida and Soares (2003) it is shown that the evapotranspiration and water uptake from eucalyptus trees in fact doesn’t differ

from that of the native Atlantic Forest, but according to Ferreira et al. (2000) the unsaturated overland flow is increased by plantations 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. Taking into account the clayey texture of the lower valley Cambisols, Robinson et al. (2006) suggests that the early phase of *Eucalyptus spp.* can be responsible for the lowering of the water table until a depth of at least 8-10 m. Because of the deep penetration of the eucalyptus roots, a dry zone is created in the upper soil horizons that inhibit rainwater penetration and thus prevents a natural recharge of the groundwater table.

Within the group of farmers that have specialized in cultivation of eucalyptus, we have also included the cultivation of Palmito Juçara, *Euterpe edulis*, which plays an important role in the food production economy of some farmers. Palm heart, the core of the Palmito Juçara can be sold at a reasonably good market price (Palmito-www.geocities.com). Today *Euterpe edulis* is considered to be one of the key species in the Atlantic Forest ecosystem as written in a document about the value of Palmito Juçara (Ambiente Brasil-info), but in the last decades it has suffered from illegal over-extraction and has now become threatened. One household in Brilhante II was found to have established a plantation of Palmito Juçara, which at the same time worked to protect the river against pollution as a riparian forest buffer as seen on fig. 14.

4.2 Forests and water resources

The natural Atlantic Forest that surrounds the Brilhante Valley is a precious resource for the local inhabitants, because it protects and generates the natural springs from where 75 % of the households receive their drinking water (fig. 23).

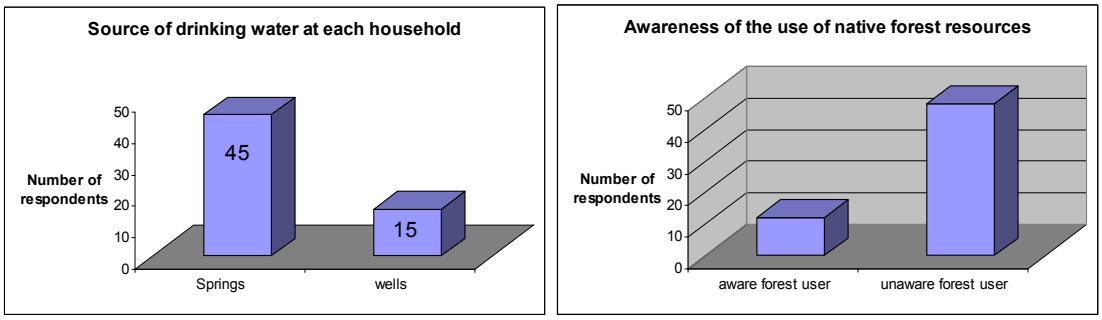


Fig. 23. Left, the number of interviewed households having access to either natural springs or private wells. Right, the number of households being aware of the alternative use of forest resources.

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, who had access to spring water, answered that the water is clean enough to be drunk readily. Spring water flows by the force of gravity and is led through a hose that connects the spring source in the forest to domestic water storage water tanks. This water transfer system is shown on fig. 24. Most families have placed the water-storage device on a high wooden stand to create a pressure-gradient by which the water can enter the household by its own force.

Fig. 24. Left, a domestic water storage barrel receiving spring water from the forest by gravity flow via a hose. Right, a family having discovered the artisanal value of bark from a native tree specie, previously used as building material and rainwater gutter by indigenous tribes.

Most respondents expressed their gratitude towards this natural water supply and stressed the importance of preserving the natural forest for future water supply:

"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." (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.

Before the arrival of the Europeans the ancient indigenous tribes living in the area of the Atlantic Forest Corridor possessed a highly developed ecological knowledge about the conservation of water (UNESCO, 2006; Raffles, 2002) and other resources coming from the native forest (Jacobsen, T. R., 2003). In fact many benefits can be obtained from knowing the native forest - as argued by (Ramakrishnan, 2007, p.98) 'building upon biodiversity (natural and agricultural) linked to traditional ecological knowledge is to be seen as a means to create buffering mechanisms within socio-ecological systems,

to cope with increasing socio-ecological uncertainties emerging from ecological global change and economic globalization.'

From the field survey it was found that nowadays, very few people seek to make practical use the forest. A small number of activities were common: Extracting palm heart,"palmito", from the native *Euterpe edulis,* using Cipó hanging as lianas or making artisanal crafts from the native tree species like the family shown in fig. 24 has done.

Therefore the inhabitants of Brilhante still view the native forest as a natural ecosystem, relatively undisturbed by man's activity.

Considering this fact, a question arises: "Can this natural ecosystem be used in a sustainable way, to help improve the life quality and the flora and fauna existing in the Brilhante forests?" When asked, the general answer among the local inhabitants was:

"Yes, but how"?

As much of the native forest has already been replaced with eucalyptus plantations, eucalyptus has apparently substituted the need for wood - a resource which has traditionally been extracted from the native forest. Keeping the eucalyptus plantation for industrial wood production can therefore have a positive effect for preservation of the native forest in the coming years. New shoots of *Eucalyptus spp.* can grow to a considerable height just 5-10 years after felling (Reflore MS-info), whereas it can take several decades for native Atlantic Forest to regenerate once it has been felled.

The future of the native forest is therefore much dependent on the demand for space to expand the agricultural activities practised in the area. Considering the possibility for combining agricultural activities with sustainable forest management (Vivan, 1998), a key issue is for the Brilhante population to gain a deeper knowledge of the resources hidden in the forest. This would help the local population to benefit from the forest

resources as an economic alternative to agriculture/cattle ranching. Tietenberg, (1996, pp. 247-270) argues that forests, besides giving shelter to wildlife, provide a variety of readily exploitable products and ecological services that strengthen the self-sustainability of a rural society. And most important for Brilhante is, that the forests play an essential role in maintaining a natural buffer for the watershed as well as supplying much of the available drinking water for the community (Forman, 1995).

In Brilhante, a management plan that describes the permitted activities and specific requirements for sustainable land use would help to define to which degree the areas that have not yet been occupied can be used. IUCN (1994) points out that protected areas should not be seen as isolated units. Economically, ecologically, politically and culturally they are linked to areas around them. A sustainable use of the forest resources of Brilhante would therefore help other communities to use the natural forest as an ecological good instead of a barrier to further development.

4.3 Use of agro-toxics and fertilizers

Sixty-one percent of the interviewed households responded that they avoided the use of agro-toxics because it was unnecessary for their agricultural needs (fig. 25). The production from these households was characterized as mixed agriculture or gardening for own consume. Most of these households were also found to depend more on organic than chemical fertilizers, whereas the households using agro toxics were mostly dependent on chemical fertilizers, many of these being rice- pineapple or eucalyptus-farmers.

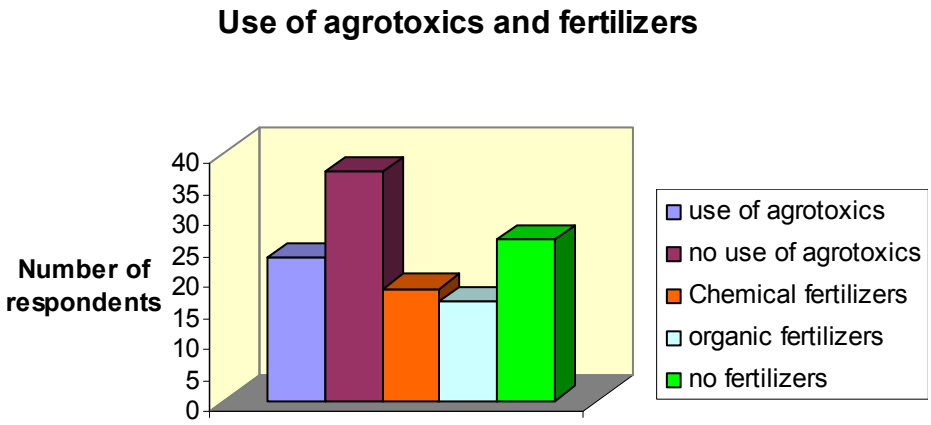


Fig. 25. The number of respondents using organic or chemical fertilizers and agrotoxics in land use practises.

About 20 % of the households were sometimes using pesticides such as "Round-Up" to remove the weeds growing around the houses or in their garden. Local inputs of agro toxics should therefore not be ignored as a potential disturbing factor affecting the local stream ecology in the Brilhante River, even the small amounts of toxics coming from subsistence farming.

For the bigger farmers, the use of agro-toxics was unavoidable. When cultivating rice, pineapple and other intensive crops, the farmers had to make use of agro toxics to keep their production on a viable level and keep the needs for manual weeding on a minimum. According to Altieri (1999) an excessive use of inorganic fertilizers can cause nutrient imbalances and lower pest resistance in agricultural plants. Thus for resource poor farmer the application of poly cultures can reduce the risk of pest outbreaks and increase the yield from different crops (Brookfield and Padoch, 1994).

In Brilhante I, the pesticides are currently being applied by aeroplanes that pass the fields a few times a year at springtime (August-September) after the sowing season (June-July). Chemical fertilizers are being supplied in the months after germination and

during the growth season (October-February). A few families were interviewed in regard to this. They commented that they fear that the spreading of pesticides is threatening their health:

"The airplane usually passes just above our house spreading poison to the rice fields. The poison goes everywhere, and we fear we will be suffocated if we don't close our windows and doors, because the venom kills everything, our orange trees, our vegetables…everybody around here are being affected" (retired housewife, Brilhante I).

In periods of pesticide spreading everyone must stay in their houses with closed windows in fear of not being poisoned by the venomous pesticide, which is a very strong chemical substance, dangerous to plants and animals. During the interviews the people showed us their gardens, and it was clear that the pesticides not only affect the people living in the surrounding areas, but also their fruit trees and other cultivated crops. The leaves and stems of these fruit trees showed clear signs of maltreatment by pesticide dispersion.

According to non-farm families, application of organic or chemical fertilizers is contributing to the nutrient pollution of the Brilhante River. Combining the input of untreated domestic wastewater and the use of chemical fertilizers for agricultural production the Brilhante River is in risk of becoming too rich in Nitrogen, N, and Phosphorous, P. This can lead to an increase in periodic algal blooms, because N and P are the primary nutrients that limit the growth of phytoplankton and algae in freshwaters and coastal waters (Rabalais, 2002).

As an alternative solution to cultivation with use of chemical fertilizers, the Brilhante River flood plain could be converted into low-input fields characterized by the cultivation of legumes that can grow by atmospheric uptake of Nitrogen. This can help

to improve overall crop production efficiency and profitability, even on extensively cultivated patches of the Brilhante Valley (Leikam & Lamond, 2003).

Furthermore by providing spatial information to farmers about the point sources of nutrient pollution a collective understanding of the environmental effects of farming can help local inhabitants to participate in risk management at watershed level (Basic et al., 2006).

4.4 Destiny of wastewater

The analysis of the Project Microbacias II, elaborated by Estado de Santa Catarina (2005), considers untreated wastewater the most important source of pollution affecting the water quality of the Brilhante River. This was confirmed by the interviews with inhabitants of Brilhante. Our field survey shows that the problem of wastewater discharge into the river is a common concern that needs sustainable solutions. Half of the questioned families (30 out of 60) had not yet received any cesspit installation kit for wastewater treatment. Cesspit kits have been offered to houses from the Microbacias II project, sponsored by EPAGRI and paid by the State of Santa Catarina. All the households being in need of sanitarian improvements are expected to be helped during the coming years. A housewife of Brilhante II stresses the importance of treating wastewater for the common good of people and environment:

"The majority of us don't have a cesspit for the treatment of waste water, but now, after we have been introduced to the Microbacias II project, people are voluntarily cleaning up everything. As there is a lack of hygiene, every family should have its own cesspit to keep their own water clean. I consider this to be right. The water shouldn't be dirty, when it passes all the houses, as some of us are still using the river water to hose our vegetable gardens."

Regarding the families to whom the cesspit treatment kit had already been offered, it was found that not all households have yet managed to install the kit and make it work properly (fig. 26). For the families that had already established the cesspit, the system appeared to work properly, as promised by Microbacias II.

Fig. 26. Left, a cesspit kit ready to put in place, has been provided to a household through the project Microbacias II. Right, domestic wastewater entering the river through pipelines continues to have negative impacts on water quality in Brilhante.

Wastewater entering the treatment system is treated in situ and does therefore not require much space from the owner's property. Regular maintenance should be done by the owner of the cesspit with technical assistance from the personnel of Microbacias II (Governo do Estado de Santa Catarina, 2005).

Among families that had not yet received the treatment system, the willingness to look for alternatives for wastewater disposal in the Brilhante River is growing. These families acknowledge the problem of wastewater pollution in the river and seemed to be open for more sustainable solutions. An interesting suggestion came from a mechanical operator having recently arrived to Brilhante II:

"On this area, I assume I could establish a lake with plantation of bamboo to clean the water from my household. It would help the water quality in the creek that passes my terrain and provide me with a useful organic material". (Mechanical operator, newly arrived in Brilhante)

The water coming from bathroom would most often be collected in a separate container and be treated separated independent of the residual waters from the kitchen.

For the many houses located alongside the Brilhante River, the only way to get rid of the wastewater is to let a pipeline exit from the house-kitchen and enter the streambed, carrying all the effluents of the house directly into the river without any treatment.

Water quality should be given more attention by local inhabitants as the individual household water use influences the water quality in the whole Brilhante Valley. As explained by a local, this has a reason:

"Families in the most upstream parts of Brilhante II did not respect the water quality and the vegetation that previously protected the river, mainly because they were still supplied with abundant and clean water resources coming from the surrounding forests. The main environmental concern for these families was to get enough fuel wood and to increase the size of their arable land, so they started cutting the natural forest, surrounding the river to plant Eucalyptus and cultivate. Now we are suffering the consequences of the bad management that has happened" (Housewife, lower Brilhante II valley).

The families that are being most affected by wastewater pollution are the families residing in the downstream parts of Brilhante II and the rest of Brilhante I through which the Brilhante River serves as the only constant source of surface water in the valley. When questioned about the wastewater pollution among the inhabitants in the downstream part of Brilhante II, the answer would be:

"It all starts with the families living most upstream. We should all apply a proper wastewater treatment, but it should start with the families that live in the upper part of Brilhante. It won't help if we change and they don't". (Tailor, Brilhante I)

4.5 Field burning

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 ten households assured that they occasionally practised field burning.

Formerly the need for fertilizers to regenerate the productiveness of fields was one of the great challenges for low input farming systems, 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 (Giardina et al. 2000). 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. Passing a roadside in Brilhante II, we found a plot that had been cleared of its virgin forest, most likely to be cultivated or built upon (fig. 27). Fire had been used to remove the residues, but whether there has been given a legal permission to clear this plot is still uncertain.

The primary concern of today's environmental law relates to the spreading of fire from fields to forested areas – in many cases inevitable when starting field fires adjacent to native forest (Código Florestal, Lei 4.771/65 – Art. 27). Another disadvantage of burning of crop residues is that a large part of the released nutrients will be transported into the atmosphere and thus escapes from the soil nutrient balance – as noted by Gupta et al. (2004; p. 1714), burning of crop residue results in emission of trace gases and particulate matter, loss of plant nutrients, and thus adversely affect the structure and composition of soils.

In worst cases, the burning of fields leads to erosion and accelerated land degradation with the result of creating badlands which are unsuitable for cultivation (Johnson et al. 1995). Outside the protected area, a few cases of field fires were seen. At

the rice fields, located adjacent to the school, the fields had been burned after rice harvest. This occurred in end of June and beginning of July.

Replantations and regrowth of *Eucalyptus spp*. can be facilitated when the cultivated mountain slopes are cleared by fire after the trees have been felled. This was only seen in one case, along the road from Brilhante I to Brilhante II and the local inhabitants do not consider it a normal practise.

Kitchen rubbish and other types of non-degradable garbage is being burned as litter in open fires (fig. 27), because many of the local inhabitants in Brilhante do not yet have access to collective collection of garbage (Estado de Santa Catarina, 2005).

Fig. 27. A garbage dung in Brilhante II composed of degradable and non-degradable garbage having been deposited to be removed by open fire (left). Right, a land plot next to a roadside which has been cleared of its native forest.

The Microbacias II project (Secretaria de Estado da Agricultura e Desenvolvimento Rural, 2005) recommends that open disposal and burning of rubbish should be avoided to prevent any further damage to soil and water quality. Much care should be taken when handling open rubbish fires, because many of the components in the garbage are non-degradable when entering the atmosphere and the aquatic environment. Fires can transform the material and its chemical components into more soluble chemical forms and can therefore contribute to serious organic and inorganic pollution (McEldowney et

al. 1993). Point pollution from garbage-fires therefore contributes as another environmental impact in the aquatic environment of Brilhante.

4.6 Main environmental challenges

The major environmental constrains governing land and water use among the households in Brilhante can be seen from fig. 28. Surprisingly 30 % of the respondents replied that they didn't encounter any serious problems on their property. Some of these respondents were well aware of the general problems found in the remaining areas of Brilhante, but did not consider these to be affecting their own household. Others responded that everything was fine and that they did not recognize any challenges or environmental problems in Brilhante. The remaining households pointed to pollution, drought and land fragility/deforestation as the three most important problems found on their own property or near to their home. A minor importance was given to erosion, maybe because it was considered to be linked to loss of vegetation cover, land fragility and drought.

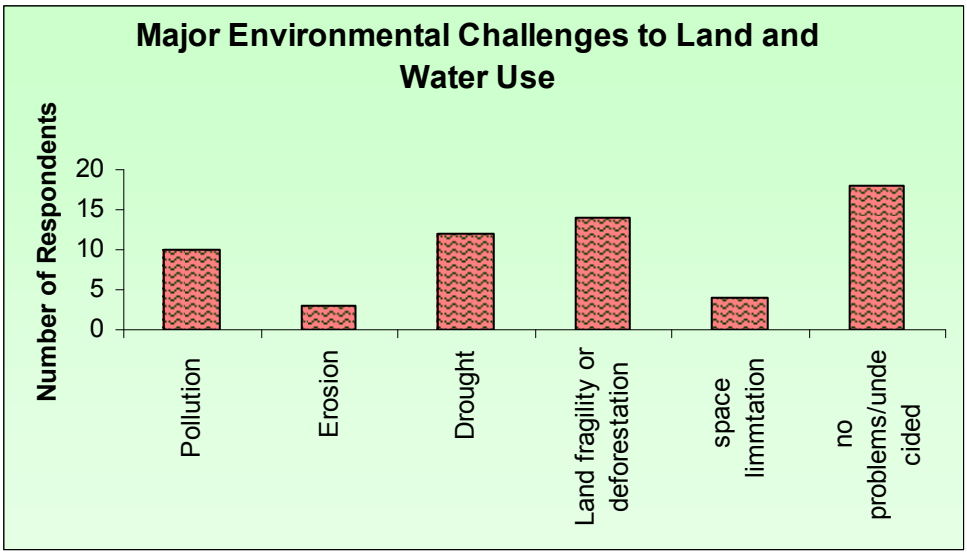


Fig. 28. Histogram showing the number of respondents highlighting specific environmental challenges to land and water use found on each property. Respondents had to give priority to one problem.

Because of the actual pollution of the Brilhante River and the loss of numerous water springs caused by deforestation, all the respondents were aware of the link between human induced changes in the river basin and the ecological problems that start to affect the community.

To emphasize the environmental changes that Brilhante had undergone, some families referred to the local condition 15 years ago:

"15 years ago the river was full of water and the forest supported enough natural springs to create a natural pond right in the place where we are standing. This pond was frequently used by us and the other inhabitants for leisure and as a secure water supply in times of drought (Small scale farmer, Brilhante II)"

A young family member refers to the problem and possible solution to erosion that affects the river when the rain falls with high intensity:

"Recently the municipality started a project at our school where we had to plant trees along the river bank and remove the litter that pollutes our water, because where we live, there are no trees to embank the river, and when it rains everything will fall into the water - soil and waste" (Secondary school student – Brilhante II).

Furthermore the respondents gave common reasons for the changes that had taken place. A large majority responded that deforestation and the replantations of eucalyptus had led to soil degradation and caused many natural water springs to disappear. According to others, the drought that affects the water cycle in Brilhante has not only been affected by change in land use, but is also affected by regional climatic changes in the rest of Brazil:

"We are feeling the effects of the big deforestation that happens in the Amazon Basin, where the mighty are controlling the land…if the climate changes continue we will not have more water in 10 years, so of course we have to take care" (citation: pineapple-farmer, Brilhante II).

Opinions about the reasons for the loss of water in Brilhante were many, but one statement was repeated by several inhabitants:

"We are receiving less rain today than before" (small scale farmer, Brilhante II)

From interviewing farmers of Brilhante, it becomes evident that they are facing many of the economic and biophysical challenges that globalization and climate change is imposing on tropical areas. Due to climate change, some regions of Brazil, especially the semi-arid Northeast will suffer from a diminution in water availability. To cope with such environmental and socio-economic pressures many farmers have already started searching for alternative land use practises, as described by Vidal de Oliveira et al. (2003),with an example from the semi-arid Municipality of Tauá in the State of Ceará.

On a long time scale, the changes in vegetation cover in the Amazon Basin may reduce the amount of rainfall that the rest of Brazil receives (Mongabay-info), but according to Stroosnijder and Slegers (2008) and Lorent and Lambin (2008), the amount of rainfall is seen to fluctuate through time and should therefore not be seen as a sole factor explaining drought. What has really changed in many drought-prone areas has been a change in the choice of crops for plantation and the related irrigation needs among farmers. The choice of crops and land cover plays a much more important role in securing soil water availability. Land degradation, a deterioration of the physical properties of the soil, decreases rainwater infiltration, soil water-holding capacity and enhances runoff and evaporation from the soil surface. If crops and cultivation methods are chosen wisely, even small amounts of rainfall can be used effectively throughout the growth season. Related to soil erosion is a loss in soil nutrients. Munodawafa (2007) found that the application of conservation tillage systems can reduce the loss of nutrients and thereby benefit surface water ecosystems by reducing the non-point source pollution coming from cultivated fields.

Many farmers considered the restrictions set upon changes of the native forest cover to hinder the expansion of cultivated areas. In fear of being fined by environmental supervision, they argued:

"Nowadays, because of this environmental protection, we are not allowed to cut a single tree if we want to increase our fields, and if we do, IBAMA will come and fine us".

In several cases, when speaking to farmers about environmental protection of Brilhante, the farmers pointed to the environmental law as being a problem that challenged the freedom of using water and land. The frustration of not being able to clear any more forested areas created a negative attitude towards any environmental protection in Brilhante. Fortunately, deforestation in APA Brilhante is no longer happening in the same rate as before, mainly because eucalyptus plantations now cover the needs for wood. Wegner (2000) has studied a similar protected area of northern Santa Catarina, and found deforestation and waste water pollution to be the most important environmental impact on soil and water. The study concludes that these changes happen because the inhabitants lack environmental awareness and suggests environmental education programmes to be designed by the municipal secretary of education and. To avoid further degradation a economic-ecological zonation that differentiates appropriate land uses within the APA should be elaborated taking into account the profound changes in landscape that have already been effectuated by human action.

4.7 Water contamination

The inhabitants were well aware of the lack of riparian vegetation that encloses the river bank, but very few respondents emphasised the importance of restoring the

riparian forest to strengthen the buffer capacity of the river against organic and inorganic pollution:

"One of the things I think should be changed deals with our consciousness in relation to the river. There are many people that are still not aware – they throw rubbish and many other things into the river, and this prejudices people. In one way or another it prejudices the whole community, because the river is necessary for everybody. If I was the one to start a project in Brilhante, the first thing I would put into action is to preserve the river, the water, the forests etc...but you must know that most people don't really think about this. If I had a free terrain, and if the law allows me, I would change…but you have to inform me about the possibilities of sustainable use". (Tailor – Brilhante II).

The lack of interest or knowledge about restoring the water quality may have been strengthened by the fact that none of the local inhabitants make daily use of the water for living, as all drinking water is supplied by springs and wells. Responsibility for the degraded water quality and active suggestions for its recuperation therefore seemed to be ignored.

A family of Brilhante II living next to the Brilhante River expressed their profound concern about the use of chlorine in the swimming pools that have been established in the most upper part of Brilhante II (fig. 29):

"The use of chlorine has killed all the fishes in our river. Earlier I used to go fishing in the creek that passed our house, but now, after the people with swimming pools have been putting chlorine in our water, all the fish have gone" (Eucalyptus farmer-Brilhante II).

Recent investigation has shown that establishment of ecological swimming pools can work as a sound sustainable alternative to conventional polls where chlorine is added to the water (Littlewood, 2005). Such types of pools could be established in areas of recreation within Brilhante to minimize the impacts on flora and fauna along the Brilhante River.

Fig. 29. Left, a swimming pool in upper Brilhante II used for seasonal recreation. Right, an artificial pond for cultivation of *Tilapia* having an inflow of clean spring water, Brilhante I.

When water pollution seemed to be far from the questioned families, answers would be more reluctant. A lack of awareness of the regional circumstances affecting the waters of Brilhante can partly explain that many of the inhabitants that live in the more isolated parts of the community do not give specific importance to the water flowing through the Brilhante Valley.

Nutrients from dirty water in fish ponds (like the pond seen on fig.29) can also affect the overall quality of water in the Brilhante. Such ponds are used by many households in the entire watershed. For the farmers that cultivate fish in ponds, the easiest way to get rid of the dirty water is to let a pipeline from the pond run into the nearest creek, which will then receive the polluted water containing high concentrations of nutrients and organic matter. According to A.C. Beaumord (UNIVALI-personal communication) a high nutrient load from fish ponds causes the river to become eutrophicated and in this way algal blooms are being unnecessarily stimulated.

It was also commented that not only nutrients and organic matter create problems for the local river, but in cases where non-native species like *Tilapia* are being cultivated, the eggs from the cultivated fish can dissolve into residual water and be carried into the local creek or river. When alien species are being introduced into a local

aquatic environment where the foreign specie has a chance to grow and develop, this specie will often out compete the local species that have been native to the area for long periods. This is a worrying development that can threaten to change the balance of the aquatic ecology.

For future management it is recommended that fish farming can be done more ecologically sound by sheltering the water cycle in fish ponds from the aquatic ecosystem and only cultivate species that are native to the South Brazilian fresh water fauna. In this way nutrient pollution and invasion of alien species can be avoided. Besides this, fish cultivation is a costly activity that requires a high energy input. Of all the fodder that is fed to the fish, only a fraction is used for the fish to grow. The rest is lost as organic nutrients diluted into water. The fish weight gain is relatively little, compared to the gain the farmers would have if they chose to breed chicken instead (UNIVALI- Antônio Carlos Beaumord, personal communication).

4.8 Suggestions for improvements

Fig. 30 show what the respondents suggested to be done to conserve the environment in Brilhante. Most people responded that preventing pollution, avoiding deforestation and recovering the native forest should be done by all inhabitants. These answers were clearly linked to the concern for water quality. About 25 % of the respondents didn't know how to contribute to an improved environmental quality and were therefore considered to be in lack of information on environmental management, but almost all respondents admitted that it was wrong to throw rubbish in the river. At the same time, they knew that such problems could be found among their nearest neighbours and thus needed an urgent solution to be solved.

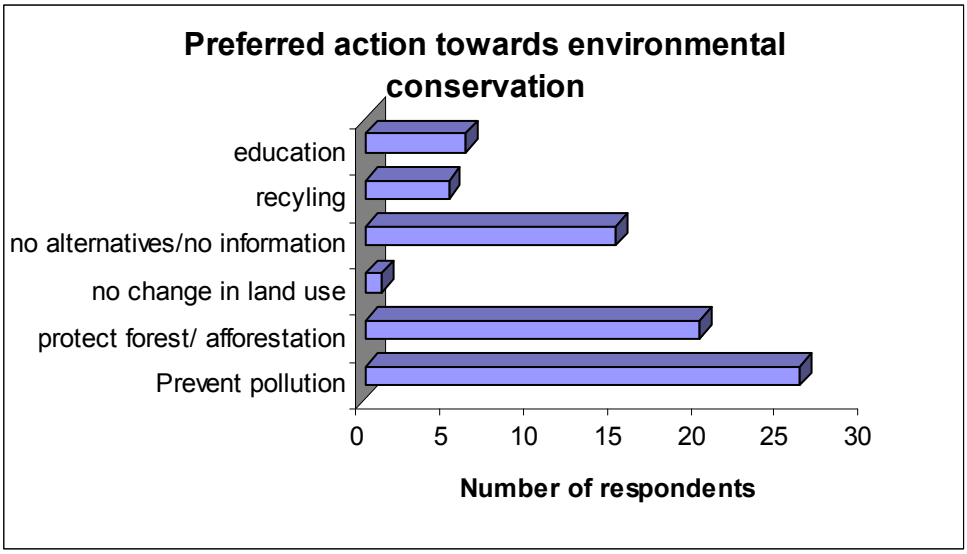


Fig. 30. Histogram showing the number of respondents that chose a preferred action towards environmental conservation in Brilhante.

Nonetheless, people who had access to municipal litter collection were generally content with this service, and they commented that collection and recycling of litter contributed to a cleaner environment and a long term sustainable development. Among the less educated, it could be expected that we would find a more acceptable and nonchalant attitude towards the environmental quality in the local area, but in Brilhante, this was not the case. Individual environmental responsibility was clearly shown by the many families responding that the environmental development was their top priority for the future of their children.

Considering this fact, many of these families were still worried about the future and stated that they didn't yet sense any community-responsibility towards environmental conservation in Brilhante. This could be a result of missing communication between households combined with different opposing interests such as the desire to conserve the native forest to conserve water resources and the general desire to expand the arable areas. These conflicts are still obstacles for the planning of beneficial projects. Conflicts

can only be solved in a sustainable manner if common goals are set, not only by the municipality but especially also among the local populations living in the affected areas (Pfeilsticker, 2007).

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 arable land plots? While interviewing a rice farmer in Brilhante I it lead to a discussion about the plans of recovering the riparian forest around the Brilhante River:

"They want to plant 30 m of riparian forest on both sides of the Brilhante River. This will give an additional 30 m of shade, so our rice production will practically end. If I am planting 100 m now and the riparian forest takes 60 m, how am I going to survive with 40 m of rice? This is ridiculous for us…speaking of preservation, we have to take into account the current situation of each farmer…if I had an enormous farm without a single tree…then of course I would have to plant…you see, they have to plant their feet here to analyse the reality of each family and not just force a law upon our heads.." (rice farmer, Brilhante I)

Another complication has to do with soil quality. If the soils could not be improved by some kind of chemical input or mechanical improvements provided by the local agricultural service (e.g. EPAGRI), the farmers didn't know how they would be able to manage the improvements themselves.

It seemed as if there was no hope among the farmers about which alternatives they could take into use, if the cultivation of the arable areas of Brilhante continues to decline.

4.9 Should Brilhante be protected as APA?

This question is crucial to the understanding of the field survey, because for the first time it introduces the concept of creating areas of environmental protection. When asked about the existence of APA Brilhante fig. 31 shows that half of the questioned people did not yet know what was meant by APA or didn't know that the designation existed. They found it difficult to understand the term APA and needed a short but careful explanation of what was meant by the environmental conditions to which the designation applies.

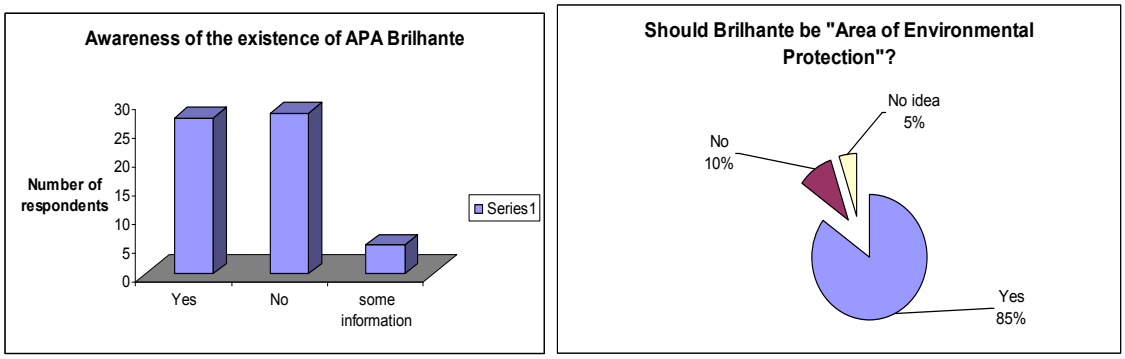


Fig. 31. Left, a histogram showing the number of respondents that were aware of Brilhante being an Environmental Protected Area. Right, the percentage of respondents that wanted Brilhante to be protected as APA.

The other half of the population had already heard about the designation and knew that the area had been protected by law, but very few of these respondents commented upon how they believed that the law would affect the population living in the designated area, most probably as a result of lacking information.

Interestingly it was found that 85 % of the respondents were positive towards the plans of implementing the APA Brilhante throughout the community, because they were convinced that this would benefit both the natural environment and cultural interaction with a purer nature. A positive response to the question of why Brilhante

should be protected as APA was given by a young tailor that was born and living in Brilhante II:

"I think Brilhante must be protected as APA because our community should continue to live in a pure environment where we can breathe the air and get clean water…I also think that if Brilhante became protected we could all benefit from tourism…but the municipality needs to help us, e.g. by planting more trees. What we can do is to protect the river by not throwing any litter, by recycling, planting more trees near to the river and by helping to avoid any deforestation or fires".

In another interview, a eucalyptus farmer living inside the APA recognized the main constrains of environmental designation, but also expressed what loggers can do to protect the environment:

"No, Brilhante shouldn't be protected by law, because then, how am I supposed to get my Eucalyptus wood from my plantations. The alternative would be that we should not be allowed to cut any trees near to the grotto from where we get our water. This is legible, but the main problem for us about continuing the APA is that we can't stop cultivating and cutting Eucalyptus because so much has already been invested into this type of land use. Eucalyptus makes us independent on the native forest wood, so cutting from the native forest should be prohibited. What we can do to help is to prevent fires from happening. Some people start fires at summer…this happened last year along the road going to the highest point of Brilhante. Everything was consumed…animals and trees."

Once having been informed about the concept of creating an APA, the attitude of people could change from negative to being positive. Comments reflected the willingness to manage an active environmental protection programme in which the inhabitants themselves could take part in the management steps. Meanwhile it was found that answers coming from the families already possessing land were different than answers coming from landless families.

Families in possession of large arable fields were seen to have a more negative opinion towards the future protection of Brilhante than families without any land. The main concern for these families was that protection of Brilhante would result in a loss of agricultural activities and a lower productivity from arable land. Opposed to this, the families that did not yet possess any great land resources were more positive towards future prospects of environmental protection. Knowing that the implementation of APA Brilhante will benefit the use of resources, the inhabitants acknowledged that applying an alternative land designation is a step towards sustainable land use and increased community responsibility for improving the environmental quality.

4.10 Benefits of protection and sustainability

Comparing fig. 32 with fig. 33 we get a picture of the priorities of each respondent when asked about the most important benefits of protecting the environment, allowing the agricultural activities to continue.

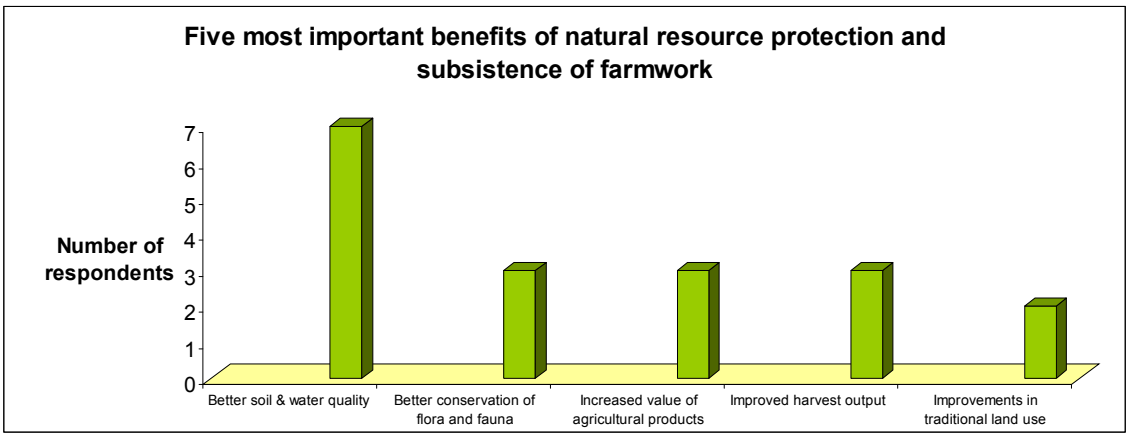


Fig 32: Histogram showing the five most important benefits coming from the protection of natural resources and the subsistence of farm work, given by the respondents.

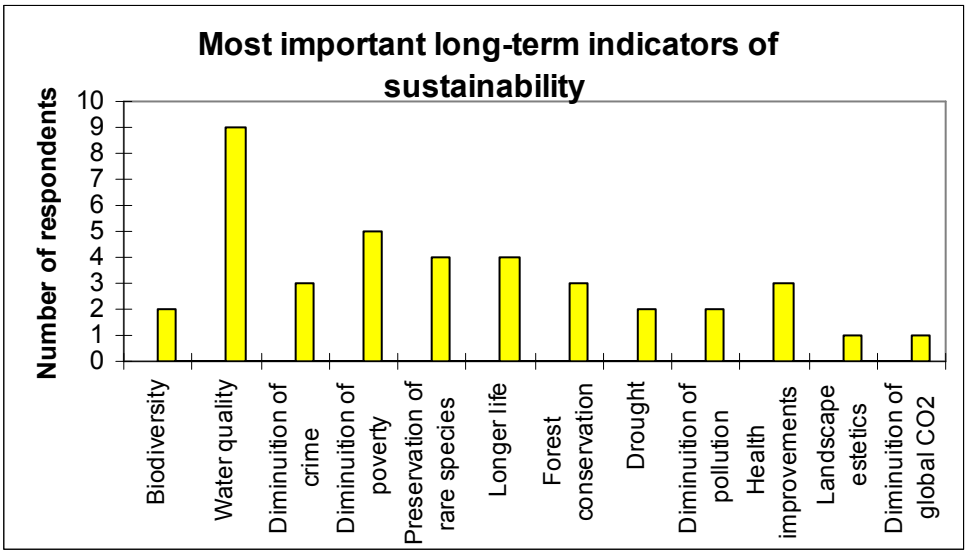


Fig. 33: Histogram showing the priority that was given to the five most important long term indicators of sustainability according to the respondents that answered the question in Brilhante.

Protecting water and soil quality was seen to be the most beneficent outcomes of natural resource conservation. Interestingly water quality was also found to be the most important long term indicator of sustainability as all the respondents (nine) chose water quality as their main concern for future development. The respondents understood that other benefits such as forest conservation, protection of rare species, diminution of poverty, health improvements etc. can all be outcomes of improving the water quality. UNESCO (2006) supports the link between improvements of water quality, health, poverty and hunger. This report states that the solution to the problems listed in The Millennium Development Goals for 2015 (formulated at the UN Summit of 2000) depends much on the adequate and equitable access to water and energy.

5. Towards improved water management

A more sustainable use and management of water and natural resources can be accomplished in the near future, but it requires a shared responsibility to recognize the problems and courage to deal with the negative challenges as a way for constructing a positive future for the protected area and its surroundings.

According to the statements of many interviewed individuals the bio-physical environment Brilhante is degrading and without careful planning focused within the human impacted areas of the Brilhante Valley, unrestricted land use will continue to cause a gradual impoverishment of water, soil and vegetation. Protecting the quality of existing natural springs is essential for securing future water supply – not only for the Brilhante community but also for the rest of the Municipality of Itajaí.

Despite the problems of upstream pollution, many questioned inhabitants of Brilhante II did not worry about water pollution because they were still being supplied by spring water coming from the forest. For these inhabitants to be supplied with clean water in the future, a community based management of the forest resources is necessary.

As described by Ivey et al. (2006) communities with drinking water supply should be encouraged to prepare or participate in the preparation of source water protection plans.

The initial aim of having designated Brilhante as Environmental Protection Area has been to reach a sustainable use of the area. According to Liitig and Greißler (2005; 67) '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'. Considering the results of the field survey, the population of Brilhante are well aware that they depend on environment for their future survival, but besides doing a special effort for protecting nature, they still need to make a living based on the traditional activities they have been practising for decades. These needs and aspirations of each social group within Brilhante can be given to public evaluation by participating in policy making and monitoring programmes for the best planning of APA Brilhante (Colantonio, 2007; p.10).

A sustainable development has to build upon a balance between social-environmental-, economic- and institutional needs. As the law that covers the Environmental Protection Area of Brilhante seeks to harmonize all these needs, this law must be implemented to its full extent and be made known throughout the community. For the many inhabitants that request information about the possibilities of continuing their lives next in APA Brilhante, the municipality and responsible institutions must do an effort to show the stakeholders that protection of water and natural resources together with economic activities can meet the needs for development in Brilhante.

Among the questioned families was a young couple that had moved from the city to the countryside, because they considered Brilhante to be a healthier environment for their children and their family life. For them the future seems closer and more tangible than for the elderly population. When asked about the future of Brilhante, most of the younger respondents wanted to help their community to become more aware of the environmental mistakes and the misuse of resources that spoils the quality of life. Building on traditions and being open to new ideas is considered a goal for sustainable development among the younger settlers in Brilhante as reflected in a comment given by a newly arrived farmer:

"The Environmental Protection Area Brilhante will bring us various benefits. But we mustn't only leave these benefits on the paper – these benefits must be carried out by us. Nature gives us peace and the most natural air we can breathe…it breaks my heart when I see plastic in the river. We have recently invited families from outside to come and visit the area, staying in Brilhante to feel more close to nature…I also think more workshops and informative meetings should be held to educate the people living here…because we all need to learn and pass on the knowledge we have gained, otherwise it won't help Brilhante."

These results show that there is a strong wish from all families to keep their agricultural activities. When preparing a management plan for the area, the local necessity for continuation of agricultural land use should be respected. This can only be done by incorporating food production into landscape conservation. In the following section is given some suggestions on how to improve environmental awareness through a number of different projects that have recently been started in Brilhante. These projects should not be seen as obligations, but as instruments that can be voluntarily taken into use by the community to reach a sustainable development.

5.1 Agro-ecology - food production and protection

Many definitions exist of the concept of agro-ecology. Basically agro-ecology is the study of the ecology of agriculture. Important is that the terminology incorporates a variety of ideas on how to practise agriculture more directly linked to the surrounding environment. This makes food production more socially sensible. Agriculture should not only focus on the production itself, but secure an overall ecological sustainability through the production system (Altieri, 1999).

As a positive sign for the education of farmers in Brilhante and the surrounding micro basins is that EPAGRI recently started inviting local farmers to participate in open workshops to inform them about a variety of alternative cropping systems which are considered environmentally friendly (Gerência Regional de Itajaí, 2001). One of these cropping systems is characterized by the combination of forestry and agriculture - Agroforestry.

In Agroforestry systems the soil must be occupied by a combination of cultivated crops and tree species with or without grazing animals. The system tries to optimize the production per area, maintaining the principle of securing a subsistence yield for the household (Fendel, 2006). Combining a large variety of native species of vegetables,

fruit trees, forage crops and medical plants in different altitude, makes maximum use of sunlight, protects the soil against erosion and loss of humidity and keeps the soil fertile throughout the year. Thus Agroforestry systems can give many more ecological benefits for the farmer than just the harvested crops.

Converting arable land into an Agroforestry system is a long term investment that often gives little yield during the first years of growth. But after several years, this cultivated ecosystem will yield a high diversity of useful crops and plants within a small plot. Because Agroforestry uses the principle of optimizing vertical space and sunlight fitted to meet the requirements of each species, the plants will develop a natural defence against plagues and drought (fig. 34). In tropical ecosystems, when applying Agroforestry systems, farmers can obtain all the benefits that a natural forest ecosystem gives in addition to receive a surplus in agricultural productivity.

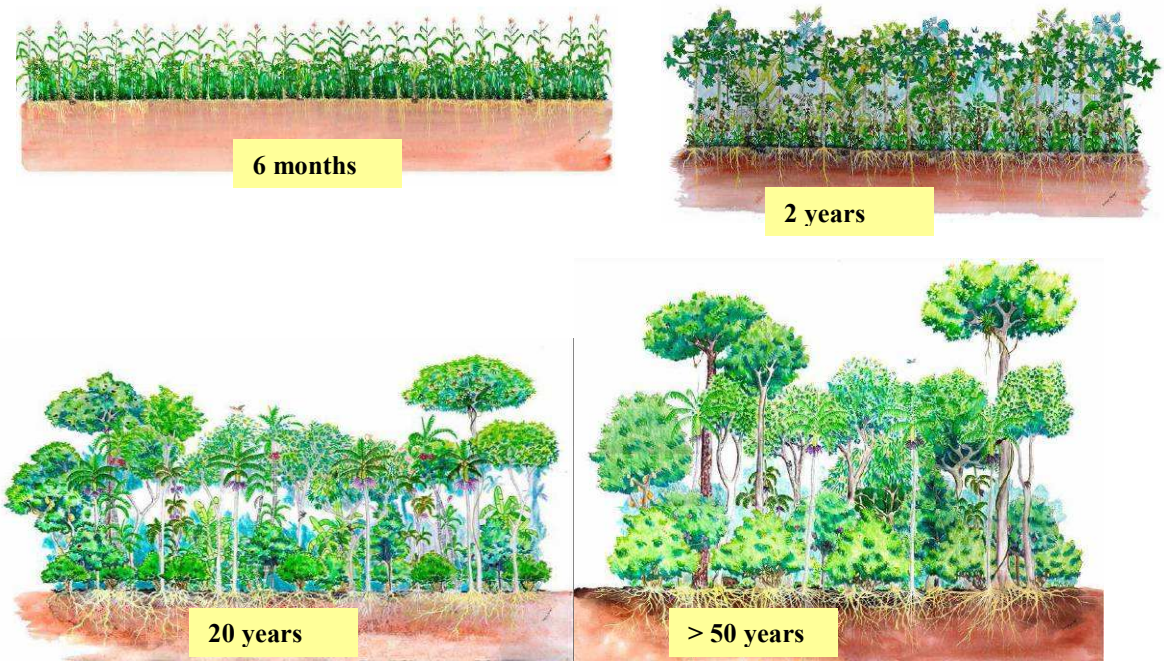


Fig. 34. A conceptual drawing of the sequential growth of an area having been converted into an Agroforestry system. Modified after (EMBRAPA – Meio Ambiente, 2007)

Within the APA Brilhante we found one family that had started to convert their garden into an agro-forest (fig. 35). The stream that passes the house had long been short of riparian vegetation, so it was decided to establish an agro-forest as riparian vegetation for protecting the stream. While protecting the stream against erosion the family will also have the opportunity to harvest crops and medical plants for their own subsistence. This project was started by Fendel (2006) and serves as a good example of practical water conservation in APA Brilhante.

Fig. 35. A family in Brilhante II having converted their garden into an agro-forest in its initial stage to protect the creek that passes their house (left). Right, dry banana leaves being used as soil cover to protect the stem of the banana palm in the agro-forest.

The challenge of spreading agro-ecological knowledge will still need a great effort from public and private organizations. As Moreira and Carmo (2004) concludes, there is an essential need for agro-ecological researchers to articulate non-governmental organizations, social movements and public and private sectors to enhance the agro-ecological space in its construction of a sustainable rural development. Protected areas like APA Brilhante, that have been designated for sustainable use, posses good institutional frameworks for these types of agricultural land use.

Through the practical use of agro-ecology a rural society will be reinforced to achieve self-sustainability of water and food. For areas like APA Brilhante, changes in land use are often hindered by lack of economic funds. Thus Cudlínová et al. (1999)

states that sustainable landscape management in environmentally sensitive areas can only gain a traditional social stewardship given that governmental subsidy programmes can change the economic incentive of rural inhabitants to invest in improved rural life-quality through a sustainable agricultural production.

The National Plan of Silviculture with Native Species and Agroforestry Systems has been started by Ministerio do Meio Ambiente (2006) to alleviate the pressure on native forests by developing forest plantation programmes where only native species and a combination of agricultural products and timber products is encouraged. By divulging the knowledge of such techniques and encouraging farmers to adapt them, it is hoped that rural communities in Brazil will gain wide social, economic and environmental benefits and help to conserve the diversity of native species, which can be used in agricultural production.

5.2 Projeto Itajaí mais Verde

The "Project a Greener Itajaí" started by FAMAI is a municipal environmental project aimed at giving continuity to the actions of recuperating the riparian forests around rivers and natural springs in the Municipality of Itajaí. Besides conserving the water resources, the project contributes to improve the quality of life among the population in urban and rural areas throughout the municipality. In elaborating the project, significant value is given to use the local flora and reduce the greenhouse effect by neutralizing CO_2. All this is accomplished through practical environmental orientation of the public sphere (FAMAI – Projeto Itajaí Mais Verde).

At the local school, Escola Professor Martinho Gervasi, an important step in the rehabilitation of the riparian vegetation along the Brilhante River has already been taken.

This rehabilitation of riparian forest in Brilhante makes part of the "Project a Greener Itajaí", and it has shown to be of great interest to the children of the school, who voluntarily took part in the first plantations of native tree species along the river stretch that passes the school (fig 36).

Fig 36. Picture showing some of the important species native to the Brilhante area, used for the restoration of riparian vegetation along the Brilhante River. Right: students from the community school, Escola Básica Prof. Martinho Gervasi replanting native species along the bank of the Brilhante River to recuperate the missing riparian forest.

From such initiatives, the youngest members of society can see that their contribution, as small as it may be, actually helps the local environment and creates joy among those who recognize the importance of making Brilhante greener.

For the rice farmers in Brilhante I it is difficult to see any benefits in having trees instead of rice on their fields. Associated with the thought that the municipality tries to punish the farmers by taking in part of their cultivated land, some of these farmers have rejected to participate in the project "Itajaí Mais Verde".

We recommend that on behalf of the municipality, the responsibility to demonstrate the benefits of converting parts of arable land into riparian forest should be shown by actual examples, in direct communication with the farmers.

Another interesting idea came from the small scale family farmers. They suggested creating an ecological fair where farmers and craftsmen unite to show the value of local

products cultivated or manufactured in Brilhante. During the interviews, some farmers (especially the farmers producing pineapple and rice) complained that the prices given on their products were incompatible to the investments and efforts that were put into the production. Having the possibility to sell their products for a higher value would also give motivation for farmers to produce more ecologically sound.

5.3 Environmental education

From the answers given by the respondents about what can be done to improve the environment, many responded that they didn't know what to do as individuals or as community to improve the environmental quality of their village.

This suggests that there is a great need for voluntary information campaigns given by scientists and students, who posses the necessary knowledge and have the willingness to share this knowledge with the population in need. As many of the local inhabitants do not possess an education that allows them to understand complicated concepts, the scientific information and development strategies that need to be conveyed must be given in a way that enables everyone to understand the concepts that are used in environmental activities (Prefeitura Municipal de Itajaí, 2003).

Simple conceptualization, using local examples that can be identified among children as well as older inhabitants is a good method to convey important information. It stimulates people to take an active part in the crucial decision-making process of environmental planning. Partaking in workshops, information meetings, fairs and environmental education activities is an indispensable condition to reach a goal of sustainability (ACAPRENA, 2007).

Matarezi et al. (2002) points to the responsibility of higher institutions like UNIVALI in the public spreading of knowledge on pedagogic practises for environmental education among the inhabitants in protected areas. Examples from the rest of littoral Santa Catarina, where local inhabitants have been involved in the collection and reuse of inorganic litter and organic residuals, show that people can be effectively stimulated to act for the benefit of their own environment.

It would help the entire community of Brilhante if the local school Escola Básica Professor Martinho Gervasi could serve as a centre for environmental education. In this way a special section of the school could be dedicated to educate local inhabitants on environmental knowledge and ecological innovation.

Workshops, informative meetings and creative projects aimed at revitalizing environmentally degraded areas of Brilhante will help the public (both the children studying at the school as well as their families) to participate actively in caring for the environment. As described in IUCN/UNEP/WWF. (1991), public participation is crucial for reaching a sustainable development in rural communities, especially when handling problems of freshwater supply and land degradation.

5.4 Ecotourism

When questioned about the possibility of developing ecotourism, many respondents were positive towards the idea. Some told that the area would benefit from tourism on a long term, because it would help to direct more attention towards environmental preservation. It is a fact that Brilhante holds many scenic beauties such as the waterfalls in the most upstream parts of the watershed.

Vieira (2006) has studied the potential for tourism in Brilhante II. This study emphasizes that the identification of natural and cultural attractions on rural properties is of great importance, because these give a potential for families to benefit from tourism as a tool for a sustainable social and environmental development.

The potential for developing ecotourism also depends on which degree of protection the area has been classified under. Reinius and Fredman (2007) argue that the name of the protected area matters much to tourists as it affects the decision to visit the area. The way tourists choose their recreational activities is associated with the activities that are permitted within the protected area. It is therefore important that APA Brilhante is made known as an area where both biological and cultural diversity is protected through a sustainable use of natural resources. This will benefit the residing population as well as the visitors that are interested to explore the area. Incorporated into a management plan, ecological tourism could therefore serve as a good alternative instrument for conserving the natural and cultural values that exist within Brilhante.

5.5 Local Agenda 21 and Project Microbacias II

One of the important programs that seek to strengthen the participation of local communities in the management of natural resources is the Agenda 21. The Agenda 21 is a document that describes the important steps each nation should take in order how to achieve sustainable development. It was formulated at the United Nations Conference on Environment and Development in Rio de Janeiro 1992.

By uniting representative families of Brilhante at the local school, Pfeilsticker (2007) has evaluated the local participation in Brilhante II to construct a sub-forum of the Local

Agenda 21 of Itajaí. From this study the local inhabitants have expressed their needs and aspirations for improving the environment and life quality in general.

According to the Permanent Forum of the Local Agenda 21 of Itajaí:

"The Local Agenda 21 of Itajaí is participatory democratic process in which the society, the public power and the economic sectors are planning actions, establishing means and assuming compromises that seek to promote a sustainable development, improving the quality of life and fortifying the autonomy of different social groups and citizens. The Local Agenda 21 should be used by the communities as a space in which they can point out to their necessities, search for solutions and show their future ideals and expectations for their respective areas" (Pfeilsticker, 2006; p.15).

For improving the environmental quality and direct more attention to the need of public participation in environmental planning, the Local Agenda 21 sub-forum, already created within Brilhante, can work as a space for the public to present and share ideas and discuss how the plans for environmental improvements can be put into action.

The Project Microbacias II is a project initiated by Santa Catarina State. It has the principal purposes of reducing poverty in the rural areas of Santa Catarina and improving the management of natural resources. This project expects to contribute to the preservation, conservation and recuperation of natural resources to guarantee a durable development in rural areas of Santa Catarina. In the environmental aspect of the project it is suggested to develop a series of actions directed to the preservation, recuperation and conservation of soil and water. That is why minor watersheds, micro basins, have been chosen as the workspace for harmonize and integrating community actions with environmental policies. It thus stimulates environmental and social sustainability in the minor river basins, by building upon local capacity and financial

support for sustainable development (Secretaria de Estado da Agricultura e Desenvolvimento Rural de Santa Catarina, 2005).

Brilhante was chosen as a representative micro-basin to receive help from the Project Microbacias II. Together with the Local Agenda 21 sub-forum, this project will also contribute to a better management of water and a more sustainable use of the resources found in APA Brilhante. With the active support from local inhabitants, such projects, combined with beneficial local initiatives on environmental protection, will help the Brilhante community onward to become a reference area of "active environmental protection".

6. Conclusion and final remarks

This study has described the present-day social and environmental conditions at the Environmental Protection Area of Brilhante. From responding to the questionnaire, a majority of the local inhabitants stated that water resources are degrading. The causes are:

1. Discharge of untreated domestic wastewater from houses without cesspits
2. Nutrient enrichment in aquatic ecosystems by spreading of chemical and organic fertilizers and use of domestic fish ponds
3. Pesticides being used by rice farmers
4. Input of litter in the Brilhante River
5. Removal of protective vegetation along streams

Poor water quality in the Brilhante River has made the water unsafe for domestic use. River water is now only used for irrigation of rice in the lower part of the valley. Today all inhabitants rely on natural springs and water coming from private wells.

These water resources are still relatively well preserved. Despite being supplied by water from within APA Brilhante, many respondents were concerned about the loss of natural springs, principally because fast growing exotic plantations of *Eucalyptus spp.* have substituted almost half of the native forest cover within the watershed. According to some, this has contributed to a lowering of the subterranean water table, disappearance of natural lakes and a decrease in the Brilhante River stream discharge.

To improve the environmental quality and thereby conserve water the preferred community actions are:

1. Protecting the native forest against deforestation and fire
2. Preventing pollution by recycling litter and applying cesspits for wastewater treatment.
3. Recovering riparian vegetation with native species
4. Educating on environmental issues

The families in Brilhante see improved soil- and water quality as a benefit of environmental protection and consider water to be the most important indicator of sustainability. When questioned, most families were positive about protecting the environment through law and regulations. Approximately half of the questioned families in Brilhante were aware that the area had been designated by law, but lacked specific information on the potential alternative land uses that the area permits. We therefore conclude that the population should be educated about the use and conservation of water and other natural resources existing in the area. By elaborating a management plan which defines and describes the role of the different types of land use, that are applicable within APA Brilhante, people will be able to see the benefits of protecting the environment through a sustainable use of the area.

After several decades of cultivation, small scale subsistence farmers now find it difficult to continue agricultural production because of soil degradation and drought. This has led many households in Brilhante to abandon farm work and rely on alternative jobs such as assembling clothes. As an instrument to revive agriculture as a livelihood we suggest that sustainable land-use practises such as “Agroforestry” should be adapted by farmers who are open to changes. Such land-use can help to recover degraded land, increase productivity at small-scale family farms and provide many ecological services to farmers. Other beneficial projects like the “Project a Greener Itajaí” for recuperation of riparian forest and the creation of a “Local Agenda 21 sub-forum” for environmental planning help the community to recognize that environmental protection is a shared responsibility that requires active participation of stakeholders with a balanced respect to social, environmental, economic and institutional needs.

If this goal is reached, APA Brilhante will serve as an example of good environmental management for the rest of the municipality and become a forerunner for sustainable development of similar protected areas in the rest of Brazil.

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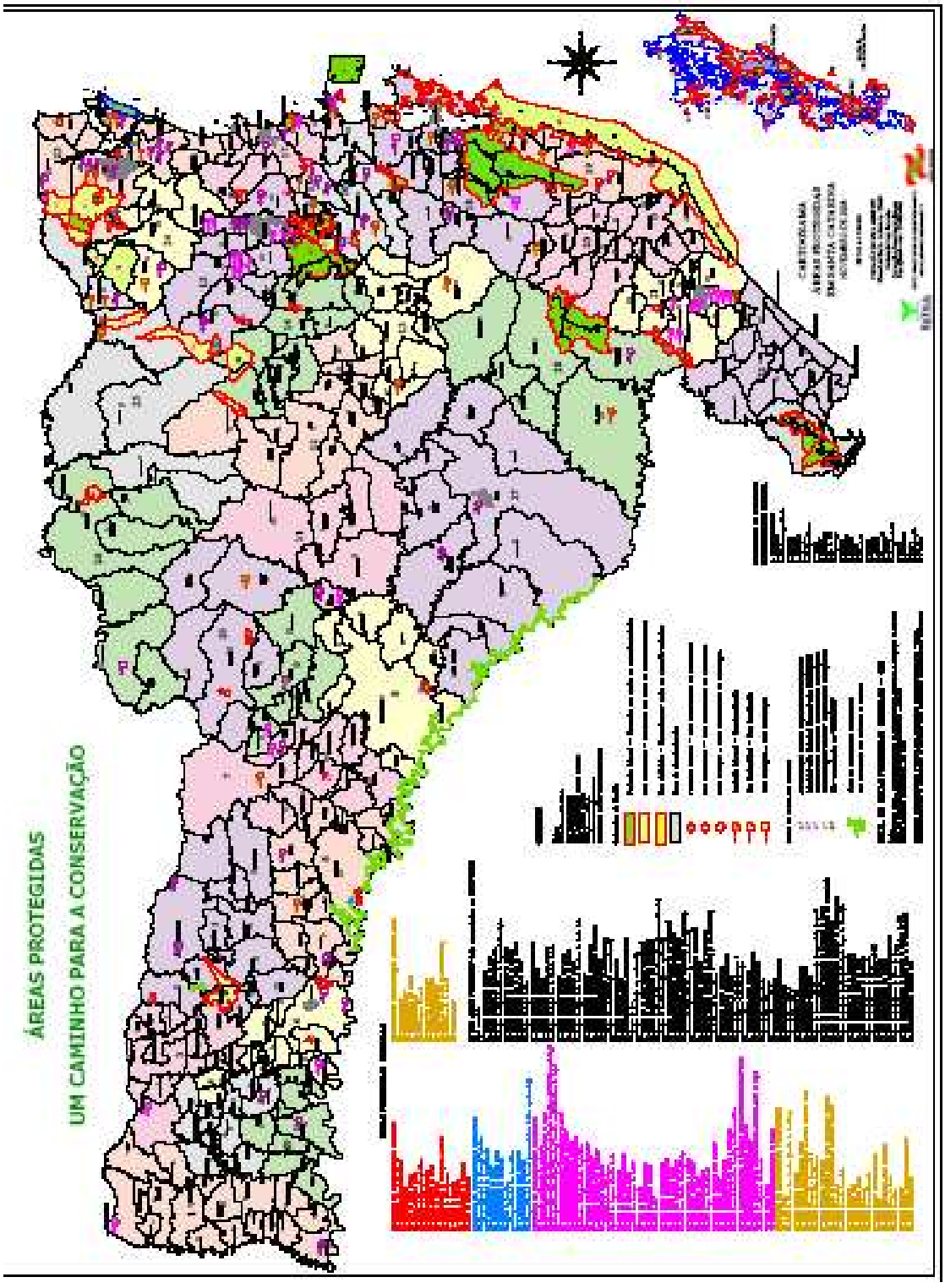
ANNEX 1 – Map of Protected areas in Santa Catarina

(adapted from FATMA, 2004)



ANNEX 2 – Field questionnaire, used for the survey performed in Brilhante

Questionário para agricultores e famílias na APA Brilhante

Descrição geral da área do estudo

Data:

Nome:

1. Homem ( ) /mulher ( )
2. Idade: Jovens 15-30 anos ( )___Meia idade 30-50 anos ( )___velho >50 anos ( )
3. Nasceu nesta comunidade? Sim ( ), não ( )
4. Educação: Primário ( )_____secundário( )_____universidade( )
5. Profissão_____
6. Morada/vila da moradia_____
7. Localidade da morada_____
8. Tamanho da propriedade em m²/ha_____
9. Qual é a atividade que praticam dentro da propriedade_____
10. Nome dos produtos cultivados_____
11. Sistema do cultivo/padrão do uso da terra (alternância de culturas, cultivo em contornos etc.)_____
12. Se praticam queimadas?_____

13. Economia de cultivo (subsistência/cultivo para exportação/comerciais)_____

14. Qual é o destino desses produtos (se os produtos são vendidos para o mercado ou se os vendedores vêm comprar os produtos diretamente)?_____

15. Propriedade da floresta (em m²)_____

16. Uso da floresta (tipo de uso)_____

17. Acesso a cursos da água_____

18. Uso dos /recursos da água_____

19. Como é o abastecimento da água na sua lavoura/casa (nascente ou poço)?_____

20. Como é o tratamento dos esgotos (se tem fossa)_____

21. Se a água para consumo humano é tratada?_____

22. Qual é o destino dos resíduos do banheiro?_____

23. Qual é o destino do lixo?_____

24. Se a lavoura possui sistema de irrigação?_____

25. Tipos de fertilizantes que se utiliza?_____

26. Utiliza agrotóxicos ? Sim ( )_____não ( )____se sim, quais?_____

27. Outros tipos de ocupação do terreno_____

Problemas/desafios da utilização da terra em relação da preservação dos recursos hídricos e ambientais na APA Brilhante

1. Quais são os problemas encontrados na sua propriedade?_____

2. Quais são as sugestões para melhorar a qualidade de vida e produtividade da sua área?_____

3. Existe poluição dos cursos da água mais próximos de você? Grave ( )_____importante ( )_____moderado ( )_____insignificante ( )____não sei ( )

4. Se sim, quais são as origens mais importantes desta poluição? Nutrientes ( )_____agrotóxicos ( )_____efluentes domésticos ( )_____efluentes industriais ( )_____de outra origem ( )

5. Como a contaminação da água afecta a sua vida aqui no campo?_____

6. Se o terreno esta sofrendo o processo de erosão: Grave ( )____bastante avançado ( )_____pouco avançado ( )____sem importância/insignificante ( )

7. Localização da erosão_____

8. Tipo de erosão_____

9. Se tem áreas reflorestadas? Sim ( )/ não ( ). Se sim, com que?_____

10. Existem problemas com secagem dos solos e as nascentes da água? Não/insignificante ( )_____pouco avançado ( )_____moderato ( )_____ Grave/bastante avançado ( )___

11. Se você acha que Brilhante devería ser protegida através da APA?____sim ( )___não ( ). Porque?_____

12. Se você sabia que 2000 ha da área da Serra Brilhante, foi designada como APA (Área de Proteção Ambiental) pela Prefeitura Municipal de Itajaí como a única APA no município? Sim ( )____não ( )

13. Quais são os beneficios que a implantação de uma APA podería proporcionar para a comunidade que mora dentro ou fora da APA?_____e quais são os benefícios que a APA podería acrescentar ao Município de Itajaí?

14. Se a Prefeitura Municipal de Itajaí deveria continuar a implantação da APA Brilhante? Sim ( )_____não ( )____se sim, porque?

15. Como você pode contribuir pelo melhoramento da qualidade do meio ambiente na APA Brilhante?_____

16. O que deveria ser feito por lado do município/Prefeitura Municipal pela melhoramento, para que vocês podem aceitar/aplicar as novas ideas de agro-ecologia/cultivo sustentável da terra?_____

17. Se a APA Brilhante vai ser realizada, o que deveria ser feito para que vocês podem sobreviver ao vosso cultivo de subsistência?_____

18. Quais são os 3 problemas mais importantes para você em relação entre o desejo a preservar os recursos naturais e a subsistência da sua lavoura (uso agricola)?

    Diminuição dos campos que são possíveis cultivar por causa da lei (qual é a lei da referência?) ( )__diminuição do rendimento das colheitas ( )____restrições em uso das pesticidas( )_____restrições em uso dos fertilizantes ( )____restrições da extração da madeira ( )____incremento do desemprego entre as pesoas que usam a terra ( ) transtornos na sua terra como conseqüência do uso turístico( )_____

19. Quais são os 3 benefícios mais importantes para você em relação entre o desejo a preservar os recursos naturais na APA Brilhante e a subsistência da sua lavoura (uso agrícola)?

    Incremento dos rendimentos dos produtos do campo ( )_____melhor conservação da diversidade da flora e do fauna no seu meio ambiente ( )_____melhor qualidade dos solos e da água ( )_____ incremento do valor da sua terra ( )____melhoramentos dos usos tradicionais da sua terra ( )____incremento do valor dos produtos da sua terra ( )

20. Devia ser "turismo ecológico" uma fonte de financiamento no Brilhante? Sim ( )___não ( ). Se sim, muito importante ( )_____importante ( )_____insignificante ( )_____não sei ( )

21. Devía pagar pelo gasto da água para melhorar o gestão ambiental na APA Brilhante? Sim ( )_____não ( )

22. Devia o publico participar na gestão da APA e nas decisões sobre o plano de manejo dos recursos naturais e o desenvolvimento socio-ambiental? Certamente ( )___não ( )

23. Quais são os 5 mais importantes indicadores de sustentabilidade ao longo prazo? Erosão ( )___biodiversidade ( )___seca ( )___qualidade da água ( )___ diminuição do crime ( )___ diminuição da pobreza ( )___ melhor qualidade de vida ( )__preservação dos espécies exóticas ( )__diminuição da poluição ( )__aumento do desemprego ( )____ diminuição do CO2 eaquecimento global ( )___estética da paisagem ( )__ aumento da saúde ( )__aumento de duração da vida ( )___diminuição da floresta ( )___conservação da floresta ( )

24. Como pode você utilizar o solo e os recursos naturais de uma maneira mais sustentável para preservar a água? Se você está disposto a mudar o seu padrão do cultivo para proteger a água e os recursos naturais na APA Bilhante?_____

25. Se você mudaria este padrão de cultivo/plantação espontaneamente, ou se o faz por temer a fiscalização?_____

Martin Sebastian Lassen,
Larissa Carniel

ANNEX 3 – Map showing locations of field interviews in Brilhante

Light blue: Stream networks draining the micro basins within the Itajaí Municipality. Red dashed line: approximate limit of the APA Brilhante (Brilhante II). Green dots: Localities of field interviews.