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3.9. Environmental management tools for basins with forest plantations: advances and proposals

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3.9.1. Introduction

In Uruguay, 400 thousand hectares have been forested with *Pinus* and *Eucalyptus*. Eighty percent of this forestation have been made with Eucalyptus sp. (MGAP, 1999), based mainly on exotic fast growing tree species since 1989 when the new National Forestal Law declared 20% of the national territory as ''soils of forestal priority''. As the main landscape of Uruguay is grassland (140,000 Km^2, 87% of the national territory), the most part of the forest plantations would currently occur in regions with prairie land cover (PÉREZ-ARRARTE, 1993). That situation accumulated many environmental claims and questions about potential negative environmental impacts on hydrologic cycles, streams water quality, soil quality, soil carbon sink, landscape fragmentation and biodiversity. These issues were intended to be approached by universities research groups since 2004 through refered publications about changes

on soil quality, soil microbiology and carbon sink process (CARRASCO-LETELIER et al., 2004; DELGADO et al., 2006), and hydrological cycle (SILVEIRA et al., 2006).

The environmental management (EM) has as main goal the sustainable development, with a clearly defined group of solutions for preventing, solving and/or mitigating several environmental problems linked to a new modification of the environment; by instance, EM generated from public sector (Integrated EM, Adaptative EM) and EM from private sector (ISO 14000, FSC certification, EUREGAP). Two initial steps must be satisfied:

(1) Diagnosis step called normally Environmental Impact Study (EIS);

and,

(2) Analysis step called Environmental Impact Assessment (EIA).

The main in goal is the solution for an environmental problem related to changes in the ecosystem, economy and society. The EIS requires the assessment of specific and recognized parameters in these three fields for an environmental problem, whose results must be compared with the guidelines defined at the environmental law, territorial planning; and regional/local characteristics in accordance with the EM or local monitoring programs, protec on of the ecosystem services and goods. However, lack of informa on is is compensated with international parameters, based in knowledge about ecosystems from northern hemisphere. These assumptions do not resist to many questions, mainly in the fields of ecosystemic damage management and risk management. Thus, biological differences between northern and southern hemisphere are important (ABELL et al., 2008).

The main goal of INIA-SA07 project was to develop and validate the first tools and parameters required for EM of agricultural basins, especially those required for environmental aspects of forest productions. With

the exception of hydrological studies that have been done inside other national and international projects in Uruguay.

3.9.2. Materials and Methods

3.9.2.1 Operational definitions

In the framework of INIA-SA07 project, the following operational definition was used: (1) a problem linked to forest production is an environmental problem only if social, economic and ecosystemic impacts are simultaneously involved; (2) the forest production was understood as including the plantations activities and the production of wood or bleaching pulp mill; and (3) this project do not have a defined goal if a situation is detected as environmental acceptable or not. This task corresponds to the local and national society through an EM process.

3.9.2.2. Study sites

The northwestern zone of the Rio Negro Department was selected as study site among several possible regions, specially in this Department, due to five reasons: (1) this region has an important pressure on natural resources to increase the use of soil resources for soybean crops and forest plantations, that wich increases regionally the use of agrochemicals, water and water pollution; (2) the high concern of the traditionally agriculture producers, from this zone, towards environmental impacts of the new use of territory; (3) the access to basins with important forest plantations that in most of the cases are reaching the second turn of harvest, (4) this zone allows the study of environmental interactions between productions of pulp mill and agriculture; and (5) this zone near from all the scientific facilities required for the project activities (Figure 3.9).

3.9.2.3. GIS studies

All the compartments under studies (water, soil and air) were previously characterized and documented in GIS environment. Soil maps, topographic characteristics, land cover situation, soil forest qualification of forest soils, and all the superficial water streams of Rio Negro Department were included (GIRÁLDEZ et al., 2009).

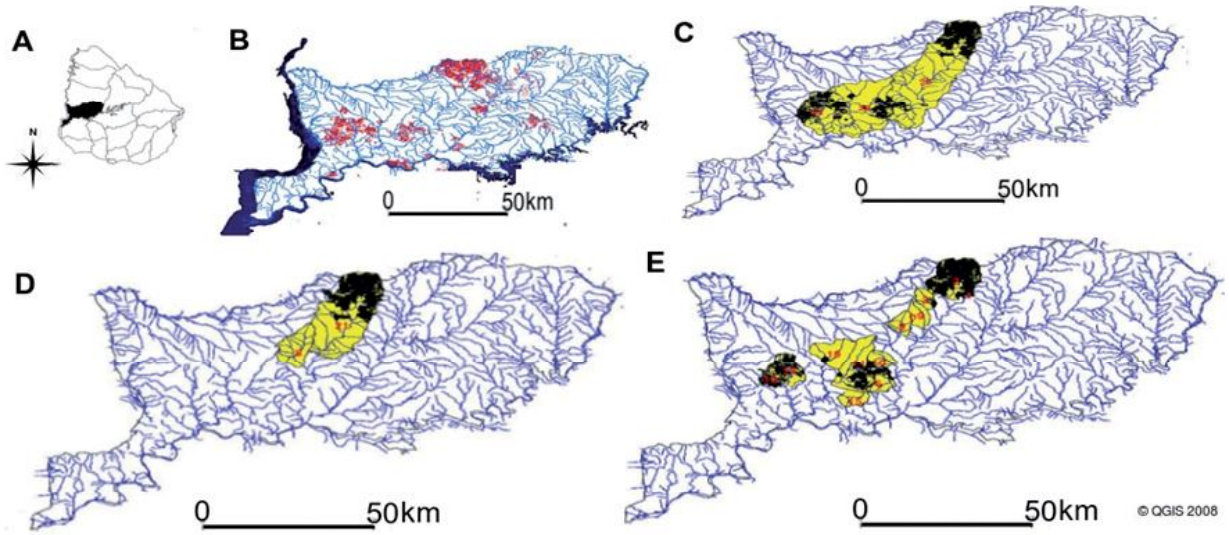

Figure 3.9. Basins for the study of soil and stream/rivers water quality changes. (A) Location of the Department of Rio Negro (black polygon) in the territory of Uruguay; (B) forest plantation (red polygons) and main streams (light blue lines); macro- (C), meso- (D), and micro-(E) basins (yellow zones) and theirs respective forest plantations (black polygons). Fonte: Carrasco-Letelier et al., 2010.

3.9.2.4. Limnochemical studies

GIS was generated in 2007 (GIRÁLDEZ et al., 2009), the selected basins were classified in three groups, related to their forest area (0-10%, 11-39%, and 40-60%). Water samples (10 replicates) were taken near to the end of each basin. Acidity (pH), temperature, conductivity, dissolved oxygen (DO), alkalinity, total nitrogen, total phosphorus, total solved solids (TSS) and organic matter were determined in the whole sample, and nitrate, soluble reactive P, Ca, Mg, K and Na in the dissolved fraction.

3.9.2.5 Water ecotoxicological studies

The following experiments were included: (1) development and validation of the first bioassay for endocrine disruptions (BED) in fish species; (2) the BED test was applied to assess sediments from Uruguay River, since Paysandú to Juan Lacaze (RIVAS, 2008), before the initiation of activities of BOTNIA mill; and (3) the BED test was applied to sediments and waters from basins with and without forest plantation. Additionally, it is assessing the change in trophic chains through stable isotopes studies.

3.9.2.6. Aerial ecotoxicological studies

The assessment of change of air quality and floral availability at landscape scale, it was carry out through the first air monitoring net based in honey beehives. Several parameters were tested according to international publications as ecotoxicological tools to asses environmental changes.

3.9.2.7. Studies of soil quality and organic matter

The soil quality changes are being studied for the development of a soil quality index. Moreover, it was studied the changes in the management of organic matter for the basins with different degrees of forest plantations, and experiments that will complement for basin metabolic studies.

3.9.3. Results and advances

3.9.3.1 Land use results

According to GIS strategy, maximum capacity of land use for forestry is 69% for the most of the basins. As a special local feature, these basins have a high density of drainage. On the other hand, monitoring of the of

beehives net showed a significant correlation between agricultural areas affected by beehives and Varroa destructor infestation rate.

3.9.3.2. Water quality and ecotoxicological studies

The BED test showed, before the initiation of BOTNIA mill activities, that the Uruguay river presented ED processes (Figure 3.10). Moreover, the comparison of basins with different land cover (agriculture vs. forest plantations) showed higher ED process in agriculture basins. The results of the winter sampling showed a significantly decrease of alkalinity and conductivity in stream waters, when the forest area is higher than 10% of basin area. Additionally, acidity and Na content showed a statistical increase only when the forest area was 11-39%. At the higher forest area, the Na and pH levels returned to its basal ranges.

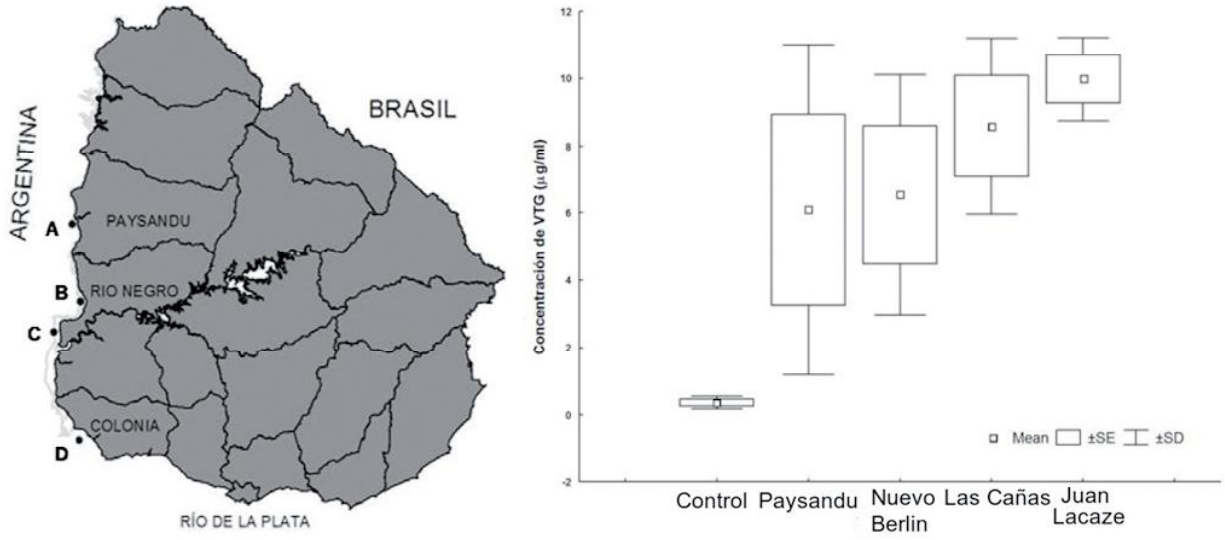

Figure 3.10. Sampling point of Uruguay River, and ED defined in levels of vitellogenin in fish males exposed to sediment samples from the river (RIVAS, 2008).

3.9.3. Air quality and ecotoxicological studies

The strategy of air quality monitoring using honeybees consists of a good strategy. The trap to assess the changes in honeybee death rates was defined for Uruguay, and in this moment this methodology must be transferred to private or public sector. Statistical significant differences

were found as a response from a biotype of honeybee to insecticides normally used in soybean crops, in a biochemical and molecular level.

3.9.4. Basins, soils and organic matter managements

The first studies of Eucalyptus litter degradation behavior, in basins with or without forest plantations, did not show differences in the lost for organic matter, N and Mg. However, there are statistical differences for inorganic lost in soils under forest. The comparison between basins with commercial forest and agriculture land cover indicates that losses of P in stream waters and differences on losses of Ca in soils and waters were larger in forest basins.

3.9.4. Perspectives and proposal

The specific goals are focused on the development of quality index, or reference values for water, soil and aerial compartments. Parameters must be developed with native species for national ecosystems. And as a complement, a proposal to improve the original strategy of INIA SA07 project for future researches or applications of its results.

Finally, we have two general comment. First, an obstacle found for the use of these results in public EM is the absence of local social organizations in charge of basins EM. Second, there are high possibilities that the private EM initiatives (i.e. Forest Stewardship Council certification), will develop an EM proposal, with more scientific content and efficiency, rather than those proposed from the public sector.

3.9.5. Acknowledgements

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3.10. Espécies frutíferas do Bioma Pampa, no Brasil

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3.10.1. Introdução

O Bioma Pampa atinge aproximadamente 700 mil km², ocorrendo em todo o Uruguai, no leste e nordeste da Argentina e no sul do Brasil, limitando-se à metade sul do Estado do Rio Grande do Sul (RS), onde ocupa 176,428 mil km² (IBGE, 2004). Atualmente, nesta última região, a perda da biodiversidade do bioma é muito rápida, pois a conversão dos campos nativos e outros ecossistemas naturais associados para monoculturas (silvicultura e agricultura) e outras atividades é acelerada, girando em torno de 137 mil hectares por ano, segundo Pillar et al. (2006).

Além da manutenção da pecuária em campos nativos, de forma sustentável e com turismo associado, uma das formas de se evitar os prejuízos ocasionados pelas monoculturas é realizar o incremento de