Chapter 5:
Impacts on the water supply

Brazil has the greatest availability of water in the world, and the use of crop irrigation is relatively small. Sugar cane crops are virtually not irrigated. The levels of water withdraw and release for industrial use have substantially decreased in the last years, with larger water reuse. Water treatment before discharge in São Paulo is adequate. The protection of areas around waterways and lagoons has advanced and may constitute an important factor also for the protection of biodiversity.

5.1 Introduction

The use of water for irrigation is considered an essential factor to agriculture worldwide. For a harvested crop surface (2000)[1] of 1,500 Mha, around 275 Mha are irrigated. There are around 190 Mha that allow agricultural use by agricultural drainage systems. The crop surface under dry farming, covering around 1,225 Mha (approximately 82% of the total), accounts for 58 percent of the production, which clearly demonstrates the importance of irrigation. The water used in agricultural production worldwide (2,595 km^3 in 2000) corresponded to an average of 9,436 m^3 / ha·year. It is estimated that this average can be reduced to 8,100 m^3 / ha·year by 2025.

The conflicts surrounding the uses of water have become more and more important around the world, with crop irrigation as one of its major issues. Likewise, the water sources and streams must be protected in order to prevent aggradations.

The impacts of the sugar cane culture on the water supply today (volumes and quality) are small under the conditions found in São Paulo. The main reasons for this are non-utilization of irrigation; an important reduction of water withdraw for industrial purposes that has been attained over the past few years thanks to internal reuse in the processes; and the practice of returning the water to the crops in the ferti-irrigation systems.

On the other hand, the forest protection legislation and its specific application to environmental protection areas (APP, in Portuguese) consisting of riverside woods have been releasing those areas from planting. This may lead to a major advance, creating corridors for biodiversity restoration, as proposed by the Office of the Secretary of Environment (São Paulo).

1 Estimations (2005) for 2003, Christofidis, D.; complementing Min. Integração Nacional /SIH/ DDH (1999); also Christofidis, D.: "Irrigação, a fronteira hídrica na produção de alimentos", Item, vol. 2., no. 54, 2002, pp. 46-55

Availability and use of water in Brazil; irrigation

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Fresh water is distributed[2] around the world as follows: 76.7 percent in glaciers and ice tables; 22.1 percent in water tables; and 1.2 percent in surface waters. Brazil stands out for its great abundance of water resources both on the surface and in water tables. **Table 1** compares the figures of Brazil to the world average supply (mean runoff of basins) and consumption of surface water. Brazil has 50,000 km² of its surface covered by fresh water (rivers, lakes).

2 Freitas, M.A.V.: "Hidroeletricidade no Brasil: Perspectivas de desenvolvimento e sustentabilidade", Seminário Sustentabilidade na Geração e Uso de Energia no Brasil: Os próximos vinte anos, UNICAMP / ABC, 2002

Table 1: Surface water supply and consumption, Brazil and the world

	Supply[1]		Consumption[2]	
	km³ / year	m³ / inhab·year	km³ / year	m³ / inhab·year
Brazil	5,740	34,000	55	359
World	41,281	6,960	3,414	648

1 Mean runoff, 2000

2 Consumption as evaluated in 1990

As to water tables, the Guarani Aquifer covers a total area of approximately 1.2 million km² – 839,800 km² of which in Brazil's Center-West and South regions. It stores around 40,000 km³ of water (which is equivalent to the world's total annual runoff). Because of both its huge availability and its low *per capita* use of water, Brazil is in a privileged position to plan the multiple uses of water in a sustainable way. As a matter of fact, Brazil is viewed as an important reserve for the world.

The space distribution of surface water resources and population causes only a few regions to appear as "critical" (supply below 1,500 m³ / inhab·year). According to a preliminary analysis conducted by the National Water Agency,[2] the main utilization conflicts (with different regional emphases) should consider: electricity generation; irrigation in agriculture; waterways development; human supply; leisure; and special cases of borders, floods and droughts. If well-grounded, the billing for use of water that starts being implemented in some regions of the country may favor the adoption of appropriate handling practices for the various applications, particularly the use in irrigation projects.

Although water does not seem to be a limiting factor today, the use of irrigation in agriculture is very small in Brazil. In most of the Brazilian territory, the agriculture used is dry farming: crops are grown depending exclusively on natural rainfall. In some regions, especially the *cerrados*, or savannahs, the total rainfall in the rainy season is enough for the development of agriculture. This is in spite of the frequent occurrence of successive dry days during the rainy season, which affects the development of crops and the final productivity.

Irrigation in Brazil's crop areas took up only 2.9 Mha in 2002.[3] More recent estimations point to 3.3 M ha, including all systems (drainage control on the surface, or using standard sprinkling, central swivel systems or localized irrigation). This corresponds to only 1.2 percent of the world's irrigated areas (277 Mha). Some studies[3] indicate that additional areas considered to be fit for a "sustainable irrigation" (fit soils with assured water) worldwide have reached 195 Mha. Around 15 percent of those areas are in Brazil (30 Mha), two thirds of which being located in the North and Center-West regions.

3 FAO, Data Base: Faostat, 2004

Even though the use of water for irrigation is very little in Brazil, it should be pointed out that the use efficiency (relation between the water coming to the crops and the water withdrawn from sources) is low: 61 percent on average. This results from the use of surface irrigation for 50 percent of the total water in Brazil. The future should consider the re-conversion of those systems: with equipment easier to control, adequate handling of surface irrigation systems, more uniform water application systems (by sprinkling), and spot irrigation (dripping and microsprinkling).

The use of irrigation is being investigated in Brazil for sugar cane, on a very small scale. The uses being tested correspond to very conservative technologies with a minimum use of water. Taking full advantage of the natural climatic conditions while implementing irrigation systems – for full, supplementary or salvage irrigation – may lead to interesting cost-benefit ratios in some cases.

Irrigation in sugar cane production is more widespread in the Northeast.[4] It also displays gradual growth in the Center-West and some areas in the Southeast, especially in Rio de Janeiro, Espírito Santo and west of São Paulo. "Salvage irrigation" is used after the planting of sugar cane in order to ensure sprouting in long periods without rain. "Supplementary irrigation" with different blades at the most critical of development stages is used in order to mitigate any shortages of water; and irrigation is used throughout the cycle, in relatively small areas.

4 Anselmi, R.: "Irrigar é preciso", JornalCana, ed. 124, Apr. 2004, pp. 36-40

Practically all of the sugar cane produced in São Paulo State is grown without irrigation,[5] based on economic analyses that were conducted considering full irrigation and productivity gains. However, experiments conducted by the Sugar Cane Technology Center have demonstrated the economic feasibility of subsurface sprinkling in the Ribeirão Preto region. The sugar cane harvesting season and the increase in longevity of the sugar cane crop, among other factors, have an influence of the feasibility of irrigation.

5 MATIOLI, C.S.: *Irrigação suplementar de cana-de-açúcar: modelo de análise de decisão para o Estado de São Paulo*, Piracicaba, SP, Doctor's thesis – Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, 1998

Although it is usual to associate sugar cane productivity with water availability (a 8.0-12.0 mm ratio of water evapotranspired for each t of sugar cane produced is widely used), that ratio varies according to many factors.[6] However, it is important to keep a suitable humidity level throughout the growing process in order to get high yields. Depending on the weather, the water required by sugar cane crops amounts to 1,500 to 2,500 mm, uniformly distributed across the cycle. The growing demand for the incorporation of new sugar cane areas in the Center-South region of Brazil has lead to the exploitation of regions having higher water deficits. In these cases, irrigation can be economically feasible, especially using more efficient methods.

6 DOORENBOS, J.; KASSAM, A.H.: *Yield response to water* (Irrigation and Drainage Paper, 33), Rome, FAO, 1979

For the most part, it can be said that some of the environmental problems arising from irrigation, and found in many sugar cane and beet crops around the world, do not exist in Brazil. An evaluation provided by EMBRAPA[7] now rates the impacts of sugar cane crops on water quality as level 1 (no impact).

7 ROSSETTO, R.: "A cultura da cana, da degradação à conservação", Visão Agrícola, ESALQ-USP, Ano 1, Jan 2004

5.3 Water withdraw and use in sugar cane processing

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The sugar cane culture in Brazil has traditionally not used irrigation. This is highly important in the reduction of environmental impacts (not only because of the little use of water, but also to avoid the dragging of nutrients and agrochemical residues, loss of soil, etc.). The water goes into the mills with the sugar cane (around 70% of the crop stalks weight) and it is also withdrawn from sources to be used in the industry. The collected water is used in several processes, at different reuse levels. Part of it is returned to the water streams after the necessary treatments, and another part is used in ferti-irrigation together with the vinasse. The difference between withdrawn and released water, is the water consumed internally (processes and distribution in the field).

5.3.1 The São Paulo context

The levels of water collection and release have been decreasing in a sensible way over the past ten years. In fact, this has been occurring in the industry in general, and is the result of a greater awareness of the need to save water and the indications of future legal actions in this respect. In the 1990's, the sugar cane industry's share of water withdraw was around 13 percent of the demand in the state, and around 40 percent of entire industrial sector, according to the São Paulo State Plan on Water Resources (PERH-1994/95).[8] **Table 2** briefly shows the water availability and demand data of the forementioned plan and the PERH-2004/07.[9]

Table 2: Surface water availability and demand, São Paulo

Availability and demand			PERH - 1990 [1]				PERH - 2004-07 [2]	
			1990		2010 (Pessimistic)		2003	
			m^3/s	%	m^3/s	%	m^3/s	%
Availability	$Q_{reference}$		2,105				2,020	
	$Q_{7,10}$		888				893	
Demand	Urban		97	24	200	23	151	39
	Irrigation		154	44	490	55	102	26
	Industrial	Total	112	32	190	22	137	35
		Mills	47	13				
	Total		353	100	880	100	390	100

1 State Plan on Water Resources – 1994/95 (1st Plan of São Paulo State – 1990 – Summary)
2 State Plan on Water Resources – 2004/2007 (Brief, 2004)

8 Conselho Estadual de Recursos Hídricos, Plano Estadual de Recursos Hídricos – Primeiro Plano do Estado de São Paulo – 1990 – Síntese, CRH, CORHI, GTP, São Paulo, 1994

9 Conselho Estadual de Recursos Hídricos, Plano Estadual de Recursos Hídricos 2004/2007 Relatório 1: Síntese dos Planos de Bacia, CHR, CORHI, Consórcio JMR Engecorps, São Paulo, junho 2004

The pessimistic value of 880 m^3 / s estimated for 2010, which dangerously puts the demand on the minimum available flow level ($Q_{7,10}$) is unlikely to be reached, as shown by the values for 2003. The demand in the state increased by only 11 percent, to 389 m^3 / s. Of this, urban demand accounted for most of the increase (74%), followed by a 22-percent increase in industrial demand, and a 34-percent decrease in the demand for irrigation purposes. Part of these changes can be attributed to the reviews of concepts in the new PERH. A piece of relevant information is that irrigation does not have the weight that was previously attributed to it; the leading user of water is the urban sector, with around 39 percent of the state's surface water.

In the industrial sector (including the sugar cane agribusiness), the demand for water increased by only 22 percent in that period. This is partly because of the rationalization of water use that has been encouraged by the implementation of the new legislation, which provides for billing for the use of water (yet to be regulated).

Some partial estimations and measurements have been concluded for the sugar cane industry regarding water withdraw, use and release. Previously, the water release figures and the polluting load were always more important to the sector than the collection. Based on the estimated demand for 6 cropping months, and the total milling of sugar cane in 1990 in São Paulo State,[10] the water collection rate at the time was estimated at 5.6 m^3 / t of sugar cane. The specific release flow rate (32.3 m^3 / s, according to the PERH-1990) was estimated at 3.8 m^3/t of sugar cane, leading to consumption of 1.8 m^3 / t of sugar cane.

For the 2004/05 crop, 207.8 Mt of sugar cane milled in São Paulo,[11] represent a growth of 58.5 percent since 1990, which has outpaced the increase in demand for water without a doubt.

10 Fernandes, A.C.: "Desempenho da agro-indústria da cana-de-açúcar no Brasil (1970 a 1995)", Piracicaba, SP, CTC – Centro de Tecnologia Canavieira, July 1996

11 UNICA, "Resumo da produção da região Centro-Sul", site www.portalunica.com.br/referencia/estatisticas.jsp accessed in Feb 03 2005

5.3.2 Legislation on the use of water resources

The billing for use of water is based upon the "user-payer" and "pollutant-payer" principles: based on the amount and quality of the water collected and released by the user. All uses that require consent are subject to billing, such as collection, derivation, disposal dilution, energy production, navigation and others.

The costs affecting the industrial sector correspond to water withdraw, consumption and disposal. Billing for the use of water in São Paulo has been implemented for two geographic basins, the PCJ (Piracicaba, Jundiaí e Capivari) and the Paraiba do Sul. Both have established federal and state committees, and the water in rivers crossing state borders are already being billed for urban, industrial and rural utilization. For the state rivers (within a single state) and for underground water billing will be effective in 2007 (Decrees 51449 and 51450, from 2006, for the PCJ and Paraiba do Sul). The majority of the remaining 18 basin committees (in São Paulo) will start the billing in 2008; in São Paulo the billing of water for irrigation was postponed till 2010. The main legal mechanisms to bill for use of water at the federal and state levels for São Paulo State are as follows:

• The São Paulo Constitution, 1988: it provides that the use of water resources shall be billed, and the proceeds shall be used to maintain the quality and quantity of water.
• State Law (SP) no. 7,663, 1991: it introduces the State Policy for Water Resources and the Integrated Water Resources Management System; provided for the Water Resources Management Hydrographic Units (UGRHI), the basis for billing water collection and use; the apportionment of multi-use works costs, and the granting of rights to use by the state. It also sets the priorities for uses, to be effective for as long as the plan for a certain basin is not established.
• Federal Law no. 9,433, 1997: it provides for the National Policy for Water Resources and creates the National Water Resources Management System, which is based on principles of decentralized management, multiple uses of water, and priorities.
• CEIVAP Decision no. 08, 2001: whereby the Committee for Integration of the Paraíba do Sul River Basin (CEIVAP) provides for the implementation of billing for the use of water resources from the basin, effective as of 2002. The billing considers the collection, consumption, the treated effluents-total effluents ration, and the BOD (Biochemical Oxygen Demand) reduction level of the treated effluent.
• CEIVAP Resolution 65/2006, establishing new mechanisms to consolidate the billing of water in the Paraiba do Sul with the State regulations
• CNRH Resolution 52 (2005) approving the methodology and values for the billing in the PCJ (federal) rivers for 2006
• Law 2183 (2005) establishes the methodology, limits and values for the billing in State rivers
• State Decree 50667 (2006), including the procedures for determination of the final prices
• CRH (State Water Resources Council), in Dec 2006, approved the propositions for the billing in State areas
• State Decrees (S Paulo) 51449 and 51450 (Dec 29, 2006) determine the billing in the PCJ and Paraiba do Sul basins.

5.3.3 Water withdraw for industrial use in the sugar cane agribusiness

Table 3 sums up the specific water use ranges and averages for industrial processing of sugar cane. It considers that the sugar cane is used in the production of sugar and ethanol on a 50/50 basis.[12]

The estimated mean end use of 21 m^3 / sugar cane t corresponds to much lower levels of water collection, consumption and release due to water reuse. Note that about 87 percent of the uses take place in four processes:

12 ELIA NETO, A.: "Workshop sobre cobrança pelo uso da água" – Convênio AIAA Comitê da Bacia Hidrográfica dos Rios Piracicabas, Capivari e Jundiaí (CBH-PCJ), Piracicaba, 1996

Table 3: Water uses (mean values) in mills having an annexed distillery

Sector	Process	Mean use (total m^3 / sugar cane t)	Distribution (%)
Feeding	Sugar cane washing	5.33	25.4
Extraction (grinding)	Imbibition	0.25	1.2
	Bearing cooling	0.15	0.7
Juice treatment	Preparation of lime mixture	0.01	0.1
	Cooling at sulphiting [1]	0.05	0.2
	Filter imbibition	0.04	0.2
	Filter condensers	0.30	1.4
Juice concentration	Condensers/multijets evaporation [1]	2.00	9.5
	Condensers/multijets heaters [1]	4.00	19.0
	Molasses dilution	0.03	0.1
	Crystallizer cooling [1]	0.05	0.2
	Sugar washing [1]	0.01	0.0
Electrical power generation	Steam production	0.50	2.4
	Turbo-generator cooling	0.20	1.0
Fermentation	Juice cooling [2]	1.00	4.8
	Fermentation cooling [2]	3.00	14.3
Distillery	Condenser cooling [2]	4.00	19.0
Other	Floor & equipment cleaning	0.05	0.2
	Drinking	0.03	0.1
Total		21.00	100.0

1 in sugar production only

2 in ethanol production only

sugar cane washing; condenser/multijet in evaporation and vacuum; fermentation cooling; and alcohol condenser cooling.

With the rationing of water consumption (reuses and circuit closing, as well as some process changes, such as the reduction of sugar cane washing), water collection has been decreasing. A preliminary, limited survey conducted in 1995[13] in mills owned by the Copersucar Group pointed to a mean collection rate of 2.9 m^3 / sugar cane ton. A more comprehensive review released in 1997 indicated that the collection was actually at 5 m^3 / sugar cane t. Such a rate is equivalent to that estimated for 1990, based on the total demand in São Paulo, which was 5.6 m^3 / sugar cane t.

13 Elia Neto, A.: "Tratamento de efluentes na agroindústria sucroalcooleira", presented at FEBRAL/95 – Brazil-Germany Fair, São Paulo, SP, 1995

The results for water withdraw, consumption and release are shown in **Table 4**.

Table 4: Water withdraw, consumption and release: 1990 and 1997

Specific volume (m^3 / sugar cane t)	1990 [1]	1997 [2]
Collection	5.6	5.07
Consumption	1.8	0.92
Release	3.8	4.15

1 State Plan on Water Resources – 1994/95 (1st Plan of São Paulo State, 1990 – Summary)

2 Survey (review) conducted in 1997 by the CTC with 34 mills owned by Copersucar

Over the past few years, there has been more action concerning the rationalization of water consumptions and reuse, and the reduction of release levels at São Paulo-based mills. In order to examine the extent of the changes, a survey was conducted through questionnaires and interviews with a large number of mills, accounting for a total sugar cane milling of 695,000 tons per day (around 50% of the Center-South production).[14] The result was 1.83 m^3 of water / t of sugar cane, and excluding the mills having the highest specific consumption, the mean rate for the mills that account for 92 percent of the total milling is 1.23 m^3 of water / t of sugar cane.

14 Internal report (reserved), UNICA, 2005. Survey on water collection by sugar cane industry, M. Luiza Barbosa, assisted by Centro de Tecnologia Canavieira

These figures indicate an extraordinary advance in water handling during the period.

5.3.4 Main effluents, organic load and treatment

With regard to the effluents and their organic load, the survey conducted in 1995 with 34 mills[13] pointed to a remaining organic load of 0.199 kg BOD_5 / sugar cane t. This represented an efficiency level of 98.40 percent compared with the estimations of the pollutant potential for that same period. Note that ferti-irrigation of sugar cane crops is the major disposal channel for that organic matter, with environmental and economic benefits.

The main effluents and their treatment systems are as follows:

• Sugar cane washing water: 180-500mg / l of BOD_5 and high concentration of solids. Treated with settling and stabilization ponds for the case of release to water bodies. For reuse, the treatment consists of settling and pH correction of 9-10.

• Multijet and barometric condenser waters: low pollutant potential (10-40 mg / BOD_5) and high temperature (~50ºC). Treatment with sprinkler tanks or cooling towers, with recirculation or release.

• Fermentation vats and ethanol condenser cooling waters: high temperature (~50ºC). Treatment with cooling towers or sprinkler tanks for return or release.

• Vinasse and wastewaters: large volume and organic load (10.85 / l of ethanol, with around 175 g BOD_5 / l of alcohol).[15] Vinasse is used in sugar cane crops together with wastewaters (floor washing, closed-circuit purging, condensate remainders), promoting ferti-irrigation using the nutrients.

15 Elia Neto, A.; Nakahodo, T.: "Caracterização físico-química da vinhaça", Project no. 9500278, CTC – Centro de Tecnologia Canavieira, Piracicaba, SP, 1995

5.3.5 Prospects for the industry

Since 1995, the industry (especially the Sugar Cane Technology Center) has been assessing techniques for a rational use of water and reuse of waste. The possibility of reaching a water collection rate of 1 m^3 / sugar cane t and an effluent release rate of zero in the mid term has been considered. The organic load would be treated by using waste in crop ferti-irrigation together with the vinasse. Water consumption (difference between the amount of collected water and released water) would be near the collection value, i.e. 1 m^3 / sugar cane t. We noted that sugar cane itself carries 70 percent of water, which does not represent utilization of water resources.

These basic guidelines imply a management of water, including a decrease in collection and a maximum reuse of effluents. This has already occurred partially, and may be accelerated by the incorporation of new technologies, including dry cleaning of sugar cane (eliminating sugar cane washing). Treatments like biodigestion of vinasse might reduce the organic load, thereby allowing recirculation upon tertiary treatment.

The results of the latest assessment indicate that there has been an evolution to these goals over the past few years. Even when the particularities of mills are taken into account, which will certainly imply different results, the withdraw averages may continue to decrease. An optimization of reuse shall be the subject of studies over the next few years, aiming at reducing the costs of disposal.

5.4 Protection of water sources and streams

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The preservation and recovery of riverside woods, combined with appropriate soil preservation and handling, are essential to ensuring one of the main natural resources, water. Riverside woods are essential plant systems for environmental equilibrium. Their functions include controlling erosion on banks of water streams, thereby avoiding fountainhead aggradations, minimizing the effects of floods, maintaining the amount and quality of the waters, filtering any possible waste resulting from the chemicals used as pesticides and fertilizers, and helping to preserve biodiversity and the genetic inheritance of the flora and fauna.

5.4.1 Legal aspects; forest legislation

The main legal aspects of riverside woods and their preservation and restoration are distributed among several rules at the state and federal levels.[16] The subject is addressed by several pieces of the environmental legislation, such as the Forest Code, the Environmental Crime Law, rules on permits and licenses and recovery projects, as well as the tax legislation on rural properties. In addition to the specific legislation on the subject, the legislation on Preservation Units is also relevant.

Brazil's main legislation on forests[17] is the Forest Code (Law no. 4,771/65, as amended by Law no. 7,803/89 and Provisional Measure no. 2,166-67), which contain the following items applicable to riverside woods:

Article 2nd - For the purposes of this law, forests and other forms of natural vegetation are considered permanent preservation units when located as follows:

a) along rivers or any water streams, from their highest level, in a marginal width range of at least:

1) 30 m, for less than 10 m wide water streams;
2) 50 m, for 10-50 m wide water streams;
3) 100 m, for 50-200 m wide water streams;
4) 200 m, for 200-500 m wide water streams;
5) 500 m, for more than 600 m wide water streams;

b) around lagoons, lakes, or natural or artificial water reservoirs;

c) at springs, yet intermittent, and at "water holes", whatever the topographic situation, within a radius of at least 50 m.

16 Estado de São Paulo, Secretaria de Estado do Meio Ambiente: "Projeto de recuperação de matas ciliares no Estado de São Paulo: proposta o GEF", Documento de avaliação ambiental, São Paulo, 2003, site www.ambiente.sp.gov.br accessed in Feb. 1 2005

17 Ventura, V.J.; Rambell, A.M.: *Legislação federal sobre o meio ambiente*, Vana Editora, 3rd ed., 1999

These principles and limits extend to urban areas.

Riverside woods are the main example of Permanent Preservation Areas (APP, in Portuguese), as defined in the Forest Code (Law no. 4,771/65) and its regulation (particularly CONAMA Resolution 303/02). In addition, the São Paulo State Constitution, article 197, defines springs, fountainheads and riverside woods as permanent protection areas.

Under the federal legislation, riverside woods are protected from cutting. However, their restoration, if no environmental infringement is characterized, is not mandatory, except for springs (Law no. 7,754, of 04/14/1989). The riverside strips, if duly covered by woods or other natural vegetation, are excluded from the taxable area of the property, as set forth in the specific legislation on the Rural Property Tax (ITR, Law no. 9,393/96).

Formally, there is no explicit determination in the federal legislation that riverside woods should be recovered if previously degraded. There is no clear definition of acceptable uses in the law either, and such uses as public utility and/or social interest are often mentioned for suppression of vegetation (articles 2nd and 3rd of the Forest Code). In São Paulo State, Law no. 9,989, of May 22, 1998 requires riverside woods to be recovered by owners of rural property. This, however, was not regulated within the expected period.

It is an environmental crime to damage a forest or cut trees in APPs. The punishments and fines are set forth in the Environmental Crime Law (Law no. 9,605/97). There are also punishments for "*preventing or hindering the natural regeneration of forests and other forms of vegetation*" (Forest Code, Law no. 4,771/65).

5.4.2 Provision of seeds and seedlings

Obtaining seeds and seedlings of native species in an adequate manner, considering such factors as quality and intra- and inter-specific diversity, is a critical aspect of forest recovery actions. In this case, Preservation Units (UCs, in Portuguese) and State Parks may represent an important, if not the only source of such genetic material. In São Paulo State, those units, under Law no. 9,985, of July 18, 2000, and Decree no. 25,341, of June 04, 1986 (Regulation of São Paulo State Parks), have restrictions on the collection of plant specimens and seeds. For the sake of recovering degraded areas, such restrictions should be reviewed.

Law no. 10,711, of 2003, on the National Seed and Seedling System (SNSM, in Portuguese), regulates the production of and trade in seeds of forest, native or exotic species. Decree no. 5,153, of 2004, provides for the forest species seed and seedling production and certification process.

5.4.3 SMA initiatives – São Paulo State

Only 13.7 percent of São Paulo State is covered by the remaining native vegetation (8% of which being part of the original Atlantic Forest). The area of degraded riverside woods that need restoring is estimated at around 1 million hectares, representing 120,000 km along the banks of unprotected water streams.[16] The SMA (Office of the Secretary of Environment) is carrying out a long-term project for recovering riverside woods within the state. In addition to local environmental benefits, the program aims at creating alternative jobs and contributing to the reduction of greenhouse gas emissions. The carbon dioxide fixation by the vegetation could use resources from the CDM (Clean Development Mechanism).

16 see p. 115

5.4.4 Possibilities in the sugar cane culture

In most sugar cane culture cases, places considered permanent preservation areas (APPs) have been left for natural, spontaneous recovery. This has been happening especially over the past few years. The recovery of degraded riverside woods by reforestation activities is still limited to only a portion of the total area.

In order to evaluate the dimensions and situation of the permanent preservation areas corresponding to old riverside woods, a survey was concluded in 2005 involving a large number of mills in São Paulo.[18] The areas comprise owned and leased land, and in many cases, land owned by sugar cane suppliers. The main results, denoted in % of the sugar cane crop area, are shown below. For the first item (total permanent protection area, corresponding to riverside woods), the sample consists of 781,000 ha; for the other items, between 650,000 and 780,000 ha.

18 Survey by Maria Luiza Barbosa for UNICA, questions prepared by CTC – Centro de Tecnologia Canavieira, Jan 2005

Total APP (banks, springs, lagoons)	8.1 % of the sugar cane area
APP with natural woods	3.4%
APP with reforestation	0.8%
Abandoned APP	2.9%
APP with sugar cane	0.6%

Those estimations allow the total APPs relative to riverside woods for the sugar cane crops alone in São Paulo, to be evaluated at around 200,000 ha. The portion having natural woods is important, and the reforested area has grown over the past few years. The importance of implementing programs like that of the São Paulo SMA, besides the necessary protection of water streams, has to do with the ability to foster a restoration of the plant biodiversity in the region if the programs follow appropriate criteria.

5.5 Summary and conclusions

• Even though Brazil has the greatest availability of water in the world, with 14 percent of the surface waters and the equivalent to the annual flow in underground aquifers, the use of crop irrigation is very small (~3.3 Mha, compared to 227 Mha in the world).

• Sugar cane crops are virtually not irrigated in Brazil, except for some small areas (supplementary irrigation). Efficient methods (subsurface dripping and others) are being evaluated.

• The levels of water withdraw and release for industrial use have substantially decreased over the past few years, from around 5 m^3 / sugar cane t collected in 1990 and 1997 to 1.83 m^3 / sugar cane t in 2004 (sampling in São Paulo). The water reuse level is high (the total use was 21 m^3 / sugar cane t in 1997), and the efficiency of the treatment for release was in excess of 98 percent.

• It seems possible to reach rates near 1 m^3 / sugar cane ton (collection) and zero (release) by optimizing both the reuse and use of wastewater in ferti-irrigation.

• For the most part, environmental problems relating to water quality, which result from irrigation (dragging of nutrients and pesticides, erosion) and industrial use, are not found in São Paulo. In this respect, EMBRAPA rates sugar cane as Level 1 (no impact on water quality).

• The APPs relating to riverside woods have reached 8.1 percent of the sugar cane crop area in São Paulo, 3.4 percent of which having natural woods, and 0.8 percent having been reforested. The implementation of riverside wood restoration programs, in addition to the protection of water springs and streams, can promote the restoration of plant biodiversity in the long term.