Management and monitoring of water resources in areas of eucalyptus plantations

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ABSTRACT

The eucalyptus planting in Brazil is done in large areas, and an important agricultural product. For the assessment of possible impacts arising from the exploratory activity, analysis is needed of the effects on water, soil, air and biodiversity. This work aimed to the monitoring of water resources in the Baixo Jacuí Basin, in southern Brazil, to evaluate the possible impacts of changes of land use, providing information on water resources for expansion of companies forests, given the conditions of environmental licenses, certification and forest science. For the monitoring of water resources were chosen three representative micro basins (Sanga das Pedras, Colorado and São Vicente). The estimated flow was performed twice, from February 2007 to January 2008. In evaluating the possible impacts of changes of land use on water resources were used indexes, which were the seasonality index (SI), water availability index (ID) and rate of flow generation (IE). The SI presents between microbasins analyzed quite values contrasting , showing that in some areas of the basin, there is contrasts in monthly average flow values between wet and dry months (SI <5%), on the other hand other areas have average monthly flows more stable during the year (SI> 30%).

Keywords: Eucalyptus, water management, environment, Brazil

1. INTRODUCTION

Environmental issues are increasingly being discussed in order to promote environmental conservation and sustainable use of natural resources. For the assessment of possible impacts arising from the exploratory activity analysis is needed of the effects on water, soil, air and biodiversity.

In that it increases the need to maintain and improve environmental quality, organizations of all types are considering the possible impact of its activities, products and services. In order to obtain areas liable to forest expansion of the base, the company Aracruz Celulose in the state of

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Rio Grande do Sul, performs a program of monitoring water that aims to continue the study of possible environmental impacts in relation to survey and analysis primary data needed for conclusive understanding of the intervention required in the quantity and quality of water resources.

The activity of the cultivation of eucalyptus is constantly questioned in relation to consumption of water by the culture as well as the impacts caused on the soil moisture, rivers and groundwater. Many advocate the idea that the culture promotes the drying of eucalyptus soil, however, studies have shown that not only the quantity of water consumed should be assessed, but the precipitation occurred in the region of cultivation. Davidson (1993) suggests that only in areas with rainfall below 400 mm year-1, eucalyptus may cause dryness of the soil. According to FOELKEL (2005), it is estimated that the range of evapotranspiration from a planting of eucalyptus is equivalent to the rainfall, something around 800 to 1200 mm by year.

The area examined by the company Aracruz Cellulose to expand the cultivation of eucalyptus in the basin of the Baixo Jacuí is located in the river basin Guaiba. The region of Guaiba is located in the northeast region of Rio Grande do Sul, between parallels 28 º S and 31 S and the meridians 50 º W and 54 W. It has an area of about 86,000 km2, distributed in the provinces of the Central Plateau and Depression.

It is in the baixo Basin Jacuí the intensive use of land for cattle and agriculture, there are still areas for extraction of coal. Regarding water use, the main uses are the public supply, industrial processes and irrigation of rice and horticulture.

This work aimed to the monitoring of water resources in the baixo Basin Jacuí to assess possible impacts of changes of land use.

2. METHODOLOGY

For the monitoring of water resources in the basin of baixo Jacuí were chosen three representative samples, to be included in the analysis of changes microclimatic and hydrological characteristics of the region of intervention. The microbasins were selected: Sanga das Pedras (IA 132), Colorado (IA 012) and San Vicente (IA 044) (Figure 1).

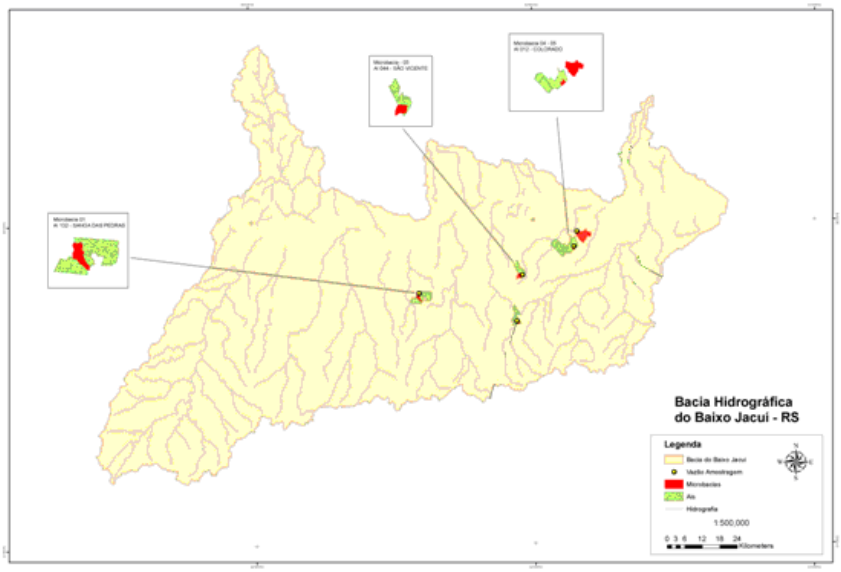

Figure 1. Location of microbasins monitored in the basin of the baixo Jacuí

For the estimation of flow were made during the period February 2007 to January 2008, biweekly measures of cross sections of water courses, and these were divided into sub-sections, resulting in the velocity of flow of water in each one. The different areas were correlated with their speeds, and the sum of flows calculated in each sub-section allowed to estimate the monthly average flow of water going over a seasonal cycle for the analysis of hydrological behavior in young plantations.

In evaluating the possible impacts of changes of land use on water resources were used indexes, which were the seasonality index (SI), water availability index (ID) and rate of flow generation (IE). To obtain these indices were used the following formulas:

- Seasonality Indicator (%) - indicates the change in the pattern of flows during the year.

$$IS = \frac{Q_{95}}{Q_{lp}} \times 100$$

- Indicator of water availability (%) - indicates the availability of resources facing the new demand

$$ID = \frac{Q_{dem}}{Q_{95}} \times 100$$

- Indicator of flow generation (%) - indicates the time of residence of water in the basin

$$IE = \frac{Q_{lp}}{P_{tot}}$$

3. RESULTS AND DISCUSSION

The watershed monitored in Sanga das Pedras has an area of 310.63 hectares. In the period of measuring the flow analysis, the highest total rainfall was recorded in June and presented as value 288.5 mm month-1, the peak flow occurred in the same month showing a value of 79.78 Ls-1. It appears there is a direct correlation between the amount of rain with the correlation coefficient (R^2) of 37.14% (Figure 2).

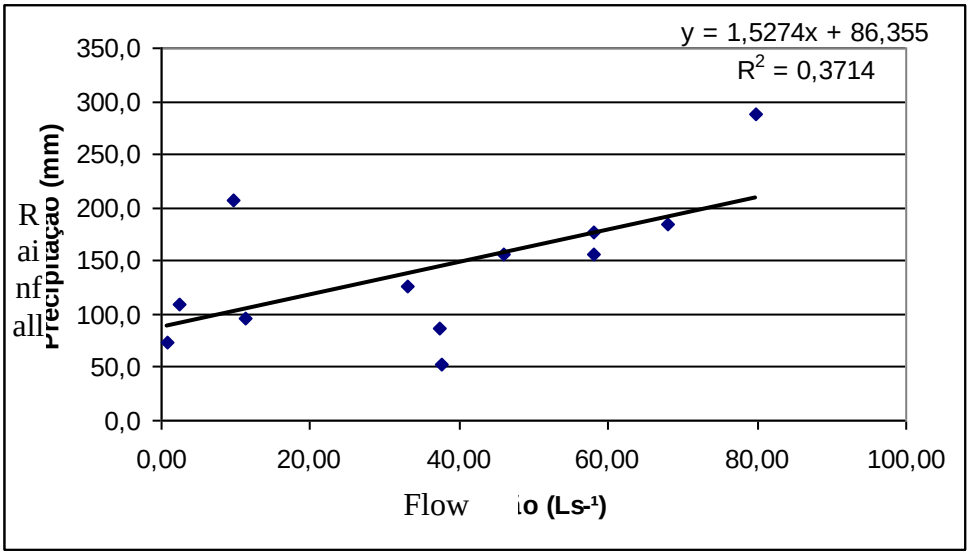

Figure 2. Correlation between rainfall and flow in the watershed Sanga das Pedras.

For index, as seen in Table 1, the highest index of flow was 61.89% and 1.04% lower. This indicates that the reduced flow in the driest months of the year (April and May) had the flow in this period represented by only 1% of total monthly rainfall. In rainy months (June-October) flow in the bed of the water course was observed to be greater than 30% of total monthly rainfall. The seasonality index showed values of 2.07% indicating a marked contrast between the rainy and dry period of the year. The higher water availability was in April (93.83%) and lowest in June (14.91%), indicating that more dry in the month was the highest total demand for the minimum flow.

Table 1. Indices for evaluation the hydrological intervention in vegetation cover performed.

Month	Average Flux/month (Ls^{-1})	PRP ($mm\ month^{-1}$)	IE (%)	IS (%)	ID (%)
				2,07	
feb/07	11,21	96,0	9,09		55,50
mar/07	9,55	207,0	3,98		59,41
apr/07	0,92	73,7	1,04		93,83
may/07	2,31	108,2	1,84		85,83
jun/07	79,78	288,5	23,08		14,91
jul/07	68,05	183,6	31,96		17,04
aug/07	58,13	176,8	28,35		19,38
sep/07	45,96	156,2	24,55		23,32
oct/07	57,95	156,2	31,99		19,43
nov/07	32,97	126,0	21,84		29,77
dec/07	37,54	52,3	61,89		27,13
jan/08	37,32	86,4	37,26		27,25

In Colorado, which has an area of 146.36 hectares, the largest amount of rainfall was recorded in June (244.1 mm month-1) and peak flow occurred in December, with a value from 42.50 Ls-1. The correlation between the monthly values of flow rate and total rainfall was low, not allowing

an analysis in this direction.
As seen in Table 2, the highest rate of flow greater than 100% and 15.13% lower, indicating that this would probably have been right after a rain, where the flow signal was still the runoff fast. The seasonality index showed values of 52.73% indicating a good distribution of flow (flow adjusted) between dry and wet periods of the year. The higher water availability was in November (33.48%) and lowest in December (13.42%) indicating that more dry in the month was the highest total demand on water availability.

Table 2. Indices for assessing the hydrological intervention in vegetation cover performed.

Month	**Average Flux/month (Ls^{-1})**	**PRP ($mm\ month^{-1}$)**	**IE (%)**	**IS (%)**	**ID (%)**
				52,73	
mar/07	29,2	126,8	42,10		18,43
apr/07	21,87	46,7	82,89		23,14
may/07	20,17	115,3	32,02		24,61
jun/07	20,85	244,1	15,13		24,01
jul/07	19,88	49,8	73,09		24,88
aug/07	31,08	138,7	41,01		17,49
sep/07	15,17	161,5	16,63		30,28
oct/07	25,21	114,8	40,19		20,71
nov/07	13,09	129,0	17,96		33,48
dec/07	42,50	64,5	120,55		13,42
jan/08	27,48	76,0	66,21		19,33

The watershed monitored in São Vicente has an area of 266.50 hectares. In the period of measuring the flow analysis, the highest total rainfall was recorded in the month of March and presented as value 266.5 mm month-1, the peak flow occurred in November, with a value of 47.07 Ls^{-1}. The correlation between the monthly values of flow rate and total rainfall was low not allowing an analysis in this direction.
For index, as noted in the table below, the index had low flow in most months, ranging between 1.83 and 42.20% indicating that most of the rain water does not result in discharge. Beyond the capacity of water is reduced, there is a not good distribution of flow between the dry and wet periods of the year, which can be verified by the value of the index of seasonality of 18.25%. The higher water availability was in February (85.29%) and lowest in November (20.42%).

Table 3 - Indices for assessing the hydrological intervention in vegetation cover performed.

Month	Average Flux/month (Ls^{-1})	PRP ($mm\ month^{-1}$)	IE (%)	IS (%)	ID (%)
				18,25	
feb/07	2,1	102,6	1,83		85,29
mar/07	18,01	266,5	6,74		40,15
apr/07	2,88	51,8	5,37		80,74
may/07	3,01	109,9	2,73		80,03
jun/07	7,79	218,7	3,44		60,80
jul/07	11,98	129,3	9,24		50,22
aug/07	3,78	100,6	3,75		76,18
sep/07	8,17	166,9	4,73		59,65
oct/07	5,35	120,7	4,42		69,32
nov/07	47,07	107,7	42,20		20,42
dec/07	5,02	120,7	5,26		70,64
jan/08	10,96	90,2	12,12		52,44

From the data cited show that the forest cover, including the eucalyptus, tends to increase the capacity of infiltration water in the soil, which contributes to the reduction of runoff in areas occupied by the crop. Thus, although a replacement of pasture by eucalyptus will represent an increasing losses of water by evapotranspiration and a consequent reduction in the average specific discharge of long duration, the minimum impact on the flow and consequently on the capacity of sediment should the analysis of some additional aspects.

Increased infiltration of water in the soil, by the increased protection of soil against the undesirable effect of the sealing surface and the formation of biological channels that favor the infiltration of water into the soil and the tendency of reduction of soil moisture at the time of rainfall will promote the reduction of runoff and sediment production, reducing the maximum flow rate of runoff.

It is important to mention that in the sections considered in this study, the individualization of runoff and underground drainage found that the first was always above 50%.

Thus, the significant volume of additional defendant in the eucalyptus evapotranspiration will be coming from this portion of the runoff will be converted to infiltration and thus the forest cover should be an important factor in increasing the proportion of precipitation converted to infiltration , which will reduce the portion of the flow of the river which will be linked to direct runoff. This behavior should promote, even increasing the amount of losses by percolation, which are those effectively forming of minimum flows, behavior characteristic of native forest areas with blankets, which are seen, usually long-term average flow rates lower, but also, a lower range of flow rates, resulting in a reduction of maximum flow and increased flow rates during periods of drought.

The basin of the baixo Jacuí presents between microbasins analyzed IS quite contrasting values, showing that in some areas of the basin, there is monthly average flow values of the contrasts between wet and dry months (IS <5%), on the other hand other areas have average monthly flows settled during the year (IS> 30%).

4. REFERENCES

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