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ICREW Report

Analyzing Sôr River Campaign data

2005/03/01

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	ICREW Report		
	Report nº3		
DATE :	**1/Mar/2005**	**IST Project Number:**	**20EITP0803**
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ABSTRACT

Field campaign data obtained during the first year of the ICReW project is analyzed and compared to historical data present in INAG database.

All values seam to follow the same tendency shown for the average of all rivers present in INAG database.

An average loading for the reservoir of 22 tons of total phosphorous and 98 tons of total nitrogen was estimated from historical flow and quality values.

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1 Analysis of Sôr river field campaign data

The monitoring program for Montargil reservoir and Sôr River are an important part of the ICReW project. Sôr River drains most of the watershed that discharges in Montargil Reservoir, contributing with 65% of total flow to the reservoir.

At the beginning of the project 10 sampling locations, on both river and reservoir, where selected. Initially 6 monitoring where located in the watershed, all at locations upstream from the reservoir, *Figure 1.1-1*.

Analysis on point R1 where dropped due to access difficulties for this point.

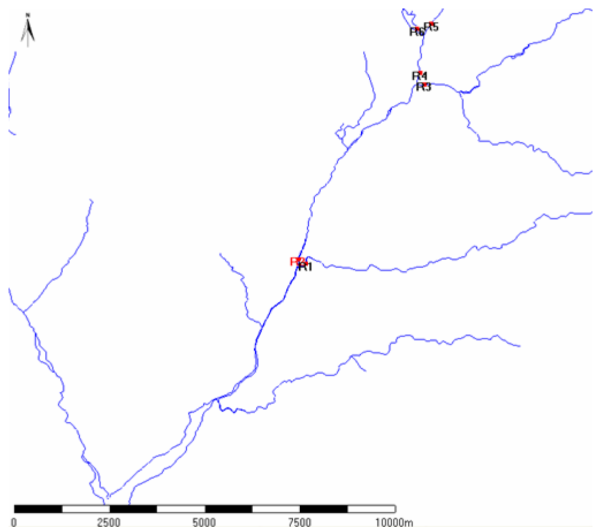

Figure 1.1-1 – Watershed sampling sites

On the remaining points and with the joint effort of three laboratories (IST, IA and INSA), the parameters in *Table 1* were monitored bimonthly since July 2003.

Table 1 – ICReW collected data

Chemical/Physical Parameters		Biological Parameters
Total Nitrogen	Dissolved Oxygen	Chlorophyll-a
Ammonium	Oxidability	Pheopigments
Nitrates	CBO_5	Microcystins
Phosphates	CQO	Coliform Bacteria
Total phosphorous	pH	E. Coli
Total suspended solids	Temperature	
Turbidity		

The National water institute (INAG) water quality monitoring plan also monitors the Sôr River watershed. A fixed automatic station referenced as “Moinho Novo” is located close to point R2. This station is a active since March 2001 and monitors the parameters described in *Table 2*.

Table 2 - Moinho Novo automatic station data

Parameters	
pH	Dissolved Oxygen
Conductivity	Turbidity

INAG's national water quality monitoring program also includes monthly sampling at this point for the parameters in *Table 3* since November 1999.

Table 3 – INAG collected data

Physical/Chemical Parameters		Biological Parameters
Total Phosphorous	Orthophosphate	Fecal streptococcus
pH	Nitrate	Total Coliforms
Suspended Solids	Nitrite	Fecal Coliforms
Ammonium	Oxidability	Chlorophyll-a
Dissolved Oxygen	Temperature	
QOD		

1.1 Nutrients

1.1.1 Phosphorous

Data available at the INAG water quality database for "Moinho Novo" has an average concentration of $0.6[mgP/l]$, with a maximum value of $3.8[mgP/l]$.

This doubles what was registered during ICReW campaigns, an average value of about $0.3[mgP/l]$ and $0.7[mgP/l]$ maximum.

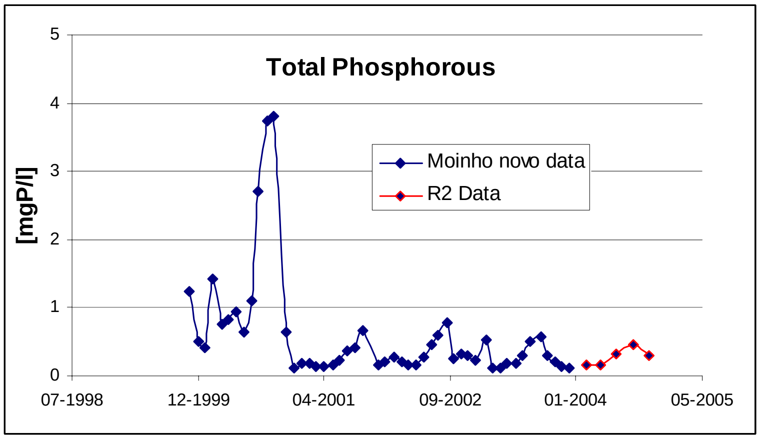

Figure 1.1-1 - Total phosphorous variations in Moinho Novo station and R2 sampling points

$0.54[mgP/l]$ is the national average for streams, calculated from all values present in INAG database.

Data collected by INAG after 2000 is significantly similar to values recorded during the ICReW monitoring program, *Figure 1.1-1*.

The values that caused INAG average to rise were all registered before 2000. If only data collected after this year is considered, the average value drops to the same recorded in ICREW sampling.

The higher concentration values are recorded around August, when precipitation values reach their minimum. Apparently total phosphorous concentrations increase during months with a low flow regime *Figure 1.1-2*. This figure was obtained with a moving average with a monthly period for available phosphorous data (200-2004), and historical flow values (1980-1990). This event is also noticed for most streams registered in the INAG database.

One explanation for this event could be the release of phosphorous trapped in the river bed under organic forms. This supply of phosphorous is often referred to as internal pool, and under certain conditions can release mineralized nutrients such as phosphorous to the water column. This combined with a low flow regime would increase the total phosphorous values in the water column due to the increase of orthophosphate (dissolved phosphorous).

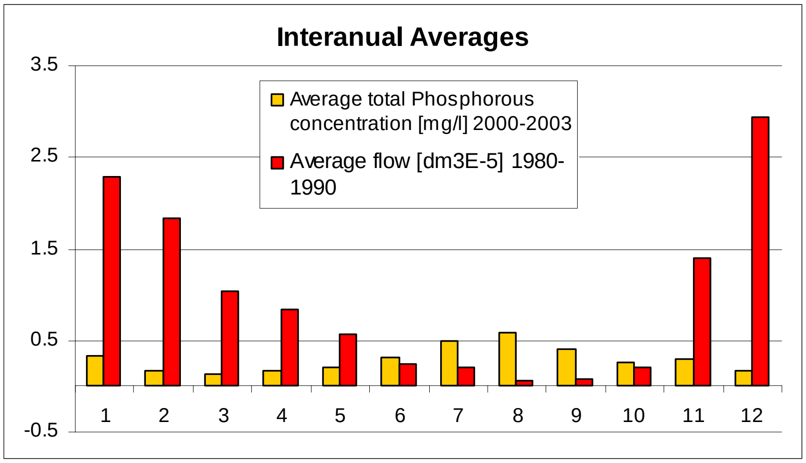

Figure 1.1-2 - Average Monthly flow at Moinho Novo (data from 1980-1990) and Monthly average phosphorous concentration (2000-2004)

Discharges from point sources are another possible explanation. During summer months phosphorous discharges from point sources remain the same has during winter months. On the other hand loadings from diffuse sources tend to diminish, since no surface runoff is produced due to low precipitations. If less water exists in the river the same discharge from point sources will produce a higher concentration.

This would highlight the importance of point sources has an input of phosphorous to the reservoir during summer months. Most of the phosphorous that could reach the reservoir under these conditions would have a point source.

Bibliography describes the major source for phosphorus in a river the discharges produced from precipitation. After reaching the soil, par of rainfall is be converted to overland flow, dragging phosphorous or sediments that contain phosphorous in the soil to the nearest stream.

Apparently the described increase of phosphorous concentrations during summer months seams incompatible with what is described in the bibliography. However if total phosphorous mass that passes trough “Moinho Novo” is calculated, using mobile averages with a monthly period of both flow and concentration, *Figure 1.1-3*, we can verify that the increase of concentration during summer moths isn’t enough to compensate the low flow regime that occurs.

The monthly average loading of total phosphorous that pass trough “Moinho Novo” increase with the flow regime *Figure 1.1-3*, pointing out the importance of diffuse pollution in this system.

More phosphorous will reach the reservoir during the winter months. According to this data an average of about $23[t]$ of total phosphorous will reach the reservoir every year.

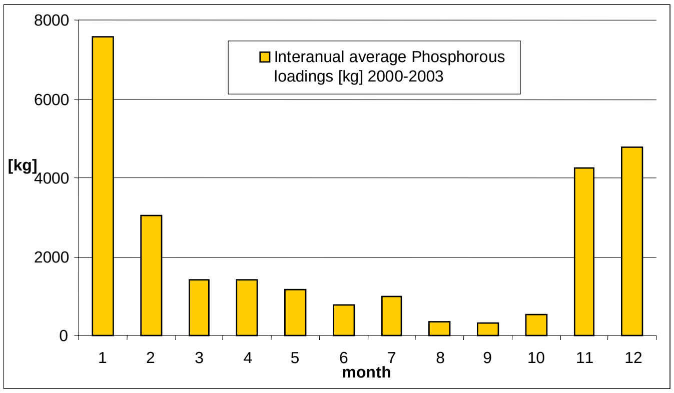

Figure 1.1-3 – Monthly moving averages for phosphorous mass at Moinho Novo (2000-2004)

The remaining points monitored in the watershed (R3 – R6), didn't quite follow the same tendency for increasing concentrations during low flows, *Figure 1.1-4*.

Unfortunately only 6 samples exist so far for each of these sites, making it difficult to estimate if this is a real tendency or just an exception.

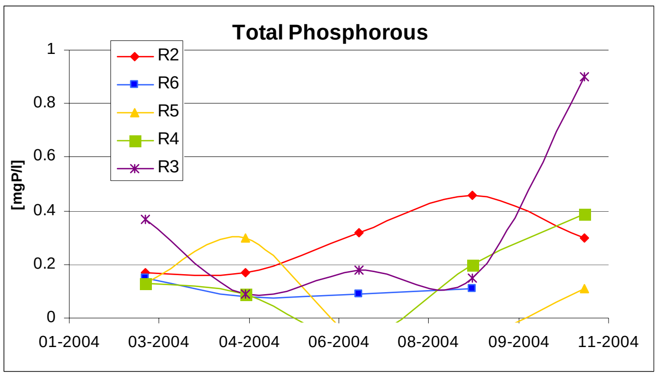

Figure 1.1-4 - Total phosphorous variations at ICReW sampling points

A small dam exists at point R4 creating a small reservoir extending all the way to R5.. The low concentration values obtained during spring time at these points *Figure 1.1-4* (below detection limit) may be related with the different characteristics of a reservoir system. During spring higher algal production associated with the higher residence time will consume all the available phosphorus.

Point R3 and R6 are of special importance since they control significant sub-basins with important point sources. No correlation to stream flow seams evident at any of these points. Further sampling must be carried out before significant conclusions can be draw.

Dissolved phosphorous variations at "Moinho Novo" and R2 follow the same tendency has total phosphorous *Figure 1.1-5* and *Figure 1.1-2*. Months with low precipitations and consequently low flow experience the higher concentrations *Figure 1.1-5*.

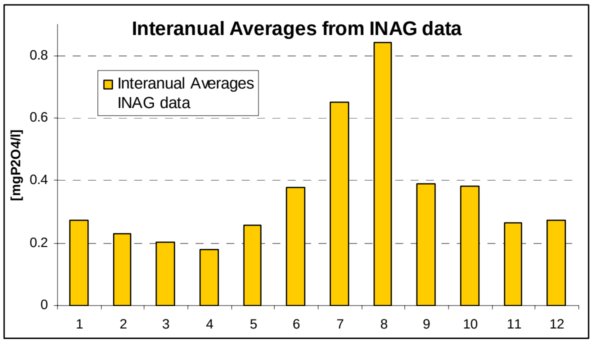

Figure 1.1-5 – Monthly moving averages for orthophosphate variations at Moinho Novo (2000-2004)

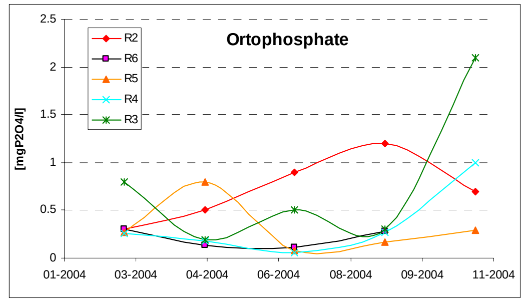

Figure 1.1-6 - Orthophosphate variations at ICReW sampling points

In average, orthophosphate levels account for 38% of total Phosphorous levels. However no clear patter for this percentage is recognized.

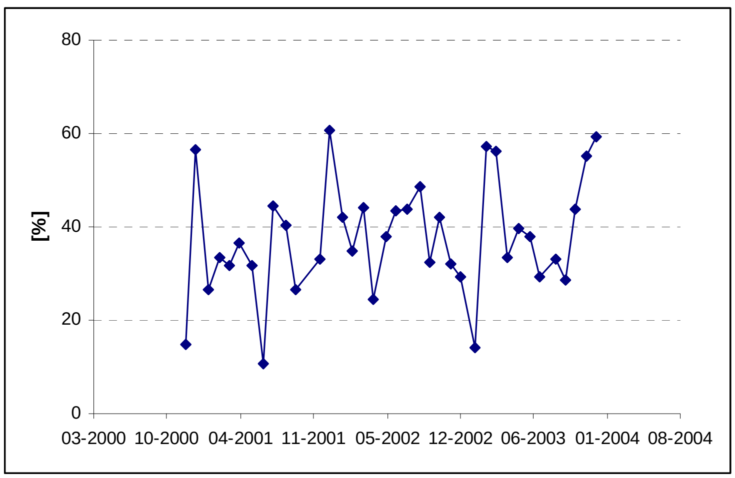

Figure 1.1-7 - Percentage of Orthophosphate in Total phosphorous

At the remaining ICReW sampling points, *Figure 1.1-6*, a pattern very similar to what was registered for total phosphorous was obtained, *Figure 1.1-4* . Once again no clear variation for orthophosphate percentage in total phosphorous was recognized.

1.1.2 Nitrogen

Data available at the INAG water quality database doesn't contain any values for total Nitrogen or Kjeldhal Nitrogen at "Moinho Novo" station. Only Nitrate and Ammonia were monitored.

An average concentration of $4.1\left[mgN0_3/l\right]$ is recorded in INAG data from 1999 to 2003 about the same has the average value recorded during ICReW campaigns at R2, $5.1\left[mgNO_3/l\right]$. Unlike phosphorous there is no clear patter for concentration variations for Nitrate with the flow regimes. Nitrate concentrations seam to show some inertia, characterized by small variations year long.

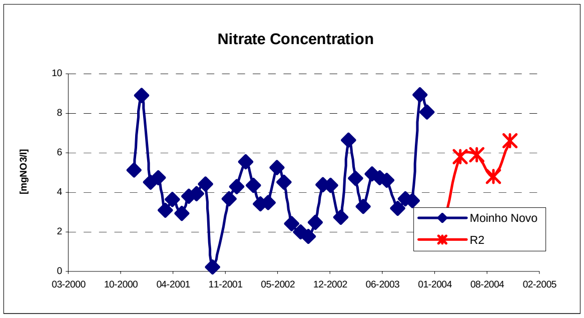

Figure 1.1-8 - Nitrate variations at Moinho Novo and R2

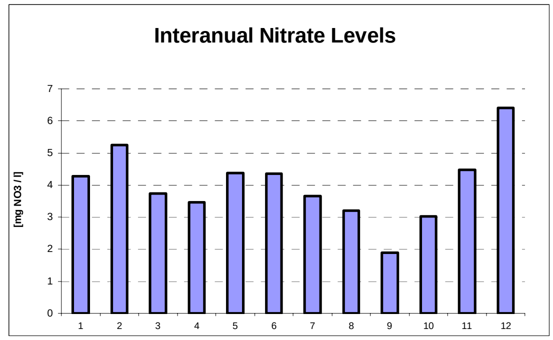

Figure 1.1-9 - Monthly moving averages for Nitrate at "Moinho Novo" (2000-2004)

The remaining ICReW sampling points weren't too different from each other *Figure 1.1-10*. Point R3 registered a very high concentration for of Nitrate at October 2004, a behavior similar to what had happened for the total Phosphorous concentration.

All points except R2 had a clear decrease during early spring months recovering towards the end of summer. This decrease is also present in historical data *Figure 1.1-9* and should be related to the increase of primary productions during these months.

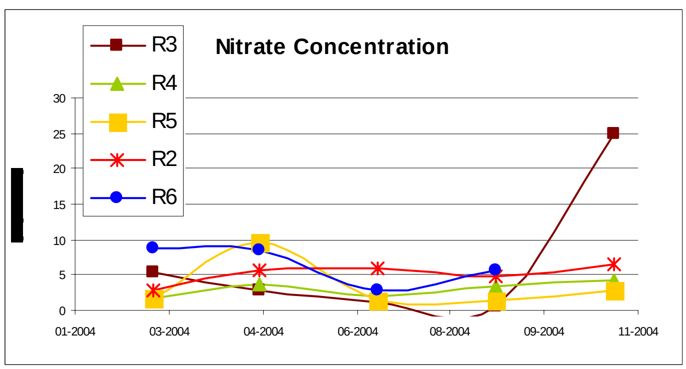

Figure 1.1-10 – Nitrate Variations for ICReW sampling points

For Ammonium variations at "Moinho Novo" and R2, a clear relation with the flow regime can be seen from both monthly moving averages, and time series variations *Figure 1.1-11* and *Figure 1.1-12*.

Once again these variations could re related to the mineralization of organic forms of Nitrogen trapped in the river's internal pool (see *1.1.1 - Phosphorous*). This associated with a low flow regime will increase ammonia concentration during (spring - summer) months.

Ammonium is the first inorganic form of Nitrogen to be used by most primary producers, decreasing its life span in natural waters. This makes ammonium a good indicator of point sources contamination.

Wastewater treatment plants discharge most nitrogen under the form of ammonium, so a high concentration of ammonium is an indicator that a point source may be near by.

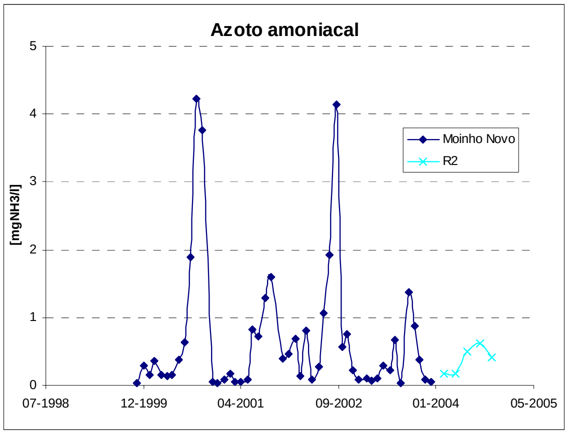

Figure 1.1-11 - Ammonium Variation at Moinho Novo and R2

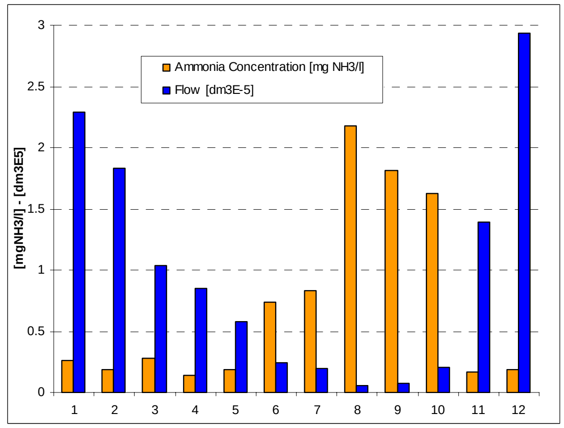

Figure 1.1-12 - Monthly moving averages for Ammonium (2000-2004) and Flow (1980-1990)

The proximity to “Ponte Sôr” wastewater treatment plant, the largest in the watershed with 7000 equivalent inhabitants, could be another explanation for these variations.

The ammonium discharged from this treatment plant should remain constant year round. The same discharge will produce a higher concentration during low flow regimes due to less dilution.

All other monitored points show very low concentrations of ammonium, but once again point R3 shows anomaly high values for October *Figure 1.1-13* - Ammonium variations at ICReW sampling points.

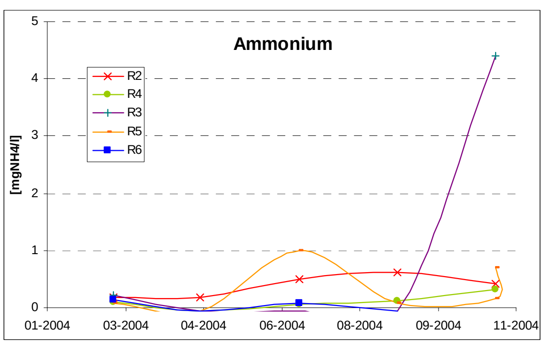

Figure 1.1-13 - Ammonium variations at ICReW sampling points

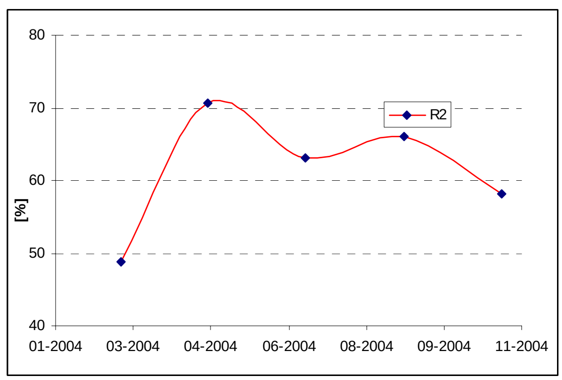

Figure 1.1-14 - Percentage of mineral Nitrogen in total Nitrogen at R2

For ICReW data, an analysis can be made for the percentage of mineral forms of nitrogen in total Nitrogen. For point R2 (*Figure 1.1-14*), the annual average is about 61%, for the remaining sampling points the average value varies from 46% in point R3 to 63% in R6.

If the percentage calculated from ICReW data is applied to INAG historical data, an average of 98 tons of Nitrogen are expected to reach the reservoir every year.

1.2 Chlorophyll-a

Even in a river system, characterized by short residence time, an increase in chlorophyll-a concentration during summer months is expected.

This event is present in both data from "Moinho Novo" and R2 monitoring point *Figure 1.2-1*.

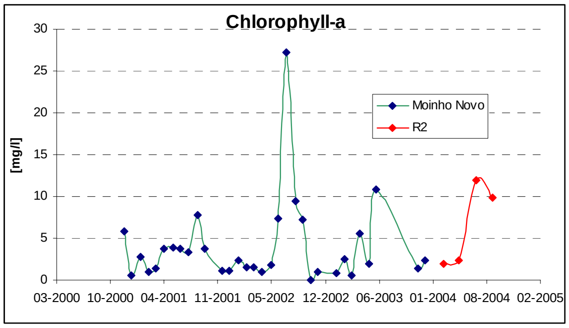

Figure 1.2-1 - Chlorophyll-a variation at Moinho Novo and R2

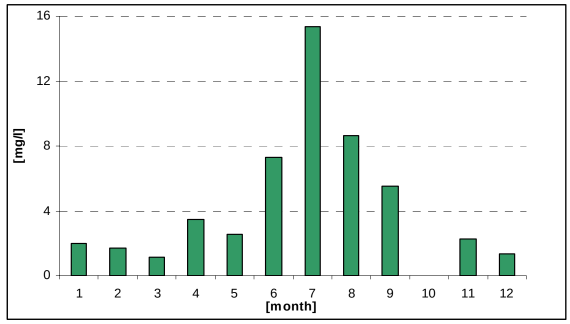

Figure 1.2-2 – Monthly moving averages for Chlorophyll-a at Moinho Novo (2000-2004)

Looking at moving averages *Figure 1.2-2*, the higher concentrations occur in July. A single "bloom" event that occurred in 2002 with a concentration of $27[mg/l]$ is responsible for this. Discarding this value the monthly average for July drops to $3.4[mg/l]$, less than August.

For ICReW sampling points *Figure 1.2-3*, the reservoir like behavior of monitoring points R4 and R5 is once again verified

The fact that monitoring points R4 and R5 are located inside the small reservoir described in *1.1 - Phosphorous* can be significantly responsible for the differences between monitoring point curves in *Figure 1.2-3*. During summer months, the higher residence time and associated temperature and radiation conditions are more suitable for the biological processes of algal growth, originating higher chlorophyll-a concentrations.

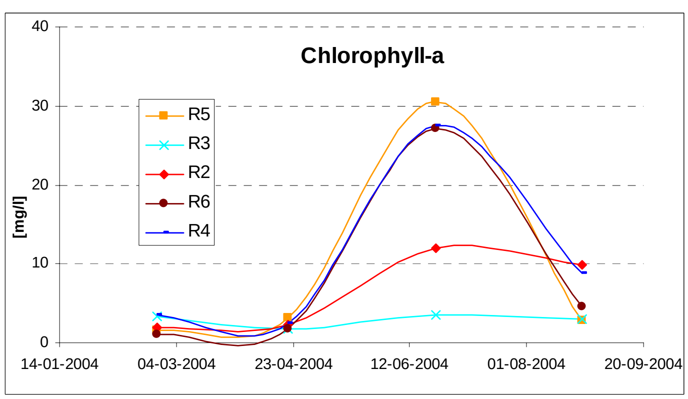

Figure 1.2-3 - Chlorophyll-a variation at ICReW sampling points

1.3 Bacterial Indicators

The monthly moving average for "Moinho Novo" historical data on bacterial indicators, show an increase for October and November, coinciding with the beginning of the rain season.

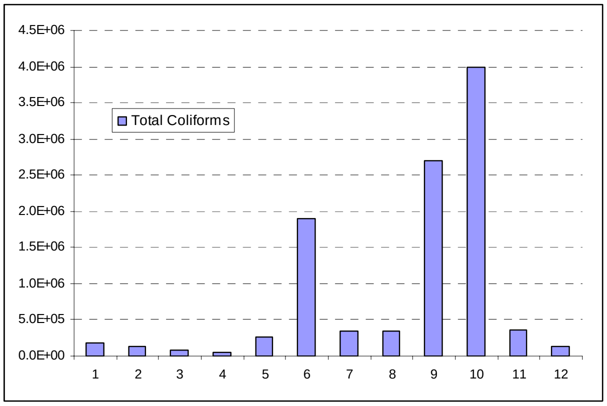

Figure 1.3-1 - Total Coliforms monthly moving averages (200-2004)

The same patterns can be verified for ICReW sampling, for both total Coliforms and E. Coli.

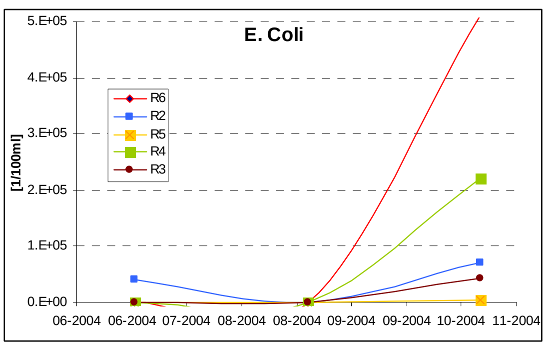

Figure 1.3-2 - ICReW sampling E. Coli

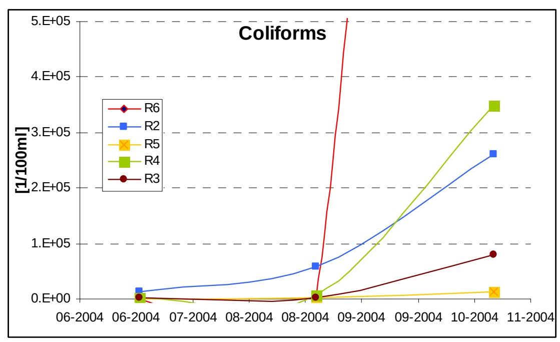

Figure 1.3-3 - ICReW sampling Coliforms