Carbon dynamics in a medium-size semiarid basin: The Suquia River, Cordoba (Argentina)

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This contribution deals with the dynamics and sources of carbon in a medium-size drainage basin from the Pampean Ranges in Central Argentina. The drainage basin has nearly pristine headwaters, and is variably affected by human impacts along its way towards an endorreic saline lake (Mar Chiquita).

The Suquía River system (Fig. 1) is located in central Argentina (31°S, 63°W). Its drainage area reaches 7,700 km^2 of which over 42 % are accounted for by its headwaters. The mountainous portion (800 to 2000 m a.s.l.) of the drainage feeds a reservoir lake (San Roque), which is presently the main source of water for consumption in the city of Córdoba (*c.* 1.3 million inhabitants). Mean rainfall is 750–900 mm y^{-1}. and mean discharge leaving the reservoir lake is 9.6 m^3 s^{-1}. Mean discharges of diverse tributaries (i.e. San Antonio, Cosquín, Las Mojarras, and Los Chorrillos) entering the reservoir fluctuate between 1 and 3 m^{3}s^{-1}.

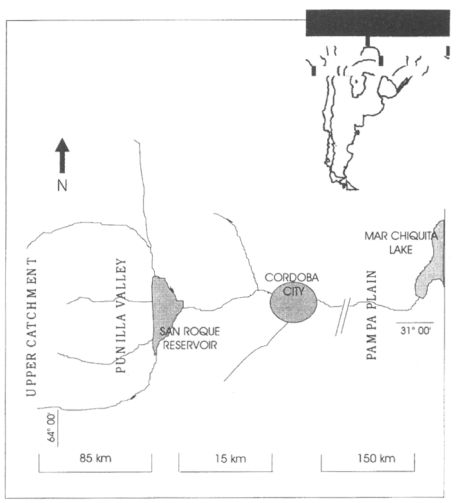

FIG. 1. Location map of the Suquia river system in Argentina.

Figure 2 shows the spatial and seasonal variability of the mean concentration of dissolved inorganic and organic carbon(DIC and DOC), particulate organic carbon (POC) and the C/N ratio in the different environments of the Suquía River basin. The figure exhibits that the lowest DIC concentrations are present in the upper catchment stations (< 10 mg l^{-1}). DIC results entirely from soil and atmospheric CO_2 through the igneous and metamorphic rock weathering. Conversely, the highest DIC concentrations are

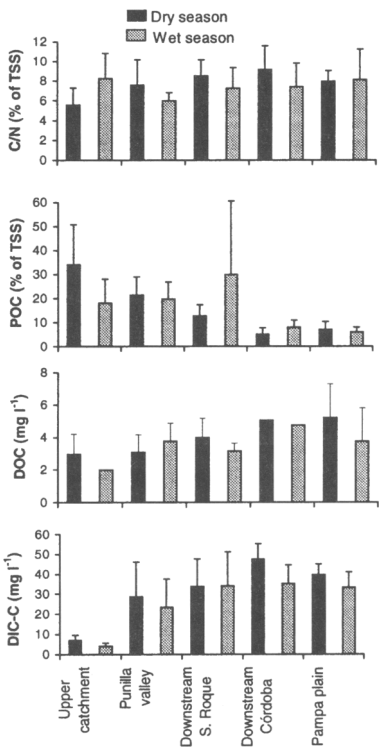

FIG. 2. Spatial and temporal variation of DIC, DOC, POC and C/N ratios in the differents environments of the Suquía River basin.

found downstream the city of Córdoba (~42 mg l^{-1}). In this stretch, the river affects the groundwater, determining that solutes provided by means of two sources: La Cañada creek (a polluted stream that cross the city) and non-point and point anthropogenic effluents. In this stretch during the low water period, the carbon input through primary respiration could represent up to 10% of the total DIC (Gaiero, 1995). The importance of organic matter respiration after the city is also pointed out by the significant correlation between oxygen saturation index (O_2 sat.) and P_{CO_2} ($r = -0.64$; $p > 90\%$). DIC concentration exhibited the higher concentrations during the dry winter period (groundwater contributions) in contrast to what is shown during summer (wet period) where the flow increases and the dilution processes are more important. However, the reservoir-regulated flow, clearly interrupts this pattern allowing the DIC seasonal concentration to remain comparatively invariable after the lake. The relatively high DIC concentration present in other environments of the basin (mean value of 30 mg l^{-1}), are mainly supplied through the groundwater dissolution of carbonate minerals from the crystalline basement, in Tertiary sedimentary rocks (Punilla valley) and in Cretaceous sandstones (downstream the dam). Moreover, some of the tributaries that dissect the Punilla valley and finally reach the lake have high calcite saturation index. This situation promotes that, due to the continuos increase of the lake eutrophication and especially in the shallow areas, carbonate precipitates. As a first approximation, the mechanism retains 56 gr. m^{-2} y^{-1} (890 t y^{-1}) of the inorganic carbon produced by the upper catchment.

In the Suquia basin, DOC concentrations showed a similar spatial pattern compared to DIC variations. This is more noticeable during the high discharge period, where DIC and DOC showed a significant correlation ($r = 089$; $p > 95\%$) indicating that a similar mechanism control their sources and circulation. Further, the spatial variation showed that, opposite to DIC, downstream the city of Córdoba (at the Pampa plains stations) DOC supplied by groundwater increases its concentration during the dry period, a likely response to the presence of the loess mantle and to the humus-rich soils. Only the Punilla Valley stations have shown DOC increasing its concentrations during summer time in concordance with an increase of the temporary human population due to tourist activity. Downstream the dam and during the high water discharge, temporal DOC concentrations showed a sharp decrease probably due to its consumption within the reservoir. Nevertheless, in the year round balance we calculated that the reservoir behaves as a source of DOC supplying about 76 tons of dissolved organic carbon per year (4.7 gr m^{-2} y^{-1}).

The spatial and temporal POC variation exhibited a completely different pattern, compared to DIC and DOC fluctuations. The highest POC values were found at the upper catchment stations where the total suspended matter (TSS) showed its minimum concentrations. With the exception of the stations located downstream the San Roque dam and Córdoba city, POC temporal variability has shown higher concentrations during the low discharge period in agreement with the fact that POC correlates inversely with TSS (Ittekkot and Laane, 1991). As can be seen in Fig. 2 during summer time, when there are algae blooms and the reservoir evacuates the water upper layer through the spill outlet, POC concentrations reach the highest percentage of TSS of the whole basin. Using C/N ratios of POC to characterise the origin of the organic debris in the Suquía basin, these figures suggest that the material is supplied by both eroded soil humus and fitoplanktonic sources. They are supplied in different ways depending not only from seasonal deviation but also from environmental control. The significant ($p > 95\%$) inverse correlation between POC, O_2 saturation index and P_{CO_2} during low water stage, could suggest that a large proportion of the particulate carbon is labile in nature. The average relative abundance of labile carbon (i.e. particulate carbohydrates + particulate amino acids) in POC suggest that almost 30% of the particulate organic carbon is supplied by fresh biological material.

Finally, the total carbon exported annually from the Suquía catchment to the Mar Chiquita Lake can be estimated in $15x10^3$ t y^{-1} (2,0 gr. m^{-2} y^{-1}) of which 92% correspond to DIC, 6% to DOC and only 2% to POC. The northernmost portion of the Punilla valley in the upper catchment, supplies more than 50% of the total DIC produced by streams that cross Tertiary sedimentary rocks rich in carbonates minerals. In the lower basin and downstream the city of Córdoba a high proportion of the total DIC is supplied by anthropogenic sources.

References

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