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Investigating the influence of rice crop irrigation on streamflow in the Ibicui river basin using trend analyses

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Problems of water shortages and floods are often attributed to the damming of rivers, agriculture, mining, deforestation, forestry, urbanization, and other practices. In the south of Brazil, most river basins experience water deficit problems related to the indiscriminate use of water to irrigate rice. We present a statistical analysis of streamflow data of the Ibicuí Basin, to verify if there are significant trends in water availability related to the withdrawal of water for rice crop irrigation. The Ibicuí basin, located in the southwest of the state of Rio Grande do Sul, Brazil, has ∼50,000 km2 drainage area. It is part of the Uruguai basin, and is characteristic of the Pampa biome. This analysis is based on twelve stream gauge stations with data covering the period of rice cultivation between 1970 and 2011.

Records of daily flow data were standardized by subtracting the long-term monthly mean and then dividing by the long-term monthly standard deviation. Then for each month we calculated the flow for 50%, 60%, 70%, 80%, 90%, 95% and 99% duration. Trends in these series were assessed using Mann Kendall test. The results showed that there are trends of increasing discharge for nine of the twelve analyzed stations, and in six of those nine stations, the increasing trend was statistically significant. Just three stations presented negative trends. The result for six stations that streamflow is increasing is surprising, because historically it has been assumed that there are deficits of water due to major withdrawals for rice irrigation during the growing season of the crop. River discharges are typically low in this withdrawal period of November to February, although precipitation is similar for all months of the year. Also, some studies using physical models have confirmed the impact of irrigation withdrawals on flow. But the decrease in flow due to irrigation withdrawals was not supported with this statistical analysis. However, analyzing the trend values for several time flow durations, it was observed that there was a reduction of the trends with the duration. Only two stations presented increasing trends with duration. Also, it could be verified that in a river with sequential stations, the trends showed that the Mann Kendall Zs decreased with irrigated area. For verifying if it is possible to see the difference with water withdrawals for irrigation of rice, the station that showed the highest increasing trend was chosen for simulating an increasing water withdrawal on up to 5% of the area in 2011. In this analysis, despite the simulated water withdrawals in this basin, the trend of the water flow was still increasing. However, comparing the current situation to one without water withdrawal for irrigation of rice, the increasing trend was lower with the corresponding Mann-Kendall Z value reduced by half. We conclude that for the Ibicuí Basin comparison of trends in the flow data does not clearly reflect the effect of water withdrawals for irrigation of rice.