The effect of water transposition on the quality of water in a tropical reservoir, São Paulo – Brazil

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ABSTRACT

The aim of the present study is to analyze the influence of water transposition from Rio Grande System on the quality of water in Taiçupeba Reservoir, Suzano city, SP. Water samples were collected every two months for one year (from June 2016 to April 2017) in four sampling spots. Physical, chemical and biological water analyses were carried out; Water Quality and Trophic State indices were also applied. There was influence of water transposition from Rio Grande System on the quality of the water in Taiaçupeba Reservoir throughout the assessed period. The quality of the water was similar in all sampling spots, except for P3, which recorded the worst results. Point 3 was located in an urbanized zone of Taiaçupeba sub-basin; therefore, it is likely that the worse water quality in this spot has resulted from contamination by domestic sewage. It is recommended to carry out further studies based on longer sampling period in the same environment.

Keywords: Water quality index. trophic state index. land use and occupation.

RESUMO

O objetivo do trabalho foi analisar a influência da transposição das águas do Sistema Rio Grande na qualidade da água do Reservatório Taiaçupeba, Suzano, SP. As amostras da água foram obtidas bimestralmente durante 1 ano (junho/2016 a abril/2017) em quatro pontos de coleta. Foram realizadas análises físico, química e biológica da água e aplicado os Índices de Qualidade de Água e de Estado Trófico. Durante o período de estudo, não se observou a influência da transposição das águas do Sistema Rio Grande na qualidade da água do reservatório Taiaçupeba. A qualidade da água mostrou-se semelhante em todos os pontos amostrados, exceto no ponto P3 que se mostrou inferior. O ponto 3 está localizado em uma área urbanizada da sub-bacia Taiaçupeba e, provavelmente, a qualidade inferior da água se deve a contaminação por esgotos domésticos. Recomenda-se que sejam realizados estudos posteriores que contemplem um maior período de amostragem nestes ambientes.

Palavras-chave: *índice de qualidade da água. índice de estado trófico. uso e ocupação da terra.*

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1 Introduction

Water transposition has been performed by many countries to, overall, implement actions to boost regional development and to improve the quality of life of the population (SHAO; WANG; WANG, 2003; MATSUZAKI, 2007).

Water transposition projects in Brazil are related to public supply and to agricultural irrigation. The most known water transposition case in Brazil is the one referring to São Francisco River, which aims at solving the water shortage issue in the semi-arid region by transferring its water to streams and smaller rivers in the Northeastern region in order to mitigate the effects of drought seasons (MATSUZAKI, 2007).

Most large scale water transposition cases in the Metropolitan Region of São Paulo City, known as *RMSP,* such as Cantareira System, have aimed at public supply. This system transposes water from Alto Piracicaba River to Alto Tietê River basin, which is the main RMSP water supply resource, since it produces approximately 33.0 $m^3.s^{-1}$ – it accounts for almost 74% of the total of consumed water (CBH-AT, 2014).

RMSP is the biggest economic center in Brazil, besides being the biggest urban population agglomeration in the country and one of the biggest in the world. It covers 39 counties and houses almost 20 million inhabitants. This region has seven times less water per inhabitant than UN's recommendations for critical cases (WHATELY; DINIZ, 2009). It would be necessary to have eight water producer systems, with nominal capacity of 68.2 $m^3.s^{-1}$ (or 5.8 billion liters of water a day) to fulfill the current water supply demand. The quality of the water produced to local supply in the region was quite close to the water availability in the existing resources, and it puts the region at risk in times of prolonged rain shortage, such as in 2014. The drought season goes from April to September, at this time of the year monthly rainfall rates were lower than 100mm back in 2014, and drought lasted up to October of the same year, when the rainfall rate was 75% lower than the historical average recorded for this period (CETESB, 2015).

Gross water transposition from Rio Grande System to Taiaçupeba System – Alto Tietê System – was one of the ways found to mitigate water shortage in RMSP back in 2014. However, the water transfer from one waterbody to another may not be compatible in ecologic and sanitation terms. This process can introduce features intrinsic to a certain medium in a new one, mainly the ones of biological and chemical nature (GODOY, 2000; SHAO; WANG; WANG, 2003; MATSUZAKI, 2007).

The limnological characteristics of a given waterbody can be assessed through physical, chemical and biological water analyses and through water quality indices such as Water Quality Index (WQI) and Trophic State Index (TSI). WQI was created in the United States and adapted by CETESB. It was developed to assess the quality of gross water, with emphasis on its use for public supply. This index is calculated based on nine parameters that, in most cases, are indicators of contamination caused by domestic sewage discharge.

TSI aims at classifying waterbodies at different trophic degrees. Results in this index are calculated based on phosphorus and Chlorophyll-a values. Phosphorus evaluations must be understood as mean eutrophication potential, since this nutrient works as the agent causing the eutrophication process. On the other hand, Chlorophyll-a evaluations must be considered as waterbody response measure to the causing agent; therefore, it properly indicates the growing rates of algae and cyanobacteria in water (BARRETO *et al.,* 2013)

With respect to the trophic degree in Rio Grande and Taiaçupeba reservoirs, it is important highlighting that Rio Grande System presented worse water quality than water from Taiaçupeba back in 2015. Rio Grande water was classified as 'mesotrophic' in this same year, it recorded total phosphorus concentration higher than that observed for Taiaçupeba (CETESB, 2015). Moreover, it is important having in mind that high concentrations of this variable can lead to waterbody eutrophication and to high cyanobacteria growth, which are toxic in up to 70% of the cases.

Thus, the hypothesis advocated in the present study lied on the assumption that water transposition from Rio Grande System to Taiaçupeba Reservoir would increase nitrogen and phosphorus concentrations in water, which, in its turn, would rise water trophic degree and, consequently, compromise the use of water provided by this system to the population. The aim of the present study was to analyze the influence of water transposition from Rio Grande System on the quality of the water in Taiaçupeba Reservoir – Alto Tietê System, Suzano, SP.

2 Materials and methods

2.1 Study site description

The study was carried out in both Rio Grande System and Taiaçupeba Reservoir - Alto Tietê System. Rio Grande System is located in Alto Tietê System (Figure 1), Southern Metropolitan Region of São Paulo (23° 46′ S and 46° 32′W), altitude 746 m. The total area of the system covers 7.4 Km^2; its volume is 116 $x10^6$ m^3 and mean depth is 5.5 m. Rio Grande System is an arm of Billings Reservoir (Rio Grande Arm), which was intercepted by Anchieta Dam construction – the eutrophic water from the main body in Billings Reservoir became totally independent from the rest of the system. Billings is the biggest water reservoir in the Metropolitan Region of São Paulo; it covers 120 km^2 and has maximum volume of 1.2 billion m^3.

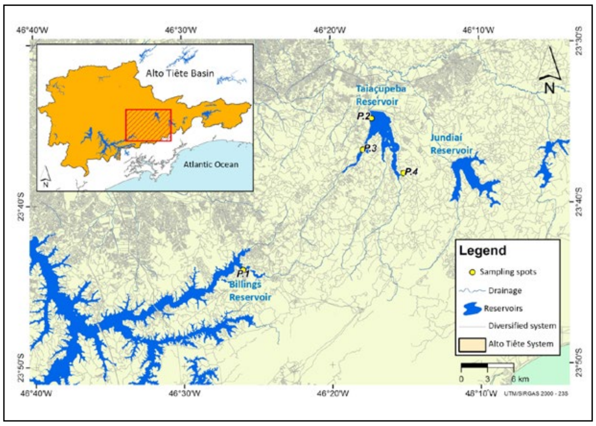
Rio Grande System accounts for supplying 1.2 million people in Diadema, São Bernardo do Campo and Santo André counties. Besides supplying the local population, this reservoir is also used for different leisure activities such as water sports, swimming and fishing, as well as is receptor of industrial and domestic waste coming from Ribeirão Pires city and from underground networks. When it comes to land use and occupation, this city is featured by great contrasts between leisure sites, and irregular and underground allotments (CETESB, 2014; NISHIMURA; MOSCHINI-CARLOS; POMPÊO, 2015).

Taiaçupeba Reservoir is located in Alto Tietê Basin (Figure 1), Southwestern Metropolitan Region of São Paulo (23° 34′S and 46° 17′W), between Suzano and Mogi das Cruzes counties, SP - altitude 750 m. It presents flood area of 19.36 km^2, useful volume of $85.2x10^6$ m^3 and mean depth of 5.5 m. Its drainage area covers approximately 234 km^2, and its main tributaries are Taiaçupeba-Mirim and Taiaçupeba-Açú rivers, and Balainho Brook (CETESB, 2014). Taiaçupeba reservoir belongs to Alto Tietê Producer System, known as SPAT, which accounts for 15% of the total water supply in Western Metropolitan Region of São Paulo. The area surrounding the reservoir is mainly featured by irregular houses, small farms and crop areas.

2.2 Sample collection and limnological analyses

Sampling was carried out every two months for one year (from June 2016 to April 2014) in four sampling spots: P1 – water capture spot in Billings Reservoir, which is an arm of Rio Grande, coordinates (-23.735174, -46.433576); P2 – SABESP's sampling station in Taiaçupeba Reservoir, Coordinates (-23.584288, -46.288023); P3 – Taiaçupeba Mirim River, before the water inflow spot in Taiaçupeba Reservoir, coordinates (-23.611824, -46297645); and P4 – water inflow spot in Jundiaí Reservoir, coordinates (-23.637520, -46.252807) (Figure 1). Sampling spots were delimited by a global satellite positioning system (GPSMAP 76CS/Garmin).

Figure 1 – Sampling spot locations in Rio Grande System (Billings Reservoir) and in Taiaçupeba Reservoir. Source: Elaborated by the author.



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2.3 Physical, chemical and microbiological analyses

Water samples were collected on the lake sub-surface, stored in appropriate bottles and maintained cooled until the transportation to water analysis laboratory of the University UNIVERITAS/UNG. Biochemical oxygen demand (BOD), total nitrogen, nitrate, nitrite, ammonium ion, total phosphorus, orthophosphate, turbidity, total solids, chlorophyll-a and *Escherichia coli* were analyzed in laboratory environment.

Glass microfiber filters (AP 20 – diameter = 47 mm) were used to analyze chlorophyll-a. Filters were wrapped with aluminum paper after filtering and stored in freezer until the laboratorial analysis. Extraction was assessed in ethanol (solvent) and the analyses followed the technique recommended by Wetzel e Likens (2000). BOD was assessed in electronic BOD analyzers based on the manometric method. The other laboratorial analyses were carried out according to the methodologies described in APHA (2012). Subsequently, the values of the assessed variables were assessed - they were within the limits established by the legislation (BRASIL, 2005).

Water temperature, dissolved oxygen, electric conductivity, pH and turbidity in the field were analyzed with Sanxin multi-parameter measurer model SX751.

WQI calculations were based on the selected limnological variables, according to CETESB (2015); TSI was assessed according to Lamparelli (2004).

Rainfall and air temperature data were collected in the National Weather Institute (*Instituto Nacional de Metereologia – INMET*) at Mirante de Santana Weather Station (INMET, 2017).

2.4 Land use and occupation

Soil coverage standard mapping was carried out based on the classification by Stewart e Oke (2012) in *Sistema de Informações Geográficas (SIG) ArcGIS 10.2*, according to the methodology described by Bechtel *et al.* (2015). The supervised classification used the Maximum likelihood sorter (MAXVER), which lies on statistical criteria of average, variance and covariance. This calculation could estimate the probability of a pixel to belong to a pre-defined class (training samples) (JENSEN, 2005).

This classification was based on the colorful orbital image corresponding to infrared limits, close infrared and to infrared visible from satellite Landsat-8 from 11/15/2017 (USGS, 2017).

The accuracy of the soil coverage classification map was assessed through the Kappa index analytical technique (k, Equation1), which calculated the difference and the agreement likelihood between reference and classification values based on reference areas (n), which were randomly distributed in the image (CONGALTON; GREEN, 2009). In total, 50 polygons representative of the mapped class were used as reference area.

$$k = N \sum Xii - \sum Xi+ X+i \; / \; N2- \sum Xi+ X+i$$

(Equation 1)

Wherein, Xii is the observed agreement; X i+ and X+i (product of marginal) are the expected agreement, and N is the total of observed elements.

2.5 Statistical Analysis

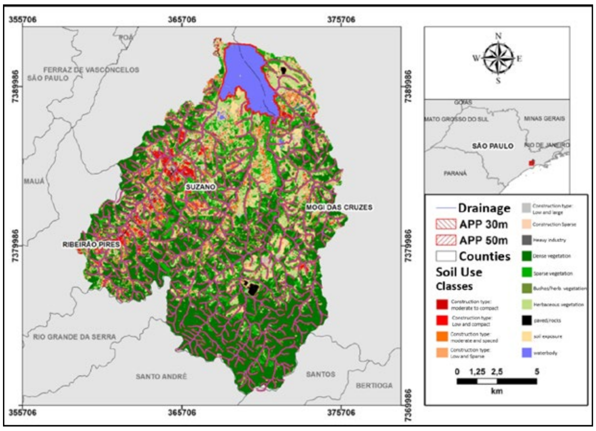
The Principal Component Analysis (PCA) was performed to analyze the environmental variability of abiotic data in the assessed months (time) and different sampling spots (spatial). Abiotic variables, "ranging" changes ([(x - xmin)/Xmax - Xmin)]) and the covariance matrix were used in the calculations. Data were analyzed in the PC-ORD software, version 6.0, for Windows (MCCUNE; MEFFORD, 2011).

3 Results and discussion

With respect to land use, 13 classes were identified in Taiaçupeba sub-basin; the ones recording the greatest representativeness were dense vegetal cover (38.8%), which was found in Southern sub-basin region; sparse vegetation (22.3%); and herbaceous vegetation class (8.8%). The herbaceous vegetation class covered the central sub-basin region and the sides of Taiaçupeba Reservoir – the sides corresponded to crop fields. The urban area accounted for 12% of the sub-basin area, and 8% of it was represented by class "sparse constructions" and 4% by class "moderate and sparse constructions" (Figure 2).

Vegetal cover areas covered most of the soil in Taiaçupeba sub-basin; however, it is important highlighting that part of these areas were used for cultivation, and it posed risk to the quality of the water in the basin, since fertilizer applications (widely used in agriculture) are seen as the main cause of water quality loss (RESENDE, 2002). Urban zones, even the less occupied ones, were located close to Taiaçupeba-Mirim River, which received water transposed from Rio Grande System to Taiaçupeba Reservoir. Such process can also change the quality of the transferred water and, consequently, of water in Taiaçupeba Reservoir, mainly due to domestic and industrial waste disposal into the aquatic environment (HACKBART *et al.*, 2015).

Figure 2 – Land use and occupation map of Taiaçupeba sub-basin. Source: elaborated by the authors.



Source: the author

The meteorological analyses have recorded rainfall values between 104.1 mm – 454 mm and mean air temperature 20.6 °C – 24.7 °C in the rainy/summer period, and between 0.8 mm - 206.8 mm, and between 15.5 °C – 23.7 °C, respectively, in the dry/winter period. This outcome confirmed what was expected for the study site, whose climate is featured by two seasonal periods, namely: rainy season (from October to March – summer), with high temperatures and rainfall (average 2,000-2017: 22.3 °C and 211.6 mm per month, respectively) and dry season (from April to September – winter), with lower temperatures and reduced rainfall (average 2010-2017: 18.6 ° C and 63.8 mm, respectively) (INMET, 2017).

Water temperature almost did not change between sampling units. There was little variation in these parameters in the sampling spots with time. Their values were close to each other in the assessed months, except for October, when temperatures were higher.

Similar to temperature, pH almost did not change between sampling units. Its values ranged from 6.6 to 7.5; therefore, they were within the limits established by CONAMA 357: 6 to 9 for aquatic-life protection; and by Ordinance 2,914/2011 by the Ministry of Health: 6.5 to 8.5, for appropriate population supply (BRASIL, 2005; BRASIL, 2011).

The pH value is closely related to dissolved oxygen and BOD, which is a strong indicator of organic matter decomposition in the environment. Thus, high BOD means that the organic matter has been consumed and, consequently, that oxygen has been deleted and that CO_2 has been released and acidifying the water. This association is not as clear in the current study; however, it is important taking into account that pH is a variable hard to be interpreted given the large number of factors that can affect it, as stated by Esteves (2011) and Sperling (2006). On the other hand, the association between dissolved oxygen and BOD was herein easily observed. Dissolved oxygen concentration ranged from 3.4 mg L^{-1} and 15.4 mg L^{-1}, i.e., its values were lower than the ones allowed by CONAMA 357 (never lower than 5 mg L^{-1}). Overall, the lowest O_2 values were observed at P3 (3.4 mg L^{-1}) and the highest BOD values (18.1 mg L^{-1}) were also observed at this spot, regardless of the sampling period. It is noteworthy that water from the Billings Reservoir flowed into Taiaçupeba Reservoir.

After being discharged into Taiaçupeba-Mirim River, the water from Billings Reservoir transposed to Taiaçupeba Reservoir crossed the urbanized zone of Taiaçupeba sub-basin before entering the reservoir. It likely happened due to domestic waste disposal in it, a fact that may have influenced the quality of the water in this very spot of the sub-basin, since P3 is downstream the trajectory the transposed water takes to cross the urbanized zone. Such statement is corroborated by some studies that have reported O_2 concentration decrease due to domestic sewage discharge (PINTO; OLIVEIRA; PEREIRA, 2010; SILVA *et al.*, 2017).

Other variables assessed in the present study also corroborated the influence of domestic sewage on P3 in the sub-basin, namely: total phosphorus, total nitrogen and electric conductivity.

Total phosphorus concentrations ranged from 0.007 mg L^{-1} and 0.2 mg L^{-1}, which are values quite higher than those within the legal limits (<0.02). The highest values, regardless of the sampling period, were observed at P3, mainly in August, when all sampling spots exceeded the legal limits set for this variable, except for P4 (BRASIL, 2005). P1 also recorded high total phosphorus concentrations in most of the assessed periods.

Total nitrogen (always recorded values lower than 0.6 mg L^{-1} in all assessed periods) and electric conductivity (values between 52.7 μS.cm^{-1} and 172.2 μS. cm^{-1}) overall presented the highest values in this spot. These two variables did not follow any pre-established legal limits; however, it is important pointing out that conductivity values higher than 100 μS.cm^{-1}, such as the case of all analyses conducted in P3, indicate that the environment has suffered from external impacts. Total nitrogen, in its turn, similar to phosphorus, showed the highest concentrations in all assessed sampling spots in August 2016, except for P5. It likely happened due to low rainfall rates at this time of the year, which influenced dilution and favored the concentrations of these nutrients in waterbodies.

Nitrogen, just as total phosphorus, is one of the main nutrients coming from domestic sewage, but, at high concentrations, it can cause excessive increase in algae and cyanobacteria growth in aquatic environments (SANT'ANNA *et al.*, 2008). The concentration of these nutrients in the assessed environments seem not to have been enough for phytoplankton community blooming; even in August, when chlorophyll concentration was relatively higher than in other periods. Chlorophyll-a concentration was always low in the assessed period, except for P1, in April 2017, whose value (13,7μg L^{-1}) exceeded the limit established by the legislation (< 10μg L^{-1}) (BRASIL, 2005).

Turbidity was too low in all sampling spots throughout the whole assessed period; however, P1 showed 48 UNT in April 2017, which is a value higher than that established by the legislation (< 40 UNT). This result likely happened because of significant rainfall events hours before sample collection, which caused sediments to move and allochthonous material input. Consequently, this process has reduced light beam intensity when it crossed water, as observed by SANTI *et al.*, (2012). Although the highest turbidity value was observed in P1, in general terms, P3 recorded higher values than the other sampling spots throughout most of the assessed period.

This outcome was corroborated by data from total solids, whose behavior in most of the sampling spots in the assessed period was similar to that observed for turbidity. It indicated association between turbidity and solids in suspension, i.e., the fraction of total solids impairing solar beams to pass through the water (CHAGAS, 2013).

E. coli values were higher than 1150 UFC/100ml in all sampling points throughout the whole assessed period, it exceeded the limits established by the legislation (120 UFC/100ml). This outcome points towards contamination with feces in all assessed spots, mainly in P3, where *E. coli* values were higher than in the other assessed spots throughout most of the assessed period. This contamination type can be related to waste coming from residences and shops located in areas around the sampling spots, mainly in P3, which suffers the most significant influence from urbanization. It is so because *E. coli* uses waste-based organic material as food source (ROSSI *et al.*, 2011; COLAÇO; ZAMORRA; GOMES, 2014).

Table 1 – Values recorded for physical, chemical and biological parameters assessed in Rio Grande System and in Taiaçupeba Reservoir, between June 2016 and April 2017. Reference values in the column of parameters are in compliance with CONAMA Resolution n. 357/2005. Values highlighted in bold indicate that they did not meet the legal standards.

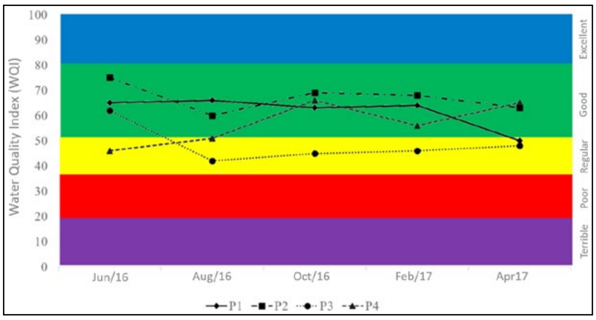
		Temp. (°C)	pH	EC (μS cm^{-1})	DO (mg L^{-1})	TU (UNT)	TP (mg L^{-1})	TN (mg L^{-1})	TS (mg L^{-1})	Chlor (μg L^{-1})	E.coli (UFC/100 mL)	BOD (mg L-1)
ONAMA Lim			6 to 9		> 6	< 40	< 0.02			< 10	< 120	< 3
jun/16	P 1	19	7.1	92.8	15.4	1	0.000	0.061	72	7.3	**2000**	0.0
	P 2	16.7	6.9	76.1	9.5	1	0.007	0.088	124	3.7	**1150**	0.0
	P 3	21.5	7.0	156.5	8.6	3	-0.034	0.063	165	4.1	**17000**	0.0
	P 4	18.9	7.0	54.6	15.2	8	0.007	0.100	3703	9.6	**4000**	0.0
Aug/2016	P 1	21.9	7.4	119.1	8.3	2	**0.092**	0.680	224	7.3	**4900**	1.6
	P 2	24.5	7.5	70.7	7.5	2	**0.118**	0.314	91	7.3	**33000**	0.0
	P 3	20.1	7.3	120.3	**5.3**	32	**0.175**	0.421	71	5.9	**27000**	**20.0**
	P 4	21.4	7.1	52.7	6.9	5	0.007	0.026	178	8.5	**4000**	**19.0**
Oct/2019	P 1	21.2	6.6	77.9	5.0	2	0.007	0.093	57	0.5	**3500**	1.6
	P 2	23.6	7.5	122.4	7.0	4	0.000	0.091	62	3.3	**1900**	2.7
	P 3	22.4	6.8	170.8	**3.4**	8	**0.136**	0.130	123	4.4	**90000**	**6.8**
	P 4	25.2	6.9	102.3	7.4	1	**0.106**	0.20	85	1.6	**4500**	**9.3**
Feb/ 2017	P 1	26.1	7.0	91.1	6.7	3	0.007	0.128	0.05	3.8	**5500**	**14.8**
	P 2	28.7	6.9	73.4	6.4	2	0.007	0.076	0.02	-1.6	**2000**	**12.0**
	P 3	26.5	6.8	172.2	**3.8**	6	0.007	0.131	0.07	3.3	**13500**	**15.9**
	P 4	28.9	6.6	61.0	**5.3**	2	0.007	0.149	0.01	2.2	**3500**	**15.3**
Apr/2017	P 1	22.0	7.0	105.0	6.9	**49**	0.058	0.053	76	**13.7**	**590000**	1.6
	P 2	23.2	6.9	79.8	6.8	1	0.007	0.013	12	2.2	**15000**	0.0
	P 3	20.0	6.7	114.4	5.7	20	**0.164**	0.020	5	-4.9	**220000**	1.3
	P 4	22.9	6.6	60.9	7.2	1	0.007	0.004	7	0.0	**3000**	**4.1**

Source: the author

With regards to indices used in the current study, WQI values recorded "good" classification for most of the assessed sampling spots at all sampling periods, except for P3, whose classification was only "good" in July 2016 and "regular" in the other analyzed months; and for P4, which was classified as "regular" in June and August, 2016; as well as for P1, classified as "regular" in April, 2017 (Figure 3). Similar to WQI, TSI (Figure 4) also pointed out good water quality in most of the assessed sampling spots, except for P3, which was classified as "mesotrophic" in June, August and October 2016, and in April 2017; and for P1, which was classified as "mesotrophic" in August 2016 and in April 2017.

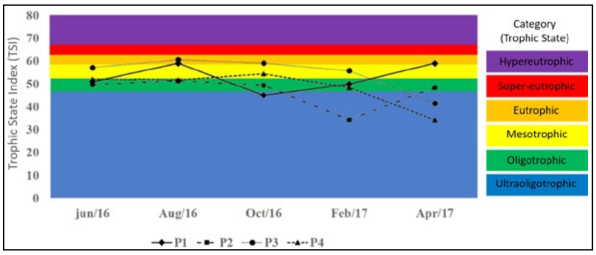
These results corroborate the analysis applied to the physical-chemical and biological variables, in separate, which have shown greater water degradation in Taiaçupeba sub-basin in the P3 region. These analyses also showed that the influence of these variables on Taiaçupeba Reservoir water was much more related to the use and occupation of land surrounding the reservoir than to water transposition from Rio Grande System (assed at P1), whose quality was similar to that observed for P2 – SABESP's water capture spot in Taiaçupeba Reservoir for population supply.

Figure 3 – Water Quality Index (WQI) from June 2016 to April 2017 in the four sampling spots



Source: the author

Figure 4 – Trophic State Index (TSI) from June 2016 to April 2017 in the four sampling spots

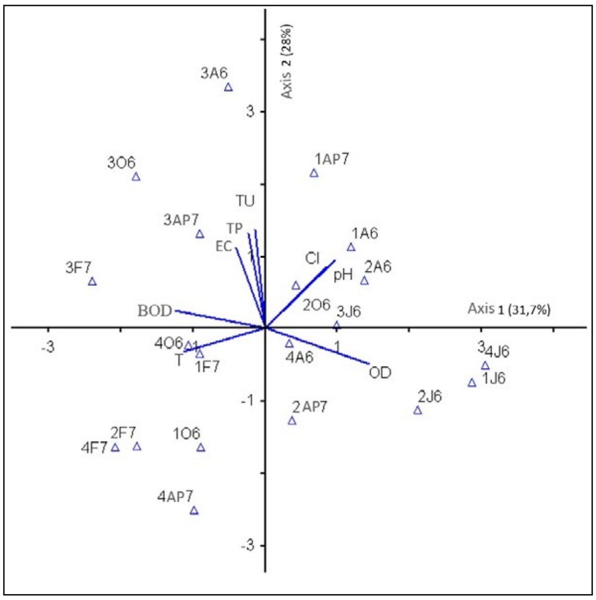


Source: the author

PCA has ordered the sampling units based on the environmental variables; it explained the 59.7% joint data variability in its two first components, whose eigenvalues (axis 1 = 2.5, axis 2 = 2.2) was significant, based on results of the permutation test (axis 1 = 0.02 and axis 2 = p=0.001) (Figure 5). PCA grouped most sampling units from P3 in the positive side of axis 2. These units are associated with total phosphorus (r = 0.75), turbidity (r = 0.78) and electric conductivity (r = 0.64) values. Most sampling units corresponding to the coldest months of the year were ordered in the positive side of axis 1. These units were associated with the highest dissolved oxygen concentrations (r = 0.87), whereas, sampling units concerning the hottest months of the year were ordered in the negative side of axis 1. These units were associated with the highest temperatures (r = - 0.69) and BOD values (r = - 0.76).

Based on PCA results, high urban occupation was the main cause of changes in the quality of the water in Taiaçupeba-mirim River and in the water transposed from Rio Grande System to Taiaçupeba. However, it seems that it did not influence the quality of the water in Taiaçupeba Reservoir used for population supply, since axis 2 was quite important to separate most sampling units in P3, despite the influence of seasonality. It is important highlighting that water in P3 was significantly influenced by urban occupation.

Figure 5 – Ordering based on the principal component analysis (PCA) and on the eight limnological variables of 20 sampling units in Rio Grande System and in Taiaçupeba. Abiotic variables: Temperature (T), dissolved oxygen (DO), electric conductivity (EC), turbidity (TU), pH, total phosphorus (TP), chlorophyll-a (Cl) and biochemical oxygen demand (BOD). Sampling units: months (J: June, A: August, O: October, F: February, AP: April). Number before the letters of the months indicate the sampling points. Number after the letters of the months indicate collection year (6 = 2016 and 7 = 2017).



Source: the author

4 Conclusion

Results have shown that water transposition from Rio Grande System to Taiaçupeba Reservoir seem not to have influenced the physical and chemical features of water in this reservoir. The quality of the water at Taiaçupeba-Mirim's water inflow spot in Taiaçupeba Reservoir seem to have been influenced by the urbanized zone surrounding the Taiaçupeba sub-basin, since the highest concentrations of nutrients typical of domestic sewage were observed in this spot, which is located upstream the water capture spot for population supply. On the other hand, they have mitigated disturbances in water quality caused by the use and occupation of land surrounding the sub-basin, since the water capture spot for population supply recorded the best water quality in comparison to spots tributary to the reservoir.

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