

Evaluation of the environmental quality of urban streams, through the use of rapid assessment protocols

Water constitutes one of the most important natural resources of our planet, however, the expansion of urban areas, has caused great degradation in its quality, with diverse associated environmental problems. The diagnosis and monitoring of the aquatic ecosystems are essential to the management of hydric resources. For this endeavour, some Rapid Assessment Protocols has been proposed, in order to make a quick and satisfactory characterization of the environmental quality of different ecosystems. Thus, this study aims to contribute to an evaluation of the degree of deterioration of urban streams in a municipality of the southern Brazil, using an adapted Rapid River Assessment Protocol. The results obtained showed a strong impact of urbanization on the headstream region, the most urbanized of each micro-basin, being the substrate modification, the parameter that most negatively influenced the protocol scores, unlike vegetation, which presented the best indexes. A gradient of environmental quality was observed between the streams, apparently determined by greater or lesser extent of their course in the urban area. As such, it is suggested that conservation and restoration actions focus especially on aspects related to the substrate and, even with better scores, actions to restore the abundance and quality of riparian forests, must be considered.

Keywords: Anthropic impacts; Environmental management; RAP; Water resources; Urbanization.

Avaliação da qualidade ambiental de córregos urbanos, através do uso de protocolos de avaliação rápida

A água constitui um dos recursos naturais mais importantes do nosso planeta, no entanto, a expansão das áreas urbanas, tem causado grande degradação na sua qualidade, com diversos problemas ambientais associados. O diagnóstico e monitoramento dos ecossistemas aquáticos são essenciais para a gestão dos recursos hídricos. Para tal, foram propostos alguns Protocolos de Avaliação Rápida, de forma a fazer uma caracterização rápida e satisfatória da qualidade ambiental dos diferentes ecossistemas. Assim, este estudo visa contribuir para uma avaliação do grau de deterioração de córregos urbanos em um município da região sul do Brasil, utilizando um Protocolo de Avaliação Rápida de Rios adaptado. Os resultados obtidos mostraram um forte impacto da urbanização na região de cabeceira, a mais urbanizada de cada microbacia, sendo a modificação do substrato, o parâmetro que mais influenciou negativamente os escores do protocolo, diferentemente da vegetação, que apresentou os melhores índices. Foi observado um gradiente de qualidade ambiental entre os córregos, aparentemente determinado pela maior ou menor extensão de seu curso na área urbana. Dessa forma, sugere-se que as ações de conservação e restauração se concentrem especialmente nos aspectos relacionados ao substrato e, mesmo com melhores pontuações, devem ser consideradas ações para restaurar a abundância e a qualidade das matas ciliares.

Palavras-chave: Impactos antrópicos; Gestão ambiental; RAP; Recursos hídricos; Urbanização.

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INTRODUCTION

Water is one of the most important and abundant natural resources on our planet (WETZEL et al., 1999), being considered indispensable for sustainable development and for the maintenance of human health and ecosystem services (MEHRALIAN et al., 2020). In nature, water participates in important physiological processes, such as photosynthesis and respiration (PIMENTEL, 2004), and is responsible for most of the climatic phenomena that regulate the occurrence and distribution of organisms on Earth (PIMENTEL, 2004; TUNDISI, 2008). For humanity, water has become even more important, as we depend on it for the production of food and energy, industrial development and the disposal of effluents, in addition to physiological and cultural needs (WETZEL et al., 1999).

There is a variety of human activities that impact aquatic ecosystems, whether in the rural or urban portion. The expansion of urban areas and the multiple uses of water alter the characteristics of water resources, causing significant degradation in their quality and in the balance and dynamics of aquatic ecosystems (BLUME et al., 2010; NASIR et al., 2011; HARFUCH et al., 2019). In opposite, in the rural area, when the riparian forest is removed, the entire landscape is altered to permit agricultural production systems and/or pastures. This, in addition to the continuous use of pesticides and fertilizers and the lack of treatment of human and animal wastes, which end up determining the deterioration of the environmental quality of these ecosystems (ALMEIDA et al., 2001; ANDRIETTI et al., 2016).

Among the most representative changes in aquatic environments, we have those of a physical nature, such as increased frequency and magnitude of runoff in rainy periods (ZHOU et al., 2007), increased erosion processes and altered channel morphology, with subsequent impacts bodies of water (BOOTH et al., 2004); those of a chemical nature, such as increased concentrations of toxic substances and nutrients (HATT et al., 2004); and those of a biological nature, such as increased entry of inputs and organic matter, as well as loss of riparian vegetation, which directly impacts the structure and functioning of biological communities (QUINN et al., 2001).

Streams and rivers provide habitats that are very different from other aquatic systems, as they are subject to variations along their course, associated with the physical and chemical properties of the environment. Actions aimed to preserving and recovering ecosystems are preceded by a stage of characterization and evaluation of their conditions and peculiarities of the problem, that is, an environmental diagnosis. In the case of small water body ecosystems, not must only the water body should be characterized, but also the adjacent environment along its course, due to the intense interaction between them (MINATTI-FERREIRA et al., 2004). According to Magalhães Júnior (2000), diagnosis and systematic monitoring are essential for putting water management tools into practice, since they provide strategic information that allows the establishment of a database based on the characteristics of each water body. This hydrographic basin management should be the guiding instrument for the actions of public authorities and society, in the long term, in controlling the use of natural, economic and socio-cultural resources by man, in the area covered by a hydrographic basin, with a goal to sustainable development (LANNA, 2000). In this sense,

updated knowledge about the quality of available water is essential for the management of water resources (LANNA, 2000; HARFUCH et al., 2019).

In the existing rapid assessment environmental protocols, the characterization of water quality is done using physical-chemical and biological parameters of the water (MINATTI-FERREIRA et al., 2004; GUIMARÃES et al., 2017). However, the quality of water resources acts on a spatial and temporal scale, and its properties cannot be assumed in a constant time and place (SEIDMOHAMMADI et al., 2020). Therefore, these protocols do not have a universal character for the assessment of water bodies, in view of the great diversity of environments; because of this, they are subject to adjustments or additions according to the reality of the study area. Each stream has different characteristics, mainly due to the climate, relief, geology, vegetation, among others (RODRIGUES et al., 2008; GUIMARÃES et al., 2017).

The maintenance and preservation of river and riverside ecosystems are indispensable needs for modern society, but studies in this direction are still scarce, (KIM et al., 2019), especially in Brazil (MINATTI-FERREIRA et al., 2006). According to Minatti-Ferreira et al. (2006), efforts are based on unproven methods or little applicable to the characteristics and conditions of Neotropical systems, and the results, when obtained, are not very expressive, require highly specialized personnel and are generally very expensive. Thus, this study aims to assess the environmental quality of urban streams of an important city in southern Brazil, using a Rapid River Assessment Protocol.

To this end, the following predictions were tested: i) Although all the streams analysed are in the urban area, there will be differences in environmental quality between them due to the characteristics of the surrounding occupation; ii) Likewise, there will be differences in environmental quality along each stream and, considering that the springs are located at the urban area, there must be a gradient, with improvement of the environmental quality from the head to the mouth; and finally, iii) the relative importance of the parameters analysed to determine the environmental quality of each stream will be distinct between them.

MATERIALS AND METHODS

Study Area

Maringá is the third largest city in the State of Paraná, and the seventh in the southern region of the Brazil. It has a Population Growth Index (ICP) estimated at 1.86% and a Human Development Index (HDI) of 0.841, occupying the 67th position in the country. It covers lands belonging to two important basins in the region, the Pirapó river basin and the Ivaí river basin, whose watershed spike is located in the highest region of the municipality, with an altitude of 599 m. For this reason, due to their location, several small water courses are born in the urban area of the city, which receive direct influences from anthropic impacts (BORSATO et al., 2004).

Agriculture predominates in the region, with areas of livestock, industrial and agro-industrial activities (KLEPKA, 2011). These activities cause erosion, silting and contamination of their bodies of water by chemical products, which are intensified by the suppression of riparian forest. Due to their size and

geographic location, these basins are highly vulnerable to the process of occupation and population development and are, therefore, more susceptible to environmental impacts (CASSARO et al., 2005).

In this study, four urban streams were analysed, whose springs are located within the urban zone of Maringá. Among the streams, Morangueiro and Maringá are tributaries of the Pirapó River basin and, the Floriano and Pinguim streams belonging to the Ivai River basin. In addition to these, the Dourados stream was used as a reference, which is located entirely in a rural area, outside the urban perimeter of the city (figure 1).

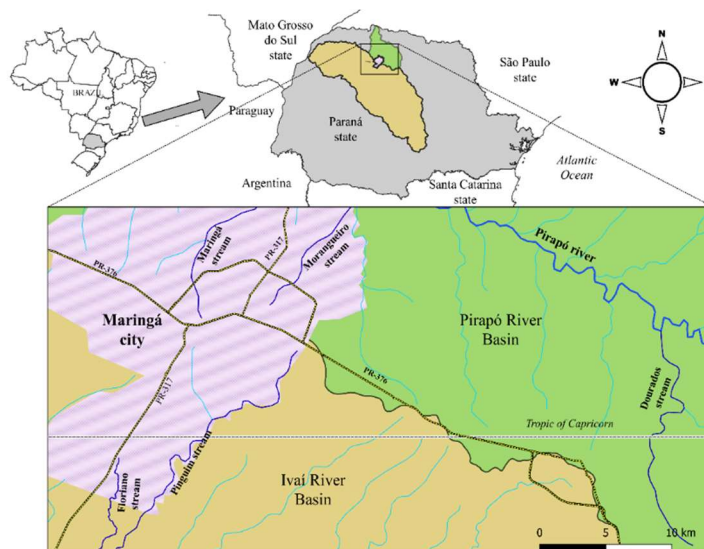


Figure 1: Location map of streams where RAP was used as a methodology for assessing environmental quality. Note that all streams analysed (Morangueiro, Maringá, Floriano and Pinguim) have their springs within the urban perimeter of the city of Maringá, except the Dourados stream.

Data collect

In this study, we used a protocol developed by Barbour et al. (1999) and adapted by Cionek et al. (2011). Small adjustments were made taking into account, mainly, the situation found in the reference water body, Dourados stream. Among the alterations made, the absence of submerged vegetation, little presence of sand, among others, can be mentioned.

Thus, nine visual parameters were proposed to determine the environmental quality of the selected water bodies (Table 1). The indicators selected to form the form were: background substrate, background substrate complexity, flow velocity variation, sinuosity, level fluctuation, channel changes, ravine stability, plant protection and conservation status of surrounding vegetation, all of which were classified based on the score presented in Table 1. We opted for urban streams whose springs were located within the urbanized area of the municipality of Maringá and with part of the course outside the city. This design aimed to assist in the identification of the environmental gradient of each stream (headland/urban and mouth/rural).

For each selected water body, data collection was carried out in points at least 1 km apart, in order to guarantee a change in their physical and morphological aspects and to avoid the possible repetition of data generated due to the proximity of the points. Thus, in the stream used as a reference, the Dourados stream, 4 different points were determined, with maximum scores added according to the protocol used. Due to the difficulty of access in certain streams, the number of points established for each one varied

considerably, with four collection points being evaluated for Morangueiro stream, for Pinguim five, Floriano three and Maringá eight points.

Table 1: Form used as a Rapid Assessment Protocol (RAP) at the sample points.

Item 1: Background substrate - Parameter: Substrate																				
Great					Good					Regular					Bad					
Stretch with deposition of organic material, submerged aquatic vegetation, trunks, and branches and leaves fallen into the water, making available various substrates from the bottom of 76% to 100% of the assessed section.					Stretch presents from 51% to 75% of potential substrates, such as sand, trunks, branches and leaves fallen in the water; as well as submerged aquatic vegetation and/or decomposing organic material.					Stretch with 26% to 50% substrate, with minimal presence of organic material and/or submerged aquatic vegetation, fine sediments, trunks, branches and leaves fallen into the water.					Stretch with predominance of fine sediments, where the water speed limits the establishment of submerged aquatic vegetation and decomposing organic material. Less than 25% of the section with trunks branches and leaves.					
Item 2 : Submerged habitat complexity - Parameter: Substrate																				
Great					Good					Regular					Bad					
Presence of 76% to 100% of aquatic vegetation and/or organic material, branches and leaves fallen into the water, marginal vegetation sloping over the channel, presence of backwaters, small waterfalls and excavated banks distributed along the stretch evaluated as potential habitats.					Presence of in 51% to 75%, of aquatic vegetation, with branches and leaves fallen in the water, marginal vegetation sloping over the channel, small waterfalls, excavated margins and/or representative backwaters, habitats in the evaluated stretch.					Presence of 26% to 50% of potential habitats, with branches and leaves fallen into the water, marginal vegetation sloping over the channel, small waterfalls and little or no type of backwater for shelter and reproduction of aquatic communities.					Presence of 25% vegetation in the stretch, the channel is devoid of backwaters and waterfalls, marginal vegetation sloping over the channel, and minimal presence of trunks, branches and leaves.					
20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Item 3: Flow speed variation - Parameter: Physical																				
Great					Good					Regular					Bad					
Presence of the 4 types of regimes: fast/shallow; fast/deep; slow/shallow; slow/background.					Presence of 3 regimes, with the presence of the fast/shallow regime being mandatory.					Presence of 2 types of regimes; if the fast/shallow regime is absent the score is lower.					Prevalence of only 1 type of regime, if the slow regime predominates, the score is lower.					
Item 4: Channel winding - Parameter: Physical																				
Great					Good					Regular					Bad					
Occurrence of sharp and evident curves along the evaluated stretch.					The channel's sinuosity is not evident, with less sharp, more distant curves.					The stretch has few smooth and distant curves.					Rectilinear stretch, if there is anthropic channelling, the score is lower.					
Item 5: Channel level fluctuation Categories - Parameter: Physical																				
Great					Good					Regular					Bad					
The water reaches both lower margins, with a minimum amount of exposed channel.					Water fills more than 75% of the channel and less than 25% of substrates are exposed.					Water fills between 26% and 75% of the channel, and/or most substrates are exposed.					Very little water in the channel, most of it standing in wells.					
Item 6: Changes to the Categories channel - Parameter: Physical																				
Great					Good					Regular					Bad					
Absence or minimal presence of alterations such as plumbing, dredging, bridges, dikes, embankments, dams, concretely or diversion of flow. The water course follows a natural flow pattern.					Presence of some old changes such as bridges or dredging up to 20% of the stretch, with no recent changes.					Presence of dams, dikes, runoff or any of the alterations mentioned, changing from 21% to 50% of the natural course of the river.					Presence of cement or gabions on the margins, or places with more than 51% of the length of the canalized course and with the presence of breaks or any other alteration.					
Item 7: Ravine stability Categories - Parameter: Physical																				
Great					Good					Regular					Bad					
Stretches with minimal occurrence of erosive processes, presence of preserved and dense vegetation supporting the soil, presenting up to 10% of its extension with small signs of loss of soil masses.					The ravines show 11% 30% signs of erosion, with soil exposure in sparse points, lack of preserved vegetation, exposure of roots, formation of "little beaches" with potential for later colonization by terrestrial vegetation.					Erosive processes reach 31% to 65% of the stretch, with exposure of roots, minimal presence of vegetation and consequent susceptibility to the effects of heavy rains, with movement of soil masses, limiting the vegetation succession.					More than 66% of the banks are eroded, with clear signs of burial, interruption of water flow and the absence or minimal presence of vegetation.					
20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Item 8: Vegetable Protection of the Margins - Parameter: Vegetation																				
Great					Good					Regular					Bad					
Stretches with more than 90% of their extension covered by vegetation, with no evidence of cultivation areas, pastures and/or urbanization in the vicinity.					From 70% to 89% of the extension of the margin covered by vegetation, with minimal evidence of cultivation areas, pastures and/or urbanization, absence of major					From 50% to 69% of the margin is covered by vegetation, with representative areas of human occupation for agricultural, pastoral and/or urban purposes. In case of urban					Less than 50% of the margins' surface is covered with vegetation, with great discontinuities or absence of vegetation.					

	discontinuities in vegetation.					impacts, the score is lower.														
Item 9: Conservation status of surrounding vegetation - Parameter: Vegetation																				
Great					Good					Regular					Bad					
The surrounding vegetation is composed of species in good condition					Vegetation composed of native species in good condition, with minimal evidence of anthropic impacts.					Vegetation in a regular state of conservation, associated with the presence of anthropic impacts.					Vegetation practically non-existent due to the removal of native vegetation, giving rise to invasive species.					
20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00

Source: Barbour et al. (1999) and adapted by Cioneck et al. (2011) (with minor modifications).

Data Analysis

Analysis of variance (one-way ANOVA) was carried out in order to test the significance of the difference in environmental quality obtained by RAP, between the streams studied. In addition, it was tested whether the groups of parameters (vegetation, physical and substrate) have different influences in determining the scores for each stream alone and between streams. When the values were significant ($p < 0.05$), a posteriori test (Tukey's test) was performed in order to identify these differences. Still, in order to synthesize the results obtained for the different sampling points and to identify spatial patterns of environmental quality, as well as to infer about the most important parameters in the determination of these patterns, a Principal Component Analysis (PCA) was used.

Data collections were carried out in the months of October and November 2019, during the dry season, when streams are less unstable, ensuring more robust results. Data collections were carried out in the months of October and November 2019, in the dry season, when streams are less unstable, ensuring more robust results. The final RAP value (for each assessed point or for the entire length of the water body) was given by the sum of the scores obtained in each parameter and the classification of each point or stream made according to the score in Table 2.

Table 2: Sum of scores corresponding to assessments of different states of environmental conservation.

Conservation State	Grade
Great	136-180
Good	91-135
Regular	46-90
Bad	0-45

RESULTS AND DISCUSSION

The RAP values for the four urban streams studied showed relatively low total values of environmental quality, which varied, on average, between 82 to 114 points, for a possible value of 180, considering the 9 parameters analysed (Figure 1). The ANOVA results demonstrated the existence of significant differences for the total RAP values, between the streams ($F = 564.1$, $p < 0.001$). Thus, the Morangueiro stream had the highest RAP value, being statistically different from the Maringá stream (Tukey HSD, $p = 0.041$) and also from the Pinguim stream (Tukey HSD, $p = 0.036$), which had the lowest environmental quality (Figure 2), according to the protocol.

The evaluation of the total RAP values, along the sampling points, in each stream, showed that, in general, the environmental quality improves considerably from to head to the month, considering the springs are located at the urban perimeter of the city, (Figure 3). Among the streams, Maringá and Floriano, were

the ones that showed the most accentuated tendency to improve quality in the head-to-mouth direction. However, in the case of the Maringá stream, the stretches near its head obtained the worst quality values (55 and 69 points) and, even with the distance from the city, towards its mouth, it remained as one of the most strongly impacted streams. On the other hand, the Morangueiro stream, although it showed an absence of an upward trend in environmental quality, in the head-to-mouth gradient, presented the highest RAP values (121 and 125), as shown in Figure 3.

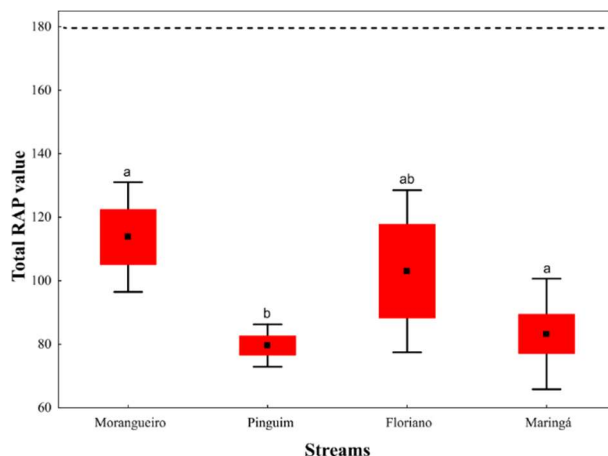


Figure 2: Average values of the sum of the parameters of the points of each stream. The dashed line indicates the maximum values of an ideal stream (Dourados); the dots indicate the average; the boxes represent the standard error and the whiskers represent the standard deviation. Different letters indicate significance at $p < 0.05$.

This result was expected, considering that the municipality of Maringá is located exactly in the division of two hydrographic basins, whose springs of the streams that cut the city are located in the densest urban areas and therefore more anthropized. This result corroborates those described by Rodrigues et al. (2008), who observed that, in urban areas, the streams sampling points were classified as “terrible”, while the most distant areas were classified as “excellent”. This longitudinal gradient in environmental quality was also reported in the study by Tran et al. (2010). They evidenced that urbanization were inversely and significantly correlated with the values of biological and water quality assessment protocols, having the urban areas a more negative effect on the environmental quality of streams than agricultural and forest ones.

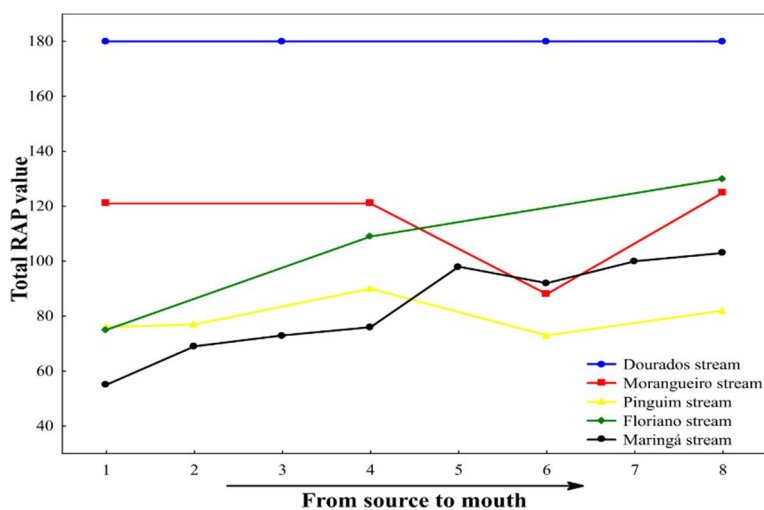


Figure 3: Line graph representing the variation in the RAP value of each stream, as they moved away from its source (urban perimeter of Maringá) towards its mouth.

Maringá stream, despite the improvement in environmental quality along its course, is severely impacted in a small stretch, where the water flow was restricted to a small passage, a kind of gutter, to cross a highway on the outskirts of the city. The water depth is approximately 60 centimetres deep in a fully concrete area, with direct launching from galleries coming from the highway. Contrary, Pinguim stream, also relatively impacted close to its source (Figure 3), did not show an improvement in its environmental quality due mainly to the instability of the ravine and the absence of vegetation in some of its banks.

Regarding the influence of the parameters used for analysis, it is possible to observe that those related to vegetation were the most important for raising the quality of streams (Figure 4). When streams were compared, Morangueiro showed the highest quality values in relation to this group, being statistically different from the streams Pinguim (Tukey HSD $p = 0.000$) and Maringá (Tukey HSD $p = 0.000$). The Pinguim stream had the worst values for vegetation, and was also statistically different from the Floriano stream (Tukey HSD $p = 0.000$).

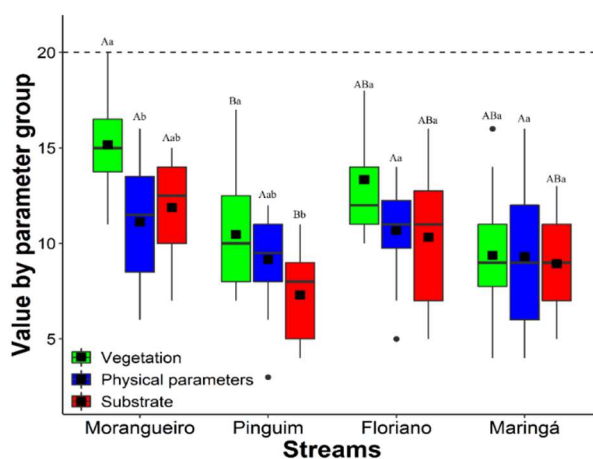


Figure 4: Graphical representation of the influence of the parameters in each stream and between streams. The central line represents the medium value, the square in the box the average value, the box represents 25% and 75% percentiles, the whiskers represent respectively the smallest and the largest value within 1.5 times the interquartile range below the percentage limits, and the dots indicate outliers. Uppercase letters above the boxes indicate comparison between streams for each group, and lowercase letters compare between groups within the same stream (equal letters indicate similarity and different letters indicate significant differences ($p < 0.05$)).

Our findings suggest that the presence of exotic vegetation was not considered a condition of alteration, in view of its occurrence in all points analysed in Dourados stream. In this sense, even though it is an exotic species, it contributed to the increase in the scores of parameters related to vegetation. In addition, in the urban region, it is mandatory by law, that valley floor areas are surrounded, even on private properties (Municipal Law 1093/2017). Such laws as this, help in the preservation of these areas and raise the values of environmental quality. However, this reality does not apply to all cities of Brazil, being common to observe highly altered urban streams. As for the physical parameters, in all streams the values remained similar, with no significant differences between them (Figure 4).

The results of a PCA (Figure 5), performed with the goal of identifying streams' environmental quality standards, showed, in relation to the parameters considered in the RAP, that the first two axes explained 70.63% of the total data variability (Figure 5). Of these, axis 1 explained 50.68%, while 19.95% was explained by axis 2. Regarding the ordering of streams, Axis I discriminated, in general, the points of the Maringá and

Pinguim streams, positively correlated to this axis, while the sampling points of the Morangueiro and Floriano streams were negatively correlated to this axis. Regarding the parameters, all were negatively correlated to axis 1 of the PCA, so that their highest values determined the best environmental quality of the streams Morangueiro and Floriano, as Maringá and Pinguim, in general, have the lowest values of these attributes (Figure 5).

Relation to axis 2, it generally discriminated the streams most influenced by physical and sediment factors, especially the Maringá stream, more positively correlated to that axis, from those streams whose environmental quality was more influenced by the parameters related to vegetation, more negatively correlated to this axis. Exception was observed for the physical parameter “channel change”, which was also positively correlated to axis 2 (Figure 5).

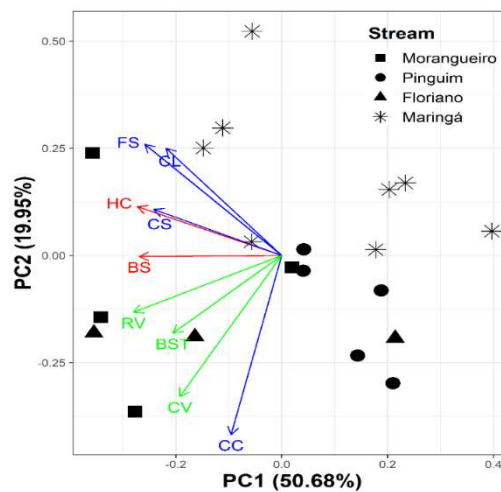


Figure 5: Relationship between the items analysed and their distribution on the PCA axes. SF = Background substrate; CH = habitat complexity; VT = flow velocity; SC = Channel winding; NC = Channel level; AC = Channel change; EB = bank stability; VM = margin vegetation; VE = Conservation of the surrounding vegetation. Blue arrows represent the grouping of physical parameters; green arrows indicate grouping of vegetation parameters and red arrows indicate substrate parameters.

For all points, the samples were taken in access routes, with anthropic interventions, such as bridges, at different degrees of impact. With the exception of Dourados stream, considered to be a reference for this study, in all access points there is channelling or total waterproofing of the watercourse. These alter the stream channel, cause the loss of natural sinuosity, and allow the excavation of the margins. Consequently, there is the removal of its substrate, due to the greater flow of water, especially in rain periods (TRAN et al., 2010). At some points, it was still possible to observe retention of materials of the most varied types. This situation is aggravated in Maringá stream, for example, where the passage of water is very small in relation to the width of the water body. According to Kieling-Rubio et al. (2015), a large amount of material is retained in these places, be it fallen branches and solid waste, the vast majority derived from anthropic activities.

Physical and substrate parameters are intrinsically linked to the quality of the surrounding vegetation, so that good vegetation on the banks of streams implies substantial improvements in the quality of these parameters. For example, the stability of the margins is directly associated with the length of the riparian vegetation area, which, when suppressed, causes instability followed by soil erosion and leaching,

high degrees of turbidity, especially in rainy periods, in addition to extensive mud deposition on the bottom of the water body (KIELING-RUBIO et al., 2015). Thus, natural vegetation in the sources of streams, guarantees a better quality of water than in places where anthropogenic activities such as agriculture predominate (DONADIO et al., 2005).

The substrate was the group of parameters that presented the lowest values in most of the points studied, especially close to the urban area of the city. Despite the presence of vegetation in a good state of conservation, which could have a positive impact on these parameters, as it acts as a barrier for materials of foreign origin (KIELING-RUBIO et al., 2015), it was observed that the bottom substrate was composed by sandy materials and also civil construction waste, determining a bottom substrate with low complexity and quality. This is due to the presence of rain galleries, in which rainwater is concentrated. Through these, different materials are transported to the water body, decreasing its environmental quality (TRAN et al., 2010). Therefore, the concern with the rapid degradation of water resources generates a sense of urgency in the need to develop rapid assessment protocols to measure environmental quality. Thus, the Rapid Assessment Protocol (RAP) can be a complementary instrument to monitor not only water resources, but also ecosystems that are inserted, since it evaluates the parameters that determine the quality of the physical conditions of rivers in an integrated manner (RODRIGUES et al., 2012; GUIMARÃES et al., 2017).

In summary, our results showed a strong impact of urbanization on the streams studied, with greater effects observed, in general, in the headwater region, all located in the most urbanized regions of each micro-basin. Despite the strong impact on the streams, part of them seems to be more impacted (Maringá and Pinguim), probably because they have the largest portion of their extension in the urban area. Among the parameters analysed, even with considerable degradation, the parameters related to vegetation were the ones that most positively impacted the obtained RAP scores, and those related to the substrate were the ones that most negatively influenced the evaluation.

Thus, considering that the physical factors are strongly influenced by structures built in the streams, with no possibility of alteration, it is suggested that conservation and restoration actions focus especially on aspects related to the substrate and, even the vegetation showing better scores, actions to recompose the riparian forests should have an even more positive impact on the improvement of the environmental quality of the urban streams.

CONCLUSIONS

The four water bodies evaluated in the municipality of Maringá-PR through the Rapid River Assessment Protocol presented classifications given as “regular” and “good”. The results demonstrated that the grouping of substrates parameters requires more attention, due to their low values of evaluations. The inflow of sediments and other materials in the river channels takes place through pluvial galleries and runoff at access points, making the bottom of the rivers homogeneous due to the deposition of sediments.

Despite the good evaluations given to the grouping of vegetation, it is important to remember that the presence of exotic species was not considered as negative aspect, a very common fact in the riparian

vegetation of the region, including the Dourados stream. Therefore, an important aspect to be evaluated by the public authorities is the recovery of these areas with the introduction of native species. The surrounding vegetation also acts as a filter for the entry of sediments and ravine stability, thus helping to improve the quality of the substrate of rivers.

The environmental quality of water bodies, based on RAP, improves according to their distance from the mouth; this is due to the lower intensity of anthropogenic activities in the surroundings when it moves away from urban area. However, this does not mean that streams are not impacted in these areas, as there are activities in the surrounding areas, mainly agricultural.

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