v. 3, n. 4, 2023

International Journal of Biological and Natural Sciences

RAPID DIVERSITY ASSESSMENT FOR ATLANTIC FOREST RIPARIAN BIOTOPES IN A COASTAL PLAIN IN SOUTHEASTERN BRAZIL

Marcelo Américo de Santana
Programa de Pós-Graduação em Sustentabilidade de Ecossistemas Costeiros e Marinhos – ECOMAR - Universidade Santa Cecília
Santos, SP, Brasil.
https://orcid.org/0000-0002-2429-6382

Ursulla Pereira Souza
Programa de Pós-Graduação em Sustentabilidade de Ecossistemas Costeiros e Marinhos – ECOMAR - Universidade Santa Cecília
Santos, SP, Brasil.

Fábio Giordano
Programa de Pós-Graduação em Sustentabilidade de Ecossistemas Costeiros e Marinhos – ECOMAR - Universidade Santa Cecília
Santos, SP, Brasil.

Walter Barrella
Programa de Pós-Graduação em Sustentabilidade de Ecossistemas Costeiros e Marinhos – ECOMAR - Universidade Santa Cecília
Santos, SP, Brasil.

Abstract: Despite intense urbanization, the coastal region of southeastern Brazil is home to natural ecosystems of the Atlantic Forest, such as the forests on the slopes of the Serra do Mar, the mangroves and the vegetation of the coastal plain. These natural systems show high levels of fragility, as they are heavily pressured by anthropic action. Urban pressure in natural environments generates ecological imbalance and consequent impacts and environmental changes in their watersheds, directly affecting water resources. This work aimed to evaluate the environmental changes on riverside biotopes of the Atlantic Forest in urbanized and coastal environments, in Praia Grande-SP (municipality of the Coastal region of Southeast Brazil). Through a Rapid Assessment Protocol (PAR) urbanized and natural environments were compared, in three vegetation physiognomies of the Atlantic Forest (dense rainforest, sandbank and mangroves). The stretches in rain forest showed the best results due to their high levels of preservation. The mangrove areas had the lowest scores due to intense urban occupation. Sandbank environments showed intermediate scores, with no anthropic alterations in their natural areas. However, considering the anthropic interference already consolidated in the urbanized areas, the natural environments of the sandbanks are subject to imminent degradation. The research results confirmed that the use of the PAR tool is an instrument that proved to be valid and efficient to assess environmental impacts in urban landscapes. The stretches of dense rainforest vegetation, due to the greater distance from the urban perimeter, had better evaluations, unlike the sandbank and mangrove vegetation, which, because they are closer to the urban axis, presented more precarious conditions in their habitats.

Keywords: rapid assessment protocol, urban ecosystems, Atlantic forest, environmental changes, anthropic actions.

INTRODUCTION

Urban areas have a substantial impact on the local, surrounding and regional environment. Research over the last decade has placed particular emphasis on the transformation of urban or metropolitan peripheries, because it is in these spaces that dynamic changes are taking place. The analysis of large cities shows that metropolitan expansion has a different dynamic from previous decades (Aguilar, 2008). In demographic terms, growth rates in large cities, particularly in Latin America, have slowed down over the past two decades. As a result, different types of transition zones between city and rural areas can be observed. For example, some areas show highly uniform peri-urbanization with compact and extensive developments, other zones contain small urban patches with open spaces between them, and others constitute corridor-like development lines like roads or rivers (Kremer et al., 2015).

The rural-urban gradient can change greatly over short periods of time, depending on the nature of the pressures within the growing metropolis and the migration towards it. As a consequence of this dispersed urbanization taking place on the outskirts of the city, there is a formation of a broad rural-urban fringe with increasingly diffuse boundaries between these spaces. It is important to consider the rural-urban periphery as an extension of the city, and not as an independent zone, because in reality it is integrated into the city in many ways, not only because of ecological issues, but also because of the economic and social processes that are present within it. this fringe (Simon et al., 2006). This urban pressure on natural environments generates ecological imbalance and consequent impacts and environmental changes in their watersheds, directly affecting water resources. Researchers

who conducted a study evaluating flow responses to urbanization in 9 US metropolitan cities concluded that urbanization results in different effects on hydrology, physical habitat, water quality and biota in different metropolitan areas (Brown et al., 2009).

Anthropogenic alterations such as construction, agricultural and industrial activities, in aquatic ecosystems, increase soil erosion, alter ecosystem services, cause biodiversity losses and decrease water quality (Vitousek et al., 1997; Mas et al., 2004 ; Kindu et al., 2013). In this context, studies on the quality of ecosystems have been conducted, considering the hydrological, hydrographic and biological characteristics (Metcalfe, 1989; Oliveira and Cortes, 2006; Molozzi et al., 2012; Molozzi et al., 2013). Among the tools to support environmental analysis used in the field, we can mention the application of the Rapid Assessment Protocol (PAR), which is based on questions developed with the aim of assisting in the environmental monitoring of water systems, so that qualitative information is diagnosed medium, in a simple and easy way to apply (Bersot et al., 2015). PARs can be used to characterize the environment, or are adaptations of existing protocols, such as those of the American Environmental Protection Agency (EPA), which evaluates the characteristics of stretches and the level of environmental impacts resulting from anthropic activities. in rivers (Vargas and Ferreira, 2012). The PAR developed by Hannaford et al. (1997) evaluates the complexity of the habitat and its level of conservation, analyzing characteristics such as water flow, type of substrate for the establishment of aquatic communities, in addition to the analysis of vegetation around the watercourse. In the Brazilian context, PAR has been used for the diagnosis and monitoring of natural areas susceptible to anthropic pressures (Costa et al., 2018).

Despite intense urbanization, the coastal region of southeastern Brazil is home to natural ecosystems of the Atlantic Forest, such as forested areas in the mountains, mangroves and sandbank vegetation. These natural systems present high levels of fragility, as they are heavily pressured by human action (Souza and Cunha, 2012). In view of this scenario, there is a growing need to assess and monitor environmental changes and their effects on water resources, especially with regard to the development of methodologies used as instruments to measure the "health" of an ecosystem.

The objective of this work is to evaluate the environmental changes on riverside biotopes with Atlantic forest vegetation in the coastal plain of southeastern Brazil, through a Rapid Assessment Protocol (PAR), comparing urbanized and natural environments, with three physiognomies of forest vegetation Atlantic (dense rainforest, sandbank and mangroves).

MATERIALS AND METHODS

The Southeast region of Brazil is the second smallest region in the country, being bigger only than the South region. It covers an area of 924,620.00 km², representing 1/10 of the country's surface. The municipality of Praia Grande is located on the south-central coast of the State of São Paulo (Fig.1 A), between the geographic coordinates 24º00'17"S and 24º05'00"S and 46º24'45"W and 46º35'31"W. To the west it borders the municipality of Mongaguá, to the north and east to the municipality of São Vicente and to the south to the Atlantic Ocean. According to the climate classification, the municipality is located in a coastal region with a humid climate, controlled by tropical and polar masses. Relative air humidity is normally above 80% due to high evaporation and the barrier formed by Serra do Mar. It is located in a region dominated by

the Atlantic Forest (Table 1), with 66.55% of its area covered by natural vegetation, including dense rainforest (Montana, Submontana and Lowlands), mangroves and extensive associated ecosystems of sandbank (which extend between the urbanized area and Serra do Mar (Afonso, 2006).

Climatic conditions, combined with lithological and pedological aspects, influence the growth of three important and distinct plant formations in the municipality: the Atlantic Forest, present on the steep slopes of Serra do Mar and in the Isolated Massif, conserved by the presence of two Conservation Units: the Serra do Mar State Park (São Paulo, 1977) and the Xixová-Japuí State Park (São Paulo, 1993). The sandbank forest extends over the sandy soil of the Quaternary or Coastal Plain; and the mangroves on the muddy soil of the fluvio-marine plain of the Piaçabuçu River (Souza and Cunha, 2012). The previously described attributes, added to the existence of important environments for the reproduction and preservation of marine biota, ended up justifying the creation of four conservation units in the Municipality, shown in Table 2.

The types of vegetation present in the study area are influenced by several factors such as soil types, with three main types occurring more frequently: Salic Gleissolos, Ferrocarbic Spodosols and Haplic Cambisols (Oliveira et al., 1999).

The geomorphological conditions of the region prevent the formation of extensive rivers. The river network is made up of small rivers that start in the Serra do Mar, pass through the Quaternary Plain and flow into the Atlantic Ocean (Afonso, 2006). In mountainous areas, the steep slope of the terrain causes torrential characteristics in the upper and medium courses of the rivers. When they reach the plain, the rivers suffer a decrease in speed due to the gentle slope, which causes the process of deposition of sediments. The geomorphological and geological characteristics of the region, which influence several physical factors in the study area, such as hydrography, are linked to the origin and evolution of Serra do Mar and to the formation of the Quaternary sedimentary plain (Souza and Cunha, 2012).

Environmental legislation restricts land use, with the function of preserving its natural attributes. In addition, access to the mountain area is limited by the very existence of the Atlantic Forest and the presence of excessively steep slopes, with a predominance of slopes equal to and/or greater than 30%. Due to its flat relief, with predominant slopes equal to and/or less than 2% (Souza and Cunha, 2012), and its proximity to the sea, the Quaternary Plain presents types of land use with greater diversification, with the terrain chosen for the implantation of the urban area. Plots originally covered by sandbank vegetation, from the 1960s, were taken over by buildings.

The first neighborhoods of the municipality were located close to the seafront, between 1972 and 1996, urbanization was consolidated in the oldest neighborhoods and extended to the interior of the continent. Between 1996 and 2005, urbanization occupied areas adjacent to those previously urbanized and filled existing voids between subdivisions (Souza and Cunha, 2012). In addition, urbanization moved towards the Permanent Preservation Areas (APPs) of the Branco and Piaçabuçu rivers. The area occupied by mangroves also suffers from the growth of urbanization and in order to protect these environments, the Piaçabuçu Park was created (Praia Grande, 2006). In addition to the removal of part of the sandbank vegetation for the implementation of the urban sector, the occupation of the coastal plain also resulted in the appearance of areas with exposed soil and patches of undergrowth. Also noteworthy is the existence of old mining operations that

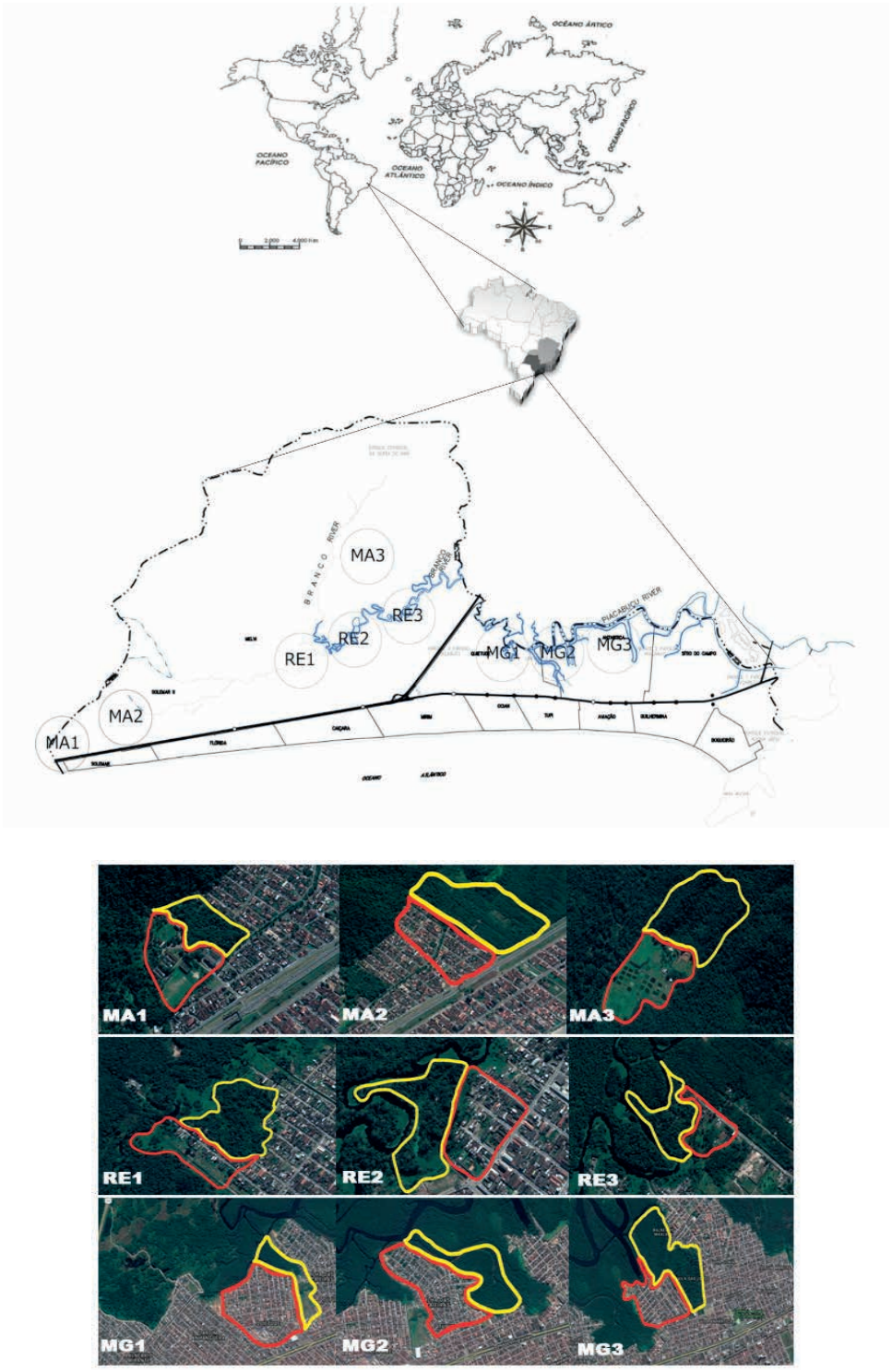

Fig 1 The location of the municipality of Praia Grande in southeastern Brazil, State of São Paulo and the demarcation of the 9 evaluated points of Atlantic forest; **B** Biotopes compared through urban-environmental contact (MA1, MA2, MA3-Dense Ombrophylous Forest; RE1, RE2, RE3- Sandbank; MG1, MG2, MG3 - Mangrove; natural stretches-yellow; urban stretches-red).

altered the original characteristics of the area.

This vegetational continuum, which is of fundamental importance for the gene flow and for the maintenance of the ecological balance of the core zone of the PESM, presents sparse occupations constituted by precarious dwellings, rural sites (where cassava and bananas are planted for their own consumption and for commercialization of small scale) and recreational farms located on the border with the Municipality of São Vicente.

This situation calls for greater care with regard to inspection and control of land use, since its expansion represents a serious risk to the environmental functions of the Buffer Zone, as it leads to disruption of the local ecological balance.

COMPARATIVE ANALYSIS OF NATURAL AND URBAN AREAS USING A RAPID HABITAT DIVERSITY ASSESSMENT PROTOCOL

Nine points were selected in vegetation with different levels of preservation (Fig.1 B), three points in stretches of dense rainforest (MA) in MA1 environments (24°4'40.92"S-46°35'53.68" W), MA2 (24°4'31.06"S-46°35'24.62" W) and MA3 (23°59'21.57"S-46°32'31.42" W); three points in sandbank stretches (RE), in environments RE1 (24° 2'0.53"S-46°32'28.19" W), RE2 (24°1'37.95"S-46°31'59.32" W) and RE3 (24° 1'37.95"S-46°31'59.32" W); three points in mangrove stretches (MG), in MG1 environments (24°0'43.71"S-46°28'32.73"W), MG2 (24°0'50.84"S-46°28'0.73"W) and MG3 (24°0'18.65"S-46°27'23.50" W), in various naturally altered situations, to modifications caused by anthropogenic actions, thus allowing a wide gradient of environmental conditions. The points were defined from field visits and analysis of maps and satellite images. The criteria used to select the points were based on environmental conditions, levels of anthropic intervention and use and occupation of the soil by different activities and the accesses were carried out by land and sea means.

The proposal used was based on the quantification of 17 parameters (Table 3). The first 4 parameters seek to evaluate the characteristics of the stretches and the environmental impacts resulting from human activities, parameters 5 to 17 were adapted from the protocol used by Hannaford et al. (1997), which evaluates the characteristics of the water and surroundings of aquatic ecosystems. From the attribution of scores to each of the parameters based on the observation of habitat conditions, three levels of preservation were defined: 0 to 27 points indicate impacted stretches, 28 to 40 points altered stretches and greater than 40 points, natural stretches.

RESULTS

The vegetation evaluations of the dense rainforest-MA presented scores that varied between 20 and 64 points (Table 4). Of these, 50% are represented by natural segments, 33.5% as altered and 16.5% impacted.

The environments of dense rainforest MA1N and MA3N presented similar results in their evaluations, with a score of 64 points in both segments without urban occupation, considered natural stretches against 38 and 44 points respectively in the occupied segments (MA1O, MA3O). In the MA1N environment, the river system is preserved with a predominance of riparian forest, the anthropic interference in the region focused more on the issue of the influence of garbage and some debris due to the flow of people due to the presence of a municipal school in the region, since the property used at the time it housed an educational complex that remains preserved until the present day. The

Vegetation Categories	Hectares
Montana Dense Ombrophylous Forest (places between 500 and 1000 meters altitude)	1.139,9
Submontane Dense Ombrophylous Forest (on mountain slopes between 50 and 500 meters in altitude)	2.808,4
Lowland Dense Ombrophylous Forest (altitudes less than 50 meters)	295,7
Arboreal/shrubby-herbaceous Formation of Muddy Marine Terrains (mangrove)	681,1
Arboreal/shrubby-herbaceous Formation on Recent Marine Sediments (sandbank)	3.152,8
Secondary Vegetation of Dense Ombrophylous Forest (altitude forest)	186,7
Secondary Vegetation of the Submontane Dense Ombrophylous Forest	1.222,9
Secondary Vegetation of the Lowland Dense Ombrophylous Forest	363,4
TOTAL	**9.850,8**

Table 1 Atlantic Forest vegetation categories existing in the Municipality of Praia Grande (Source-Instituto Florestal-Forestry Inventory of Natural Vegetation of the State of São Paulo, 2007).

Conservation Unit	Year	Act of creation	Responsible	Area (ha)
Parque Estadual da Serra do Mar	1977	State Decree No. 10,251 of 08/31/1977	Forest Foundation	4.531,61
Parque Estadual Xixová-Japuí	1993	State Decree No. 37,536 of 09/27/1993	Forest Foundation	901 554,00 em Praia Grande
Parque Municipal do Piaçabuçu	1996	Complementary Law No. 152 of 12/26/1996	Prefeitura Municipal de Praia Grande	826,85
APA Marinha Litoral Centro	2008	State Decree No. 53,526 of 10/08/2008	Forest Foundation	Setor Carijó 270.239,98

Table 2 Forest inventory of natural vegetation in the municipality of Praia Grande (Fonte-Instituto Florestal-Forest Inventory of Natural Vegetation in the State of São Paulo, 2007).

Parameters	4 points	2 points	0 point
1- Type of Occupancy of the margins of the water body	natural vegetation	Pasture fields	Residential, commercial, industrial.
2- Erosion near and/or on the banks of the river and silting in its bed	Absent	Moderate	accentuated
3- Anthropic alterations	Absent	change of domestic origin	Changes of industrial origin urban (factories, plumbing)
4- Plant cover on the bed	Total	Partial	Absent
5- water odor	None	Sewage	Industrial Oil
6- water oiliness	Absent	Moderate	Abundant
7- Water transparency	Transparent	Blurred strong tea color	opaque or colored
8- sediment odor	None	Sewer (rotten egg)	Industrial Oil
9- background oiliness	Absent	Moderate	Abundant
10- background type	Stones/gravel	Mud/sand	Cement/channel
11-Habitat disturbance	Intact	Disturbed	Degraded
12- soil type	Earth	Clay	Sand
13- Vegetal cover	Dense	Stains	sparse
14-Fauna	Big ones	Medium	small
15- Endangered rare species	threatened	rare	Absent
16- Succession stage	Climax	Subclimax	Pioneer

17- Biome	floodplain	Woods	Field	
TOTAL				

Table 3 Habitat Diversity Rapid Assessment Protocol, modified from the protocol proposed by the Ohio Environmental Protection Agency, USA and Hannaford et al. (1997): 4 points = natural situation; 2 points = situation changed; 0 point = situation severely changed.

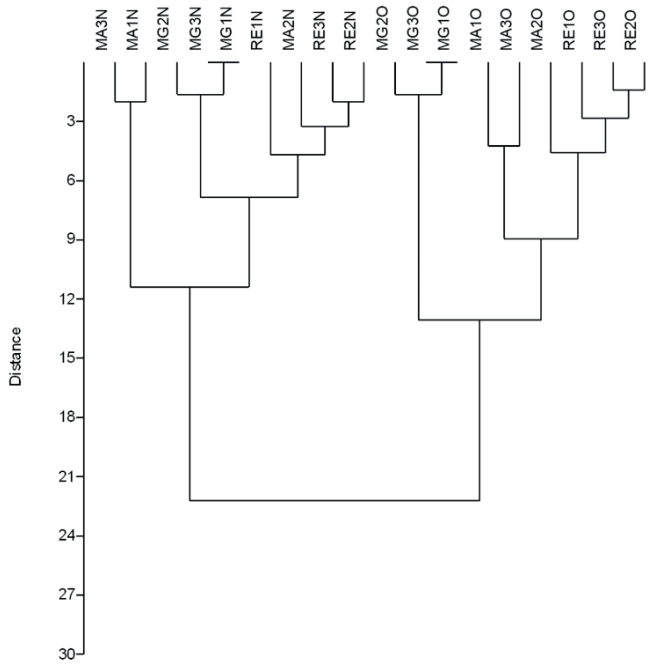

Fig. 2 Comparative analysis of biotopes (Ward distance index), MAN- densus tropicae silvae naturalis tractum, MAO- densum tropicae silvae tractum occupatum; REN-sandbank tractum naturale, REO-sandbank, tractum occupatum; Mgn-mangrove tractum naturalem, Mgo-mangrove, tractum occupavit.

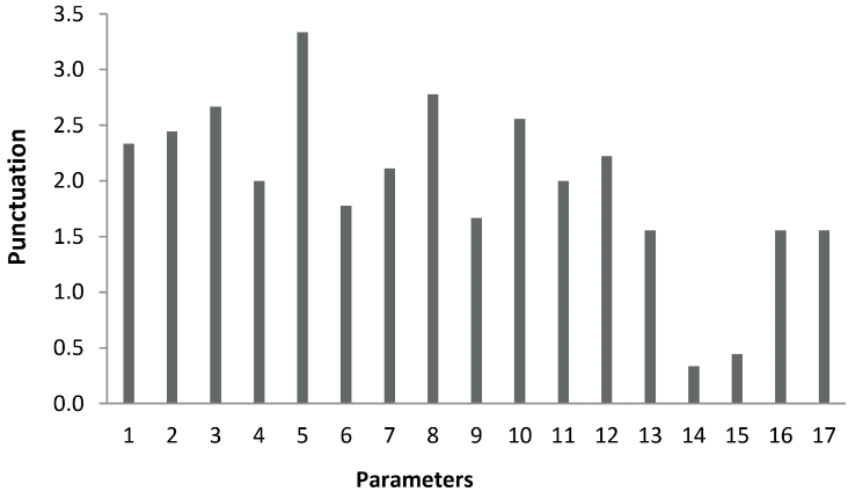

Fig. 3 Mediocris habitaculi diversitatem taxationem parametri pro 9 punctis interfaciei enucleatis (1. Typus Occupationis in ripis corporis aquae, 2- Erosion prope et/vel in ripa fluvii et in lecto suo siltans, 3. Mutationes anthropicae, 4 — Vegetal cover on the bed, 5. Odor aquae, 6. Oleum aquae, 7. Perspicuus aquae, 8. Odor faecis, 9. Oleum fundi, 10. Genus imi, 11. Disturbance. of the habitat, 12. Soil type, 13. Vegetation cover, 14. Fauna, 15. Rare periclitata species, 16. Succession stage, 17. Biome).

	MA-1		MA-2		MA-3		RE-1		RE2		RE3		MG-1		MG-2		MG-3	
Parameters	MA1N	MA1O	MA2N	MA2O	MA3N	MA3O	RE1N	RE1O	RE2N	RE2O	RE3N	RE3O	MG1N	MG1O	MG2N	MG2O	MG3N	MG3O
1- Type of Occupancy of the margins	4	2	4	0	4	4	4	0	4	0	4	0	4	0	4	0	4	0
2- Erosion near and/or on the margins	4	2	4	2	4	2	2	2	2	2	4	2	2	2	2	2	2	2
3- Anthropic alterations	4	2	2	2	4	2	4	2	4	2	4	2	2	2	4	2	2	2
4-Vegetable cover on the bed	2	2	2	2	4	4	2	2	2	2	2	2	2	0	2	2	2	0
5- water odor	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2
6-Oilyness of the water	4	2	2	0	4	2	2	2	2	2	2	2	2	0	2	0	2	0
7- water transparency	4	4	2	2	4	4	2	2	2	2	2	2	2	0	2	0	2	0
8- sediment odor	4	4	2	2	4	4	4	4	4	4	4	4	2	0	2	0	2	0
9- Background oiliness	4	4	2	2	4	4	2	2	2	2	2	2	0	0	0	0	0	0
10-Type of Fund	4	2	2	2	4	2	2	2	2	2	4	4	2	2	2	2	2	2
11-Habitat Disturbance	4	2	2	0	4	4	4	2	2	2	2	2	2	0	2	0	2	0
12- Soil Type	4	0	4	2	4	4	4	0	4	0	4	0	4	0	4	0	4	0
13- Vegetal cover	4	4	2	0	4	2	2	0	2	0	2	0	2	0	2	0	2	0
14- Fauna	2	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0
15-Rare endangered species	4	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0
16-Succession stage	4	2	2	0	4	2	2	2	2	0	2	0	2	0	2	0	2	0
17- Biome	4	2	2	0	4	0	4	2	2	0	2	0	2	0	2	0	2	0
	64	**38**	**38**	**20**	**64**	**44**	**46**	**28**	**40**	**24**	**44**	**26**	**32**	**8**	**34**	**10**	**32**	**8**

Table 4 Habitat Diversity Rapid Assessment Protocol, modified from the protocol proposed by the Ohio Environmental Protection Agency, USA and Hannaford et al. (1997): 4 points = natural situation; 2 points = situation changed; 0 point = situation severely altered; MA-dense rainforest, MAN-natural rainforest, MAO-occupied rainforest; RE-sandbank, REN-natural sandbank, REO-occupied sandbank; MG-mangrove, MGN-natural mangrove, MGO-occupied mangrove.

MA3O environment has in its anthropized section the activity of fish farming, the tanks that are located in the highest part of the land were excavated taking advantage of the slope of the land with the construction of dams that allow the containment of sediments in events of high rainfall, avoiding the discharge directly into water bodies, a factor that may have contributed to a better assessment of its occupied segment in relation to the MA1O environment. In the MA2O environment, the result of 20 points obtained in its occupied segment, an environment considered impacted, had as its main factor the urban pressure resulting from the settlement of residences and small businesses. In the MA2N environment that obtained a score of 38 points, considered altered, it was observed that the watercourse has a partially silted bed, in addition to close erosion resulting from anthropic changes.

The evaluations of sandbank vegetation (RE) presented scores that varied between 26 and 46 points (Table 4), of which 33.33% are represented by segments as being natural, 33.33% as altered and 33.33% impacted. Environments RE1N and RE3N presented similar results in their evaluations, pointing, respectively, 40 and 44 points, considered natural, environments RE1O and RE3O presented respective scores of 28 and 26 points, sections considered respectively altered and impacted. These results in the anthropized stretches are due to the existence in the neighborhoods of subdivisions with single-family residences and commerce in the housing itself. As a result of anthropization, the silting up of the Branco River is visible despite the dense sandbank vegetation with forest physiognomy in connectivity with the watercourse and with the Serra do Mar State Park (PESM), with characteristics of primary vegetation. In the transition zone of these anthropized environments, isolated tree individuals of the invasive exotic species Leucaena leucocephala (leucena) were found, despite the existence of a bushy individual of the native species Cecropia pachystachya (embaúba). The RE1N environment showed better results in the evaluation, the absence of anthropic alterations in the area without urban occupation contributed to the good evaluation of this environment, despite the natural areas that resist in maintenance and balance, but that are imminent for degradation considering the anthropic interferences already consolidated in the occupied area such as invasions, misuse of APPs; some areas with disposal of urban solid materials; various irregular activities such as: pigsties, hunting, collecting native plants (bromeliads), etc.

Aestimationes herbae mangrovae (MG) pereuntium exhibentium variae inter 8 et 34 puncta (Tabulae 4), quarum 50% per segmenta tanquam impacta et 50 alterata repraesentantur. Ambitus MG1N et MG3N pares eventus in segmentis aestimandis in locis sine occupatione urbana praesentati sunt, 32 puncta exhibens, ambitus mutatos consideratos. In ambitu MG2N non differt, quamvis aestimatio 34 punctorum, aliquantulum altior quam in MG1N et MG3N ambitus, ob anthropizationem minus, hoc quoque tractum mutandum putatur. Ambitus MG1O, MG2O et MG3O exhibitae pereuntium respective 8, 10 et 8, segmentis impactis. Eventus negativam vim in his biotopis ostendit, cum hae occupationes propriae sint suppressionis vegetationis, landimpletionis mangrovi, inordinatae dispositionis domus solidae vastitatis et aquae facultatum contagione, cum noxiis consectariis ad conservationem huius areae conservandae. Propter has irregularitates, Flumen Piaçabuçu fere totum siletur cum facie coliformum fecalium visualium et fortem odorem purgamentorum. Vegetatio mangrota insculpta et occupata *speciebus incursivis,*

maxime Hibisco pernambucensi, Achrosticum aureum et graminibus solo mutato subiecto et exposito.

COMPARATIVA AESTIMATIO MUTATIONUM IN BIOTOPES

Analyses per PAR indicatae (Tabulae 4) ostenderunt herbas densas pluviales (MA1, MA2, MA3) altiores ustulos habuisse propter summam indicem in extensionibus conservationis, quam sequitur vegetationis sandbank (RE1, RE2, RE3), perisse ad absentiam anthropicae mutationes in locis naturalibus, et cum infimis pereuntis herbae mangrotae (MG1, MG2, MG3) cum ingenti pressione urbana in area naturali.

Relatio inter biotopes videri potest in Figura 2, quae formationem globi cum ambitibus naturalibus exhibet (MA1N, MA3N, MG2N, MG1N, MG3N, RE1N, MA2N, RE2N, RE3N) et alia cum ambitibus occupatis (MG2O., MG1O, MG3O, MA1O, MA3O, MA2O, RE1O, RE2O, RE3O). Cum omnes biotopes considerantes, globus ubi classes pluviarum densarum MA1N, MA2N, MA3N et RE1N, RE2N et RE3N collocantur, maiorem similitudinem prae se ferunt, propter melioris naturae vegetationis notam. Naturales biotopes mangrovi (MG2N, MG1N et MG3N), considerantur omnia impacta secundum suum cuique pereuntis 32, 34 et 32, similitudinem prae aestimationibus in extensionibus absque occupatione urbana, vegetationis suppressione, landfill mangrove, dispositionem irregularem. solida vastitas domus et aquarum contaminatio facundia. Subdivisio etiam naturalium biotoporum quiescendi et densae rainoris (RE1N, RE3N, MA3O), omnia naturalia a PAR considerata cum valoribus respectivis 44, 46 et 44. Tractus RE1N et RE3N summas similitudines obtinuerunt. scores in vegetatione indices in suis censibus (fig. 2). In altero coetu maximae similitudines quae identificantur inter mangrove biotopes MG1O, MG3O et MG2O, cum respectivis pereuntis 8, 10 et 8, ob aestimationes eorum in PAR minorum, ob hoc quod utraque extensiones impactae sunt et considerantur. habet altior ratings. humilis ad reliquas tractus. Haec aestimationes consequuntur actiones directas humanorum actuum in his oecosystematibus, quae maxime demonstrata praesentia habitationum, cloacarum et quisquiliarum dispositionis corporum riparum et aquarum demonstrantur. Parallel huic aggregationi a similitudine sunt densae pluviae forestae biotopes MA1O et MA2N, extensiones in aestimatione alteratae consideratae, sed cum indicibus vegetationis optimis in hoc segmento, cum similibus eventibus 38, forte ex technicis vigilantia professionalibus in area oriunda. ambitu in interpellationibus exercendis. Propius huic coetui sunt sandbank biotopes RE1O, quae aestimatio 28, alterata considerata, et biotopes RE2O et RE3O cum extensionibus respectivis 24 et 26, impacta, sed quae optimae aestimationes ob resistentiam huius vegetationis habebant, sed degradationem susceptibilis.

Figura 3 infra exhibet valorem medium 9 punctorum interfaciei enucleatum referendo ad parametri taxationem diversitatis habitaculi.

Parametri aestimandi ustulo superiores optulerunt in densissimis spatiis rainforest. Notae nonnullae non diversae erant, parametri ad aquam qualitatem et fluxum pertinentes, necnon operculum diaphanum et vegetationis in lecto (fig. 3 et tabula 4). E contra, notae quae ad faunam referuntur, species rarae minatae, biome stadium successionis et vegetationis integumentum, maxime in vegetatione et mangroves sandbank, ad infima parametris pereuntia contulerunt.

DISCUSSION

Pro perpenso biotopes, eventus ab 8 ad

64 puncta discurrentia. Horum 33,5% per segmenta impacta, 39% mutata et 27,5% per segmenta naturalia considerata, parametri manifestam distinctionem inter densas pluvias et mangroves patefecit. Cum haec regio maritima expectata cuius ratio de occupatione humana deficit, summa score, sicut maior pars parametri seorsim aestimata, multo inferior mangroves fuit. Intercessio anthropica directa in oecosystematis aquaticis, demonstrata per praesentiam habitationis, cloacas et purgamentorum dispositionem in ripis et corporibus aquarum aquaticarum demonstratum est, praecipua ratio est propter valores punctuales humiles parametrorum in hoc tractu aestimandos. Praesentia condiciones impactae et mutatae pro biotopis fluvialibus consequitur propinquitatem harum ambituum ad perimetrum urbanum, quod inevitabiliter ducit ad accelerationem eutrophicationis et degradationis processuum harum systematum et qualitatem aquarum (Corgosinho et al., 2004).

Multiplex impactus humanus author fuit depravatio qualis aquarum environmental. Pelves studiosa flumina Piaçabuçu et Branco peculiare momentum repraesentant pro municipio Praia Grande. Labrum fluminis Branco magni momenti est oecologicum et environmental, quod in regione silvae pluviae mixtae cum Araucaria praesentia bene conservata et etiam, pars extensionis continet fontes maximi fluminis, intra ambitum Environmentalem. Area conservationis (APA da Serra do Mar). Praeterea, haec adficio pelvis magnum habet momentum sociale-oeconomicum, quod responsabile est aquam municipio praebere.

Quamvis copia aquarum copiae, Brasilia aquarum qualitatem diminutionem passus est. Urbanizationes et actiones intensae incolarum urbanarum, necnon substantialis expansionis agrorum agriculturae et iumentorum, notantur principales causae problematum environmentalium in Brasilia, inter pollutiones opum aquarum (Tucci 2008; Lorz et al. 2012; Da Silva; et al. 2013). Condiciones urbano-environmentales magni ponderis partes agunt in determinando qualitatem vitae, ut sanitas, purgamentorum officia, vastitas collectio, pollutio actionis anthropicae, vastitas abiecta in aperto, multiplicatio vectorum, inter alia, quae si non sunt gravi momenti tractata. potest generare inaequalitates adipiscing. Bizzo et al. (2014) credunt omnes parametros observatos et applicatos ad analysim in protocollo necessarias esse ad intellegendam studiorum aream, ut commercium analysi qualitatis aquae et oecosystematis circumfusum efficiant.

Parametri "genus occupationis marginum corporis aquae" et "exesionis vel siltationis" aestimant signa qualitates aquarum per praesentiam vegetationis ripariae. Exesio ab actionibus anthropicis in quibus aquae ductus afficiuntur cumulum faeces in materia super lectum suum evenit. Modus "anthropicae mutationes" effectum metitur in ambitu per vastum dispositionem irregularem et occupationem urbanam. Parameter "tegumentum lectum vegetabile" aestimabatur per praesentiam silvae ripariae indigenae in ambitu vestigato. Modus "typi fundi" repraesentatur per tigna, saxa et alias habitandi formas stabilis per flumen. Fluvius cum diversis habitaculis necessarius est ad conservationem organismi aquatilium, tamen, cum subiecta saepe modificantur, possibilitas sanorum habitaculorum minuit (Callisto et al., 2002).

Quoad "mutationes in alveum fluvii" notari possunt constructione aggerum, matrum vel aliarum formarum stabilizationis artificialium riparum. Rectificatio fluminum, ductus vel waterproofinge causata opera operativa in area INCILE deductionem causant, quae reductionem facit in densitate et diversitate specierum aquatilium. Humilis

sinuositas secundum flumen in campis maritimis (locis cum parvis differentiae altitudinis et aquae demissae potentiae) indicat qualitatem environmental humilem, alta gradus sinuositatis praebet loca et fauna varia, praeter adiuvandum ad dissipandam industriam ab impulsu impulsum provectam. aquae motum. Energia effusio per anfractus ab exesa et inundatione fluxum tuetur, itemque perfugium praebet invertebratis et benthicis piscibus in eventibus tempestatis. Ceteri parametri late observati sunt "genus soli", "scaenus successio" et "biome", quae spectant ad hodiernam vegetationis genus in ambitu. Sylvae Ripariarum fundamentales sunt componentes ad propriam operationem oecosystematis aquatilium. Vegetatio etiam quasi quoddam colum operatur, extenuando cumulum residuum originis anthropicae in fluviis, etiam processum infiltrationis in imbribus movet, id est conservationem vegetationis adiuvat in effusio pluviae dum degradatur. vegetationem habet humilem effusio potentialem, quae condiciones auget in superficie runoff, causando exesum et etiam augmentum faecis oneris in flumine (Barrella, 2000; Barbour et al., 1999; Callisto et al., 2002; Minatti-. Ferreira et Beaumord 2006, Rodrigues et al., 2010, Tundisi et Tundisi, 2010. Omnes parametri in analysi protocolli observati et applicati essentiales sunt ad cognoscendam aream investigandam, ut commercium analysi qualitatis aquae et oecosystematis circumfusum efficiant.

Bechter et al. (2018) methodologiam homogeneam aestimandi et monitoris status magnorum fluminum trans Europam, ex notitia georeferenced innixa, probavit. Summa causa fuit ad resolvendum quod parametri differentias inter flumina impacta optime explicant et classificationem geomorphologicam exsistentem in agro datae comparant. Aestimatio notio ad tres casus studiorum fluminum applicatur: altissima flumina impacta et canaliculata, Albis (IKSE, 2015; Raška et al., 2017) et Danuvius (Hohensinner et al., 2014), ac minus impacta. Liger in Gallia (Lasne et al., 2007). Haec aestimatio morphologiam magnorum fluminum insignivit, etiam condiciones campi appellans praeter condiciones geomorphologicas canalis, gratis per systema georeferen- cium promptum. Attamen, ob defectum accuratae cognitionis locorum naturalium, in aestimationerum exhibitarum, auctores adhuc existimant maiorem elegantiam in investigatione necessariam esse, cum respectivae collectionis notitiarum ex aliis pelvibus fluminis in Europa (Hohensinner et al. Newson and Large 2006).

PARs optimum instrumentum esse potest ad aestimationem ac notitiarum collectionem methodologiae a Betchter et al evolutae. (2018). Sicut in Australia, ubi programma a gubernatione conditum et appellatum Australiae flumen Assessment System utitur celeri censu protocolla ad monitor qualitas fluminum patriae environmental, similiter celeri Bioassessment Protocols -RBP's et flumen Habitat Survey-RHS (Parsons et al, 2002), respective, a US et UK agentia environmental, censum visualem rapidum et qualitatorem adoptare ad notandum altiorem qualitatem corporis habitaculi (Barbour et al., 1999). Haec protocolla considerari possunt analoga cum thermometris adhibitis in aestimatione salutis humanae, in qua valores temperatus ab apparatu comparatur cum iis quae "normales" considerantur. Scores unicuique parametrorum aestimatorum assignati statum systematis "salutis" indicant. Aliquot studia circum orbem versata sunt ad factores externos aestimandos fluminibus qui agunt sicut buffers contra aquam runoffam portantes faeces et contaminantes, cum primario focus in silvis ripariis (Nigel et al., 2014; Sweeney et Newbold, 2014; Hansen et al, 2015). Degradatio aquae dulcis periclitari

potest diversitatem specierum piscium, faciliorem exitum speciei incursionis (Oyugi et al., 2014).

In Brasiliensi contextu, PAR diagnosi et vigilantia locorum naturalium ad pressuras anthropicorum susceptibiles adhibitus est. Krupec (2010) usus celeri habitat diversitatis censuum protocollo ut instrumentum ad comparandas duas pelvis INCILE in Brasiliae meridionali regione positas, statum Paraná in municipio Guarapuava, pelvim fluminis Cascavel, et labrum fluvii allidens. Lapides, qui relative sunt. prope ac sub diversis intensitatibus influxuum anthropicarum. Eventus aestimatus in pelvim fluminis Cascavel significavit 55% repraesentari per segmenta alteranda et 45% sicut impacta. Ad Rio das Pedras pelvim, eventus significavit 5% mutatos esse, 30% impactos et 65% condiciones naturales exhibere. Omnibus parametris prae-bendis consideratis, segmenta fluminum et rivorum rio das Pedras pelvis altiorem score praebebant quam segmenta pelvis rio Cascavel. Notae notae ad actionem anthropicam prominebant, ut, exempli gratia, praesentia silvae ripariae, erosionis, praesentia purgamentorum et in aqua corporum vastorum, praeter mutationes in communi fluminis cursu, necnon decrescentibus. in diversitate locorum. In praesenti studio, magna differentia observata est inter biotopes aestimatos in Praia Grande et eos qui in Brasilia australi Krupec studuerunt (2010). Rio das Pedras rivus in regione Brasiliae australis meridionalis in locis naturalibus maxime porrectas (65%) in naturalibus conditionibus obtulit, quamvis portio ambituum condiciones impactas (30%) vel etiam immutatas praesentavit (30%). Haec conditio potest ob heterogeneam distributionem spatialium arearum quae in bono statu conservandae sunt. Quoad flumen Cascavel maiorem similitudinem cum eventibus parametri comparati in Praia Grande, ob id quod spatia in ambitu urbana municipii sita sunt, et consequenter condiciones fluminum et fluminum multum sunt. precario. Intra eandem pelvim hydrographicam, fluminum et fluminum extensiones inveniri possunt vegetatione totam suam longitudinem, sine ullo signo anthropicae influentiae vel exesionis in ripis et extensionibus in deiectis civitatibus. Hoc sensu, accuratiora studia perficienda sunt, quaerentes regiones debilitatissimas deprehendere, eo consilio, ut integrae administrationis evolutionis consilia in his ambitibus recipiendis intendant et ea serventur quae adhuc in bonis ambitus condicionis sunt. Impulsu negativi ab actionibus humanis oriundi sunt, in principio, ad damnum potentiale ad ambitum pertinentes. Oeconomiae naturalis saepe has actiones non alunt neque nimiam incolarum multitudinem sustinent. Usus methodi PAR contulerunt ad faciliorem et ducendam collectionem analyseos camporum, integrantes informationes de indicibus de impactibus environmental, aquae qualitate et suggestionibus circa conservationem facultatum naturalium (Costa et al., 2018).

CONCLUSION

Eventus confirmavit usum instrumenti PAR instrumentum egregium esse ad aestimandas impulsus in urbana landscapes environmental, quandoquidem vegetationis densae pluviae spatio longius ab urbana perimetro municipii Praia Grande mutationes minus repraesentativas habuerunt. biotopae aestimatae, diversae ab requietione vegetationis et mangrove, ubi condiciones habitat plerumque plus precariae ob actus anthropicos. Nihilominus, influxus processus urbanizationis, vel progressus urbani et humani non adhibeantur praetextu effrenatae degradationis harum oecosystematum.

Indiscriminatus usus facultatum naturalium ab homine, cum inde alteratio notae, processus

oecologici et regiminis fluvialis, variat promptitudinem habitaculi et compositionis trophicae in ambitu aquatica. Quatenus taxatio methodi ad percipiendas parvas mutationes aptas adhibentur, conservatio et administratio facultatum aquarum facilior et efficacior in longum tempus fit. Praemature verificationis mutationum potentialium efficit ut ne dilatatio ad totam ecosystem, permittens mitigationis mensuras excolendas. Post aestimationem environmental in extensionibus selectis peractam, cognoscere potuit Par instrumentum utile fuisse in celeri extensione extensionum biotoparum exploratarum, cum perturbationes rerum in ambitu, sicut etiam ad deprehendere potuit. differentiae, per genera statuta, condiciones environmentales minime perturbantur a condicionibus humanis actionibus graviter affectis. Haec instrumenta visualia perspicere potuerunt, per aestimationem locorum, arearum quae interveniunt ad recuperationem et conservationem biodiversitatis et aquae copiarum.

ACKNOWLEDGMENTS

To the commission for the improvement of higher education personnel (CAPES) for granting a scholarship and to Praia Grande City Hall for providing a vessel and municipal guard employees for monitoring during the work.

REFERENCES

Afonso CM (2006) A paisagem da Baixada Santista: Urbanização, transformação e conservação, SãoPaulo, Editora da Universidade de São Paulo; FAPESP, 2006.

Aguilar AG (2008) Peri-urbanization, illegal settlements and environmental impact in Mexico City. Cities, 25(3), 133–145

Barbour, MT ; Gerristsen J, Snyder, B D, Stribling J B (1999) Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish. 2. ed. Washington: EPA 841-B-99-002, 339p.

Barrella W, Petrere Júnior M, Smith WS, Montag LFA (2000) As relações entre as matas ciliares, os rios e os peixes. In Matas Ciliares: conservação e recuperação. EDUSP, São Paulo, p.187-207.

Bechter, T, Baumann K, Birk S, Bolik F, Graf W, Pletterbauer F (2018) LaRiMo A simple and efficient GIS-based approach for large-scale morphological assessment of large European rivers. Science of the Total Environment 628–629 1191–1199

Bersot MR de OB, Menezes J M, Andrade SF (2015). Aplicação do Protocolo de Avaliação Rápida de Rios (PAR) na bacia hidrográfica do Rio Imbé – RJ. Ambiência. 2015;11(2):277–294.

Bizzo, MRO; Menezes, J; Andrade, SF (2014) Protocolo de Avaliação Rápida de Rios (PAR). Caderno de Estudos Geoambientais - CADEGEO. v.04, n.01, p.05-13.

Brown LR, Cuffney TF, Coles JF, Fitzpatrick F, McMahon G, Steuer J, Bell AH Bell, May JT (2009) Urban streams across the USA: lessons learned from studies in 9 metropolitan areas. Journal of the North American Benthological Society 28:1051–1069.

Callisto M, Ferreira W, Moreno P, Goulart MDC, Petrucio M (2002) Aplicação de um protocolo de avaliação rápida da diversidade de habitats em atividades de ensino e pesquisa (MG-RJ). Acta Limnologica Brasiliensis, v. 14, n. 1, p. 91-98, 2002.

Corgosinho PHC, Calixto LSF, Fernandes PL, Gagliardi LM, Balsamão VLP (2004) Diversidade de habitats e padrões de diversidade e abundância dos bentos ao longo de um afluente do reservatório de Três Marias, MG. São Paulo: Arq. Inst. Biol., v. 71, p. 227-23.

Costa DAT, Guiçardi ACF, Sardinha DF Mincato RL (2018) Environmental quality of an urban sub-basin: A study case of Alfenas - MG Revista do Centro de Ciências Naturais e Exatas - UFSM ISSN impressa: 0100-8307 ISSN on-line: 2179-460X.

Da Silva ARI, Oliveira CO, Abreu TKA, Julião FC, Trevilato T M B, Segura-Muñoz SI (2013). Water quality of the Ribeirão Preto Stream, a watercourse under anthropogenic influence in the southeast of Brazil. Environmental Monitoring and Assessment, 185, 61–1151.

Hannaford MJ, VH Resh (1995) Variability in macroinvertebrate rapid bioassessment surveys and habitat assessments in a northern California stream. J. North Amer. Benthol. Soc. 14(3):430-439.

Hannaford MJ, Barbour MT, Resh VH (1997) Training reduces observer variability in visual-based assessments of stream habitat. J. N. Am. Benthol. Soc., v. 16, n. 4, p. 853-860.

Hansen BD, Reich P, Cavagnaro RTR, Lake PS(2015) Challenges in applying scientific evidence to width recommendations for riparian management in agricultural Australia.Ecological Management & Restoration, 16, 50–57.

Hohensinner S, Jungwirth M, Muhar S, Schmutz S (2011) Spatio-temporal habitat dynamics in a changing Danube River landscape 1812–2006. River Res. Appl. 27, 939–955.

Hohensinner, S., Jungwirth, M., Muhar, S., Schmutz, S., 2014. Importance of multi-dimensional morphodynamics for habitat evolution: Danube River 1715–2006. Geomorphology 215, 3–19.

IKSE (2015) Internationalen Bewirtschaftungsplan für die Flussgebietseinheit Elbe″ (Teil A) für den Zeitraum 2016–2021. 2017. Internationale Kommission zum Schutz der Elbe (IKSE).

Kindu M, Schneider T, Teketay D, Knoke T. (2013). Land use/land cover change analysis using object-based classification approach in Munessa-Shashemene landscape of the Ethiopian highlands. Remote Sensing, 5(5), 2411–2435.

Kremer P, Andersson E, McPhearson T, Elmqvist T (2015) Advancing the frontier of urban ecosystem services research. Ecosyst Serv 12:149–151

Krupec R (2010) Variação Sazonal das variáveis físicas e químicas em riachos de duas bacias da região centro-sul do Estado do Paraná, sul do Brasil. Ambiência Guarapuava (PR) v. 6 n. p.147 - 158 ISSN 1808 – 0251.

Lasne E, Bergerot, B, Lek S, Laffaille P (2007) Fish zonation and indicator species for the evaluation of the ecological status of rivers: example of the Loire basin (France). River Res. Appl. 23, 877–890.

Lorz C. G, Abbt-Braun F, Bakker P, Borges H, Bornick L,Fortes F H (2012). Challenges of an integrated water resource management for the Distrito Federal, Western Central Brazil: climate, land-use and water resources.Environmental Earth Sciences, 65, 1575–1586.

Mas J F, Velázquez A, Díaz-Gallegos JR, Mayorga-Saucedo R, Alcántara C, Bocco G, Pérez-Vega, A (2004) Assessing land use/cover changes: a nationwide multidate spatial database for Mexico. International Journal of Applied Earth Observation and Geoinformation., 5, 249–261.

Metcalfe JL(1989). Biological water quality assessment of running waters based on macroinvertebrate communities: history and present status in Europe. Environmental Pollution, 60(1), 101–139.

Minatti-Ferreira DD, Beaumord AC (2008) Adequação de um protocolo de avaliação rápida de integridade ambiental para ecossistemas de rios e riachos: aspectos físicos. Health and Environmental Journal, 7:39-47, 2006.

Molozzi J, Feio MJ, Salas F, Marques JC, Callisto M (2012) Development and test of a statistical model for the ecological assessment of tropical reservoirs based on benthic macroinvertebrates. Ecological Indicators, 23, 155–165.

Molozzi J, Salas F, Callisto M, & Marques JC (2013) Thermodynamic oriented ecological indicators: application of eco-exergy and specific eco-exergy in capturing environmental changes between disturbed and non disturbed tropical reservoirs. Ecological Indicators, 24, 543–551.

Newson MD, Large ARG (2006) 'Natural' rivers, 'hydromorphological quality' and river restoration: a challenging new agenda for applied fluvial geomorphology. Earth Surf. Process. Landf. 31, 1606–1624.

Nigel R, Chokmani K, Novoa, J, Rousseau AN, Alem AE (2014). An extended riparian buffer strip concept for soil conservation and stream protection in an agricultural riverine area of the La Chevrotière River watershed, Québec, Canada, using remote sensing and GIS techniques. Canadian Water Resources Journal, 39, 285–301.

Oliveira, SV, Cortes RMV (2006). Environmental indicators of ecological integrity and their development for running waters in northern Portugal. Limnetica, 25(1), 479–498.

Oliveira, JB (1999) Solos do Estado de São Paulo: descrição das classes registradas no mapa pedológico**.** In: Boletim Científico, n.45, Instituto Agronômico de Campinas.

Oyugi DO, Mavuti KM, Aloo PA, Ojuok JE, Britton JR (2014). Fish habitat suitability and community structure in the equatorial Lake Naivasha, Kenya. Hydrobiologia, 727, 51–63.

Parsons M, Thoms M, Norris R.(2002) Australian river assessment system: AusRivAS physical assessment protocol. Monitoring river health initiative technical report number 22. Canberra: Commonwealth of Australia and University of Canberra.

Raška P, Dolejš M, Hofmanová M (2017) Effects of damming on long-term development of Fluvial Islands, Elbe River (N Czechia). River Res. Appl. 33, 471–482.

Rodrigues ASL, Castro PTA, Malafaia G (2010) Utilização dos Protocolos de Avaliação Rápida de Rios como Instrumentos Complementares na Gestão de Bacias Hidrográficas Envolvendo Aspectos da Geomorfologia Fluvial: Uma Breve Discussão. Enciclopédia Biosfera – Centro Científico Conhecer, Goiânia, v.6, n.11, p. 1-9.

Simon D, McGregor D and Thompson D (2006) Contemporary perspectives on the peri-urban zone of cities in developing areas. In The Peri-urban Interface, D McGregor, D Simon and D Thompson (eds.), pp. 3–17. Earthscan, London.

Souza T Cunha C (2012) Análise dos atributos físico-ambientais do município de Praia Grande-SP. Soc. & Nat., Uberlândia, ano 24 n. 2, 303-318.

Sweeney BW and Newbold JD (2014) Streamside forest buffer width needed to protect stream water quality, habitat, and organisms: a literature review. Journal of the American Water Resources Association 50, 560–584

Tucci CEM (2008) Urban waters. Estudos Avançados, 22, 97– 111.

Tundisi, JG and Matsumura-Tundisi (2010) T. Recursos hídricos no século 21. Oficina de Textos.

Vargas JRA, Ferreira JÚNIOR PD (2012) Aplicação de um protocolo de avaliação rápida na caracterização da qualidade ambiental de duas microbacias do rio Guandu, Afonso Cláudio, ES. RBRH,17(1):161-168.

Vitousek PM, D'antonio CM, Loope LL, Rejmanek M, Westbrooks R (1997). Introduced species: a significant component of human-caused global change. New Zealand Journal of Ecology, 1–16.