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Water Legislation and Surface Waters in the Northern Region

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Abstract. The hydrographic basin and variables, the water bodies such as rivers, lakes, ponds, streams, streams, canals, swamps, veredas, and the springs that constitute the surface waters, as well as the areas that protect them, APA's and APP's, are environmentally pressured since the emergence of cities, both in the need to provide food and housing, due to population growth and exploitation of natural resources. The objective of this research was to carry out a quantitative analysis of the academic productions on the state of conservation of the surface waters of the seven states of the northern region. The method applied was a systematic and bibliometric review, with a survey of documentary data whose temporal cut was between 1981 and 2020. The bases for this search were: Coordination of Improvement of Research and Studies in Higher Education (CAPES), Google Scholar, Scientif Electronic Library Online (SciELO), Scientific Periodicals Electronic Library (SPELL), and the repositories of federal universities in the northern region. The statistical treatment of the data was done with the use of Excel software from the application of Descriptive Statistics. The data obtained and analyzed indicated that in the seven states ($\overline{x}$=12.7) of this region 168 surveys were made, of which 89 (n = 53.0%) are related to the eight selective descriptors: hydrographic basin (n = 13; 14.6%): sub-basins (n = 4; 4.5%); micro-basins and APA's (n = 3; 3.4%) each; APP's (n = 11; 12.3%); water quality (n =31; 34.8%); water bodies (n = 8; 9.0%), and springs (n = 16; 18.0%). These researches have indicated that the state of conservation, especially of the springs, is not adequate, although there are specific state legislations for their conservation, but in practice this does not occur, mainly when urban growth, agriculture and cattle raising are involved, besides mining, the most impacting of them.

Key words: Hydrology, Hydrogeographic, Water quality, Urbanization

Introduction

The territorial (3,870,000 km^2) and hydric (>60%) extension of the northern region, the number of basins (98) in 440 municipalities compromises the research and studies about the state of conservation of the hydrographic basins, hydric bodies and mainly the springs, although all seven states of this region have already enacted hydric environmental legislation (Mma, 2006).

In the state of Acre, studies on Ecological Risk Indices (ERE) measure the integrity of aquatic ecosystems in the following aspects: water quality, energy source, biotic interactions, hydrological regimes and habitat structure from eight "stressors" (e.g. mining, sand dredging) that act on water bodies, including springs and river basins (Sema-AC, 2012).

As for the Amazon, it has the largest territorial and hydric extension, the Amazon basin. Among its many sub-basins, there is the Tarumã-Açu, whose main river bears the same name, and is already impacted by oil spills from vessels, ballast water exchange, waste dumping, slurry among others (Melo & Romanel, 2018).

In the state of Amapá, land use and occupation due to non-agricultural, agricultural and mining anthropic activities drain into the waters of the sub-basins, especially by the growth of marginal urbanization of lakes, hangovers, lagoons and other types of water bodies occurring there, including on the riverbank of Macapá (Cunha et al., 2005; Cunha, 2010).

About Pará, the pollution of rivers, in certain localities such as the arc of deforestation reaches the Ararandeua and Pena rivers, in the municipality of Rodon, do Pará (Rego et al., 2011), and this action, in Castanhal (Silva, 2013), has involved the loss of the riparian forest and caused erosion, and in Eldorado dos Carajás (Barros et al., 2017), is already reaching springs, especially on private properties.

The degradation of the riparian forest also occurs in the municipalities of Espigão D'Oeste and Mirante da Serra (RO) which has caused silting up and loss of water quality As for the state of Rondônia, the erroneous use and occupation of the soil has caused contamination and loss of water quality. Another impact is the degradation of the riparian forest as it occurred. This has also been proven in the municipium of (Cerqueira et al., 2015; Kruscher et al., 2005; Lima & Silva, 2015).

In the penultimate political and geographic space of this region, Roraima, the lack of environmental planning has reached the watersheds of that state, and this has already caused the extinction of springs. The environmental implications are like what occurred in Rondônia because the pressures from deforestation have caused erosion, even so, the irregular occupation continues fast (Araújo Junior, 2016; Falcão; Pinheiro & Rodrigues, 2009).

Not even the youngest state in this region, Tocantins, which emerged on January 1, 1989, that is, after the enactment of the National Environmental Policy, Law n. 6.938/81, achieved effective control over the disorderly urban growth that determined the loss of water quality in Rio Branco (Sant'Anna; Vital & Silva, 2019).

Due to all the negative influences that are occurring in all 440 municipalities in this region, studies to update data must be constant, and this justified this research, whose relevance was determined by the need to verify the water legislation in force in these states, the river basins, and springs, to find answers to three guiding questions: 1) do all states have defined water legislation? 2) Are the researches identifying the main environmental impacts on the hydrographic basin? 3) Have the springs been frequent objects of study, and their state of conservation, as it is?

Methods

This is bibliographic research because Treinta et al. (2014) state that this method prioritizes a set of data that reflect the state of the art. It also allows the application of “filters” in stages until the formation of a database of information converging with the themes of the research. He associated himself with it, bibliometric because Moretti and Campanário (2009) exposed he wrote that it allows the use of Statistics and mathematics for quantification and description of the data obtained and analyzed.

As for the filters, in this research, they were used under the name "descriptors" because Utagawa, Gambarato and Pereira (2018) synthesized that they are facilitators to catalog publications and that, in the article, they follow a hierarchical order. In this research, they were selected in primary and secondary. For the primary selection, five descriptors were used and at least one of them was present in the three sections analyzed. In the secondary, descriptors 2, 3 and 4 should occur in at least one of the sections, and always related to the primaries (Table 1).

It is worth noting that the secondary descriptors were used soon after the application of the primers. Their presence can be isolated in the three sections, or simultaneously in them. For final composition, those who obtained the lowest values for absolute sequence were selected, because Souza and Ribeiro (2013) state that, in the Zipf Law, the lowest indexes, hierarchically, are the highest orders, and vice versa. Finally, the "objective" of each of the selected articles was observed to then approve it and use it in the composition of this research.

The search for past data was carried out based on three environmental legislative milestones which, in chronological order, are: (1) enactment of Law n. 6.938/81; (2) enactment of Law n. 9.4337/97; (3) Forest Code, Law n.12.651/12. Because of this, the time cut-off was between 1981 and 2020, to verify the real situation of the research topics in the states of that region about the legislation of each one of them.

Table 1. Descriptors applied to the selection of scientific literature

		HIERARCHIES		
Nº	**I**		**II**	**III**
1	River Basin	**A**	Sub-basin, Microbasin	1) Title. 2) Resume. 3) Keywords.
2	Hydrography (Academic nomenclature)	**B**	Hangover areas, brejo (s), channel (s), streams, watercourse (s); water body (s); igarapé (s), lake (s), lagoon(s), river (s); Surface water resources; urban water bodies; water bodies.	
3	Hydrology	**C**	Water quality, pollution (hydric; microbiological; heave metals).	
4	Environmental Terms	**D**	Analysis, diagnosis, degradation, APA, APP, conservation, environmental impacts, preservation; conservation unit; Park (State and municipal); vulnerability, sedimentation.	
5	River composition	**E**	Riverheads or watery eye; mouth.	

Note. Subtitles: I - primary descriptors; II - secondary descriptors; III - Search sections of the descriptors in literature. Source: authors (2020)

These data were obtained from access to two academic storage facilities: Higher Education Staff Improvement Coordination (CAPES), Google Scholar, Scientific Electronic Library Online (SciELO), repositories of the Federal Universities of the seven states of this region: Federal University of: Acre (UFAC); Amapá (UFAP); Amazonas (UFAM); Pará (UFPA); Rondônia (UFRO); Roraima (UFRR) and Tocantins (UFT), as well as periodicals specific to the theme, such as the Brazilian Journal of Water Resources.

The data obtained and analyzed were treated statistically using spreadsheets contained in Excel software, version 2013 (Microsoft corporation, 1993) and BioEstat 5.3 (IDSM, 2013) with the application of Descriptive Statistics (absolute and relative frequencies, arithmetic mean and sample standard deviation). After analysis, they were allocated in tables and graphs as established by the Brazilian Institute of Geography and Statistics (IBGE, 1993).

To better understand the data analyzed and described in Results and Discussion, the following script was formulated: Application of descriptors; selection of literature for each state; the states and they're individualizes (basins, micro basins, sub-basins, APP's; APA's, UC's, water quality in canals, wetlands/wetlands, lakes, lagoons, rivers, streams, and springs). Soon after, the statistics (relative and average frequency) on the data for each state are presented. It is finished with inter-State Comparative Statistical data.

Results and Discussion

Application of Descriptors

The data obtained and analyzed for the scientific literature indicated that in the application of the primary descriptors. At this stage, 168 articles were pre-selected, and the descriptor 1 "river basin" was more frequent in the abstract. In the second phase, descriptors 2, 3 and 4 were applied, and the data obtained indicated that of those selected in the previous phase, the majority (*n* = 89; 67.71%) satisfied the pre-established guidelines because they presented secondary descriptors in the three sections analyzed, of which the most prolific was "nascent", allocated in river composition, and water quality belonging to the group of "environmental terms".

Table 2. Final selection of the scientific literature after the application of the primary descriptors in the three sections analyzed

PRIMARIES										
N.D	**D.P**	**TITLE**			**SUMMARY**			**KEYWORDS**		
		fi	***fr (%)***	$\overline{x}$	***fi***	***fr (%)***	$\overline{x}$	***fi***	***fr (%)***	$\overline{x}$
1	R.B	11	12.08	2.2	16	48.48	3,2	06	18.18	1.20
2	Hdg	39	42.85	7,8	53	45.29	4,41	25	21.36	2.08
3	Hdl.	12	13,18	2.4	15	45,45	3.0	04	12.12	0.80
4	T.A	15	16,48	3.0	18	43,90	9.0	08	19.51	1.60
5	C.R.	14	15.28	2.8	18	50.0	3.6	4.0	11.11	0.50

Note. Subtitles: N.D. - Number of Descriptors. D.P - Primary Descriptors: R.B – River Basin; Hdg. - Hydrography; Hdl. - Hydrology; T. A. Academic Terms; C. R. River Composition. Source: authors (2020)

Table 3. Identification and values for the absolute, relative (%) and mean frequency for the secondary descriptors in the three sections analyzed

SECONDARIES										
N.D	**D.S**	**TITLE**			**SUMMARY**			**KEYWORDS**		
		fi	***fr (%)***	$\overline{x}$	***fi***	***fr (%)***	$\overline{x}$	***fi***	***fr (%)***	$\overline{x}$
1	**A**	02	40,0	1.0	10	62.5	2.0	01	6.25	0.2
2	**B**	37	31.62	3.8	53	45.29	4,4	25	21.36	2,0
3	**C**	10	32,25	5.0	15	43.38	7,5	06	19.35	3.0
4	**D**	32	36.36	2.5	48	54.54	3.69	19	21.59	1.46
5	**E**	14	14.17	7.0	18	54.94	9.0	04	11.76	2.0

Note. Subtitles: N.D. - Number of descriptors; D.S - Secondary descriptors; A) micro-basin and Sub-basin; B: Hydrography - surface waters, hangover areas, wetlands, canals, water bodies, urban water bodies, streams, streams, lakes, water resources, rivers; C: Hydrology - water quality; pollution (hydric; microbiological); D: Environmental Terms - Environmental analysis, water quality analysis, APA, APP (riparian forests/gallery), silting, environmental degradation, environmental diagnosis, environmental impacts, environmental parks (state; municipal), conservation units; environmental vulnerability; E: mouth, spring or water eye).
Source: authors (2020).

Selection of Literature for Each State

After the application of the secondary descriptors, the rank described by Zipf indicated that the best descriptors for selection were: Microbasin and subbasin, used in both "title" and "keywords ($\overline{x}$ = 0.2)". About the rank, Mello et al. (2017) synthesize that the lower the value, the greater the importance for a descriptor, and the lower the value, are the best orders for a literary selection. This was used in this research.

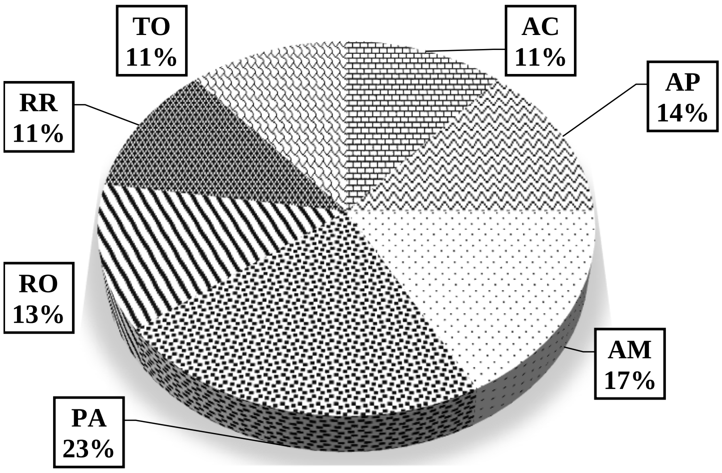

Figure 1. Relative frequency of selected scientific literature after the applications of primary and secondary descriptors

Note. Subtitles: AC - Acre; AP - Amapá; AM - Amazonas; PA - Pará; RO - Rondônia; RR - Roraima; TO - Tocantins.

The analysis of the data obtained, after the application of the secondary descriptors, indicated that the state of Amapá was the most proliferating one over the river basins and springs. Also, the data indicated that three of them: Acre, Pará, and Rondônia, produced the same number of surveys.

States, Municipalities, Hydrographic Basins and Sub-Basins of the Northern Region

Table 4. Composition of the Northern Region states in terms of the number of states, municipalities, hydrographic basins, sub-basins and hydrographic legislation

States	*fi*	*fr (%)*	H.B.	SBH	States Legislations	A. P
Acre	22[2]	03,60	04	06	State Water Resources Policy. Law n. 1.500.	2003
Amapá	16	03,60	43[7]	21[8]	State Water Resources Plan	2012
					Water Resources Management Policy. Law n. 0686	2002
					Water Rush Protection and Conservation Program, Law n. 1.284	2008
Amazonas	62	13,96	01	08[3]	State Water Resources Plan Law n. 2.712.	2001
Pará	143	32,43	14[1]	--	Water Resources Policy of the State of Pará, Law n. 6381	2001
Rondônia	52	11,71	07	42[4]	State Water Resources Policy. Law nº. 225	2002
Roraima	15	03,40	24	73[5]	State Water Resources Policy. Law n. 547.	2006
					State System of Management of Water Resources Law n. 9.123	2007
Tocantins	139	31,30	30	13[6]	State Water Resources Policy. Law n.1.307.	2002
					State Water Resources Plan.	2011
Totals	**444**	**100,00**	**98**	**139**		

Note. Subtitles: *fi* - absolute frequency; *fr* (%) - relative frequency; B.H – Hydrographic basin; SBH - Sub-Basins. [1]Pará (2001); [2] ANA (2010); [3]Coutinho (2016); [4]Simões (2017); [5]Lemos, Vieira & Ferraz (2017); [6]Tocantins (2011); [7]Portilho (2010); [8]Correa & Porto (2017); A.P - Year of Promulgation.Elaborated from data contained in the above literature.

Regarding the geographical composition of each of these states, the analysis of the data obtained indicated that the largest number of municipalities is in the state of Pará (*n* = 144; 32,43%) and the smallest composes the state of Roraima (*n* = 15; 3,37%). The average value for the territorial composition is equivalent to 63,4 municipalities for each of them. With 98 basins and 139 sub-basins, the waterway needs constant monitoring, especially the APP's, APA's and springs. Among the river basins in this region, there is the largest river basin in the world: the Amazon which encompasses the states of Acre, Amazonas, Amapá, Pará, Roraima, Rondônia, part of Mato Grosso and Tocantins, which represents 40% of Brazilian territory and a volume of water equivalent to 60% of that available in Brazil (Mma, 2006).

However, in the seven states that constitute it, research on conservation of APPs, APA's, springs, environmental diagnosis, erosion of springs are still scarce (*n* = 1; 3,22%). As for the recovery of a degraded area in them, the data indicated a trend of evolution when compared to the five previous themes (*n* = 2; 6,44%), however, about the water extension (4,106 km^2), the number of researches is minimal.

States and Their Individual Water Sources

Acre

Table 5. Selection of the scientific literature conducted in the state of Acre on the themes of this research

Descriptors	Aas; A.P.	Research location	Conclusion or final Consideration
Hydrographic Basin (*n* = 2;25%)	Santos (2005)	Judia igarapé basin	It suffers from pressures and influences of deforestation of the margins of the main tributaries.
	Franco & Barbosa (2016).	Acre-Purus basin.	Generation of conditions to solve these problems, especially for her because according to them, the urban area of the study presents great commercial activity, therefore, the consequences could be even more harmful.
	Pereira et al. (2016).	Purus basin river	The risk of disaster (10 to 18) is associated with variations in the precipitation rate, especially where there is a high rate of urbanization and deforestation.
Sub-basin (*n* = 1;12,5%)	Castro et al. (2019)	Iquiri, Antimary, Andirá, Iaco, Caeté e Xapuri.	Degradation of APP's: Iquiri: 62.3% of consolidated area; Antimary: 1.6%; Andirá: 1.5; Iaco: 25%; Caeté: 97.4$; Xapuri: 96m4%.
Microbasin (*n* = 1;12,5%)	Ferreira (2005).	Igarapé Batista	Anthropic environmental impacts, especially on headwaters, locations of springs, the impact was evidenced by fires, subsistence agriculture, and livestock

APP's (*n* = 2;12,5%)	Silva et al. (2014)	Igarapés Canela Fina e Preto	Replacement of those with crops.
Water Quality (*n* = 3;37,5%)	Abud et al. (2015)	Sub-basin do Alto Acre, Xapuri[1], Xipamanu e Riozinho do Rôla.	Deforestation caused impacts on the soil that they classified as "very high" due to the extent of the area where this occurred (±45 there is).
	Costa et al. (2006)	[2]Rivers Envira, Tarauacá e Juruá	Presence of mercury (Hg), in those, where the highest concentration of this metal occurred in the river Tarauacá (25, 96 µ).
	Domingos Neto (2014).	River Acre, urban stretch.	pH (6.16 to 7.88) and turbidity (65 to 971 FTU) with upward trends.
Springs (*n* = 1;12,5%)	Sectam (2012)	Igarapé Judia	Marginal deforestation is high. Vulnerable sites with a high Ecological Risk Index (ERI).

Note. [1]Chapurus = river before; [2]Juruá Basin. Subtitles: Aa: Author(s); A.P. Year of Publication. Elaborated from data contained in the above works of literature

For this state, data analysis indicated that of the 14-literature selected for this state, two of them (*n* = 14.28%) is water legislation (Acre, 2012). After the applications of the primary and secondary descriptors, the selection indicated that more than half of them (*n* = 10; 71.4%) were surveys that involved watersheds, but without approaching the state of conservation APA's. The data obtained also indicated that environmental parameters influence the flow of BH's and variants. The principal impacts are deforestation, urban growth on the APP (Franco & Barbosa, 2016; Santos, 2005), and these acts be caused environmental hazard and disaster risk (Pereira et al., 2016)

However, the anthropic actions practiced, how gold extraction with use of elementary mercury (Costa et al., 2006), in the APPs to growth crops (Silva et al., 2014) and springs have caused environmental changes, especially in the function of open-air discharges and receptors of effluents generated in homes, agricultural production and livestock, which compromises water quality (Domingo Neto, 2014). Other indications were directed at State water legislation that is not considered by the communities, either due to lack of knowledge, lack of inspection by the competent environmental agencies (Sectam, 2012), or lack of environmental sensitivity.

This research did not analyze the local biodiversity, but the literature indicates that the higher the vegetal suppression, the more it affects that, besides, the loss of potentially agricultural soils are lost by the erosive processes that the suppression causes, consequently, the loss of the central and marginal gutter depths compromise the communities whose economic vein is fishing. About the springs in that state, they are already in a phase of extinction, with this there is the possibility of a decrease in the number of tributaries of the Acre River, the main one in the basin of the same name.

Amapá

Table 6. Scientific research on the descriptors of this survey in the state of Amapá between 2000 and 2019

Descriptors	Aas; A.P.	Research location	Conclusion or final Consideration
Hydrographic Basin (*n* = 1; 6,6%)	Lima et al. (2015)	Cassiporé Basin	The water column of this basin showed high concentrations of heavy metals. The contribution to this was the presence of agricultural farms, riverine communities, and farming activities.
APP's (*n* = 1; 6,6%)	Medeiros et al. (2018)	Indian Lake	Changes in marginal soils due to the urbanization of floodplains, which makes their waters receptive to domestic effluent and debris.
Water Quality (*n* = 6; 40,0%)	Cunha et al. (2003)	Igarapé da Fortaleza, Curiaú River , Pedrinha, Matapi e Vila Nova.	In all these waters there are Hight levels of fecal coliforms.
	Cunha et al. (2005)	Igarapés do Matapi, Fortaleza Vila Nova e Paxicu	Risen pollution levels on the Paxicu and Fortaleza rivers when compared to the Matapi and Vila Nova rivers.
	Cunha (2010)	Canais do Jandiá e Mendonça Junior; Igarapé das Mulheres, Paxicu e Pedrinhas; áreas de ressaca do Beirol, Chico Dias, Pacoval e Cidade Nova.	In all those waters there are high levels of fecal coliforms.
	Damasceno et al. (2015)	Waterfront of Macapá	Rising pollution levels in the Paxicu and Fortaleza rivers compared to the Matapi and Vila Nova rivers.
	Lima et al. (2010)	Indian Lake	Elevation trends for pH, COD, ammonia, phosphate, and iron values.
	Vargas & Bastos (2013)		Territorial conflict causes the conservation of spaces inherent to vegetation and soil.
Hydric body (*n* = 4; 26,6%)	Portilho (2010)	Macapá City: hangover areas	Urban growth determines the creation of neighborhoods installed in the hangover of the Indian Lagoon, where there was a grounding that contributed to the flooding of the city.
	Takayama et al. (2013)	Wet areas or hangovers	These areas suffer exploitation of natural resources (e.g. clay); use and occupation of the soil carried

			out by buffalo farming, fishing and in the drought, burns occur for cleaning and pasture.
	Oliveira et al. (2016a,b)	Pedrinha and Mendonça Júnior Street Channels	Only the first water body keeps part of the riparian vegetation intact, especially downstream.

Note. Subtitles: Aa: Author(s); A.P. Year of Publication. Elaborated from data contained in the above works of literature

For the state of Amapá, 31 publications were pre-selected with the application of the primary descriptors. But after the application of the secondary ones, almost half of them (*n* = 15; 48.3%), and legislation, Law. nº 1.284 (Amapá, 2008), Program of protection and conservation of water sources, included such descriptors as objects of research. Analysis of the data also indicated that there were no studies on the springs. This is worrying because they are responsible for the appearance of the rivers (main and tributaries) that generate the HB's and its variables and do not generate enough data to provide good water management in this state. Furthermore, the number of surveys on the APPs is a minority about the number of HB's (*n* = 43; 43.9%) and Sub-basin (*n* = 21; 15.1%) contained in the geographic area of the state of Amapá.

It was observed that the water quality of 13 water bodies (12 lotic and one lentic), a large number of them (*n* = 9; 69.2%) are contaminated by heavy metals, among them the Hg, 13 times more dense than water and deposited in the substrate of these bodies, which drawl the aspects of soil. Furthermore, detritivores fish can accumulate, during their life cycle, concentrations above what is allowed by legislation, and pass, via food to the human species.

These are irreversible effects on them, as on the reproductive and nervous system. Another factor in the research was the study of social conflicts for the use of natural resources (soil and water), this can cause severe socio-environmental impacts such as possession and use of land irregularly and, consequently, affect water bodies.

But all this information is useful to municipal managers and residents, although there has been no research on the state of conservation of the springs of these water bodies, even with the enactment of Law n. 1.284 (Amapá, 2004) itself and, as the advance of urbanization intensifies in the state of Amapá over the areas of APP's, this may be compromising their state of conservation and the springs that occupy these areas.

Amazonas

Table 7. Scientific literature selected due to the presence of descriptors in the surveyed sections. The Amazonas State

Descriptors	Aas; A.P.	Research location	Conclusion or final Consideration
Sub-basin (*n* = 1; 7,1%)	Melo & Romanel (2018)	Amazonas e Tarumã-Açu	1) River/rail transport has caused oil to spill into the waters of these water bodies. 2) the passengers of these vessels throw into the waters the waste produced by them during the trip. 3) the open-air outlet produces slurry that flows into the Sub-basin.

			4) there are marinas, restaurants, floating houses, allotments, jungle hotels, among others.
Microbasin (*n* = 1; 7,1%)	Vendruscolo et al. (2020)	Médio Rio Escondido, Bacia do Guaporé.	On that river, there are 86 rural properties along their course. Thus, the density of the springs is equivalent to 10.48 km^2. In the face of the occupation, it presents high erosive susceptibility.
APA's (*n* = 2; 14,2%)	Nascimento (2009)	Duck Reserve	Two hydrographic basins: Tarumã-Mirim and Tarumã-Açu. There are predatory explorations, irregular land use, and occupation; the presence of the Tarumã-Mirim Settlement.
	Seixas (2018)	APA Guajuma.	Microbasin: Igarapé do Daguari, Juruá and Mamoriacá/Mamuriacá
APP's (*n* = 1; 7,1%)	Oliveira (2012)	Espírito Santos Basin	Her area's occupation is 56% of Coari's entire population. To this end, vegetal suppression of riparian forests occurred.
	Pereira (2013)	Puraquequara River	Cetram conducts activities in the APP area, well coo there is the presence of residents in it.
Water Quality (*n* = 6;42,9%)	Santos (2014)	Igarapé of Bindá.	Because of environmental losses such as marginal deforestation, leaching, silting, soil sealing, and domestic sewage contributed to the loss of water quality.
	Almeida et al. (2017)	Balneário does Parque 10. Igarapé do Mindu	The waters of this stream were degraded from urban growth because of the deposition of domestic effluents.
	Souza et al. (2018)	Igarapé of Mindu	The elevations in pH, OD conductivity values compromise the quality of the water.
	Machado et al. (2019)	Igarapé do Mindu	Environmental impacts have occurred for 40 years with changes both in the bed and in the margins; the springs show quality like the natural state.
	Melo et al. (2005)	Igarapés do Quarenta e Mindu	Acid water, low electrical conductivity, high levels of dissolved oxygen, low concentrations of anion cations.
	Ferreira et al. (2012)	Igarapés Bolívia, Sabiá e Alliance with God.	Ig. Bolivia: pH=4.1 and 4.9; Wisdom and Covenant with God = 6.1 to 7.3; Electrical conductivity = Bolivia 6.4 to 20.6 µS-1; Wisdom = 81.6 to 136.9 µS-1; Covenant with God = 72.4 to 194.5 µS-1.
Springs (*n* = 3; 21,4%)	Borges & Santos (2011)	Igarapé ofMindu	The disorderly occupation of marginal areas has caused pollution, silting up, vegetal suppression, waste disposal on a high scale, housing construction, is included in the riverbed and the spring.

	Mendes (2015)	Rufino's sub-Ramal Springs	From the four springs analyzed and located in the sub-Ramal area, three of them were considered in a good state of preservation and one degraded (total removal of vegetation, high fish mortality, due to the road terminal in its area.
	Costa et al. (2018)	Igarapé Goiabinha.	After physical-chemical and environmental analysis that the stream is in Class C, i.e. a reasonable environmental state.

Note. Subtitles: Aa: Author(s); A.P. Year of Publication. Elaborated from data contained in the above works of literature

Their analysis also shows that streams (*n* = 10; 71.4%); areas protected by law (*n* = 2; 14.3%), The Laws ns. 2.712 and Law 002 (Amazonas, 2001; 2014), and mora a lotic water body (*n* = 1; 7.1%) were the areas of greatest concentration of research in Amazonas. Independent of this, all the data analyzed indicated that there is degradation in them. Since waterways are prevalent in Amazonas, the communities that use them are contributors to their pollution.

Also, the vessels we transport are not subject to inspection for maintenance because one of the sources of pollution is exactly the oil that leaks from them in the waters in which they travel. Regarding APA's and APP's both are already in a stage of degradation in this state, although federal legislation, Law n. 9.985, National System of Conservation Units (Brasil, 2000), the springs that are inside them are still intact, however, those springs that generate water and these transit through those two types of areas, already arrive contaminated.

The factors that contributed most directly to this was the urban expansion. Finally, the springs, in the researches made only one three of them present a good state of conservation. The others are degraded. This may compromise the maintenance of the water bodies, be they tributaries or main rivers of the existing BH's in this state.

All of this is contrary to art. 10, item II of the Urban Master Plan for Manaus (PDDM), which deals with the protection of water resources and the use and occupation of the soil and the UC's (PDDM - AM, 2014). Therefore, in the state of Amazonas, there was no research on HB’s, but SBH and MBH were analyzed, and in both, there is an occurrence of environmental impacts of anthropic origin. APA and APP, too, and it was found that human presence is frequent. Regarding water quality, this has been the selective descriptor with the highest rate of research (*n* = 42.9%).

Pará

Table 8. Selection of surveys conducted in the state of Pará on the themes of this survey

RH1			
Descriptors	**Aas; A.P.**	**Research location**	**Conclusion or final Consideration**
Hydrographic Basin (*n* = 2; 10,5%)	Vale et al. (2015)	Apeú basin	Between 1999 and 2014 the pasture area in the area of this basin increased; that of urbanism, too. This generated vegetal suppression, exposure of the soil to pluviometric storms.

	Oliveira (2017)	Mocajuba of basin river	Its socio-environmental quality is compromised due to the disposal of solid waste that causes high health severity. The open-air spillway still exists.
Sub-basin (*n* = 1; 5,3%)	Ferreira et al. (2017	Moju River Sub-basin	The pressures due to the presence of natural resources are intense; the evolution of pasture and secondary vegetation, such as Dendeiculture and evident.
APP's (*n* = 4; 21,0%)	Sectam (2006)	Ciliary Forest	Booklet paw preservation of the riparian forest.
	Almeida & Vieira (2014)	APP, Moju.	In the municipality only 5.2% is classified as APP; 15.6% is an area of conflict with pastures; Palm cultivation, 0.63% of the APP area.
	Souza et al. (2012)	Apeu River	Growth in livestock farming has degraded 22% of his area.
	Salgado (2017)	Assentamento Cupiúba	The Apeú River in this locality is under erodibility due to the loss of vegetation cover. Environmental actions with the use of tires almost without use have halted the increase in erosion.
Water Quality (*n*= 6; 31,6%)	Maranhão (2007)	Val-de-Cães Microbasin	High parameters: pH, turbidity, electrical conductivity and OD resulting from urbanization.
	Brito et al. (2009)	Urumajó River, Augusto Corrêa.	In the five stations analyzed: A and C, good condition. B, D, E present marginal erosive processes .
	Medeiros (2012)	(1)Arapiranga River. Abaetetuba (2) Murucupi River, Barcarena	(1) IQA according to rainy period, 48±3,7 to 51±5,6, and dry period, 48±4,6 and 55±5,7. (2) IQA: rainy period = 44± 9,4 and dry period = 51± 8,3.
	Moraes (2012)	Santa Izabel River	In 12 extension points, 11 of them present OD and DBO concentrations are outside the standards established by CONAMA resolution 357/05.
	Paredes (2016)	Microbasin river São Joaquim. Microbasin Val-de-Cães.	The water from this water body was classified as "bad."
	Pereira et al. (2016)	Peixe-Boi river	The worst water conditions correlated with the irregular areas of use and occupation within the APPs.46% of the APP1s are areas of conflict of use by the class urban, exposed soil and pasture (>84%).

Hydric bodies (*n*=2; 10, 5%)	Rego et al. (2011)	Rivers Ararandeua e Peba	Water with uses for laser, fishing, maintenance of fauna and flora, navigation and animal dessedentation.
	Silva (2016)	Tracuateua River	The two most frequent uses of this river are domestic and agricultural.
Springs (*n* = 1; 5,3%)	Silva Filho et al. (2018)	Cereja River, Tracuateua, Bragança.	The Ecological Integrity Index (EI) has been classified as average, so the state of conservation is satisfactory.

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For this state, the data obtained and analyzed indicated that with the application of the descriptor 1, 31 works of literature were pre-selected, including two Laws. After the application of the secondary descriptors, most of them (*n* = 19;61.3%) are the satisfaction this. In **RH1**, data analysis indicated that two (n = 14.3%) of the 14 BH and one SBH were the subjects of research in two municipalities: BH Rio Apeú, in Castanhal and SBH Moju (n=1;5.9%), in the municipality of the same name both belonging to the Atlantic Coast-Northeast Hydrographic Region; and HB Mocajuba (Tocantins-Araguaia Hydrographic Network). In them, it was verified that the impacts caused are due to the environmental sensitivity of the communities that make use of the natural resources that they offer, and this is not related to the geographical position of the municipalities, but to an effective action of the Municipal Environmental Departments, with the application of Environmental Education as, for example, the effective participation of the communities in the management of these resources.

Another important piece of data was inherent in the APP. An of the river Apeú, the vegetal suppression reached 22% so that they appeared in the same soil, pastures. Still in its marginal extension, in a settlement in a protected area, the absence of vegetation has already caused marginal erosion that was mitigated with the use of 333 almost unserviceable tires, in which sawdust was placed and overlapped in strategic locations to reduce the loss of marginal soil. Regarding the quality of the water, only in **RH1,** it was effective. In the five surveys found, contaminants and pollutants changed the physical and chemical parameters, but the biological was not identified.

As the APP's are losing vegetation, it was expected that the turbidity would change, and this occurred. Since water bodies are economic sources for fishermen, and phytoplankton will produce little photosynthesis, primary production tends to decrease, which compromises fish food. The variations identified for the concentrations of COD and BOD can identify an aerobic bacterial proliferation, due to the allochthonous entry of organic matter that, in decomposition, there will be the high consumption of the first, therefore, it tends to decrease, and the second tends to suffer elevation. This can be the litter to the bare soil, or domestic and industrial effluents.

Table 9. Selection of research conducted in the state of Pará on the themes of this research

RH2			
Descriptors	**Aas; A.P.**	**Research location**	**Conclusion or final Consideration**
Springs (*n* = 4; 21,0%)	Silva et al. (2013)	Conceição do Araguaia.	The springs are being degraded due to the exploitation of natural resources, alternative use of the soil, compaction and sealing of it.

	Bello et al. (2014)	Utinga Environmental Park	Physical-chemical and biological parameters indicated that the actions to protect the APP, besides recovering what has already been degraded through the recomposition of the vegetation cover.
	Barros et al. (2017)	Eldorado dos Carajás	Springs in need of recovery. The "soil-cement" technique was used.

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On the other hand, the research on them was more effective (3:1) when comparing **RH2** with **RH1**. Regardless of the hydrographic region, all the ones that were researched (five of them only in Eldorado dos Carajás) were already degraded. With this, recovering them, it became necessary to apply techniques such as "soil-cement". However, the causes of the degradations are similar: anthropic activities. In Pará, Law 5630/90, in art 1, already establishes that the 'eyes of water' must be maintained from the maintenance of the riparian forest or their planting.

Rondônia

Table 10. Surveys carried out in the river basins in the state of Rondônia

Descriptors	Aas; A.P.	Research location	Conclusion or Final Consideration
Hydrografy basin (*n* = 3; 27,7%)	Mello & Victória (2010)	Basin of the river Ji-Paraná.	Delimitation of the sub-basins, from the width of the APP following the CONAMA Resolution. 357
	Zulfo & Abreu (2010)	River basin: Guaporé, Mamoré Abunã, Madeira, Jamari, Machado and Roosevelt.	Formation of the State Basins Committee to promote more effective management over the water resources, having as a standard unit the hydrographic basin.
	Moura et al. (2016)	Piranha River Basin	The extension of her area is equivalent to 7,405,16 ha, and in 296,22 ha, they shelter APPs and springs. In these areas, plant suppression is already evident in 56.77¨% of which 22.16% were in APPs.
APP's (*n* = 1; 9,0%)	Tavares & Silva (2016)	Igarapé April 2nd. Ji-Paraná Basin.	There are 224 houses in the APP's areas, 12 of them.
Water Quality (*n* = 5; 45,5%)	Lima (2007)	Analysis of the water collected by the Water and Sewage Company of Rondônia.	The values for turbidity and color identified that the water offered to the population has no potability.
	Martins (2009)	Candeias Rivers, Santa	The Sub-basin of the Candeias River, which 'is composed of the cited rivers, is

		Cruz, Preto, Ambição and Barra do Garça	under anthropic pressure, although it still has values considered normal.
	Zulfo et al. (2013)	Rivers: Guaporé, Jamari, Machado, Madeira, Mamoré.,	See Table 11.
	Krusche et al. (2005)	Comemoração and Pimenta Bueno Rivers	Changes in soil affect water quality by the biogeochemical relationship. This has allowed the classification according to the ionic load, whose loads come from the pasture.
	Silva (2018)	Igarapé April 2nd. Machado River Sub-basin	Deforestation, exposed soil, leaching and the occurrence of pollution by a point or diffuse sources, final disposal of solid waste in the area of the water body and the population concentration impact its water.
	Silva et al. (2018)	Igarapé April 2nd	Eight springs of this stream have negative environmental impacts, identified by a low concentration of OD and high concentration of Iron.
Springs (*n* = 2; 18%)	Lima & Silva (2015)	Preguinho River	CD1, already presents laminar and linear erosions, around the source, this also occurs. The construction of the road originated a pluviometric flow towards the springs, which increased the transport of sediments to the source. CD2 there is only the appearance of the waters in normal furrows. However, a voçorocamento was observed by researchers.
	Silva et al. (2019)	Igarapé 2 de abril.	In all the springs are negatives impacts; OD below standards; phosphorus, above.

Note. Subtitles: Aa: Author(s); A.P. Year of Publication. Elaborated from data contained in the above works of literature

Table 11. Water quality of the five river basins. Rondônia

Hydrografy basin	C1	C2	C3	IQA variables amended
Guaporé	--	B	M	Color
Jamari	B	B	M	Color and OD.
Machado	B	M	M	Color; pH and OD.
Madeira	B	M	M	Color; turbidity; OD and TST.
Mamoré	B	B	M	Color; turbidity; OD; and TST.

After the selection and analysis of the data obtained, it was found that in this state, a generation of important technical information about watersheds was carried out in the research conducted by Zulfo and Abreu (2010). This is because the formation of a Basin Committee in an extensive hydrographic network (92,500 km^2), should have effective management of water resources, and allow the development of more effective state legislation.

Another extremely important information on BH's was identified in the study carried out by Moura et al. (2016) in the Piranha basin and concluded that APP's and springs occupy an area equivalent to 296.22 ha. These extensions may be limiting factors for studies and research on the environmental conditions of the APPs and springs, because of the 11 selected types of research only three (Mello & Victória, 2010; Moura et al., 2016; Zulfo & Abreu, 2010) dealt with BH's, but without involving their environmental status. In the 11 selected scientific literature, five (n = 45.5%) on water quality were identified (Krusche et al., 2005; Lima, 2007; Martins, 2009; Silva, 2018; Zulfo et al., 2013).

Its degradation occurred by similar anthropogenic actions and caused physical-chemical alterations, erosion, both laminar and linear, land use and occupation by the urban expansion that compromises even the quality of the water collected by Water Company of Rondônia. This raises the cost of its treatment, evidencing an increase in the cubic meter distributed to the population. The descriptor "springs" only two surveys (n = 18.2%) were about them (Lima; Silva, 2015; Silva et al., 2019). All of them have impacts on both their soil and water quality. Therefore, the water resources in Rondônia still need more research, especially in the area of springs because they generate all and any water bodies existing there.

Roraima

Table 12. Publications about the surveys conducted in Roraima from 2010 to 2019

Descriptors	Aas; A.P.	Research location	Conclusion or Final Consideration
Hydrography Basin (*n* = 4; 40,0%)	Sander et al. (2008)	Igarapé do Carrapato Basin	The lakes that make it up are of vital importance for its survival.
	Araújo Júnior (2016)	Caranã, Franco, Grande, Mirandinha and Pricumã basins.	In the urban perimeter and the other stretches of these basins, urbanization has advanced over them and has already caused the extinction of numerous springs.
	Fortes (2017)	Cauamé River Basin	Burial of springs, construction of architectural units, disorderly occupation, absence of basic sanitation, accumulation of waste in the areas of this basin.
	Lemos et al. (2017)	The drainage basin of the Rio Branco	Identification of 73 sub-basins which make up the main.
Microbasin (*n* = 1; 10%)	Falcão et al. (2010)	Igarapé Pricumã Microbasin	The process of disorderly occupation and the lack of an Environmental Education policy and efficient inspection with allotments and invasions including in rivers and streams
Water Quality (*n* =2; 20%)	Lima et al. (2018)	Uraricoera River, Yanomami Land	The waters consumed by the indigenous people contain total coliform and E. coli, which is causing cases of acute diarrhea in them.
	Sant'Ana et al. (2019)	White River	The water quality of this water body is compromised due to the urbanization that occurs over it. This river is used by the Roraima Water Company as a spring.

Hydric Body (*n* = 3; 30%)	Amorim (2017)	Igarapés Água do Bom Intento/Boa de Cima	The proximity to the urban area determines great pressure on the environmental quality of this water body and causes impacts such as erosion, invasions, vegetal suppression of APP.
	Souza et al. (2018)	Caxangá	Impacts caused by the macro-drainage that was performed on him. The community living there causes pollution, vegetal suppression, irregularities in the settlements, and lack of basic sanitation.
	Meneses et al. (2016)	Lakes	The fast and disorderly urban expansion of Boa Vista causes environmental impacts such as early extinction of wetlands and lakes, compromising the quality of lake waters from washing clothes and launching domestic effluents.

Note. Subtitles: Aa: Author(s); A.P. Year of Publication. Elaborated from data contained in the above works of literature.

After selection 2, the data obtained were analyzed and indicated that about the BH's, four surveys carried out on them the environmental impacts that they suffered were innumerable, which pass through the disorganized urbanization, water bodies used as receptors of domestic effluents, among many. But the one of greater relevance was the loss of springs. This may cause tax losses, regardless of the hierarchical order, in addition to determining a decrease in water quality, including those that have local economic vein (eg: fishing).

Another fact, now positive, was the identification of 72 sub-basins, which increases the hydrographic network but also increases the responsibility for the management of this natural resource. If Lawn. 547/06, had been applied and the active inspection, it is possible that the extinction of springs will be mitigated.

The analysis of the data also indicated that the water bodies, especially the streams, are under intense anthropic pressure because urban expansion, macro-drainage works, vegetal suppression, among other actions, have negatively impacted these water bodies, although the protective law has existed since 2006.

The data obtained indicated that water quality (Lima et al., 2018; Sant'Ana et al., 2019) in the face of negative facts both in BH's (Araújo Júnior, 2016; Fortes, 2017; Lemos, 2017; Sander et al., 2008), MBH's (Falcão et al., 2009) and water bodies (Amorim, 2017; Meneses et al., 2016; Souza et al., 2018) objects of research, especially the one that and captured in the spring (Rio Branco) finds with the compromised quality, beyond what it occurs in the Uraricoera river, in lands Yanomami, where the presence of intestinal parasites was verified.

Tocantins

Table 13. Surveys conducted in the state of Tocantins, in the period analyzed (2010 - 2019)

Descriptors	**Aas; A.P.**	**Research Location**	**Conclusion or Final Consideration**
Microbasin (*n*=1; 10%)	Cesaro (2018)	Ribeirão Taquaruçu	Potential of urban expansion and irregular occupations the availability of water resources in it are already considered critical

APA's (*n*=1; 10%)	Panotin (2019)	APA Serra do Lajeado	Agricultural progress in the UC, and state of preservation of the springs in terms of water quality: Dry Lagoon: reasonable; Slab: good.
APP's (*n*=2; 20%)	Ribeiro (2015)	Fresh Water streams; Mutuca; Two Brothers and Pouso do Meio.	Areas already degraded in each of them Fresh Water: 28.56 ha; Mutuca: 21.48 ha; Two Brothers: 7.34 ha; Middle Landing: 6.9 ha.
	Santos (2016)	Cold Water Stream, urban perimeter	Current land cover and occupancy: Agricultural: 11.74%; urban area: 14.43%; exposed land: 16.21%
Water Quality (*n*=3; 30%)	Condo (2016)	Taquaruçu River Basin	The density of the farms and baths around her generate effluents that compromise her quality.
	Bernardeli (2017)	St. John's Stream	Environmental degradation of the basin is increasing due to the expansion of agriculture, pastures, and urban growth.
	Santos & Monteiro (2018)	Ribeirão Bananeira Conservation Unit	His spring waters already have high concentrations of total coliforms and *E. coli*
Springs (*n*=3;30%)	Neres et al. (2015).	Mutuca Stream	The impacts on it have hit the biotic environment more, and the recovery should begin with the isolation of the area.
	Oliveira et al. (2015)		In a 50 m radius between the bank and the vegetation, and proposed terrace, isolation, and reforestation.
	Carvalho et al. (2017)	Good Luck Agricultural Production Nucleus. Taquari River.	The spring is already degraded by both agriculture and extensive livestock farming. Recovery with the methods of enclosure and planting of native species.

Note. Subtitles: Aa: Author(s); A.P. Year of Publication. Elaborated from data contained in the above works of literature

In the state of Tocantins, between 2010 and 2019, 18 surveys were pre-selected, which included two state legislation, on river basins, after the application of the other descriptors, the majority (*n* = 10; 55.5%) satisfied the conditions for final selection, including two state laws. In this state, there is a commitment to water resources due to so-called irregular occupations. Moreover, the UC's (APA; APP's) are also targets of degradation in water quality, although the state of the source is still considered reasonable (Panotin et al., 2019), the problem is to know until when it will remain in this state if there is an increase in agricultural production that occurs there, and what is being done to mitigate such aggression. It is worth noting that it is not legal support that is absent because the Tocantins already have laws (Tocantins, 2011; 2012) that well managed, applied and inspected may contribute to the management, conservation through proper use of water resources.

It was verified after the data analysis that the number of dwellings, recreational or not, abound along the margins of water bodies (Bernardeli, 2017; Condo, 2016; Santos & Monteiro, 2018) and that they produce residues and effluents whose final destination and disposal has been the margins and central gutters of these resources. The consequence of this is a loss of water quality and an increase in vulnerability to the spread of gastrointestinal diseases in riverside or traditional communities such as the indigenous and fishing communities.

The springs are under recovery because the impacts reported on APA's, APP's have caused degradation in them. Studies on that action (Carvalho et al., 2017; Neres et al., 2015; Oliveira et al., 2015), proved that all the impacting activities that occurred at the level of micro basins, protection areas, whether environmental or permanent, reflect on the springs and the quality of water that springs from them, and that it can negatively affect the population in both rural and urban areas, since both have a participation in their degradation, which denotes a wide lack of applicability of laws such as the PNMA, PHRH (Brasil 1981; 1997), and Forest Code (Brasil, 2012a,b).

Conclusion

The water jurisprudence in the seven states of the Northern region was Elaborated based on Federal Legislation (PNRH, Law nº 9.433/97), and involves the State Policies, Plans, and Systems for the management of water resources. Therefore, there is no legal deficit in the North region regarding hydro resources. Regarding the conservation of APP's, the Forest Code is not observed regarding the distance rays between margins and vegetations.

The environmental impacts of anthropogenic origin, of state political scarcity involving urban growth, land use and occupation by "invasions", installation of industries, trades, ports of embarkation and disembarkation without the appropriate inspections that allow leaks of fossil fuels in water bodies, absence or deficiency of basic sanitation and especially marginal vegetal suppression are frequent in this region.

The water eyes or springs, in most states in the north, do not have legislative protection as occurs in the state of Amapá. However, in the seven states analyzed they are not the object of research in two of them, and in the others, they are still scarce, and this has caused the extinction of countless of them, especially when deforestation and leaching occur, therefore, their state of conservation is not satisfactory in the northern region.

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