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Environmental conservation index of urban streams of *Cavouco* and *Parnamirim* streams, Brazil

Índice de conservação ambiental de riachos urbanos dos riachos do Cavouco e Parnamirim, Brasil

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ABSTRACT

Historically, urban watercourses have been rectified and channeled, directly impacting their hydrological dynamics and the water cycle. Currently, the recovery of environmental and social services of urban rivers and streams has been a worldwide trend in an attempt to make cities more sustainable. This study applied the Environmental Conservation Index of Urban Streams (ECIUS), developed by Cometti et al. (2022), to two streams in the city of Recife, Pernambuco, Brazil. The ECIUS is made up of nine indicators, based on the pressure-state-response model and calculated using a system based on fuzzy rules. The *Cavouco* stream presented the "regular" ECIUS in stretch 1 and "bad" in stretches 2, 3, 4, and 5. As for the *Parnamirim* stream, sections 1 and 2 presented ECIUS as "bad" and section 3 as "terrible." ECIUS proved to be an easy-to-apply tool for modeling and translating complex environmental and social variables into easy-to-understand linguistic variables. The tool can be used for diagnosis and to serve as a decision support for urban stream revitalization and monitoring interventions.

Keywords: fuzzy logic; indicators; pressure-state-response; ECIUS.

RESUMO

Historicamente os cursos d'água urbanos têm sido retificados e canalizados, o que impacta diretamente a sua dinâmica hidrológica e o ciclo da água. Atualmente, a recuperação dos serviços ambientais e sociais de rios e riachos urbanos tem sido uma tendência mundial na tentativa de tornar as cidades mais sustentáveis. Este estudo aplicou o Índice de Conservação Ambiental de Riachos Urbanos (ÍCARU), desenvolvido por Cometti et al. (2022), em dois riachos na cidade do Recife, Pernambuco, Brasil. O ÍCARU é formado por nove indicadores, baseados no modelo Pressão-Estado-Resposta (PER) e calculado por meio de um Sistema Baseado em Regras Difusas (SBRD). O riacho do Cavouco apresentou o ÍCARU "regular" no trecho 1 e "ruim" nos trechos 2, 3, 4 e 5. Já para o riacho do Parnamirim, os trechos 1 e 2 apresentaram o ÍCARU "ruim" e o trecho 3 "terrível". O ÍCARU mostrou-se uma ferramenta de fácil aplicação para a modelagem e tradução de variáveis ambientais e sociais complexas, em variáveis linguísticas de fácil compreensão. A ferramenta pode ser utilizada para o diagnóstico e servir de apoio à decisão para intervenções de revitalização e monitoramento de riachos urbanos.

Palavras-chave: lógica fuzzy; indicadores; pressão-estado-resposta; ÍCARU.

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Introduction

Urban rivers are complex ecosystems that integrate the natural, built, and socioeconomic environments (Zhang et al., 2019). They provide various ecosystem services, such as water supply for human consumption, habitats for fauna and flora species, nutrient cycling, and microclimate regulation. They contribute to urban infrastructure, helping to drain rainwater and transport people and goods. Furthermore, they are part of people's lives, developing well-being through recreational, sports, cultural, and contemplative activities (Jia and Chen, 2013; Garcia et al., 2016; Parsons et al., 2016; Kondolf and Pinto, 2017).

However, the urbanization process, without proper planning, has been altering the natural characteristics of rivers and streams. Many watercourses are grounded, rectified, channeled, or plugged, directly impacting their hydrological dynamics and the water cycle. Its margins from space to the urban road system and even irregular beds can cause tragedies in times of flood. It also receives a large amount of untreated waste and solid waste that degrade water quality and link diseases to the population (Booth et al., 2016; Capps et al., 2016).

Currently, the recovery of environmental and social services of urban rivers and streams has been a worldwide trend (Bernhardt and Palmer, 2007). From this perspective, the concept of a linear park on the banks of watercourses is seen as a viable alternative, as it brings environmental, social, and economic benefits (Garcia et al., 2016; Kondolf and Pinto, 2017). Likewise, there is growing concern about the effectiveness of urban river revitalization projects (Palmer et al., 2014).

Some studies suggest the evaluation of the health of urban rivers through the chemical quality of the water, or by the biotic integrity, or by sanitary indicators, or by indices composed of a set of environmental, economic, and social indicators (Deng et al., 2014; Tucci, 2017; Zhang et al., 2019). Cometti et al. (2019b) selected nine indicators based on a list proposed by the Urban River Basin Enhanced Methods (URBEM), funded by the European Union. The selected indicators were classified in the pressure-state-response (PSR) model, as proposed by the Organisation for Economic Co-operation and Development (OECD, 2003).

Despite the availability of an extensive list of environmental, economic, and social indicators, there are still many limitations to implementing a methodology to evaluate the situation of urban streams in Brazil, mainly because of the unavailability of data. Another difficulty is the establishment of a score, since they are ecosystems that integrate the natural, built, and social environment (Singh and Saxena, 2018; Zhang et al., 2019). Therefore, it is necessary to develop models that can be effective in simplifying complex systems to make them easier to understand and support decision-making.

In this context, fuzzy logic can offer a suitable method that is easy to implement and contributes to the knowledge about complex environmental issues (Santos et al., 2017; Shariat et al., 2019; Zhang et al., 2019; Soares et al., 2020). This technique allows us to code software that represents algorithms closer to the way human reasoning works, obtaining satisfactory results, since it does not ignore borderline values and uncertainties of the model. For fuzzy systems, unlike the Boolean system, one element can partially belong to distinct sets. This allows the management of uncertainties and vague information (Zimmermann, 2001).

In this context, Andrade et al. (2020) proposed fuzzy water quality and biotic assessment indexes for a reservoir in Brazil. Calheiros et al. (2013) used fuzzy logic to assess the conservation of aquatic environments in the Pantanal ecosystem, Brazil. Later, Santos et al. (2017) developed a tool based on fuzzy logic to assess the sustainability of beef cattle in complex environmental systems. Zhang et al. (2019) also used fuzzy logic and PSR indicators to assess the health of an urban river in China.

Thus, this work applies the fuzzy model to calculate the Environmental Conservation Index of Urban Streams (ECIUS) proposed by Cometti et al. (2022). For this study, two streams were selected in the city of Recife, Brazil. The ECIUS was essential to assess the current condition, reflect on revitalization scenarios, and lead the government and society to direct actions for the conservation of urban streams.

Methodology

Characterization of the study area

The *Cavouco* stream is a tributary of the lower *Capibaribe* right bank in Recife, *Pernambuco*. Its source is in the Universidade Federal de Pernambuco (UFPE) and runs through the neighborhoods of *Várzea*, *Cidade Universitária*, *Engenho do Meio*, *Cordeiro*, and *Iputinga*, where it flows into the *Capibaribe* River. According to Cabral et al. (2014), it has around 18 ft of extension, around 2.6 square yard of drainage area, and around 0.00488 ft of average slope. Five sections were analyzed: Section 1: the small lake of UFPE; Section 2: *Várzea*; Section 3: *Cidade Universitária*; Section 4: the intersection between BR-101 Highway and *Caxangá* Avenue; and Section 5: the intersection between *Caxangá* Avenue and the *Capibaribe* River (Figure 1).

The *Parnamirim* stream is a tributary on the left bank of the lower *Capibaribe* in *Recife*. Records show that the spring was in the *Monteiro* neighborhood, but from there to *Jerônimo Albuquerque* Street in *Casa Forte*, the entire stretch is under construction. According to Braga et al. (2009), *Parnamirim* measures 1,170 m, has an average width of 5 m, and is considered narrow, with an average slope of 0.00139 m/m and a drainage area of 153.2 ha. The following stretches of the stream were analyzed: Section 1: intersection of *Jerônimo Albuquerque* and Dr. *Samuel Lins*; Section 2: intersection of Dr. *Samuel Lins* and *Avenida 17 de Agosto*; and Section 3: intersection of *Avenida 17 de Agosto* with the *Capibaribe* River (Figure 1).

Cavouco and *Parnamirim*'s photographs of the stretches can be seen in Figure 2.

Indicators used

Cometti et al. (2019a) selected nine indicators to evaluate the environmental conservation of urban streams and grouped them in the PSR system suggested by OECD for environmental indicators (OECD, 2003). According to the authors, the indicators of the "pressure" are related to urban activities and processes that impact watercourses. "Status" refers to the condition or quality of the environment and a chemical, a physical, and a biological indicator were selected. In addition, "urban society guaranteed as security of a stream" means that urban society's actions are guaranteed to a stream. The indicators are described in Table 1.

The fuzzy rule-based system

Cometti et al. (2022) developed a FRBS or fuzzy controller using the FuzzyGen software to calculate the ECIUS. The application was developed in the Java programming language and provides a user-friendly interface to define the parts essential for an FRBS: fuzzification, inference, and defuzzification.

In the fuzzification stage, the authors established the fuzzy sets and the fuzzy rules based on the preselected PSR indicators. Table 2 shows that 125 rules were created for the pressure sub-index, 125 for state and 27 for pressure. For the sub-indices (PRESi + STATi + RESPi), 75 more rules were elaborated, totaling 352 in the fuzzy rule base. The structure of the FRBS, developed in a web application, to calculate the ECIUS is shown in Figure 3.

For the processing of inferences, the authors used the Mamdani method, which is called maximum-minimum inference. The Mamdani inference proposes a binary fuzzy relation to mathematically model the rule base previously established by experts.

In the process of defuzzification, the results of the sub-indexes (PRESi, STATi, and RESPi) are normalized in the form of a radar-type graph on a scale from 0 to 10. It presents the result of ECIUS as a center-of-gravity graph on a scale from 0 to 100 and is classified into five conservation levels (optimal, good, regular, bad, and terrible), as previously defined in the rules. The rules that were used in the definition of the ECIUS and the respective degrees of relevance are also presented by the system.

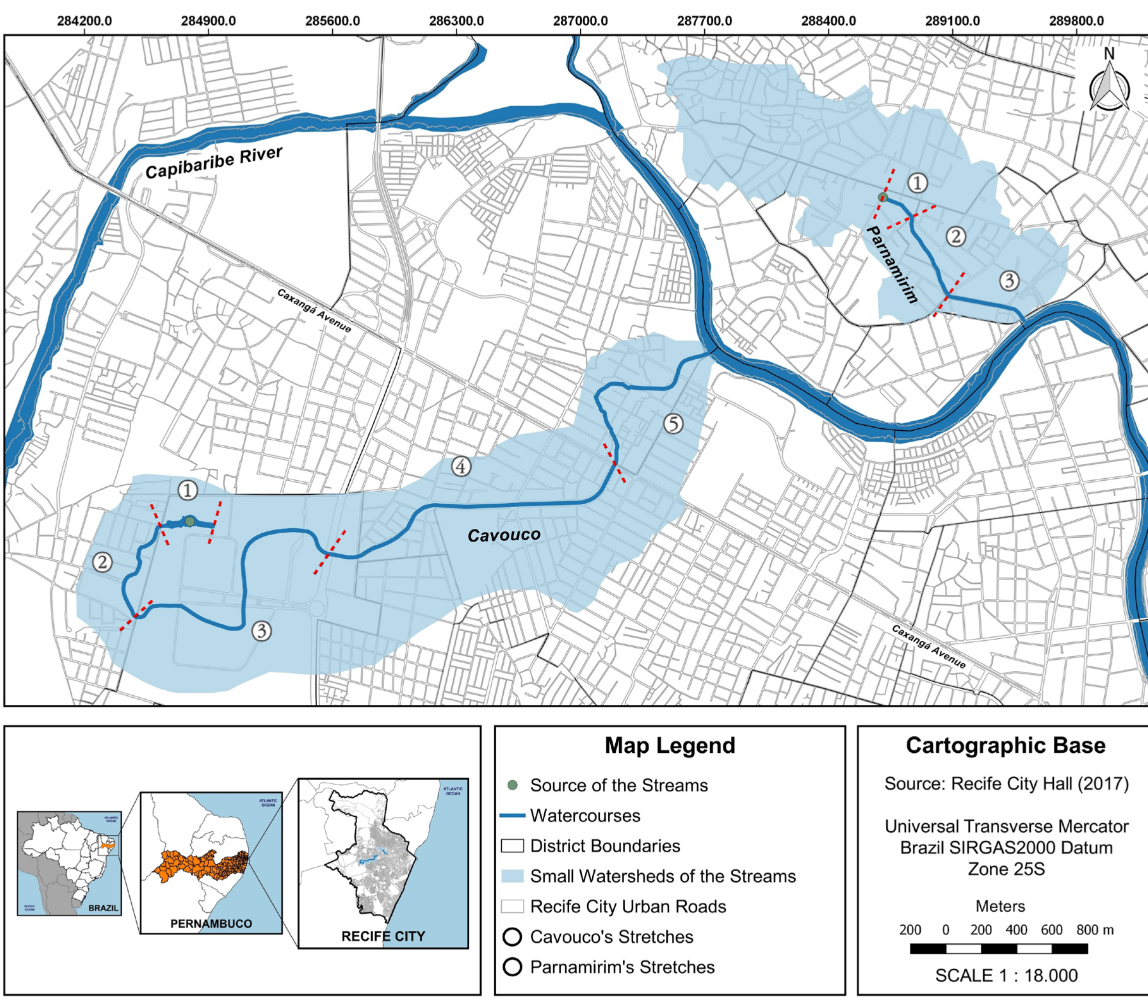

Figure 1 – Location map of the study area and characteristics of the *Cavouco* and *Parnamirim* streams.

The ECIUS can be interpreted as follows:

- Optimal: the urban stream has ecological characteristics close to the original ones and allows the sustainable use of its margins;
- Good: the urban stream has ecological characteristics a little different from the original ones and allows the sustainable use of its margins;
- Regular: the urban stream has ecological characteristics a little different from the original ones, and its margins have waterproofed parts;
- Bad: the urban stream has compromised ecological characteristics and its margins have waterproofed parts;
- Terrible: the urban stream has compromised ecological characteristics and its margins are waterproofed.

This proposed model can be used by various actors to support decisions on the revitalization and conservation of urban streams.

Figure 2 – *Cavouco* stream: (A) Section 1, (B) section 3, and (C) section 4. *Parnamirim* stream: (D) Section 1, (E) section 3, and (F) section 4.

Table 1 – Indicators that make up the Environmental Conservation Index of Urban Streams (ECIUS).

Factor	Indicators	Description
Pressure	P1: Sanitary effluent	% collection and treatment of effluent that may show pollution.
	P2: Solid waste	% collection and final disposal of solid waste that may show pollution.
	P3: Occupation at the banks	% of built occupations and road infrastructure at the banks of the stream showing the impact on lateral connectivity of the ecosystem.
State	S1: Water quality	Water Quality Index (WQI), which integrates physical, chemical, and biological parameters.
	S2: Stream channel	It tests the bedding, walls, and slopes of the stream to indicate permeability and flow between surface and groundwater and benthic fauna habitats.
	S3: Riparian vegetation	% vegetation cover on the stream banks showing the potential of habitats for fauna and stability of the stream banks.
Response	R1: Linear parks	% area with urban interventions built along the stream, with ecological, structural, recreational, cultural, and aesthetic objectives.
	R2: Drainage plan	It shows structural and nonstructural measures to reduce the impact of soil sealing in cities on flood hydraulics.
	R3: Participatory governance	It shows the mechanisms of participation in the management of urban streams to obtain better results in political-administrative actions.

Source: prepared with data by Cometti et al. (2019a).

Table 2 – Characteristics of the indicators that make up the Environmental Conservation Index of Urban Streams.

Indicator	Unit	Fuzzy variable	Reference
P1	%	P1 = 100 = very low 100 < P1 ≤ 98 = low 98 < P1 ≤ 90 = average 90 < P1 ≤ 40 = high 40 < P1 = very high[1]	National Sanitation Information System (NSIS) or other official source.
P2	%	P2 = 100 = very low 100 < P2 ≤ 98 = low 98 < P2 ≤ 90 = average 90 < P2 ≤ 40 = high 40 < P2 = very high[1]	NSIS or other official source.
P3	%	P3 ≤ 10 = very low 20 ≤ P3 < 10 = low 40 ≤ P3 < 20 = average 60 ≤ P3 < 40 = high P3 < 60 = very high[2]	Obtained through the analysis of aerial photographs, using geoprocessing tools to obtain the total area of APP and the area of the linear park within this range.
S1	Scale from 0 to 100	79 < E1 ≤ 100 = optimal 51 < E1 ≤ 79 = good 36 < E1 ≤ 51 = regular 19 < E1 ≤ 36 = bad E1 ≤ 19 = terrible[3]	Obtained through laboratory analysis following SWMM, scientific publications, or data from environmental control agencies.
S2	Scale from 0 to 25	22 < E2 ≤ 25 = optimal 16 < E2 ≤ 22 = good 11 < E2 ≤ 16 = regular 5 < Rev ≤ 11 = bad Rev ≤ 5 = terrible[4]	The coating data can be obtained via official data from the City Hall, or observed through images or field inspections.
S3	%	90 < CV ≤ 100 = optimal 70 < CV ≤ 90 = good 50 < %Veg ≤ 70 = regular 30 < %Veg ≤ 50 = bad %Veg ≤ 30 = terrible[5]	Obtained through the analysis of aerial photographs, using geoprocessing tools to obtain the total area of APP and the area of the linear park within this range.
R1	%	90 < %PL ≤ 100 = adequate 60 < %PL ≤ 90 = acceptable %PL ≤ 60 = inadequate[6]	Obtained through the analysis of aerial photographs, using geoprocessing tools to obtain the total area of APP and the area of the linear park within this range.
R2	Concept	**Adequate (100):** The plan must contain at least two structural or nonstructural measures on all the three scales: lots, public spaces, and urban infrastructure. **Acceptable (50):** The plan must contain at least one structural or nonstructural measure on all the three scales: lots, public spaces, and urban infrastructure. **Inadequate (0):** It does not contain structural or nonstructural measures on all the three scales: lots, public spaces, and urban infrastructure[6].	Analysis of the measures considered sustainable in the Urban Drainage Plan or Master Plan of the city, established by legal instrument.
R3	Concept	**Adequate (100):** It develops six or more governance instruments for the urban stream. **Acceptable (50):** It develops between 3 and 5 governance instruments for the urban stream. **Inadequate (0):** It develops two or fewer governance instruments for the urban stream[6].	Analysis of participatory governance instruments in public policies and projects focused on the management and conservation of urban watercourses.

[1]Based on the ABES ranking of the universalization of sanitation (ABES, 2019); [2]Based on Bjorkland at al. (2001); [3]Based on Von Sperling (2014); [4]Based on studies of Hannaford et al. (1997); [5]Based on and Hannaford et al. (1997) and Bjorkland et al. (2001); [6]Validated with specialists.
Source: Prepared by the authors based on data by Cometti et al. (2022).

The population is one of the main beneficiaries, as the tool is easy to apply and shows the results clearly. In this way, a society can monitor the conservation of a stream and, together with public authorities, take measures to improve local indicators.

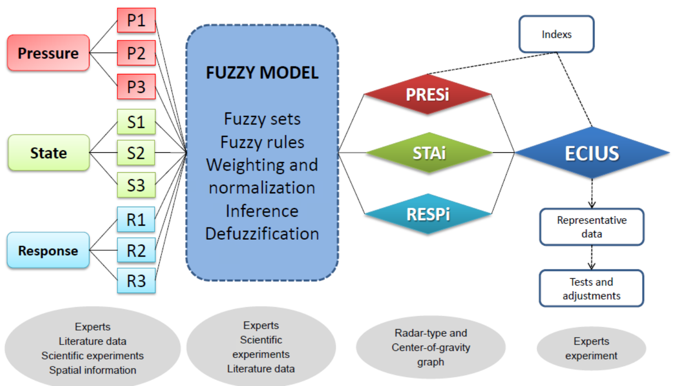

Figure 3 – Structure of the system based on fuzzy rules for calculating the Environmental Conservation Index of Urban Streams (ECIUS).

P1: Sanitary effluent; P2: Solid waste; P3: Occupation at the banks; S1: Water Quality Index; S2: Stream channel; S3: Riparian vegetation; R1: Linear parks; R2: Drainage plan; R3: Participatory governance; PRESi: Sub-index Pressure; STATi: Sub-index State; RESPi: Sub-index Response.
Source: Based on Cometti et al. (2022).

Results and Discussion

The results of the pressure (P1, P2, and P3), state (S1, S2, and S3), and response (R1, R2, and R3) indicators of the *Cavouco* and *Parnamirim* streams are described in Table 3, for each section analyzed.

The environmental conservation of the *Cavouco* stream was tested considering the results obtained through the FRBS. The first inference of each indicator was performed; then for the pressure (PRESi), state (STATi), and response (RESPi) sub-indexes, and then the third inference to calculate the ECIUS of each section. The results are listed in Table 4.

Figure 4 shows the qualitative comparative radar-type graphics, i.e., the percentage value in the fuzzy range between the worst class and the best class for sections 1, 2, and 3 of the *Cavouco* stream. Figure 5 shows sections 4 and 5. The closest indicators on line 10 (green) show positive results, and the closest indicators on line zero (red) show negative results compared to the composition of the subindicator and the ECIUS. The center-of-gravity graphs show the relevance of the ECIUS of each section to the fuzzy set, translated into the linguistic value (terrible, bad, regular, good, or optimal).

Section 1 of the *Cavouco* stream comprises the area of the UFPE small lake and presents the ECIUS as "regular." The area presents a natural gutter and good water quality. However, the deficiency of the riparian forest, linear park structures, educational actions that involve the participation of the academic community, and instruments of revi-

Table 3 – Data of the indicators per section of the *Cavouco and Parnamirim* streams.

Indicator	Unit	*Cavouco* stream					*Parnamirim* stream		
		1	2	3	4	5	1	2	3
P1 – Sanitary effluent[1]	%	32	32	32	32	32	32	32	32
P2 – Solid waste[1]	%	100	100	100	100	100	100	100	100
P3 – Occupation at the banks[2]	%	2.24	47.5	13.2	29.4	32.5	55.8	59.8	83.1
S1 – Water quality[3]	0-100	57	33	33	16	16	15	15	15
S2 – Stream channel[4]	0-25	21	11	13	13	19	16.6	16.2	13
S3 – Riparian vegetation[2]	%	18.7	38	26.7	35	43.3	39	30.5	23.7
R1 – Linear parks[2]	%	15.6	0	0	30.7	0	0	0	0
R2 – Drainage plan[5]	Concept	Inad	Inad	Inad	Inad	Inad	Inad	Inad	Inad
R3 – Participatory governance[6]	Concept	Inad	Inad	Inad	Inad	Inad	Acce	Acce	Inad

Source: [1]SNIS (2018); [2]prepared by the authors; [3]Cometti et al. (2019b); [4]Prefeitura do Recife (2016b) and validated by the authors with data observed in the field; [5]Prefeitura do Recife (2016a); [6]Prefeitura do Recife (2019).

Table 4 – Subindicators PRESi, STATi, and RESPi and ECIUS of the *Cavouco* and *Parnamirim* streams.

Sub-index	*Cavouco* stream					*Parnamirim* stream		
	1	2	3	4	5	1	2	3
PRESi	30	67.65	45.96	50	50	67.55	66.71	70
STATi	60	37.62	50	37.30	52.83	50	47.29	27.5
RESPi	25.30	25.30	25.30	25.30	25.30	25.30	25.30	25.30
Center of gravity	50	16.47	30	30	30	30	30	10.18
ECIUS	**REG**	**TERR**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**TERR**

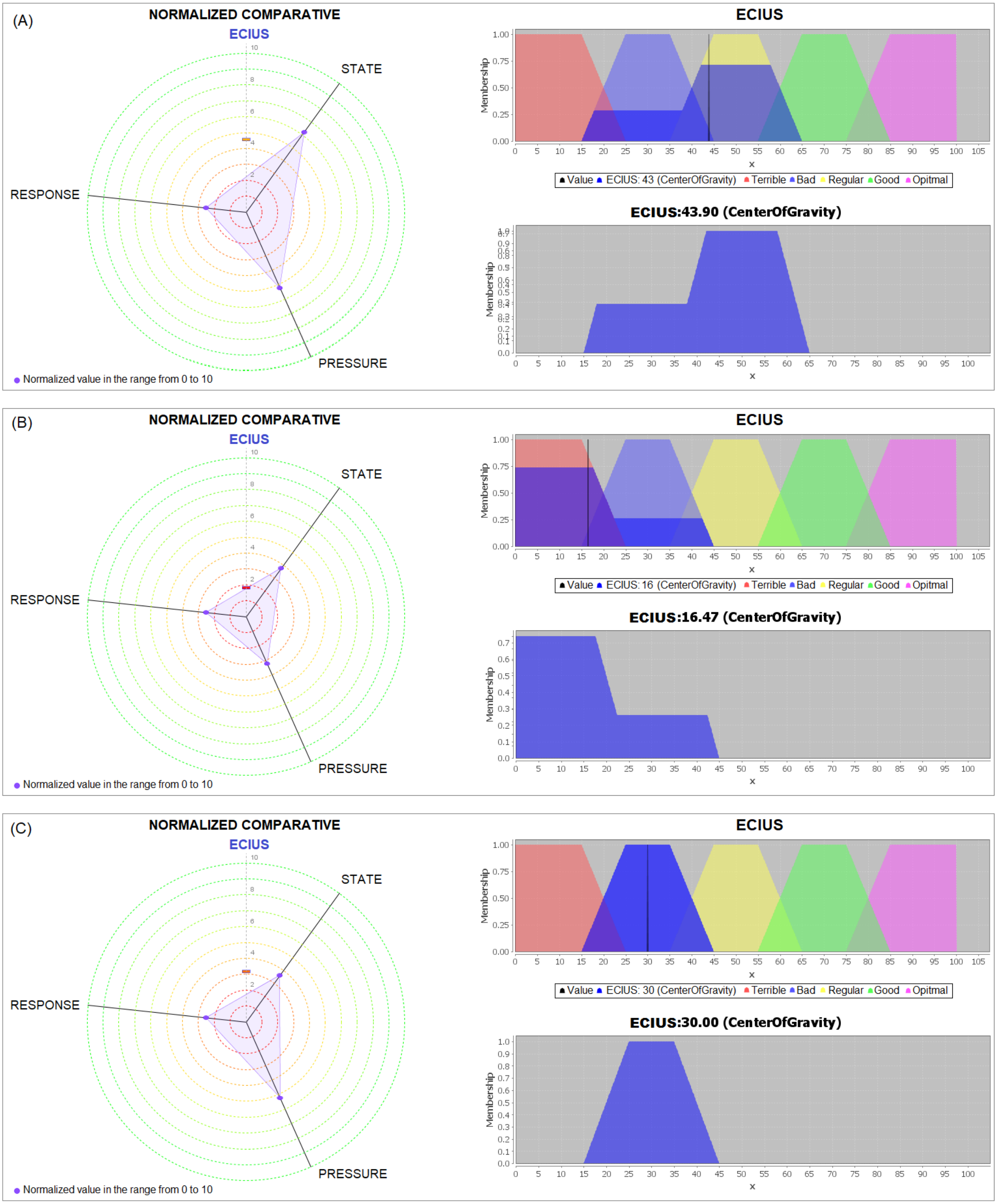

Figure 4 – Normalized values of the sub-indexes PRESi, STATi, and RESPi and ECIUS of the *Cavouco* stream. (A) Section 1, (B) section 2, and (C) section 3.
Source: Prepared by FRBS and developed by the authors.

talization of the area weakens its conservation. Yet, it presents a great potential for revitalization, since the occupation of the surrounding area causes very low pressure.

Section 2 goes through an area of already built-up residences, has part of its gutter buffered, and receives untreated sanitary effluent. It presents not only bad water quality, but it also has sections with dense vegetation and a natural gutter. It is an area that has not yet undergone rehabilitation; the ECIUS is bad, but could be improved with the removal of irregular occupations and the recomposition of the riparian forest.

Section 3 goes through UFPE. It has already been partially revitalized, with the construction of walls in stone and concrete, and slopes with grass and a few trees. Although the water quality is bad, fish were seen during the water sample collection. There is also an area near the Center for Technology and Geosciences that has not yet undergone intervention and can perfectly be revitalized with the construction of a linear park.

Section 4 has already gone through requalification work, where the *Cavouco* stream was rectified and channeled with stone and concrete walls and slopes with grass and trees. It has sidewalks, bicycle paths, and some sports equipment. However, much of its permanent preservation area (PPA) was used for building road infrastructure, and the water quality is terrible. Environmental education actions can contribute to the population by taking better care of the linear park area and contribute to conservation.

A large part of section 5 goes between residences in the neighborhood of *Iputinga*; the water quality is terrible and it has its gutter in a natural state with vegetation. In another part, near *Caiara* Park, there is a lot of vegetation and an area without use. This section also presented a bad ECIUS, but it has a great potential for revitalization by integrating it into the *Caiara* Park.

Figure 6 shows the graphs of the qualitative comparison for the stretches of the *Parnamirim* stream. The creek channel can be seen

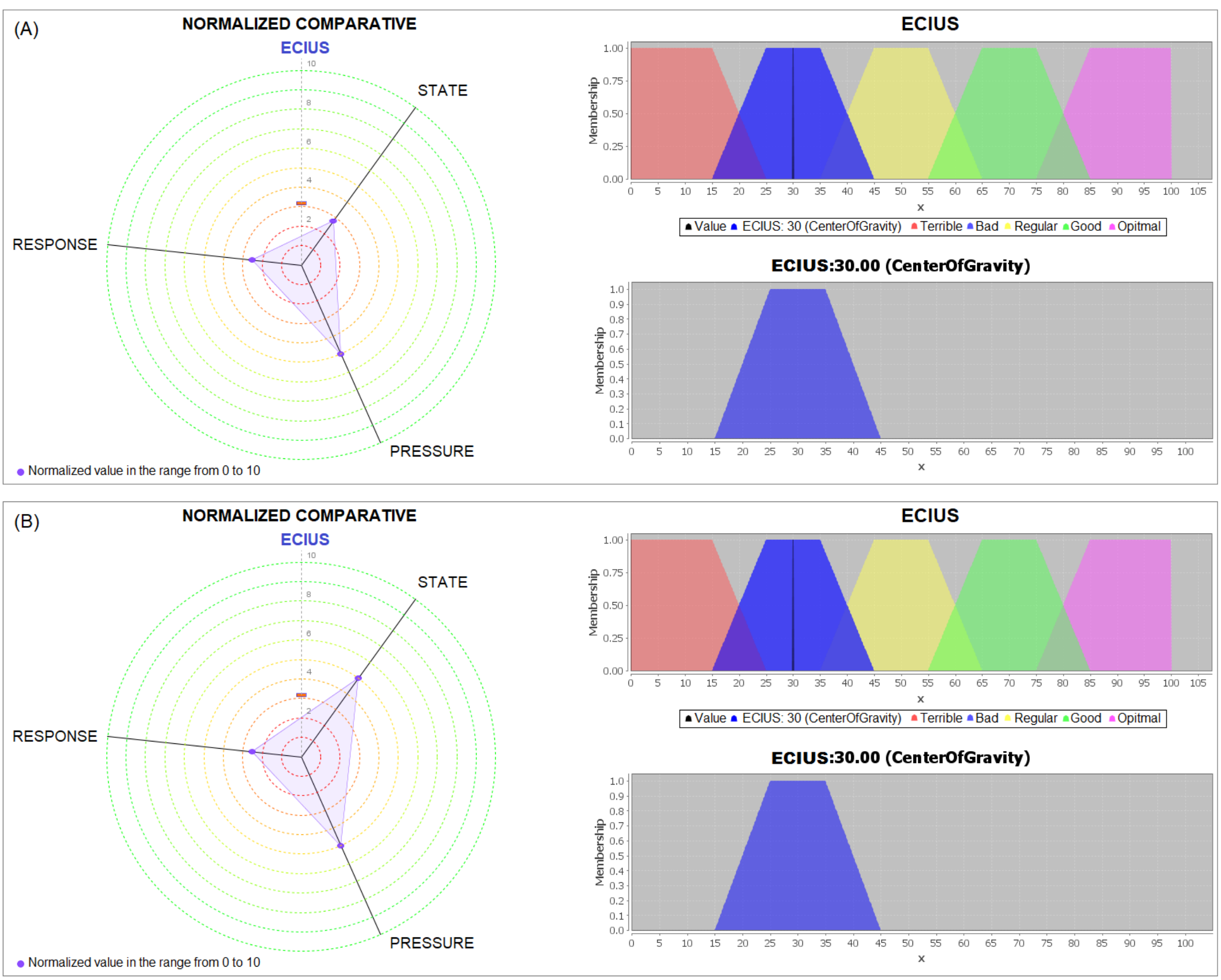

Figure 5 – Normalized values of the sub-indexes PRESi, STATi, and RESPi and ECIUS of the *Cavouco* stream. (A) Section 4 and (B) section 5.
Source: Prepared by FRBS and developed by the authors.

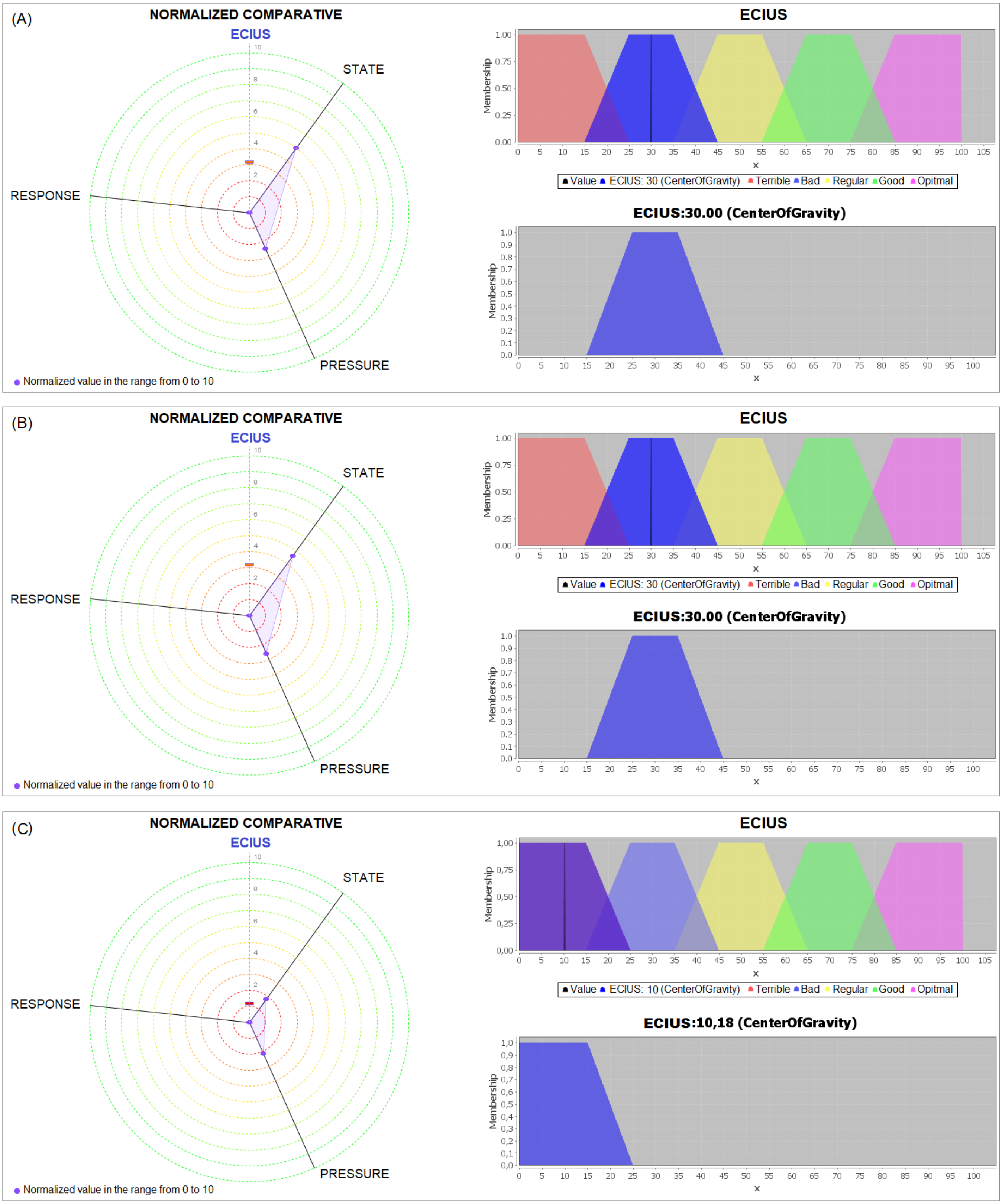

Figure 6 – Normalized values of the sub-indexes PRESi, STATi, and RESPi and ECIUS of the *Parnamirim* stream. (A) Section 1, (B) section 2, and (C) section 3.
Source: Prepared by FRBS and developed by the authors.

in section 1, as the mountain on Jerônimo de Albuquerque Street is buffered or grounded. The area is residential but still has a good part of it with dense vegetation, and that is where tortoises were sighted. Recife's city hall took on the job of removing irregulars from the APP. The ECIUS of the stretch was presented as a bad potential; however, it presents a protected area within the proposed linear park.

Section 2 of the *Parnamirim* also presented itself in 2017 with its very busy banks, including houses on its gutter. Near Dr. *Samuel Lins*, there was probably a large release of sanitary sewage or by-pass of the collection network, as it was possible to observe characteristics of sanitary sewage. At the end of 2017, the City of Recife relocated about 91 families to the residential *Lemos Torres*, built near *Parnamirim*. In this process, meetings were held with the population and environmental education actions.

Stretch 3 is located on the banks of a shopping plaza. It was channeled with concrete walls and a buffered part for the construction of roads and a viaduct. There is less depth in the margins, and inclusion has not considered the integration of people. The ECIUS was also classified as bad, and the alternative was to improve the installation of sidewalks and more important cycles.

The ECIUS presented satisfactory results, reflecting the environmental conservation of the sections of the stream studied. However, it has some limitations, such as the collection rate indicator and adequate final disposal of solid waste had a high relevance in the calculation of the pressure subindicator, because according to official data, this rate is 100% for Recife. Therefore, a considerable amount of solid waste was identified in the *Cavouco* and *Parnamirim* stream gutters. Another limitation is that the method was not applied to larger watercourses. It is strongly recommended for future studies.

Despite presenting a complex system in a simplified form, the methodology allows the adaptive improvement of ECIUS with changes in the rules and crisp numbers of fuzzy sets. It can include indicators, since experts validate them, analyze the interference in the other indicators, and create new rules. It can change whenever there are advances in knowledge and the availability of data on the proposed indicators.

Conclusion

The system based on fuzzy rules (FRBS) created to calculate the ECIUS proved to be an efficient tool, with easy application and interpretation, when applied to the *Cavouco* and *Parnamirim* streams in Recife. Through the generated graphs, it is possible to qualitatively visualize the influence of each indicator in the composition of the pressure, state, and response subindicators and in ECIUS. The tool can clearly translate, based on data measured in the field, satellite images, and official data, the conservation of the urban stream.

The *Cavouco* stream presented the ECIUS for its sections varying from regular to terrible. This ecosystem was highly affected by urbanization, having long sections rectified and channeled. Sections 3 and 4 have already gone through a requalification process. However, the road infrastructure in the PPA has been prioritized, with the canalization, waterproofing of the gutter, and reduction of vegetation on the margins. Sections 1 and 5 are still less affected by the gutter, where a revitalization project may have great success. The *Parnamirim* stream presented "bad" ECIUS in two sections and "terrible" in section 3. This stream was heavily impacted by the channeling and discharge of untreated sewage.

Another great contribution of this work is that the FRBS created to calculate the ECIUS was computationally developed in the Java language and can be made available on the web for free access. The application has a friendly, intuitive interface and allows the user to enter data regarding the nine indicators of the stretch of the stream to be studied. The ECIUS becomes relevant to carry out the diagnosis of the environment, guide the decision-making process, and subsidize the elaboration of public policies aimed at the revitalization and conservation of urban streams.

Contribution of authors:

COMETTI, J. L. S.: Conceptualization; Data Curation; Formal Analysis; Investigation; Methodology; Validation; Writing — Original Draft; Writing — Review & Editing. CABRAL, J. J. S. P.: Project Administration; Supervision; Validation. LIMA, H. P.: Software.

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