Methodology for assessing the environmental health: an application in municipalities using a multicriteria analysis[1]

Metodologia para avaliar a saúde ambiental: uma aplicação em municípios empregando a análise multicriterial

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Abstract

Currently, there are many ways of approaching the complexity of issues related to public health. One of these is the relationship between humans and the environment, specifically through environmental health indicators. Thus, this study aims to propose a methodology based on indicators of environmental health and multi-criteria analysis in order to analyze the health situation in cities, allowing environmental data to be compared between municipalities comprising the region of the upper course of the Paraíba river. To this end, archival and exploratory research and multi-criteria analysis was used. The municipality of São Domingos do Cariri had the lowest Multi-criteria Environmental Health indicator, followed by the cities of Amparo, Zabelê, São João do Tigre, Congo, Coxixola, São Sebastião do Umbuzeiro, Barra de São Miguel, Cabaceiras, Camalaú, Ouro Velho and São João do Cariri, as these municipalities had negative MEHI , in other words, they need better public management strategies in order to improve this scenario. The best performing cities, with positive MEHI were: Monteiro, Boqueirão, Sumé, Serra Branca and Prata.

Keywords: Multicriteria Decision Support; Method Promethee II; Environmental Health.

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Resumo

Atualmente são observadas muitas maneiras de abordar a complexidade dos aspectos relacionados à saúde pública. Uma delas é a relação entre os seres humanos e o meio ambiente, especificamente através de indicadores de saúde ambiental. Dessa forma, o presente estudo objetiva propor uma metodologia baseada em indicadores de saúde ambiental e análise multicritério no intuito de analisar a situação da saúde em cidades, permitindo comparar dados ambientais entre municipalidades que integram a Região do Alto Curso do Rio Paraíba. Para tanto, fez-se o uso da pesquisa documental e exploratória e da análise multicriterial. Os municípios de São Domingos do Cariri foram os que apresentaram o menor Indicador Multicritério de Saúde Ambiental, seguido dos municípios de Amparo, Zabelê, São João do Tigre, Congo, Coxixola, São Sebastião do Umbuzeiro, Barra de São Miguel, Cabaceiras, Camalaú, Ouro Velho e São João do Cariri já que estes municípios apresentaram Indicador Multicritério de Saúde Ambiental (IMSA) negativo, ou seja, que necessitam de melhores estratégias de gestão pública no intuito de melhorar esse cenário. Por sua vez, as cidades com melhores desempenhos, IMSA positivos foram: Monteiro, Boqueirão, Sumé, Serra Branca e Prata.
Palavras-chave: Apoio Multicritério à Decisão; Método Promethee II; Saúde Ambiental.

Introduction

It is possible to observe large differences in health within the same geographic context as well as economic and demographic differences, one of those being waste treatment and collection, which confirm existing inequality trends in Brazil. It is within this scenario that evaluating cities according to environmental health indicators becomes a relevant study that can stimulate discussion on the topic with the aim of proposing improvements for this scenario.

Currently, there are many ways of approaching the complexity of the aspects related to public health, one of these is the relationship between humans and the environment, specifically, through the use of environmental health indicators.

In Brazil, the practice of evaluating specific environmental factors affecting human health that come within the ambit of municipal responsibility has not been widespread. However, dramatic climate change and evolution of Brazilian society requires that the public accompaniment of government actions aimed at creating "healthy cities" be effectively evaluated (Souza et al., 2009).

For Minayo (2008) the entire health and environment debate is based on two basic assumptions: the first is that the relationship between humans and nature is essential. The second, deriving from this relationship, is that our understanding of the concept of environment is constructed from human actions. Thus, it is historical and can be thought, rethought, created and recreated bearing in mind our present and future responsibilities towards the existence, the conditions and the quality of life of society in general and of the whole biosphere.

Topics related to health have been incorporated into workers' demands. From the second half of the 19th century onwards, the so-called social medicine movement has been developing, bringing together workers, union members, politicians and doctors, especially in Germany, England and France, around the concept of health as the result of living and environmental conditions (Minayo, 2008).

The classic 1958 epidemiological study by John Snow on the transmission of cholera through sewer water in London marked the start of a new phase in analyzing health and disease conditions in human settlements. From this moment on, the importance of, and the need for, State intervention in health activities in the urban environment, in sewage, in urbanization was recognized, not only for comfort and well-being but also to prevent and control disease (Philippi Jr. and Silveira, 2004).

The World Health Organization estimates that, annually, around three million children die from water and contamination related causes. Between 80% and 905 of cases of diarrhea are cause by environmental factors (Lebel, 2005 apud Minayo, 2008).

Threats of decreases in quality of life and the spread of disease have manifested themselves due to excessive urban agglomerations allied with ecological imbalances. According to the World Health Organization – WHO, in global terms, 23% of premature deaths can be attributed to environmental factors, such as air and water pollution and exposure to chemical substances. Children's deaths, in particular, cite poisoning, respiratory infection, diarrhea and malaria (EPA, 2008 apud Souza et al., 2009).

In Brazil, the question of basic sanitation was emphasized with the promulgation of Law nº 11.445, on 5th January 2007, which established a regulatory framework in the four components of that sector: water supply, sewerage, solid waste management and stormwater management (Brasil, 2007).

In 2010, the Brazilian Institute of Geography and Statistics – IBGE, published the National Basic Sanitation Study, which showed the reality of these issues in Brazil. According to the IBGE (2010) around 35 million Brazilians, 18% of the population, live in residences which are not served by any sewage collection service.

According to information contained in the National Basic Sanitation Study – IBGE (2010), in 2006, of the 5,564 municipalities in the country, 45.7% had access to the sewer network, whereas in 2000 this figure was only 33.5%. Although half (54.3%) of the cities in the country lack this service, the percentage of population affected was 18%, as the most populous states are also those with sewage networks.

A lack of sewage treatment was also noted as, in 2008, only 28.5% of Brazilian municipalities treated their water (IBGE, 2010). However, the percentage of sewage (collected) that was treated jumped form 35.3% in 2000 to 68.8% in 2008, although this is a figure that still needs to be improved on.

With regards to the water supply, in 2008 only 33 Brazilian municipalities, concentrated in the states of Rondônia and Paraíba had no supply whatsoever. This figure is much lower than that found in 2000, when 116 municipalities had no water supply.

Even with this scenario, this information is troubling, since this current situation directly affects public health in Brazil. According to Queiroz et al. (2009), in 2005, more than 28 thousand children under five were admitted to public health care service (SUS) hospitals due to dehydration (in particular, diarrhea) caused by lack of basic sanitation.

Added to this is the fact that insufficient sanitary infrastructure clearly interfaces with the health care situation and living conditions of the populations of developing countries, in which contagious diseases continue to be significant causes of morbidity and mortality. The prevalence of these diseases is a powerful indicator of the fragility of public sanitation systems (Daniel, 2001 apud Calijuri et al., 2009).

Faced with what was stated above and given the importance of seeking better understanding of the processes by which social spaces are produces, ecological analysis of epidemiological data becomes vitally important. From this perspective, discussing this contribution consists of proposing a methodology based on environmental health indicators and multi-criteria analysis in order to analyze the health situation in cities, as environmental data can be compared between municipalities belonging to the upper Paraíba river region.

Theoretical framework

Environmental Health Indicators

The concept of health is difficult to express. At the end of the 1940s, the World Health Organization (WHO) adopted the following definition in their constitution: Health is a state of complete physical, mental and social well-being, and not just the absence of disease (Malta, 2005).

The difficulty of the health-environment relationship is characterized by the multi-disciplinarity of the factors of which it is composed. They may be political, economic, social, cultural, psychological, genetic, biological, physical or chemical (Calijuri et al., 2009).

According to Sobral and Freitas (2010), the topic of social determinants and their relationship with the health-disease process among different population groups is highly relevant to Public Health and its prominence is increasing all the time

In practice, health indicators are used when they are shown to be relevant, in other words, when they can reliably and practically show, following ethical precepts, the individual and collective aspects of health for which they were proposed (Pereira, 2007).

For the author, there are some points which need to be considered in choosing and using health indicators, including: 1) the complexity of the concept of health; and 2) facets to be considered in evaluation.

Complexity of the concept of health – measuring health is extremely complex, as there are various angles which can be focused on: mortality, morbidity, physical incapacity and quality of life, among others. There are numerous indicators for each of these aspects, making it impractical to use all of them at the same time.

According to the author, these multiple possibilities result in the indicator not being unique and liable to be used at all times. Different situations require different indicators, although many tend to correlate strictly within themselves.

Facets to be considered for review - Pereira (2007) highlights that choosing the most appropriate indicator depends on each situation, especially on the scientific issue formulated, as well as on methodological, ethical and operational aspects.

With the aim of better understanding the facets to be considered, the following points which Pereira (2007, p. 50-51) emphasized as relevant to this context are commented on:

• Validity – in the selecting an indicator to be used to reflect a given situation, the initial task is to outline the problem, condition, topic or event to be observed or measured and for which the indicator is chosen and the respective operational definition created.

• Reliability (reproducibility or trustworthiness) – a high degree of reliability means that similar results are obtained when the measuring is repeated.

• Representativeness (coverage) – analyses the population or sample representativeness.

• Ethical issues – it is an ethical imperative that the data collection not cause injury or harm to those investigated. Ethical issues also touch on confidentiality of data, although this aspect is more important in clinical than in epidemiological studies, as in this case the information divulged refers to the population as a whole in anonymous statistics

• The Technical-Administrative Angle – highlights the issue of simplicity, flexibility, ease of obtainment, compatible operational cost and opportunity. In other words, it emphasizes the availability of data for obtaining reliable and easy to manipulate data on health indicators

In addition to the specific aspects described above, it can also be affirmed that indicators play a principal role in transforming data into relevant to decision makers and the public. In particular, they may aid in simplifying a complex set of health, environment and development data, enabling a "synthesized" vision of existing conditions and trends to be produced (Vonschirnding, 2002 apud Calijuri et al., 2009).

Having said this, it can be noted that incorporating environmental together with health indicators enables a wider concept of health to be worked with, aiming to overcome the fragmented vision of the health-disease process which still prevails in analyses of health situations or even in the use of environmental indicators which include the topic of health (Sobral and Freitas, 2010).

Some indicators of environmental health are closely linked to the population's socio-economic level, including living conditions in the home and in the surrounding area. An important angle of the environmental issue concerns the coverage and quality of basic sanitations services: water supply, sewage network, refuse collection and stormwater management. A commonly used indicator is the proportion of the population served by an adequate water supply, solid waste management and regular refuse collection (Pereira, 2007). Therefore, aspects related to industrialization, urbanization and the increased circulation of people has enormous potential to alter the environment (Pereira, 2007). Thus, this study is concerned with selecting indicators capable of measuring birth rates, mortality, morbidity, health care programs (for example, Family Health Care Program coverage), demographic density and per capita health care expenditure among others.

Multi-criteria analysis—PROMETHEE II Method

Several aspects related to multi-criteria analysis, especially via the PROMETHEE method, are discussed below.

Methods belonging to the PROMETHEE (Preference Ranking Method for Enrichment Evaluation) family, which aim to construct outranking relationships for values in decision making problems, are form the French school of decision making tools. The method aims to establish a structure of preferences among the alternatives and the criteria being evaluated. (Carvalho et al., 2011a).

It is a non-compensatory method which requires data among the criteria (indicators) corresponding to their relative importance among the various objects, in other words, the weights of the criteria. These weights may result from technical calculations or expressions of value judgment. Thus, these methods encourage more balanced actions, which have better mean performance (Morais and Almeida, 2002).

In the analysis process, the objective is broken down into criteria and comparisons are made between the alternatives at the final level of decomposition and in the pairs, establishing a relationship that accompanies the preference threshold set by the decision makers (Araújo and Almeida, 2009).

According to these authors, the PROMETHEE II method (one of the methods in the PROMETHEE family) establishes a preference structure between the discrete alternatives, having a preference function between the alternatives for each criteria. This function indicates the intensity of preference for one alternative compared with another, with the value varying between 1 (indifference) and 1 (total preference).

According to Silva (2007), the steps necessary to use PROMETHEE II are:

1) The first step consists of calculating the differences between pairs according to the criterion in question for each pair of alternatives (criterion by criterion). These differences are represented by ***d***. In other words, calculating ***d*** aims to identify the difference in performance of alternative ***a*** and alternative ***b*** in relation to criterion ***j***, that is, trying to measure by how much ***a*** outranks ***b*** *(a S b);*

2) In the second stage of using PROMETHEE II, there is an evaluation process for the preference function of ***P*** (which represents the degree of preference of the decision maker when choosing one alternative in relation to another) for each ***j*** criteria according to the decision criterion model.

Almeida and Costa (2002) emphasize that the PROMETHEE method differs from other in the French school in the type of criteria used. They observe that this method can make use of six types of functions to describe the criteria considered in the implementation. For the authors, each type of criterion is characterized by a function which seeks to represent the decision maker's preference. The Preference Function *Pj (ai,ak)* which describes each criterion has values between 0 and 1.

Methodological proceedings

The methodological proceedings adopted in this study consisted of archival and exploratory research, in which multi-criteria analysis (PROMETHEE II method) was used. In the first stage, eight environmental health indicators (criteria) were chosen so as to identify aspects of the geographic context studied.

These cities are located in the sub-basin of the Paraíba river, known as the upper Paraíba river sub-basin, PB, as this is a geographic area defined according to the hydrological characteristics of the state of Paraíba. There are 17 municipalities in this sub-basin: Amparo, Barra de São Miguel, Boqueirão, Cabaceiras, Camalaú, Congo, Coxixola, Monteiro, Ouro Velho, Prata, São Domingos do Cariri, São João do Cariri, São João do Tigre, São Sebastião do Umbuzeiro, Serra Branca, Sumé and Zabelê.

The dimensions, the criteria (26 indicators) and the respective sources chosen to evaluate environmental sustainability in the sub-basin of the upper Paraíba (seventeen municipalities), were:

Chart 1 - Indicators (criteria) and relationship

Category	Environmental health indicator (criterion)	Relationship of the indicator
Health indicators	Ind1 - Infant mortality	Negative - SIM (2008)
	Ind2 - Hospitalization for dehydration in under 5s per 1000	Negative - SIAB-DATASUS (2009)
	Ind3 - Infant mortality from diarrhea (per 1,000 live births)	Negative - SIAB-DATASUS (2009)
	Ind4 - Percentage of population covered by the Family Health Care Program da	Positive - SIAB-DATASUS (2009)
	Ind5 - Quantity of health care establishments	Positive - IBGE (2009)
	Ind6 - Certain infectious and parasitic diseases	Negative - SIH/SUS (2009)
	Ind7 - Percentage of mortality from certain infectious and parasitic diseases	Negative - SIH/SUS (2009)
	Ind8 - Human Rotavirus vaccination coverage	Positive - SI/PNI (2009)
	Ind9 - Total TB vaccinations	Positive - SI/PNI (2009)
Demographic indicators	Ind10 - Demographic density	Positive - IBGE (2010)
	Ind11 - Urban population	Positive - IBGE (2010)
	Ind12 - Rural population	Positive - IBGE (2010)
	Ind13 - Ration of rural to urban population	Positive - IBGE (2010)
Economic indicators	Ind14 - Total per capita health care spending	Positive - SIOPS-DATASUS (2010)
	Ind15 - GDP per capita	Positive - IBGE (2010)
	Ind16 - SUS transfer per capita	Positive SIOPS-DATASUS (2010)
	Ind17 - Ratio between percentage SUS transfer and total health care spending	Positive - SIOPS-DATASUS (2010)
Sewage collection indicators	Ind18 - Percentage of sanitary network via sewage	Positive - DATASUS, IBGE (2002)
	Ind19 - Percentage of sanitary network via septic tank	Negative - DATASUS, IBGE (2002)
	Ind20 - Percentage with no sanitary installations	Negative - DATASUS, IBGE (2002)
Refuse collection indicators	Ind21 - Percentage of refuse collection	Negative - DATASUS, IBGE (2002)
	Ind22 - Percentage of burnt refuse	Negative - DATASUS, IBGE (2002)
Indicators concerning access to water and water quality	Ind23 - Incidence of analyses of turbidity outside the standards (%)	Negative - SNIS (2008)
	Ind24 - Incidence of analyses of residual chlorine outside the standards (%)	Negative - SNIS (2008)
	Ind25 - Incidence of analyses of total coliforms outside the standards (%)	Negative - SNIS (2008)

The choice of indicators was justified primarily by availability of data as well as analysis of the positive / negative relationship each had with environmental health related aspects. For example, the percentage of the population covered by the Family Health Care Program (PSF), the higher this indicator, the better the municipality's situation with regards issues which pervade environmental health in a specific location (positive relationship), in other words, the higher the level of PSF coverage (primary care - working to promote health), the better local environmental health. On the other hand, the higher infant mortality rate, the worse the performance of this location (area studied) with regards environmental health. Similar arguments were made for the other indicators in the study, taking into consideration other studies using the same understanding: Waquil et al. (2007), Martins and Cândido (2008), Carvalho et al. (2011b).

At this stage, the work of Calijuri et al. (2009) was taken into consideration, as they emphasized that discussion of the health-environment relationship is characterized by the multi-disciplinarity of the factors of which it is composed. These may be political, economic, social, cultural, psychological, genetic, biological, physical or chemical. The selected indicators related to environmental health issues, namely: 9 health indicators, 4 demographic indicators, 3 sewage collection indicators, 2 refuse collection indicators and 4 indicators relating to access to water and water quality.

Data with temporal differences as low as possible, whilst taking into account their availability and the authors' criterion, were sought for this study.

The PROMETHEE II method was chosen to aid in elaborating the methodology proposed for this research, firstly because it is easy to comprehend, thus reinforcing the transparency of the decision making process and also the order of the alternatives according to the various criteria - it is simple and the concepts and parameters involved in its application - indifference, weak and strong preference - has tangible meaning for the decision maker (Jannuzzi et al., 2009).

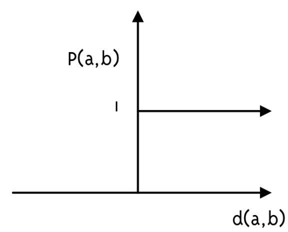
The definition of the weights (*wj*) for the (*n*) criteria present in analyzing the decision problem can be seen in Chart 2. Equal weight is attributed to each indicator when analyzing the environmental health of the cities studied, as it is assumed that no indicator has greater explanatory power than another. Therefore, all of them act on the index to be proposed with the same intensity.

Chart 2 - Weight Matrix of the Criteria

Criteria	*c1*	*c2*	*c3*	*cj*	*cn*

After analyzing the data collected, the general criteria, study parameters and preference function were chosen, the choice of which is for type 1 function. In this function, the rationale should be carried out as followed: there is only indifference between two alternatives *a* and *b*, when *f(a)=f(b)*; when the evaluations were different, there is a strict preference for the best alternative. In this case, there is no need to define parameters. In other words, in the research, 0 is attributed when the indicator is indifferent or worse than that with which it was compared, 1 when the indicators is better.

Figure 1 - Usual type 1 preference function used in the study



Source: Cavassin, 2004.

In turn, the positive and negative flows of the method adopted in the study were calculated based on the formula below (Chart 3).

The PRADIN (Program Supporting Decision Making based on Indicators) program version 3.0 was used as support in producing reports using parity analyzes between the cities and the criteria (indicators).

Chart 3 - Formulas of the Positive and Negative flows of the Promethee II Method

Index of aggregated preference (A_i, A_k):	$\pi(A_i, A_K) = \sum_{j=1}^{n} w_j \, P_j(A_i, A_K)$
The input flow, representing the Positive outranking flow, shows by how much alternative "A" outranks the others and is calculated using formula:	$\emptyset^{+}(A_i) = \sum_{j=1}^{m} \pi\,(A_i, A_K)$
The outflow, representing the Negative outranking flow expresses by how much alternative "A" is suprpassed by other alternatives and is calculated using formula:	$\emptyset^{-}(A_i) = \sum_{j=1}^{m} \pi\,(A_i, A_K)$
In the PROMETHEE II, it is necessary to calculate the net flow:	$\emptyset(A_i) = \emptyset^{+}(A_i) - \emptyset^{-}(A_i)$

Source: Adapted from Silvério et al. (2007).

Results and discussion

Comparison of the Municipalities with the respective criteria

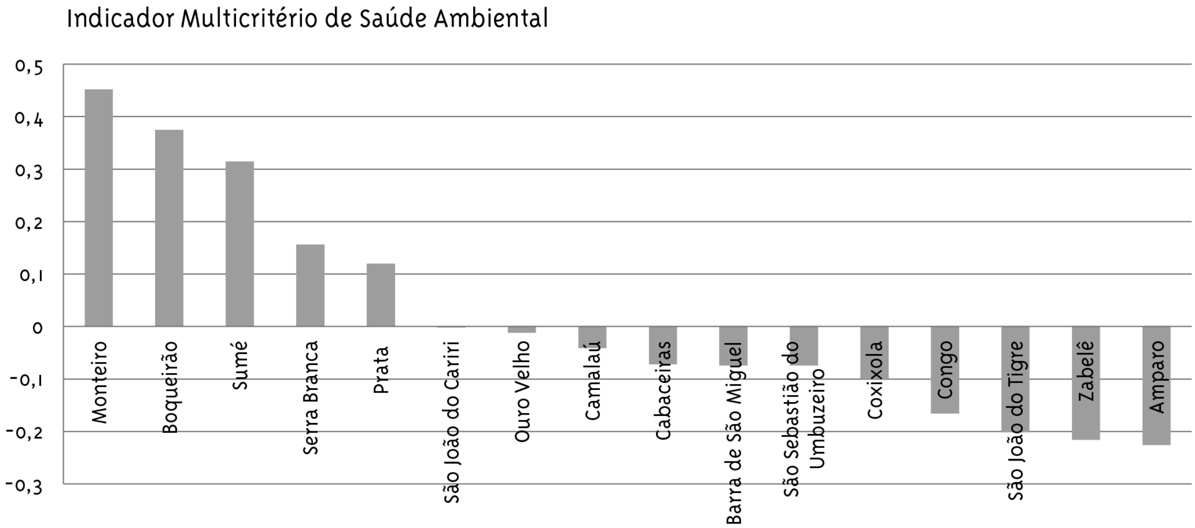
The results found after comparisons between the municipalities and the respective indicators (26 in total), the general synthesis (Table 1), shows that the municipality of São Domingos do Cariri is that which had the lowest Multi-criteria Environmental Health indicator (MEHI = -0.2332), followed by the municipalities of Amparo (MEHI = -0.2260), Zabelê (MEHI = -0.2163), São João do Tigre (MEHI = -0.2019), Congo (MEHI = -0.1659), Coxixola (MEHI = -0.0986), São Sebastião do Umbuzeiro (MEHI = -0.0745), Barra de São Miguel (-0.0745), Cabaceiras (-0.0721), Camalaú (-0.0409), Ouro Velho (-0.0120) and São João do Cariri (-0.002), as these municipalities had negative MEHIs, in other words, they need better public management strategies to improve this situation. The cities which performed best, with positive MEHIs, were: Monteiro (MEHI= 0.4519), Boqueirão (MEHI= 0.3750), Sumé (0.3149), Serra Branca (0.1562) and Prata (0.1202).

The results shown in Table 1 allow the position of the municipality to be identified according to the Multi-criteria of Environmental Health Index, on a scale of 0 to 100, as well as the decreasing order (ordinal position of the MEHI), for example, the cities of Monteiro, Boqueirão, Sumé and Serra Branca had the highest MEHI values, occupying positions, 17, 16, 15 and 14, respectively, these being the cities with the highest environmental health indicator according to the parameters of choosing the twenty-six analyzed indicators. São Domingos do Cariri, Amparo, Zabelê and São João do Tigre had the lowest MEHI scores, occupying the 1st, 2nd, 3rd and 4th positions, i.e., they were the cities in the opposite situation, needing more investment and public policies consistent with the reality of each place. The behavior of each municipality in the ranking can be seen in Table 1 and Figure 3. Ranking the municipalities becomes essential, as it enables the performance of each municipality to be visualized and may also allow them to be compared over time.

Table 1 - Ranking of the municipalities using the Multi-criteria Environmental Health Indicator (MEHI)

Ranking/Municipalities	Multi-criteria Indicator (MEHI)	Scale 0 — 100	Positive Flow	Negative Flow
1º Monteiro	0.4519	99.9	70.9	25.7
2º Boqueirão	0.3750	88.7	65.1	27.6
3º Sumé	0.3149	80.0	62.2	30.7
4º Serra Branca	0.1562	56.8	53.6	37.9
5º Prata	0.1202	51.5	52.8	40.8
6º São João do Cariri	-0.002	0.0	46.1	46.3
7º Ouro Velho	-0.0120	32.2	45.4	46.6
8º Camalaú	-0.0409	28.0	43.0	47.1
9º Cabaceiras	-0.0721	23.5	42.7	49.9
10º Barra de São Miguel	-0.0745	23.1	41.5	49.0
11º São Sebastião do Umbuzeiro	-0.0745	23.1	40.3	57.8
12º Coxixola	-0.0986	19.6	41.3	51.2
13º Congo	-0.1659	9.8	36.7	53.3
14º São João do Tigre	-0.2019	4.5	34.8	55.0
15º Zabelê	-0.2163	2.4	32.6	54.3
16º Amparo	-0.2260	1.0	32.6	55.2

Figure 2 - Ranking of municipalities using the Multi-criteria Environmental Health Indicator



The outranking flows are shown as positive and negative flows (Table 2). They indicate the percentage of comparisons of the indicators (two by two) in which the municipality outranked or was outranked by the others according to the defined preference function (in this case, the usual criteria). Monteiro had the highest positive outranking flow, compared with each of the other municipalities studied, it outranked the others in 70.9% of the comparisons and was outranked in approximately 25.7%; Boqueirão outranked in 65.1% and was outranked in 27.6%. In other words, this means that, with regards environmental health, Monteiro, Boqueirão, Sumé, Serra Branca and Prata are not in disadvantaged situations, as their indicators outranked those of the other municipalities in the majority of comparisons.

Table 2 - Parity analysis of positive and negative flows

Fluxos/Municípios	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fluxos +	70,9	65,1	62,2	53,6	52,8	46,1	45,4	43	42,7	41,5	40,3	41,3	36,7	34,8	32,6	32,6	32,2
Fluxos	25,7	27,6	30,7	37,9	40,8	46,3	46,6	47,1	49,9	49	57,8	51,2	53,3	55	54,3	55,2	55,5
Fluxos + (-) Fluxos -	42,2	37,5	31,5	15,7	12	2,8	(-1,2)	-4,1	-7,2	-7,5	-17,5	-9,9	-16,6	-20,2	-21,7	-22,6	-23,3

Source: Research data, GEOPORTAL AESA, 2012.

Final considerations

The main findings with this methodology are of great importance to the study, as they contribute more than a look at the region in question, being capable of establishing an environmental health index for the municipalities through analyzing the indicators and dimensions.

The ranking obtained using the Preference Ranking Method for Enrichment Evaluation (PROMETHEE II) method emphasizes the differences between the healthiest and least healthy cities with the context of the environment. Whereas Monteiro was considered to be more sustainable (better environmental health), with a net flow of 45.2, that of São Domingos do Cariri had the worst net flow (negative) -23.3.

It is noteworthy that using the PROMETHEE II method in the case study may present different results if the parameters of the preference functions were different, this being an intrinsic characteristic of the method. On finalizing the study, it is possible to conduct a critical analysis of the situation of the cities in the region that have a better environmental situation, contributing to this area so that reflections are made on the level of development of the cities investigated and can, in theory, aid in formulating better public policies.

Although the results generated by using this methodology are considered satisfactory, as they allow the context of Paraíba studied to be better understood, it is expected that new concerns and different analytical possibilities will arise from the results of the proposed environmental measurement, mainly because knowledge associated with measuring sustainability and environmental health in the geographic concept in question is still in the process of maturing and scientific development.

A limitation of this study is in the fact that there are many restrictions in constructing an environmental health index (not to mention environmental sustainability) and also some arbitrariness, including whether the indicator is made up of various dimensions or just one, which dimension(s) will enter into the composition of the indicator, and the definition of weights, configured as arbitrary steps as there are no dimensions, weights or indices imposed by society, as argued by Dutt-Ross et al. (2010).

It is also noteworthy that this study selected only 26 indicators and 17 cities, a greater quantity than that selected in a previous study of the region: more information can be obtained in Carvalho et al. (2011b), when they tested the methodology using only eight indicators. It is expected that these results will encourage further research, so that it will be possible to increase the number of indicators and dimensions (social, economic, environmental, political-institutional, etc.).

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