EFFECTIVENESS OF THE EMPIRICAL FRUITION OF THE RIGHT TO WATER IN URBAN CONTEXTS: AN ANALYSIS OF DISPARITIES AMONG BRAZILIAN SUBNATIONAL STATES, FROM 2013 TO 2020

Efetividade da fruição empírica do direito à água em contextos urbanos: análise de disparidades entre as unidades federativas brasileiras, de 2013 a 2020

Hugo Luís Pena Ferreira
Universidade Federal de Jataí (UFJ), Jataí - GO
ORCID: https://orcid.org/0000-0003-2647-6616
URL: http://lattes.cnpq.br/2438328359443143
E-mail: hugopena@ufj.edu.br

Daniela Silva Amaral
Universidade Federal de Jataí (UFJ), Jataí – GO
ORCID: http://orcid.org/0009-0001-6264-072X
URL: http://lattes.cnpq.br/5191442035531634
E-mail: danielaamaral613@gmail.com

Trabalho enviado em 22 de abril de 2023 e aceito em 01 de setembro de 2023

ABSTRACT

Formal recognition of the right to water does not necessarily translate into practical implementation. Objective: to establish and measure the practical implementation of the right to water through observable and measurable variables to identify significant gaps or obstacles in its implementation in Brazilian Federative Units between 2013 and 2020. Method: based on efforts to quantify the implementation of the right to water through the development of indicators, the paper employs the methodology of Positional Analysis, within the theoretical framework of Legal Analysis of Economic Policy (LAEP), to investigate to what extent the right to water is fulfilled in Brazilian Federative Units, in urban contexts, and to identify the factors that contribute to its implementation, or lack thereof, in practice. Results and contributions: (i) despite improvements in urban water supply coverage, water became, on average, more turbid, less financially affordable, and with more residual chlorine over time in Brazil; (ii) higher levels of fruition are found in the Southeast, and lower, in the Northeast; and (iii) performance indexes are mainly correlated to the control of turbidity, of the presence of total coliforms, and to the expansion of urban water supply infrastructure.

Keywords: Right to water; Urban supply of potable water; Sustainable Development Goal (SDG) 6; Public Policies; Legal Analysis of Economic Policy (LAEP).

RESUMO

O reconhecimento formal do direito à água não se traduz necessariamente em realização prática. Objetivo: estabelecer e medir a realização prática do direito à água por meio de variáveis observáveis e mensuráveis para apontar lacunas ou obstáculos significativos em sua realização nas Unidades Federativas (UFs) brasileiras entre 2013 e 2020. Método: com base nos esforços para quantificar a realização do direito à água por meio do desenvolvimento de indicadores, a pesquisa emprega a metodologia da Análise Posicional, dentro do quadro teórico da Análise Jurídica da Política Econômica, para investigar em que medida o direito à água é cumprido nas UFs brasileiras, em contextos urbanos, e identificar os fatores que contribuem para a realização ou falta desse direito na prática. Resultados e contribuições: (i) apesar de melhoras no alcance do abastecimento urbano, a água ficou, na média, mais turva, mais cara e com mais cloro residual ao longo do tempo no Brasil; (ii) maiores patamares de fruição são encontrados no Sudeste, e menores, no Nordeste; e (iii) os índices de desempenho são principalmente correlatos ao controle da turbidez, da presença de coliformes totais, e à expansão da infraestrutura urbana de abastecimento com água.

Palavras-chave: Direito à água; Abastecimento urbano de água potável; Objetivo do Desenvolvimento Sustentável (ODS) 6; Políticas Públicas; Análise Jurídica da Política Econômica (AJPE).

1. INTRODUCTION

The United Nations General Assembly recognized the human right to water through Resolution 64/292 in 2010 (UNITED NATIONS, 2010). Brazil voted in favor of the resolution, which had no opposing votes, only abstentions (SILVA; FARIAS, 2020). Subsequently, in 2015, Sustainable Development Goal (SDG) No. 6 included the goal of ensuring the availability and sustainable management of water and sanitation for all, in order to achieve universal and equitable access to safe and affordable drinking water by 2030 (MACHADO; OLIVEIRA, 2019; CINI; ROSANELI; FISCHER, 2019; WESTSTRATE et al., 2019).

In Brazil, the right to water is not formally recognized as a fundamental right in its own standing (BRZEZINSKI, 2012; CINI; ROSANELI; FISCHER, 2019). However, there is a growing mobilization in this regard at the national level (MACHADO; OLIVEIRA, 2019). There are even doctrinal proposals suggesting that the right to water could be considered as part of a new dimension of fundamental rights (MACHADO; OLIVEIRA, 2019). Constitutional Amendment Proposal (*PEC*, in the Portuguese acronym) 6/2021 seeks to include potable water as one of the items in Article 5 of the Brazilian Constitution. Should it succeed, water would be included among the fundamental rights and guarantees. The proposal was introduced in April 2021, approved in the Senate, and at the time of writing, it is awaiting consideration by the Chamber of Deputies (2023). Other countries, such as South Africa, Bolivia, Uruguay (SULTANA; LOFTUS, 2015; FANTINI, 2020) and Ecuador recognize the right to water in their constitutions (MACHADO; OLIVEIRA, 2019). Beyond the anthropocentric perspective of human and fundamental rights, there are countries whose legal systems attribute legal personality to rivers, such as India, New Zealand, and Colombia (FANTINI, 2020), in order to represent a more centrally environmental approach to possible meanings of the right to water, or rather, of *rights of nature* (MACHADO; OLIVEIRA, 2019).

The lack of recognition of water as a fundamental right in its own standing does not prevent it from being understood as a prerequisite for the practical experience of other fundamental rights. Drinking water is, after all, indispensable for a healthy life and for meeting many other human needs, beginning with nutrition and hygiene (FANTINI, 2020; BRZEZINSKI, 2012). In addition, even though the principle of human dignity has a very open texture and risks conceptual stretching, the lack or precariousness of access can easily be characterized as compromising human dignity (MACHADO; OLIVEIRA, 2019; BRZEZINSKI, 2012). Problems with water bring “consequences for public health, the environment, tourism, and quality of life, especially in large cities” (NUNES; ANDERAOS; ARAÚJO, 2021, p. 67).

Nevertheless, Brazilian legislation does not mention the guarantee of access to drinking water for people, nor a minimum amount necessary for the maintenance of life and other needs (BRZEZINSKI, 2012).

The new framework for basic sanitation in Brazil, established by Law 14.026 of 2020 (BRASIL, 2020), aims for Brazil to achieve 99% coverage of the population with drinking water by 2033, and names this goal "universalization" (NUNES; ANDERAOS; ARAÚJO, 2021, p. 75). In other words, the legal framework accepts, even programmatically, that 1% of the population be deprived of the right to water. Therefore, meeting the Brazilian legislation's goal would not satisfy SDG 6.

Internationally, benchmarks for minimum quantities and affordability of water have been established. The World Health Organization (WHO) defines that each person needs a minimum of 100 liters of water per day to adequately satisfy their hydration, food preparation, and basic hygiene needs (HOEKSTRA; BUURMAN; VAN GINKEL, 2018; HOWARD; BARTRAM, 2003; MCDONALD et al., 2011).[1] However, access to this minimum level of water consumption is nuanced by the logic of financial accessibility.

The United Nations Development Programme (UNDP) establishes that "for water to be affordable, households should not spend more than 3% of their income on water and sanitation services" (BALLESTERO, 2014, p. 29). However, as often pointed out in the literature, "the concession for private sector exploitation is a serious risk for generation and discrimination, segregation, and vulnerabilities, compromising access to water" (CINI; ROSANELI; FISCHER, 2019, p. 112; see also SILVA; FARIAS, 2020, p. 369). This perspective is not, however, unanimous. Nunes and coauthors (2021) argue that, given the limitations on public sector investment capacities resulting from Constitutional Amendment No. 95 of 2016 in Brazil, the focus on meeting the goal of universal access to clean water should rely upon private investment. In fact, the changes in the legal framework for basic sanitation introduced by Law 14.026/2020 (BRASIL, 2020) point to this direction. Nonetheless, the relaxation of restrictions on the participation of public companies in bidding processes for sanitation services concessions, represented by Decrees 11.598 (BRASIL, 2023a) and 11.598 of 2023 (BRASIL, 2023b), alongside the prospects of a new fiscal framework at the constitutional level, may invalidate the fundamental premise of this reasoning, allowing the public sector to reassume a more active role in realizing the right to water in Brazil.

As Brzezinski points out, the recognition of water as a human right is paradoxical because it is directed towards solvent individuals "who can participate in the social relations of a commodity-producing system" (BRZEZINSKI, 2012, p. 78; see also SILVA; FARIAS, 2020, p. 369; SULTANA; LOFTUS, 2015, p. 98; FANTINI, 2020, p. 3; CINI; ROSANELI; FISCHER, 2019, p. 107-112). In this way, people in extreme economic

---

[1] No legal enactment or administrative decree establishes minimum per capita water consumption levels in Brazil. Despite variations in subnational states' rules, a volume of 10 m³ is generally defined as a parameter for the minimum value of the water bill (GONÇALVES; AZOIA, 2017). However, the volume of 10,000 liters of water per month is referred to the consumption unit (the habitation), not the individual.

DOI: 10.12957/rdc.2024.75172 | ISSN 2317-7721

deprivation, such as those who are homeless, are excluded, severely compromising their ability to enjoy the human right to water adequately (NEVES-SILVA; MARTINS; HELLER, 2018). The qualification of access to the human right through the logic of its financial accessibility ultimately denies its universal character.

The absence of recognition as a fundamental right in its own standing does not preclude the *fundamentality* of the right to water from being doctrinally constructed, as pointed out, from its indispensability for the enjoyment of other fundamental rights. Nonetheless, the right to water is an integral part of the *right to the city* (SILVA; FARIAS, 2020), since the Statute of Cities, established by Law 10,257 of 2001 (BRASIL, 2001), "establishes the pressing need to have an urban policy based on the social function of cities, including in this category sanitation, which involves the supply of treated water and sewage, as well as the preservation of the natural environment and natural resources" (SILVA; FARIAS, 2020, p. 369). The supply of drinking water is also part of the National Guidelines Law for Basic Sanitation (BRASIL, 2007[2]), which structures the National Basic Sanitation Policy (SILVA; FARIAS, 2020).

However, the formal recognition of access to water as a human or fundamental right (whether eventual future recognition in its own right, or the current doctrinal recognition of this status through indirect means), or even as an aspect of the *right to the city*, does not necessarily translate into practical realization (CASTRO, 2021). Furthermore, inequalities permeate the realization of this right at various levels of analysis, an aspect frequently mentioned in the literature (SILVA; FARIAS, 2020; LOFTUS; SOUSA, 2021; SULTANA; LOFTUS, 2015; CINI; ROSANELI; FISCHER, 2019). In Brazil, more than 35 million people lack access to piped drinkable water (NUNES; ANDERAOS; ARAÚJO, 2021). The urban coverage of water supply is, on average, 92.8%. But in the North region, it is only 69.6%; and in the Northeast, it is 88.7% (NUNES; ANDERAOS; ARAÚJO, 2021). Therefore, it is important to investigate if – and to what extent – there is adequate empirical fruition of the right to drinkable water in urban contexts in Brazil. It is, therefore, an investigation into the practical effectiveness of an aspect of the *right to the city,* which, from a perspective that values the incidence of constitutional precepts, must consider the imperative of reducing inequalities (MOURA; TORRES; MOTA, 2022).

Efforts to quantify the realization of the right to water have been made through the development of indicators (MEIER et al., 2014; WESTSTRATE et al., 2019; SCHIFF, 2019; FANTINI, 2020; SHI et al., 2021). Indicators provide a tool for monitoring and evaluating progress towards the realization of the right to water, based on various dimensions such as availability, quality, safety, acceptability, physical accessibility, and affordability of water tariffs (SULTANA; LOFTUS, 2015; WESTSTRATE et al., 2019; NEVES-

[2] Recently amended by Law No. 14,026 of 2020 (BRASIL, 2020), which established the new legal framework for basic sanitation in Brazil.

DOI: 10.12957/rdc.2024.75172 | ISSN 2317-7721

SILVA; MARTINS; HELLER, 2018; BRZEZINSKI, 2012). This allows for the evaluation of the practical realization of the right to water in different contexts and the identification of areas where improvements are necessary.

Based on the efforts to quantify the realization of the right to water through the development of indicators, the research uses the method of Positional Analysis, which belongs to the theoretical framework of Legal Analysis of Economic Policy, LAEP (CASTRO, 2014, 2018a, 2021). The question that mobilizes the application of this methodology is: to what extent is the right to water being fulfilled in the Brazilian Federative Units (the Portuguese acronym for *Unidades Federativas*, *UFs*, will be used hereinafter as shorthand), in urban contexts, and what are the factors that contribute to the realization or lack of this right in practice? The objective is to establish and measure the practical realization of the right to water through observable and measurable variables to identify gaps or significant obstacles that may prevent the realization of the right to water in the Brazilian UFs between 2013 and 2020. In addition, the study seeks to identify spatial inequalities related to the fruition of this right in urban Brazil.

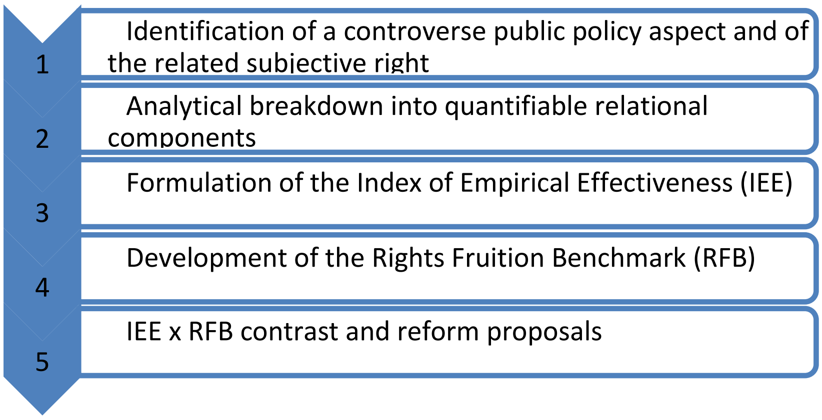
The research's temporal scope is from 2013 to 2020. The main source of data is the National Sanitation Information System (SNIS, in the Portuguese acronym), linked to the Ministry of Integration and Regional Development (2023). The next section addresses methodological aspects of the application of Positional Analysis. Afterwards, the results are presented and discussed. The final section highlights the main findings, accompanied by references.

2. METHODS

The research method used is Positional Analysis, a quantitative approach belonging to the theoretical framework of the Legal Analysis of Economic Policy (LAEP). LAEP proposes to broaden the channels through which social facts can be approached, thereby strengthening the legal capacity to critically assess empirical reality. It emphasizes how economic policy decisions and public policies affect the actions of individuals and groups differently, thus impacting the enjoyment of their fundamental and human rights. In this sense, LAEP adheres to a conception of law centered on empirical fruition. And, in this respect, it puts forward that public and economic policies which limit the possibilities of fruition of human and fundamental rights should undergo reforms in order to cease functioning as impairments and become instruments for promoting the practical experience of such rights.

In this context, the Positional Analysis methodology is applied to produce "an objective analytical description of the empirical enjoyment experience of economically relevant subjective rights of individuals and groups" (CASTRO, 2018b, p. 361). The features of Positional Analysis make its methodological proposal essentially quantitative. The approach incorporates the use of indicators in legal work, valuing the use of quantitative tools for legal analysis (CASTRO; CASTRO, 2020). This methodology has been applied to research on varied issues, such as: broadband internet access (FONTES; CASTRO, 2016), accessible housing (MOREIRA; CASTRO, 2020), urban mobility (VARELA, 2018), support for small businesses (LIMA; CASTRO, 2017), adequate childbirth policy (CASTRO; CASTRO, 2020), arboviral disease prevention (CASTRO, 2022), police lethality (SANTOS; FERREIRA; FERREIRA, 2022), child and adolescent protection (MELLO; FERREIRA, 2022), among others.

The core of the methodology consists of constructing two indices: one to represent the degree of fruition of a certain right correlated to a public policy – the *Index of Empirical Effectiveness* (IEE) – and another to express the level of fruition corresponding to its legal validation – the *Rights Fruition Benchmark* (RFB). Comparing the indices allows for evaluating if the analyzed public policy meets the requirements of concretization or effectiveness of fundamental and human rights. If the IEE is lower than the RFB ($IEE<RFB$), the level of empirical fruition of the subjective right is not legally validated, and the public policy should be reformed (CASTRO, 2018a, 2014). The flowchart below illustrates the stages of Positional Analysis:



Source: authors' elaboration, based on Castro (2018a).

Figure 1 – Stages of the Positional Analysis

To develop an IEE of the right to water in urban contexts in Brazilian subnational states (UFs), the first step is to perform an analytical decomposition of the relational contents of this right (CASTRO, 2018a, 2014). Quantifying a right implies translating its meaning into observable and measurable variables (BALLESTERO, 2014; CASTRO, 2021). This step results in defining a set of variables related to the mentioned dimensions of the right to water, which need to be parameterized. The procedure for parameterizing the variables, or "relational components" in the terms of LAEP, as defined below.

2.1. VARIABLES OF THE FRUITION OF THE RIGHT TO WATER AND THEIR PARAMETERIZATION

The procedure of translating general notions into observable and measurable variables, or for inversely constructing a general notion from the gathering of these variables, is known as “statistical objectification”. The creation of statistical objects involves the operation of coding (*codage*), “a conventional decision to construct an equivalence class between diverse objects, the ‘class’ being judged more ‘general’ than any particular object” (DESROSIÈRES, 1990, p. 198). In other words, it involves a decision about the commensurability of these objects.

The statistical objectification of the right to water in urban contexts will focus on the aspect of human consumption, and will have as starting points the dimensions of availability, quality, safety, acceptability, physical accessibility, and financial accessibility of water tariffs, as mentioned previously. The following description will outline these dimensions.

First, the “availability and physical accessibility of water” will be considered. Here, the aim is to understand *(i)* what is the coverage of the urban water supply and *(ii)* if there is enough water for human consumption. The first aspect is captured by the variable denoted by *WS*, the *urban water service coverage*, expressed as a percentage. The second stems from the *average per capita water consumption* (*WC*), expressed in liters per inhabitant per day. These are the “raw” data from which the variables related to the dimension of the availability and physical accessibility of water will be construed.

The variable *urban water service coverage* (*WS*) will be parameterized by the requirement that universal access to water service in urban areas must be achieved. In this case, since the full realization of the right to water in terms of urban water service would correspond to serving 100% of the urban population, the operationalization of this component will employ the division of *WS* by 100 ($\frac{WS}{100}$). The closer they are to 1, the results of this ratio express greater proximity to universal access. Contrarily, values below 1 and tending towards the minimum value of zero denote insufficiencies in urban water service coverage. This is the way to parameterize the variable *universalization of water service*; that is, $UWS = \frac{WS}{100}$.

The parameterization of *water consumption* (*WC*), in turn, will take into account the minimum level of 100 liters of water per inhabitant per day. This component must be approached carefully, since the reduction of *WC* can be seen positively from the point of view of water security (SHI et al., 2021) and environmental and/or scarcity-centered perspectives (GONÇALVES; AZOIA, 2017). Therefore, the operationalization must reflect the legitimacy of public policies that aim to reduce water waste, with environmental objectives. Even though globally it is agriculture, and not direct human consumption, the largest water consumer (MCDONALD et al., 2011), and it is expected that the sector will remain the largest consumer in the near future (MACHADO; OLIVEIRA, 2019). Still, the parameterization needs to reflect the need to meet the minimum consumption level without quantifying excessive consumption as positive. This leads to the parameterized variable named *minimum consumption benchmark compliance* (MCB). If *MCB* is met, the result should be 1, regardless of whether the value of *WC* is higher than 100 liters per day per inhabitant. If it is not met, the result should reflect the proximity or distance to that level. In other words, MCB will be operationalized as: $min\left(\frac{WC}{100};1\right)$.

It is should be noted, however, that this operationalization does not reflect the disparities in water consumption that make up the average. The benchmark of 100 liters per inhabitant per day is a minimum, not an average. Therefore, the operationalization of *MCB* in the form of an average, as described in the present methodology, is taken as a *proxy* variable. The limitation in the approach to *MCB* is justified by the fact that to treat *WC* as a minimum, it would be necessary to have access to data on the daily consumption of each individual in a specific UF, in order to develop a Gini coefficient for water consumption in Brazilian UFs, an aspect that should be the subject of future research. The data for the analysis of this first dimension will come from *SNIS*.

Chart 1 – Parameterization of variables for the water availability and physical accessibility dimension.

Dimension	Raw data	Coded variables	Calculation procedure
Availability and physical accessibility	WS – Urban water service coverage (%)	UWS – Universalization of water service	$UWS = \frac{WS}{100}$
	WC – Average per capita water consumption (L./inhab.day)	MCB – Minimal consumption benchmark compliance	$MCB = min\left(\frac{WC}{100};1\right)$

Source: authors' elaboration

Secondly, the dimension of financial accessibility of the water tariff will be considered. The starting point for the analysis of this dimension is the *average water tariff value* (WT) charged in each UF in a given year, which consists of the average price, in Brazilian *Reais* (BRL, expressed through "R$"), for obtaining one cubic meter of water (R$/m³), that is, 1000 liters. In this regard, the United Nations Development Programme (UNDP) establishes that "for water to be affordable, households should not spend more than 3% of their income on water and sanitation services" (BALLESTERO, 2014, p. 29). Here the parameterization begins. To translate the use of 3% of income into variables, the value of the monthly *minimum wage* (MW) for each year in the time series covered by the research will be taken as a benchmark. WT needs to be considered based on a minimum consumption parameter, which is set for WC (that is, 100 liters per inhabitant per day). However, WT has "R$/m³" as its unit of measure on a monthly scale, whereas WC is measured in litters on a daily scale. It is also necessary to take into account that in Brazil, according to data from the Continuous National Household Sample Survey (*PNAD-contínua*, in the Portuguese shorthand) of 2020, each household has an average of 2,9 inhabitants (*average inhabitants per household* – IPH). Furthermore, the months of the year have an average of 30,44 days. With this information, it is possible to parameterize the *water tariff affordability* variable (WTA) by positioning WT as the denominator of a fraction whose numerator is the result of 3% of *the minimum wage* (0,03·SM) divided by 0,1 m³ (100 liters), multiplied by 2,9 *inhabitants per household*, and by 30.44 average days in a month[3]. That is, $WTA = \frac{0{,}03 \cdot MW \div 0{,}1 \cdot 2{,}9 \cdot 30{,}44}{WT}$. The fraction can be simplified as $= \frac{0{,}03 \cdot MW}{8{,}82 \cdot WT}$. The data for the analysis of this second dimension are retrieved from *SNIS* (for WT), *Ipeadata* (for MW), and *IBGE* (for IPH).

Chart 2 – Parameterization of variables in the dimension of water affordability

Dimension	Raw data	Coded variables	Calculation procedure
Affordability	WT – Average water tariff (R$/m³) MW – Minimum Wage (R$) IPH – Average inhabitants per household	WTA – water tariff affordability	$WTA = \frac{0{,}03 \cdot MW}{8{,}82 \cdot WT}$

Source: authors' elaboration

Finally, the dimension of quality, safety, and acceptability will be considered. Water should have "acceptable color, smell, and taste" (NEVES-SILVA; MARTINS; HELLER, 2018, p.2). The variable *non-standard turbidity* (*NST*), expressed as a percentage, seeks to capture one of these aspects. It was not possible to capture acceptable smell and taste for the purposes of this research, based on the available data. *NST* is the basis for parameterizing the variable *water transparency* (*WT*). For this purpose, it is

[3] Minimum wage (*MW*) values for the covered timeframe are: 2013 - R$ 678,00; 2014 - R$ 724,00; 2015 - R$ 788,00; 2016 - R$ 880,00; 2017 - R$ 937,00; 2018 - R$ 954,00; 2019 - R$ 998,00 and 2020 - R$ 1045,00. Calculated based on the benchmark of 3% of the minimum wage per 100 liters per inhabitant per day, considering the average of 2,9 inhabitants per household and 30,44 days per month, the following values are obtained: 2013 - R$ 2,30/m³; 2014 - R$ 2,46/m³; 2015 - R$ 2,68/m³; 2016 - R$ 3,00/m³; 2017 - R$ 3,19/m³; 2018 - R$ 3,25/m³; 2019 - R$ 3,40/m³; and 2020 - R$ 3,56/m³.

DOI: 10.12957/rdc.2024.75172 | ISSN 2317-7721

considered that, ideally, 100% of samples should meet the standards established by the Ministry of Health's Ordinance 888 of 2021 for *NST*. Thus, *WT* is operationalized as $\frac{100-NST}{100}$, the results of which, ranging between 0 and 1, are indicative of the proximity to the standards of the mentioned Ordinance as they are closer to 1.

Similarly, the aspect of water quality and safety, which requires water not to pose a health risk to those who consume it, is statistically objectified based on data for off-standard *total coliforms* (TC) and *residual chlorine* (RC), both expressed as percentages, which also have their benchmarks established by the Ministry of Health's Ordinance 888 of 2021. From these data, the parameters of *total coliforms standard compliance* (TCS) and *residual chlorine standard compliance* (RCS) will be respectively parameterized. The operationalization of these variables follows the same standard established for WT, so that $TCS = \frac{100-TC}{100}$ and $RCS = \frac{100-RC}{100}$.

Chart 4 - Parameterization of variables in the dimension of water quality, safety and acceptability

Dimension	Raw data	Coded variables	Calculation procedure
Quality, safety and acceptability	NST – Non-standard turbidity (%)	WT – Water transparency	$WT = \frac{100 - NST}{100}$
	TC – Non-standard total coliforms (%)	TCS – Total coliforms standard compliance	$TCS = \frac{100 - TC}{100}$
	RC – Non-standard residual chlorine (%)	RCS – Residual chlorine standard compliance	$RCS = \frac{100 - RC}{100}$

Source: authors' elaboration

Note: the data for the third dimension stem from *SNIS*.

2.2. DEVELOPMENT OF THE INDEX OF EMPIRICAL EFFECTIVENESS (IEE) FOR THE RIGHT TO WATER

Based on the delineation of the relational components – that is, the parameterized variables described in the previous section – it is possible to define the calculation method for the Index of Empirical Effectiveness (IEE) of the right to water in urban contexts. The IEE is an indicator used for quantitatively expressing the empirical fruition of the analyzed right (CASTRO, 2018a). Therefore, it is necessary to outline the way in which the different variables are organized into a formula capable of giving quantitative expression to the right in question.

The structure of the IEE formula reflects an arithmetic average of the relational components described in the analytical decomposition. The number 6, in the denominator position in the formula, reflects the method of obtaining the simple average: the sum of the components is divided by their count:

Equation 1 – Index of Empirical Effectiveness (IEE)

$$IEE = \frac{UWS + MCB + WTA + WT + TCS + RCS}{6} \tag{1}$$

Where:

UWS – Universalization of water service

MCB – Minimal consumption benchmark compliance

WTA – Water tariff affordability

WT – Water Transparency

TCS – Total coliforms standard compliance

RCS – Residual chlorine standard compliance

The IEE formula, as described above, will be the basis for quantifying the extent to which the right to water was present in the Brazilian subnational states (UFs) during the years 2013 to 2020. The values assumed in each of the relational components that make up the IEE represent ratios or proportions of compliance with the parameterized variables described in section 2.1 and can be interpreted as percentages (on a decimal scale) of compliance with the benchmarks incorporated in these variables.

2.3. STRUCTURING THE RIGHTS FRUITION BENCHMARK (RFB)

The RFB is a "benchmark used to characterize what would correspond, in quantitative terms, to the legally validated empirical effectiveness of the right considered" (CASTRO, 2018a, p. 131). While the IEE is conceived as a numerical image of the sphere of that which *is* – it has a *descriptive* function – the RFB reflects what *ought to be* – it has a *normative* function (CASTRO, 2018a).

The strategies for the development of the RFB are manifold, and include: (i) "adoption of recommendations or goals contained in laws or normative regulations of governmental authorities, or stipulated by international organizations", (ii) comparison between levels of fruition of "populations separated by groupings (class, neighborhoods, cities, countries, nationalities, age range, race, gender, profession, etc.)" and (iii) "comparison of measurement exercises relative to different moments (T_1 and T_2)" (CASTRO, 2018a, p. 131), among others.

Regarding the development of the RFB for this research, the first of these strategies will be prevalent. After all, the components used in the formula for the IEE already incorporate conventional benchmarks in their formulation. Thus, the *universalization of water service* (UWS) variable is parameterized so that 100% coverage of urban water supply results in a value of 1. This value integrates the RFB for this relational component. Similarly, the value corresponding to the legal validation threshold for the other parameterized variables is 1. It should be noted that since the variable *water tariff affordability* does not have a defined upper limit, it admits values higher than 1. This can make the resulting IEE exceed the RFB in cases where *water affordability* is high and the values for the other relational components are close to being adequate. With this caveat, it is worth remarking that the formula for the RFB uses the same structure as the IEE, but is fed with benchmark values, given its normative role, instead of values related to empirical reality, which are pertinent to the IEE. The above considerations result in the following configuration of the RFB:

Equation 2 – Rights Fruition Benchmark (RFB)

$$RFB = \frac{UWS + MCB + WTA + WT + TCS + RCS}{6} = \frac{1 + 1 + 1 + 1 + 1 + 1}{6} = 1 \quad (2)$$

With the RFB, a parameter is established to evaluate the performance of the UFs regarding the right to water in the temporal scope of the research. The empirical fruition of the right to water will be considered legally valid if the IEE is equal to, or higher than, the RFB of 1. In the event that the value of the IEE is lower than the one stipulated for the RFB, it will denote insufficient or non-existent effectiveness of the analyzed right (CASTRO, 2018a). Thus, questions arise to be addressed through this comparison. What were the UFs with the best and worst overall performance at the end of the series, in 2020? In longitudinal and aggregated terms, did the enjoyment of the right to water in Brazil as a whole improve or worsen during the period considered? And furthermore, what do the data indicate regarding inequalities in the fruition of the right to water in urban contexts in Brazil?

In addition to a general analysis, the methodology of Positional Analysis allows for a more detailed assessment of the components that contribute most to enabling or hindering the enjoyment of the right to water. Other questions are possible here: in an aggregated manner, which dimensions of the right to water showed improvement or worsening over the series? How can the longitudinal behavior of the components of the right to water be described in an aggregated analysis comprising all of the UFs? Also, which components had the greatest weight in the performance of the UFs located at the extremes of better and worse fruition of the right to water?

The comparison between the values attributed to the variables that make up the IEE and the RFB, at these different levels of analysis, serves as a guide to identify the most problematic relational contents, which should therefore be given priority in reform recommendations. The ultimate goal is to point out priority areas for reform in the public policy of urban water supply, according to the needs identified through the comparison of the indicators.

3. RESULTS AND DISCUSSION

Table 1 shows the overall values of the IEE from 2013 to 2020, accompanied by the respective annual and UF averages. The highlighted cells contain IEE values that are greater than or equal to 1 and correspond to cases that met the RFB. It is possible to observe that Roraima (RR) and Mato Grosso (MT) were the states with best performance throughout the period considered. Roraima (RR), in particular, was the only UF that achieved an average IEE (1,002) higher than the RFB. Mato Grosso (MT) came very close to reaching it (0,998). Next, Pará (PA) (IEE = 1,002 in 2015) and São Paulo (SP) (1,001 in 2014) reached the RFB once each. The other UFs did not reach the value established as a benchmark over the historical series.

Table 1 – Results for the right to water IEE, by UF and year

	2013	2014	2015	2016	2017	2018	2019	2020	Average (by UF)	Standard deviation
AC	0,900[4]	0,890	0,899	0,933	0,936	0,866	0,864	0,868	0,895	0,027

[4] The 0,900 value for the IEE resulted from the application of the formula IEE=(UWS+MCB+WTA+WT+TCS+RCS)÷6. Each component was calculated as follows. 1) Considering UWS (Universalization of water service) is parameterized as WS÷100, and that the data for Urban water service coverage (WS) for Acre in 2013, according to SNIS, were of 57,43%, this component resulted in "0,574" in the IEE formula. 2) MCB (Minimal consumption benchmark compliance) is parameterized as *min*(WC÷100;1), and WC (Average per capita water consumption) for Acre in 2013 was 144,62 L/inhab.day, according to SNIS data. Hence, "1" was inputted in the IEE formula. 3) The WTA (water tariff affordability) component was parameterized as =(0,03·MW÷8,82·WT), where MW (minimum wage) was R$ 678,00 in 2013, according to Ipeadata, and WT (average water tariff) was R$ 1,64/m³ in Acre in 2013, according to SNIS data, resulting in "1,405" for WTA. 4) Water transparency (WT) was parameterized as (100-NST)÷100, and the value for NST (non-standard turbidity) for Acre in 2013, according to SNIS, was 4,36%, resulting in "0,956" in the IEE formula. 5) TCS (Total coliforms standard compliance) was parameterized as (100-TC)÷100, and the value for TC (non-standard total coliforms) for Acre in 2013, according to SNIS, was 8,30%, resulting in "0,917" in the IEE formula. 6) RCS (Non-standard residual chlorine) was parameterized as (100-RC)÷100, and the value for RC (Non-standard residual chlorine) for Acre in 2013, according to SNIS, was 45,03%, resulting in "0,550" in the IEE formula. Thus, IEE = (UWS + MCB + WTA + WT + TCS + RCS) ÷ 6 = (0,574 + 1 + 1,405 + 0,956 + 0,917 + 0,550) ÷ 6 = 0,900. The same procedure, *mutatis mutandis*, was used for each of the other IEE values for the remaining subnational states and years in the table.

DOI: 10.12957/rdc.2024.75172 | ISSN 2317-7721

	2013	2014	2015	2016	2017	2018	2019	2020	Average (by UF)	Standard deviation
AL	0,846	0,848	0,840	0,826	0,820	0,878	0,875	0,888	0,853	0,023
AP	0,809	0,828	0,831	0,721	0,745	0,768	0,843	0,800	0,793	0,041
AM	0,904	0,896	0,915	0,922	0,916	0,922	0,928	0,947	0,919	0,014
BA	0,939	0,944	0,936	0,948	0,941	0,910	0,918	0,939	0,934	0,012
CE	0,950	0,903	0,946	0,871	0,870	0,854	0,862	0,873	0,891	0,035
DF	0,907	0,906	0,908	0,921	0,922	0,934	0,922	0,917	0,917	0,009
ES	0,971	0,975	0,979	0,984	0,978	0,977	0,976	0,980	0,978	0,003
GO	0,922	0,912	0,878	0,898	0,907	0,898	0,914	0,907	0,905	0,012
MA	0,975	0,963	0,961	0,923	0,938	0,935	0,934	0,833	0,933	0,041
MT	1,011	1,009	0,997	0,974	0,986	1,003	1,002	1,005	0,998	0,012
MS	0,947	0,937	0,941	0,935	0,927	0,931	0,926	0,929	0,934	0,007
MG	0,967	0,974	0,951	0,953	0,969	0,948	0,946	0,947	0,957	0,010
PA	0,933	0,991	1,002	0,977	0,982	0,952	0,937	0,948	0,965	0,024
PB	0,820	0,938	0,819	0,894	0,897	0,897	0,900	0,897	0,883	0,039
PR	0,961	0,970	0,964	0,961	0,949	0,936	0,931	0,935	0,951	0,014
PE	0,949	0,933	0,950	0,924	0,944	0,938	0,955	0,957	0,944	0,011
PI	0,851	0,936	0,865	0,950	0,966	0,954	0,945	0,953	0,928	0,041
RJ	0,921	0,910	0,928	0,938	0,925	0,926	0,872	0,874	0,912	0,023
RN	0,940	0,914	0,946	0,921	0,836	0,858	0,917	0,902	0,904	0,036
RS	0,851	0,881	0,896	0,893	0,877	0,903	0,901	0,895	0,887	0,016
RR	0,990	1,021	1,009	1,008	1,000	0,984	0,992	1,008	1,002	0,011
RO	0,833	0,822	0,861	0,865	0,917	0,897	0,889	0,918	0,875	0,034
SC	0,935	0,923	0,942	0,941	0,936	0,939	0,921	0,937	0,934	0,007
SP	0,986	1,001	0,997	0,991	0,990	0,980	0,981	0,993	0,990	0,007
SE	0,923	0,895	0,917	0,886	0,883	0,910	0,887	0,886	0,898	0,015
TO	0,942	0,940	0,940	0,935	0,935	0,928	0,936	0,939	0,937	0,004
Média (por ano)	0,922	0,928	0,927	0,922	0,922	0,919	0,921	0,921	-	-

Source: authors' elaboration based on data from SNIS, Ipeadata and IBGE.

The worst IEE value was 0,721, in Amapá (AP), in 2016, which also had the worst average performance (0,793), in contrast to Roraima (RR), as already pointed out. In annual terms, the best average IEE, considering Brazil as a whole, occurred in 2014 (0,928); the worst, in 2018 (0,919). The variation, as noted, is minimal (Δ = -0,009), thus characterizing stability in the performance of the IEE of the right to water in Brazil between 2013 and 2020. The highest dispersion in the dataset (standard deviation = 0,041) corresponded to Maranhão (MA), indicating that the IEE values tended to deviate more from the annualized average. In contrast, Espírito Santo (ES) had the lowest standard deviation (0,003), indicating greater consistency in the behavior of IEE over the years.

It is appropriate to conduct a more in-depth analysis of the numbers reported at the end of the series in 2020 in comparison to the RFB after providing an overview of the overall performance of the IEE. By comparing the realized IEE to the established RFB, this analysis enables ranking the states according to the difference (Δ) between the two indicators:

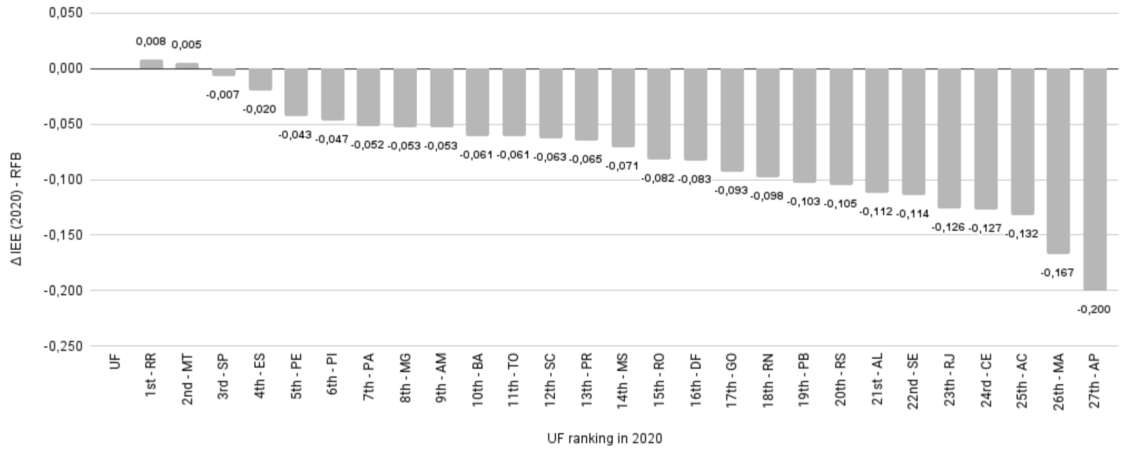


Figure 2 – Ranking of the difference between the IEE (2020) and the RFB for the right to water, by UF

Figure 2 demonstrates that only Roraima (RR) and Mato Grosso (MT) attained the RFB in 2020, with São Paulo (SP) being very near to it. In contrast, the lowest levels of fruition in 2020 were observed in Amapá (AP), Maranhão (MA), and Acre (AC). It is important to comprehend what may account for the higher and lower placing of these UFs in the IEE ranking for 2020 by analyzing the relational components of the right to water.

In Roraima (RR), the best performance per component was *water tariff affordability* (ΔWTA = +0.099). The RFB was also achieved for meeting the minimum consumption benchmark (MCB). The values for WT, RCS, and UWS are very close to the RFB, with differences in the hundredth decimal places. The

DOI: 10.12957/rdc.2024.75172 | ISSN 2317-7721

only negative difference in the tenths decimal places is meeting the *standard for total coliforms* (ΔTCS = -0.044). In Mato Grosso (MT) and São Paulo (SP), the positioning of the best components is the same (WTA and MCB). However, in Mato Grosso (MT), the component with the worst performance *is water transparency* (WT), with a difference of -0.038 compared to the RFB. In São Paulo (SP), it is meeting the *standard for total coliforms* (TCS), with a difference of -0.029. In the dataset regarding the top three positions in the ranking, good performance in all dimensions of the right to water is observable, and negative differences in relation to the validation benchmark, although they exist, are of smaller magnitude and do not exceed -0.044, in the worst case (Δ TCS in Roraima – RR). See Figure 3, further below.

The worst cases seem to be explainable mainly by restrictions in the *universalization of service* (UWS) and *compliance with the standard for total coliforms* (TCS), which appear in the top three positions of components with the greatest distance from the RFB in the cases of Amapá (AP) (-0,645 for Δ UWS, -0,279 for TCS), Maranhão (MA) (-0,309 for Δ TCS and -0,237 for Δ UWS), and Acre (AC) (-0,368 for Δ UWS and -0,057 for Δ TCS). In addition, *water transparency* (WT) is a relevant problem for Amapá (AP) (-0,555) and the main problem for Acre (AC) (-0,624), although it has a smaller dimension in Maranhão (MA) (-0,197). The higher frequency of UWS, TCS, and WT variables in the worst positions of states that had the worst IEE in 2020 raises the question: is it a singularity of 2020, or an observable pattern over the covered historical series? For the purpose of this investigation, Pearson's linear correlation coefficient was used (BARBETTA, 2006; FIGUEIREDO FILHO; SILVA JÚNIOR, 2009), yielding the results displayed in Figure 3.

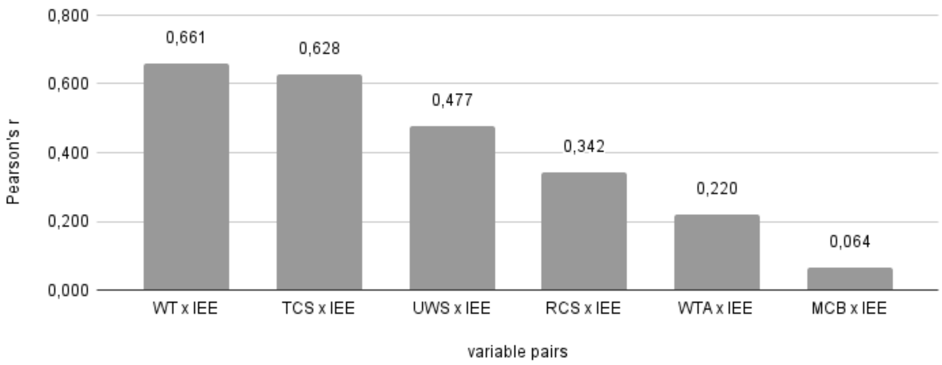


Figure 3 – Pearson's linear correlation coefficient for selected variable pairs, considering aggregate data for Brazilian UFs from 2013 to 2020

Based on the results obtained, it is possible to verify the existence of a *positive and moderately strong* correlation between IEE and water transparency (WT) and compliance with the standard for total coliforms (TCS), and *moderate* correlation between IEE and universalization of service (UWS). In other words, these are the three variables that most closely follow the variations experienced in IEE by the UFs over the historical series. For compliance with the standard for residual chlorine (RCS) and for water tariff affordability (WTA), the correlation is weak and, for minimum consumption benchmark (MCB) compliance, non-existent. It is relevant to notice that even though the Northern region of Brazil has higher freshwater abundance, several subnational states located in the region present lower IEE levels. This is suggestive of the need to prioritize public policy investments in environmental licensing and oversight of water and sewage concessionaires.

Figure 4's depiction of the variable's behavior highlights another issue that merits notice. It illustrates the dispersion between the variation of relational components in 2020 and the difference between the IEE and the RFB in the same year, for all UFs. It is possible to note that the values of the differences between the performance of the components in 2020 and the established RFB present less variation for the UFs that were better positioned, and greater variation for those that were in the last positions of the ranking. Variation, here, is understood as the difference between the maximum and minimum value in the data set. In this sense, better positions of the right to water fruition are observed in UFs that, more consistently, achieved good performance in the set of variables. This is important because, as can be seen, the punctual performance in one or another component can be even better in the UFs that finished last, as is the case with AFT. However, not enough to raise the average of a data set that denotes unsatisfactory fruition of the right to water. Therefore, the hypothesis arises that the result of the IEE may be explained from its correlation with the variation in the values of the UFs' components. The correlation, measured by the Pearson linear correlation coefficient, is r = -0,673. That is, a moderately strong negative correlation (BARBETTA, 2006; FIGUEIREDO FILHO; SILVA JÚNIOR, 2009).

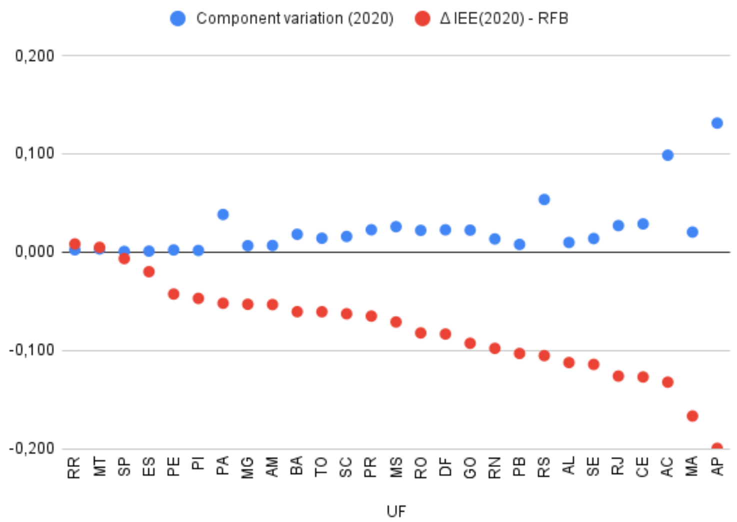


Figure 4 – Relational component variation for 2020 and the difference between the IEE (2020) and RFB, by UF

When testing the correlation of the variation of the relational components to the difference between IEE and RFB in the data set for the historical series, r assumes a very similar value of -0,657. In other words, the moderately strong negative correlation found in 2020 is replicated in the overall picture of the historical series. The linear correlation is illustrated in Figure 5, further below.

Up to this point, the analysis suggests that the main factors that should be considered in explaining the performance in the IEE are: *(i)* WT (r = 0,661); *(ii)* the variation in relational components (r = -0,657); TCS (r = 0,628) and (iv) UWS (r = 0,477). It should be noted that in *"ii"*, the correlation is negative, meaning that smaller variations between the values of relational components generally correspond to higher values of the IEE.

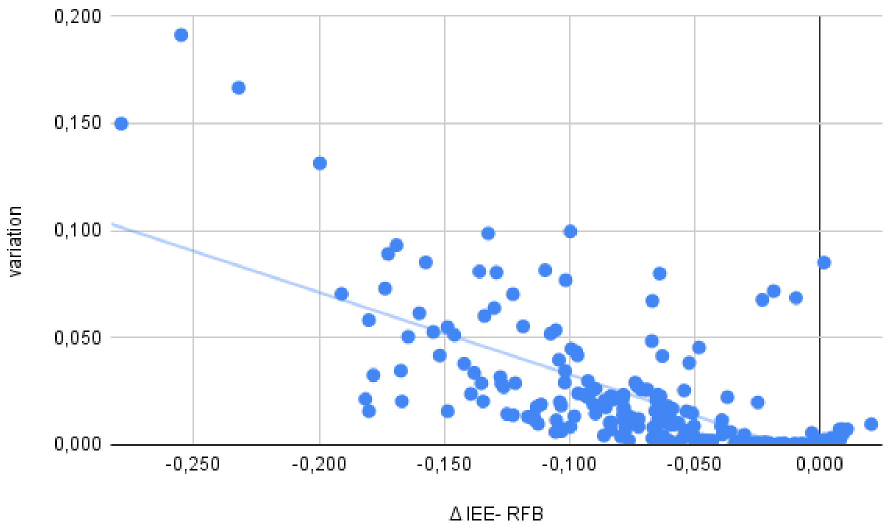
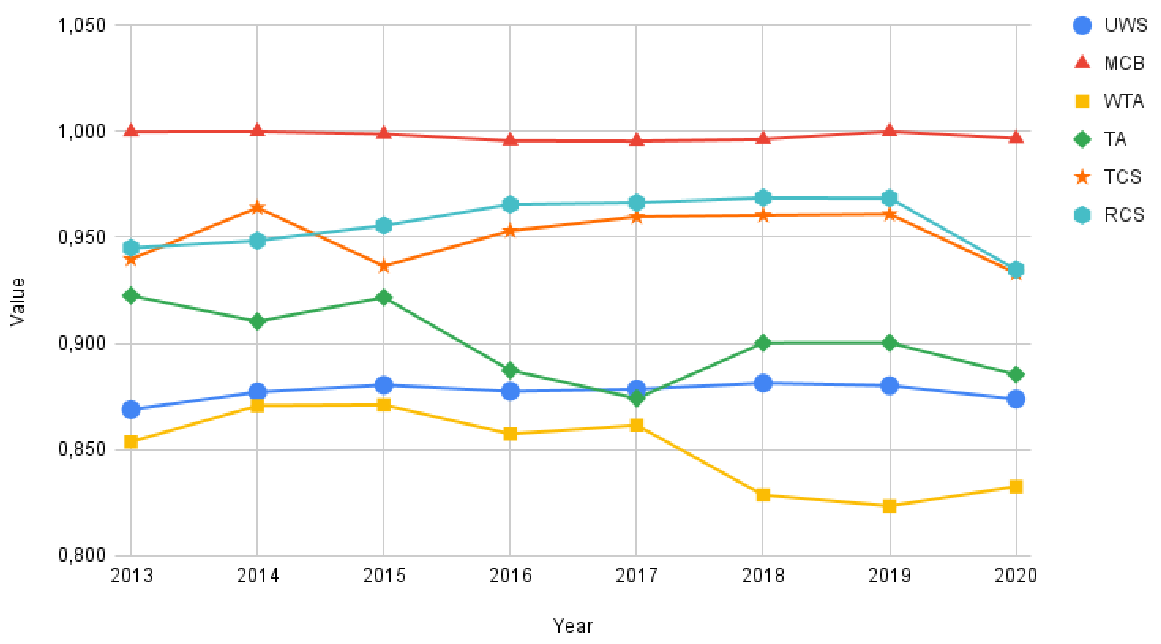


Figure 5 – Dispersion of relational component variation for 2020 and the difference between the IEE (2020) and RFB for the UFs

After coming to this partial conclusion, it is feasible to turn to a different methodology-related query: which elements of the right to water demonstrated improvement or deterioration over the series? The longitudinal trajectory of the parameterized variables, or relational components, is shown in Figure 6.

Upon comparing 2013 and 2020, the only component that ended the series with a value higher than it had in the beginning was the *universalization of service* (UWS), with a small increase of 0,005 to the initial value. The other variables underwent deterioration. None of them, however, are significant in scale, the variation value does not reach the first decimal place. The most significant deteriorations are found in *water transparency* (WT, with -0,037), *water tariff affordability* (WTA, with -0,021), and compliance with the *standard for residual chlorine* (RCS, with -0,010). In other words, although in small proportions, Brazilians drank water that was more turbid, more expensive, and with more residual chlorine in 2020 than in 2013. The deterioration in water-quality-related variables raise the issue of likely adverse health impacts in the Brazilian population. This possible correlation, however, remains subject to further inquiry.



Where:

UWS – Universalization of water service

MCB – Minimal consumption benchmark compliance

WTA – Water tariff affordability

WT – Water Transparency

TCS – Total coliforms standard compliance

RCS – Residual chlorine standard compliance

Figure 6 – Values for aggregate Brazilian UFs between 2013 and 2020, by relational component

Another question to consider is: what do the data reveal about inequalities in the fruition of the right to water in urban contexts in Brazil? In regional terms, the analysis shows that the highest levels of fruition are in the Southeast, and the lowest in the Northeast. The positions remain unchanged whether the analysis is done in relation to the average IEE of the historical series by region, or by considering the last available year, as shown in Table 2:

Table 2 – Parallel rankings of the average 2013-2020 IEE and of the 2020 IEE for the right to water, by Brazilian region

Position	Average IEE	Region	Posição	2020 IEE	Region
1º	0,959	SOUTHEAST	1º	0,948	SOUTHEAST
2º	0,939	CENTER-WEST	2º	0,939	CENTER-WEST
3º	0,924	SOUTH	3º	0,922	SOUTH
4º	0,912	NORTH	4º	0,918	NORTH
5º	0,907	NORTHEAST	5º	0,903	NORTHEAST

Source: authors' elaboration based on data from SNIS, Ipeadata and IBGE.

Table 3 below demonstrates that while the highest concentration of IEE values in the Southeast falls within the range of 0,950 to 0,999, in the other regions the most frequent occurrence is between 0,900 to 0,949. All regions have occurrences within the range of 0,850 to 0,899, but only the North and Northeast have occurrences within the range of 0,800 to 0,849. The analysis by range shows that the North is the region with the highest absolute and percentage incidence of IEE values ≥ 1,000; the Southeast, in the range of 0,950 to 0,999; the Center-West, in the range of 0,900 to 0,949, and the Northeast, in the range of 0,850 to 0,899. The South does not occupy the highest percentage incidence in any of the ranges, with intermediate positions in all of them. The distributions help understand the positioning of the regions in the ranking previously presented in Table 2. It should be noted that Table 3 has a total of 216 cases, corresponding to the multiplication of 27 UFs by 8 years.

Table 3 – Count (*n*) and percentual incidence of the UFs in IEE ranges in the 2013-2020 period, by region

IEE range	Southeast	Center-West	South	North	Northeast	Sum
≥ 1,000	1 (3,1%)	5 (15,6%)	0 (0%)	6 (10,7%)	0 (0%)	12 (5,6%)
0,950 a 0,999	20 (62,5%)	3 (9,4%)	4 (16,7%)	7 (12,5%)	11 (15,3%)	45 (20,8%)
0,900 a 0,949	9 (28,1%)	21 (65,6%)	14 (58,3%)	23 (41,1%)	32 (44,4%)	99 (45,8%)

0,850 a 0,899	2 (6,3%)	3 (9,4%)	6 (25%)	10 (17,9%)	20 (27,8%)	41 (19%)
0,800 a 0,849	-	-	-	7 (12,5%)	9 (12,5%)	16 (7,4%)
0,750 a 0,799	-	-	-	1 (1,8%)	-	1 (0,5%)
0,700 a 0,749	-	-	-	2 (3,6%)	-	2 (0,9%)
Sum	32 (100%)	32 (100%)	24 (100%)	56 (100%)	72 (100%)	216 (100%)

Source: authors' elaboration based on data from SNIS, Ipeadata and IBGE.

It is worth noting the distribution of the last column of Table 3, in percentage terms, through Figure 7, below.

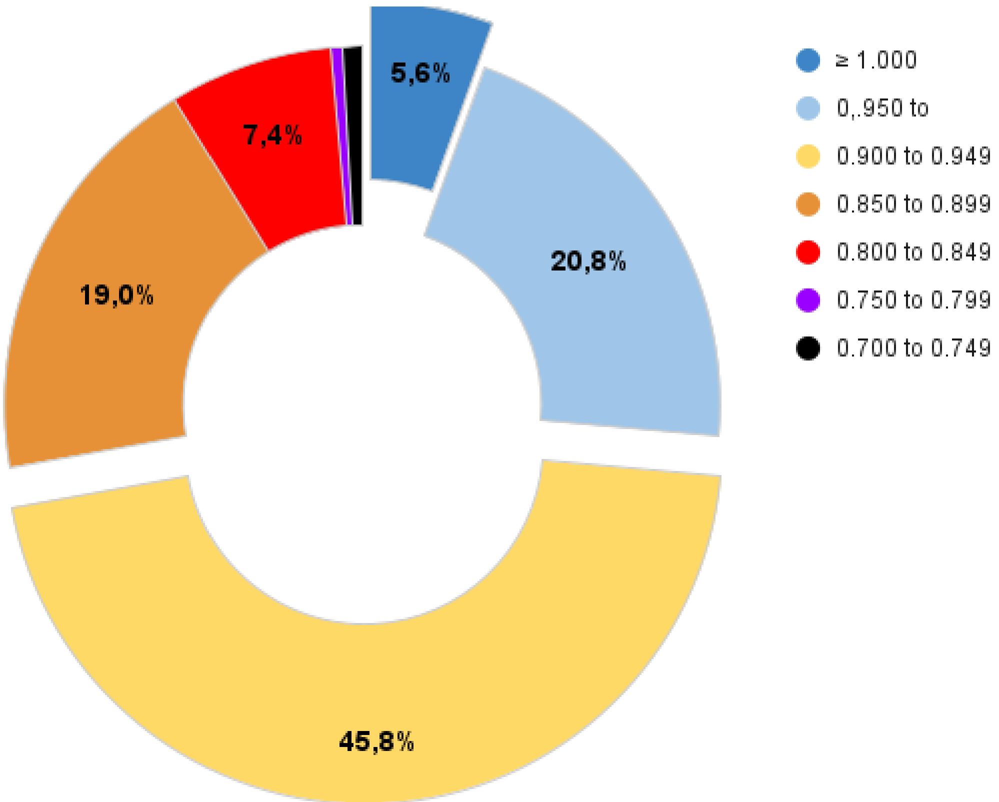


Figure 7 – UF incidence in IEE ranges for the 2013-2020 period, in percentages

Only 5,6% of the IEE measurements, throughout the historical series, resulted in legally adequate levels of enjoyment of the right to water. The incidences in this range are highlighted in Table 1, at the beginning of the results and discussion section. There is a predominance of states in the Northern region, with the main participation of Roraima (RR). Roraima's performance contrasts with the Northern region's average, which ranks second to last in the regional ranking of Table 2. However, the majority of incidences are in the range of 0,900 to 0,949, accounting for 45,8% of the results. And the region whose UFs tend to typically fall into this range, in relative terms, is the Center-West. Although the UFs of the Northern and Northeastern regions also tend to fall predominantly into this same range, the “tail” of the distribution is longer for these regions, which have more cases in lower IEE value ranges. Altogether, 8,8% of the IEE incidences are in lower ranges (below 0,849), and all of these cases are concentrated in the North and Northeast regions.

The assessments conducted in this section indicate disparities in the fruition of the right to water in urban contexts in Brazilian states. They also make it possible to identify priority areas for reform in the public policy of urban water supply, according to the needs identified through the comparison of indicators. These points are highlighted in the final remarks below.

The present study used “Google Sheets” for data tabulation, analysis, graph generation, and the application of statistical tests.

4. FINAL REMARKS

The application of Positional Analysis methodology allowed for the construction of an Index of Empirical Effectiveness (IEE) for the right to water in urban contexts in Brazilian federal units (UFs), between 2013 and 2020, encompassing dimensions such as: (i) availability and physical accessibility, (ii) affordability, and (iii) quality, safety, and acceptability of water. The creation of this indicator was based on the parameterization of variables such as: *universalization of water service* (UWS), *minimum consumption benchmark* (MCB) compliance, *water tariff affordability* (WTA), *water transparency* (WT), compliance with *total coliform standards* (TCS), and compliance with *residual chlorine standards* (RCS).

The data analysis showed that Roraima (RR) and Mato Grosso (MT) were the only states that reached legal validation thresholds for the fruition of the right to water at the end of the covered period. In particular, Roraima (RR) was the only UF whose average performance throughout the series is higher than the established Rights Fruition Benchmark (RFB). When the right to water performance in 2020 is ranked, Roraima (RR), Mato Grosso (MT), and São Paulo (SP) appear in the top three positions, and Amapá (AP), Maranhão (MA), and Acre (AC) in the bottom three.

In the best cases, the dimensions most frequently associated with higher levels of right to water performance were *water tariff affordability* and the availability/physical accessibility of water, especially in terms of *compliance with the minimum consumption threshold* (MCB). In the worst cases, the most compromised aspects were the availability and physical accessibility of water, mainly due to deficiencies

DOI: 10.12957/rdc.2024.75172 | ISSN 2317-7721

in *the universalization of service* (UWS), and the quality, safety, and acceptability of water, due to unsatisfactory performance *in total coliforms* (TCS) and *water transparency* (WT).

Roraima's higher performance contrasts with the average performance of the Northern region, to which the state belongs. In terms of regions, the highest levels of enjoyment of the right to water are successively found in the Southeast, Center-West, South, North, and Northeast regions. Overall, the most common incidence of UFs in terms of the IEE of the right to water in urban contexts in Brazil, in the analyzed period, was in the IEE-range of 0,900 to 0,949, representing differences of 5 to 10% deficit compared to the legal validation threshold established by the RFB. Only 5,6% of the incidences are within the validation range, that is, of IEE ≥ 1.

In aggregate spatial and longitudinal terms, there is minimal variation (Δ = -0,009) in the average performance of the IEE for Brazilian UFs between 2013 and 2020. That is, when Brazil's performance over the historical series is considered, there is stability in the fruition of the right to water in urban contexts, despite the slight decline; measured, however, in the scale of the third decimal number place. Still, there are longitudinal movements in the performance of the components of the right to water, with a slight improvement in *universalization of service* (UWS) – also in the third decimal place – being counterbalanced by more significant deteriorations (in the second decimal place) in *water transparency* (WT), *tariff affordability* (WTA), and *compliance with the standard for residual chlorine* (RCS, with -0,010). That is, while a higher percentage of Brazilians gained access to water in urban contexts, the consumed water became, on average, more turbid, more expensive, and with more residual chlorine over time. The deficiencies in the enjoyment of the right to clean drinking water in Brazil can lead to risks of waterborne diseases in the population, a decline in the quality of life, and an increase in costs in the public health sector.

It is important to distinguish between the examination of average performance and those factors which have most affected how UFs scored in relation to the IEE of the right to water. There is a positive and moderately strong correlation between IEE values and variables such as *water transparency* (r = 0,661) and *standard compliance for total coliforms* (r=0,628). The correlation is only moderate for the *universalization of water service* (r = 0,477). A moderately strong negative correlation was also found between the variation in performance of the relational components and the difference of IEE to the RFB (r = -0,657). The correlations suggest that the best cases correspond to UFs that achieved, in this order: *(i)* better levels of *water transparency* (WT), *(ii)* less variation in the behavior of the relational components that integrate the IEE, and better performance *(iii)* in *compliance with the standard for total coliforms* (TCS) and *(iv)* in *universalization of water service* (UWS). They also suggest that the contrary is true for the worst cases, in a *vice-versa* rationale.

It is then possible to answer the previously raised question: what are the priority points for reform in the public policy of urban drinkable water supply, according to the needs identified through the comparison of indicators? It is noted that the strongest correlations involve the dimensions of: (i) water quality, safety and acceptability, with emphasis on the variables *of water transparency* (WT) and *compliance with the standard for total coliforms* (TCS); and (ii) physical availability and accessibility, highlighting the aspect of *universality of water service* (UWS). Thus, reforms in the public policies of urban water supply should prioritize the control of the turbidity of the water and the presence of total coliforms outside the standards defined by Ordinance 888 of 2021 of the Ministry of Health. And secondly, they should aim at intensifying the expansion of urban water supply infrastructure, with a view to levels of urban service closer to universalization, as envisaged by SDG 6.

It should be noted, however, that these reform recommendations, formulated from the assessment of the overall scenario of Brazilian UFs between 2013 and 2020, do not necessarily imply appropriateness to guide reforms in specific contexts. The general findings of the study are convergent with the aspects identified as being the most compromised in the worst cases (Amapá – AP –, Maranhão – MA – and Acre – AC), which are also linked to deficiencies in the universalization of water service and in the quality, safety and acceptability of water, due to unsatisfactory performance in *total coliforms* (TCS) and *water transparency* (WT). Accordingly, these cases, in particular, contribute to the validation of the main findings. However, the priorities for each subnational state are different. In Amapá (AP), the biggest shortcoming is in urban service reach; in Maranhão (MA), in total coliforms indices, and in Acre (AC), in the turbidity of water As a result, the basic conclusions do not exclude the need for a comprehensive examination of the key weaknesses of each scenario. The methodology used in this survey can be replicated for specific diagnosis of the situation of each specific subnational state, in addition to the three states previously pointed out, in the search for contextually-appropriate priority points of attention for reforms in the public policy of urban water supply.

REFERENCES

BALLESTERO, A. What is in a percentage? Calculation as the poetic translation of human rights. **Indiana Journal of Global Legal Studies**, v. 21, n. 1, p. 27–53, 2014.

BARBETTA, P. A. **Estatística aplicada às ciências sociais**. 6. ed. Florianópolis: Editora da UFSC, 2006.

BRASIL. **Decree 11.598, of July 12th, 2023a.** Regulates article 10-B of Law 11.445, of January 5th, 2007[...]. Available at: http://www.planalto.gov.br/ccivil_03/_ato2023-2026/2023/decreto/D11598.htm. Accessed: Oct. 14th, 2023.

BRASIL. **Decree 11.599, of July 12th, 2023b**. Regulates the regional provision of public basic sanitation services [...]. Available at: https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2023/decreto/D11599.htm. Accessed: Oct. 14th, 2023.

BRASIL. **Law 10.257, of July 10th, 2001**. Regulates articles 182 and 183 of the Federal Constitution, establishes general guidelines for urban policy, among other provisions. Available at: https://www.planalto.gov.br/ccivil_03/leis/leis_2001/l10257.htm. Accessed: Oct. 14th, 2023.

BRASIL. **Law 11.445, of January 5th, 2007**. Establishes national guidelines for basic sanitation [...].Available at: https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/l11445.htm. Accessed: Oct. 14th, 2023.

BRASIL. **Law 14.026, of July 15th, 2020**. Updates the legal framework for basic sanitation [...].Available at: https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/lei/l14026.htm. Accessed: Oct. 14th, 2023.

BRZEZINSKI, M. L. N. L. O direito à água no direito internacional e no direito brasileiro. **Confluências**, v. 14, n. 1, p. 60–82, 2012.

CÂMARA DOS DEPUTADOS. **PEC 6/2021 (Fase 1 - CD)**. Available at: <https://www.camara.leg.br/propostas-legislativas/2277279>. Accessed: April 9th, 2023.

CASTRO, L. C. N. DE. **Políticas públicas, indicadores e direito: um estudo jurídico do programa de combate às arboviroses do Distrito Federal**. Dissertação (Mestrado em Direito)—Brasília: UnB, 2022.

CASTRO, L. C. N. DE; CASTRO, M. F. DE. A efetividade do direito à saúde de parturientes no Brasil: uma abordagem à luz da análise jurídica da política econômica. **Revista de Estudos Empíricos em Direito**, v. 7, n. 3, p. 146–162, 2020.

CASTRO, M. F. DE. Análise Jurídica da Política Econômica. Em: CASTRO, M. F. DE; FERREIRA, H. L. P. (Eds.). **Análise Jurídica da Política Econômica: a efetividade dos direitos na economia global**. Curitiba: CRV, 2018a. p. 109–148.

CASTRO, M. F. DE. Direito, tributação e economia no Brasil: aportes da análise jurídica da política econômica. Em: CASTRO, M. F. DE; FERREIRA, H. L. P. (Eds.). **Análise Jurídica da Política Econômica: a efetividade dos direitos na economia global**. Curitiba: CRV, 2018b. p. 373–394.

CASTRO, M. F. DE. A dimensão econômica da efetividade dos direitos fundamentais. **Revista Semestral de Direito Econômico**, v. 1, n. 2, p. 1–37, 2021.

CASTRO, M. F. New legal approaches to policy reform in Brazil. **University of Brasília Law Journal**, v. 1, n. 1, p. 31–61, 2014.

CINI, R. DE A.; ROSANELI, C. F.; FISCHER, M. L. Direito humano à água e bioética: revisão da literatura latino-americana com foco na realidade brasileira. **Agua y territorio**, v. 14, p. 105–114, 2019.

DESROSIÈRES, A. How to make things which hold together: social science, statistics and the state. Em: **Discourses on society**. Dordrecht: Springer, 1990. p. 195–218.

FANTINI, E. An introduction to the human right to water: Law, politics, and beyond. **WIREs Water**, v. 7, n. 2, p. 1–8, 2020.

FIGUEIREDO FILHO, D. B.; SILVA JÚNIOR, J. A. Desvendando os Mistérios do Coeficiente de Correlação de Pearson (r). **Revista Política Hoje**, v. 18, n. 1, p. 115–146, 2009.

FONTES, D. K.; CASTRO, M. F. DE. Some new ideas on the role of legal analysis applied to the regulation of telecommunications services in Brazil. **Revista de Direito Setorial e Regulatório**, v. 2, n. 1, p. 1–30, 2016.

GONÇALVES, O. O.; AZOIA, V. T. Os aspectos econômicos da tarifa mínima de água a partir da Lei 13.312/2016. **Revista de Direito da Cidade**, v. 9, n. 4, p. 1450–1474, 2017.

HOEKSTRA, A. Y.; BUURMAN, J.; VAN GINKEL, K. C. H. Urban water security: A review. **Environmental Research Letters**, v. 13, n. 5, p. 1–14, 2018.

HOWARD, G.; BARTRAM, J. **Domestic water quantity, service level and health**. World Health Organization - WHO/SDE/WSH/03.02, , 2003. Available at: <https://apps.who.int/iris/bitstream/handle/10665/67884/WHO_SDE_WSH_03.02.pdf>. Accessed: March 24th, 2023

LIMA, A. J. R. DE; CASTRO, C., Marcus Faro de. Policy reform with new legal tools: the example of the legal analysis of the Individual Micro-entrepreneur Program. **Revista Jurídica da Presidência**, v. 19, n. 117, p. 41–70, 2017.

LOFTUS, A. J.; SOUSA, A. C. A. DE. (In) segurança hídrica: garantindo o direito à água. **GEOUSP Espaço e Tempo (Online)**, v. 25, n. 2, 12 ago. 2021.

MACHADO, C.; OLIVEIRA, R. R. Water for life: natural resource and essential human rights to sustainable development. **Revista de Direito da Cidade**, v. 11, n. 4, p. 302–321, 2019.

MCDONALD, R. I. et al. Urban growth, climate change, and freshwater availability. **Proceedings of the National Academy of Sciences**, v. 108, n. 15, p. 6312–6317, 12 abr. 2011.

MEIER, B. M. et al. Examining the Practice of Developing Human Rights Indicators to Facilitate Accountability for the Human Right to Water and Sanitation. **Journal of Human Rights Practice**, v. 6, n. 1, p. 159–181, 1 mar. 2014.

MELLO, J. R. DE; FERREIRA, H. L. P. Diferenciais raciais na fruição do direito à infância e adolescência compatíveis com o ECA no Brasil, em 2019. Em: MAEDA, P. (Ed.). **Diversidade: direitos humanos para todas as pessoas**. Campinas: TRT 15, 2022. p. 27–46.

MINISTÉRIO DA INTEGRAÇÃO E DO DESENVOLVIMENTO REGIONAL. **SNIS**. Available at: <https://www.gov.br/mdr/pt-br/assuntos/saneamento/snis/snis-1>. Accessed: April 9th, 2023.

MINISTÉRIO DA SAÚDE. **Portaria nº 888, de 4 de maio de 2021**. Available at: < https://bvsms.saude.gov.br/bvs/saudelegis/gm/2021/prt0888_07_05_2021.html>. Accessed: October 14th, 2023.

MOREIRA, C. F.; CASTRO, M. F. DE. A análise jurídica da política econômica aplicada ao Programa Minha Casa, Minha Vida: um estudo de caso de Brasília (2014-2017). **Revista de Direito da Cidade**, v. 12, n. 2, p. 528–564, 2020.

MOURA, E. A. DA C.; TORRES, M. A. DE A.; MOTA, M. J. P. DA. Por uma Teoria do Direito Constitucional da Cidade. **Revista de Direito da Cidade**, v. 14, n. 4, p. 2847–2873, 2022.

NEVES-SILVA, P.; MARTINS, G. I.; HELLER, L. "A gente tem acesso de favores, né?". A percepção de pessoas em situação de rua sobre os direitos humanos à água e ao esgotamento sanitário. **Cadernos de Saúde Pública**, v. 34, n. 3, p. 1–10, 2018.

NUNES, C. M.; ANDERAOS, A.; ARAÚJO, C. L. M. The 2020 Reform of the Water and Sanitation Services Sector in Brazil. **BRICS Law Journal**, v. 8, n. 2, p. 66–88, 2021.

SANTOS, D. F. DOS; FERREIRA, K. R.; FERREIRA, H. L. P. O direito à isonomia racial nas abordagens policiais: análise jurídica do viés racial na letalidade policial no Brasil, em 2020. **Revista Direitos Sociais e Políticas Públicas (UNIFAFIBE)**, v. 10, n. 3, p. 55–81, 2022.

SCHIFF, J. Measuring the human right to water: An assessment of compliance indicators. **WIREs Water**, v. 6, n. 1, p. 1–10, 2019.

SHI, S. et al. Evaluation of urban water security based on DPSIR model. **IOP Conference Series: Earth and Environmental Science**, v. 880, p. 1–11, 2021.

SILVA, J. I. A. O.; FARIAS, T. Q. A tutela jurídica do ciclo urbano da água: linhas preliminares. **Revista de Direito da Cidade**, v. 12, n. 1, p. 366–389, 2020.

SULTANA, F.; LOFTUS, A. The human right to water: critiques and condition of possibility. **Wiley Interdisciplinary Reviews: Water**, v. 2, n. 2, p. 97–105, 2015.

UNITED NATIONS. **General Assembly Adopts Resolution Recognizing Access to Clean Water, Sanitation as Human Right, by Recorded Vote of 122 in Favour, None against, 41 Abstentions**. Available at: <https://press.un.org/en/2010/ga10967.doc.htm>. Accessed: April 10th, 2023.

VARELA, A. DE F. Mobilidade urbana, transporte e direito no Brasil: uma abordagem crítica. Em: CASTRO, M. F. DE; FERREIRA, H. L. P. (Eds.). **Análise Jurídica da Política Econômica: a efetividade dos direitos na economia global**. Curitiba: CRV, 2018. p. 323–346.

WESTSTRATE, J. et al. The Sustainable Development Goal on Water and Sanitation: Learning from the Millennium Development Goals. **Social Indicators Research**, v. 143, n. 2, p. 795–810,. 2019.

Sobre os autores:

Hugo Luís Pena Ferreira
Doutor em Direito pela Universidade de Brasília (UnB). Professor do curso de Direito da Universidade Federal de Jataí.
Universidade Federal de Jataí (UFJ), Jataí - GO
ORCID: https://orcid.org/0000-0003-2647-6616
URL: http://lattes.cnpq.br/2438328359443143
E-mail: hugopena@ufj.edu.br

Daniela Silva Amaral
Graduada em Direito pela Universidade Federal de Jataí (UFJ). Advogada.
Universidade Federal de Jataí (UFJ), Jataí – GO
ORCID: http://orcid.org/0009-0001-6264-072X
URL: http://lattes.cnpq.br/5191442035531634
E-mail: danielaamaral613@gmail.com