water

MDPI

Article

Reaching Universal Coverage of Water and Sanitation Services: Is Regionalization a Sustainable Path for Developing Countries?

Willian Narzetti [1,2], Francisco Silva Pinto [3,4,*], Daniel Narzetti [3] and Tiago Cetrulo [5,6]

[1] POLITEIA, University of the State of Santa Catarina (UDESC), Av. Me. Benvenuta, 2007 Itacorubi, Florianópolis 88035-001, SC, Brazil; williannarzetti@gmail.com
[2] CIGAT, University of the State of Santa Catarina (UDESC), Av. Lourival Cesario Pereira, s/n, Nova Esperança, Balneário Camboriú, Florianópolis 88336-275, SC, Brazil
[3] CERIS, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal; danielnarzetti@gmail.com
[4] EIGeS, Faculdade de Engenharia, Universidade Lusófona, Campo Grande 376, 1749-024 Lisboa, Portugal
[5] School of Arts, Sciences and Humanities, University of São Paulo (USP), 1000 Rua Arlindo Bettio, USP Leste, São Paulo 03828-000, SP, Brazil; tiagocetrulo@gmail.com
[6] Federal Institute of Rio Grande do Sul (IFRS), 7000 Av. Senador Salgado Filho, Viamão 94440-000, SC, Brazil
* Correspondence: p6701@ulusofona.pt

Abstract: Achieving universal access to water and sanitation services in developing countries requires a coherent legal, political, and institutional environment, along with a clear financial strategy. Regionalizing utilities may be crucial for addressing disparities, economic inequalities, and governance challenges. Regionalization offers economies of scale, resource efficiency, knowledge sharing, and collaboration. The cornerstone will be ensuring the financial-economic viability of regional utilities, considering their social impacts in terms of affordability. A case study of the state of Santa Catarina (Brazil) is assessed. In the case of Santa Catarina, only four regional utilities currently generate sufficient revenue, without factoring in necessary investments, indicating the need to review design parameters to improve operational efficiency and increase revenues. Additional financial support may be required to ensure universal access. Tariff adjustments must strike a balance between cost effectiveness and affordability for families.

Keywords: water and sanitation services; water governance; universal access; financial-economic capacity; sustainability; regionalization

Citation: Narzetti, W.; Pinto, F.S.; Narzetti, D.; Cetrulo, T. Reaching Universal Coverage of Water and Sanitation Services: Is Regionalization a Sustainable Path for Developing Countries? *Water* **2023**, *15*, 2756. https://doi.org/10.3390/w15152756

Academic Editor: Helvi Heinonen-Tanski

Received: 5 June 2023
Revised: 26 July 2023
Accepted: 26 July 2023
Published: 30 July 2023

1. Introduction

To achieve universal access to water and sanitation services (WSSs), a substantial investment of approximately USD 1.7×10^{12} will be necessary [1], requiring a more collaborative approach in which all stakeholders play an active role [2]. Further significant investments are required to fully achieve the Sustainable Development Goals (SDGs), e.g., covering water resources management and irrigation [3]. Due to the importance of water resources to civilization, there is a potential for conflicts within and between any administrative level, for which two main issues arise: the depletion of supplies and deterioration of quality. These issues emphasize the urgent need for sustainable practices to preserve and enable access to water resources for future generations. The worldwide financing needed to achieve universal access to WSSs is significant and has been scant historically. However, the significance of this amount should be considered within the context of the global economy, as it accounts for "only" 0.10% of the GDP of low- and middle-income countries [4].

The limited access to adequate WSSs is due in part to the poor governance regime stemming from a misalignment in public policies, institutions, and regulations (PIRs),

which does not allow for sufficient complementarity between policy objectives, instruments, and the wider political context, i.e., it does not foster a coherent policy environment and, thus, compromises policy effectiveness [5]. This situation does not create a favorable operating environment or help establish adequate incentives to achieve the SDGs [6]. In infrastructure investments, an understanding of the processes that drive public spending allocations and their efficiency is essential to ensure equitable and sustainable WSSs [7]. To achieve sustainable WSSs in terms of financial, social, and environmental dimensions, it is essential for legal reforms to be effectively implemented and translated into practical actions [8]. The sustainable development of WSSs depends on significant investments, and the current funding efforts have fallen short of meeting these needs [9,10].

WSS governance may be defined by the institutional, political-economic, and social dimensions of the human-influenced water cycle. Governance is the practice of interaction by actors to coordinate this cycle, engaging in political and power relations while considering technical and planning needs, as well as access to WSS [11,12]. WSS governance often involves the sharing of policy making, responsibilities, development, and execution at different administrative and territorial levels [13]. This challenge translates into considerable issues, namely the differences between territories, the multiple actors involved in WSS policy, the low capacity of subnational governments, fragile institutional structures, an ineffective regulatory framework, and irregular financial management [14,15].

The universalization of access to WSSs, especially for the most vulnerable people in the population, must target the inequality between and within local and regional territories, with different patterns bounded by legal or informal constraints [16]. As an example, peri-urban areas and informal settlements experience a lower access to WSSs, as these territories are often excluded from public policies [17]. WSS public policies should ideally be articulated with other urban and rural development and social progress programs, stimulating employment and income [18]. This multidisciplinary requirement is key to improving territorial resilience to an unpredictable climate [19] or pandemic stressors [20], as well as to mitigating the impacts of inadequate access to WSSs [21].

Water sector challenges, including governance and infrastructure requirements, are pronounced in developing economies, often reflecting and exacerbating existing inequalities. In these countries, territorial segregation may lead to asymmetric situations in terms of capacity (e.g., infrastructure and other resources), and the WSSs may not meet the SDGs. Thus, regionalization may come as a solution, possibly leading to improvements in the following [22]: (1) the service efficiency and/or effectiveness; (2) human resources/capacity development; and (3) accountability and participation. Point (1) can be attained by exploiting scale and scope efficiencies, improved access, and equity in delivery. Point (2) can be attained by building the capacity of smaller local WSSs and allowing them to tap into more qualified human resources. Point (3) can be attained by incorporating civil society in planning and delivery, as well as improved transparency and accountability. Naturally, the aim is to attain a suitable scale able to facilitate investment plans, resulting in improved access to and quality of WSSs, particularly in smaller municipalities where such improvements would otherwise be unattainable. These improvements hinge on the presence of robust governance principles with operational and risk management procedures that are able to enhance efficiency and effectiveness in overall management.

Brazil is an interesting case; despite the advances promoted by, e.g., Law No. 11445/07, the Brazilian population still faces difficulties in accessing WSSs [23,24]. The overall situation of WSSs is alarming with significant asymmetries. Governmental projections (PLANSAB) indicate that Brazil would need to invest around BRL 26×10^9 in WSSs per year, around 0.4% of the annual GDP, in the period of 2013–2033 [25]. (The currency exchange rate monthly averages ranged in 2019, min–max: between USD/BRL, 3.716–4.149; and EUR/BRL, 4.219–4.587. The values refer to 2019 as all the data used in this analysis were, whenever required for comparison purposes, updated to 2019).

However, other studies have calculated that the investments needed to universalize access to WSSs are much higher, e.g., BRL 753×10^9 in the period of 2018–2033, leading

to an average of BRL 47 $\times$ 10^9 per year [26]. The average investment made over the last 10 years was BRL 12 $\times$ 10^9 per year, less than half of the amount required according to PLANSAB. In addition to the low volume of investments, financial flows are unequal and are concentrated in the southern regions, even though the priority should be on the north and northeast regions (those with the greatest deficits). The universalization of WSSs would provide enormous benefits to the country, namely: in terms of direct effects on the sector, generation of employment, income, and taxes; and in terms of indirect benefits, such as reduced health costs, increased productivity, real estate appreciation, tourism, and social welfare [27]. Meanwhile, in this worrying investment scenario, the population without suitable WSSs amounts to almost 35 million people without drinking water services and about 100 million people without sanitation services [28].

The state of Santa Catarina is a particular case in Brazil, where the disparities are significant. While it stands out in a series of quality-of-life indicators and has an HDI of 0.774 [29], ranking third in Brazil, when it comes to WSSs, it faces evident challenges. Thus, the topic of regionalization rises as a possible solution to improve its WSSs, e.g., allowing for sustainable investments able to improve WSS accessibility, as well as regional growth and development. Thus, our research objectives are as follows:

1. Assess the constraints of reaching universal access to WSSs in Santa Catarina (our case study) and the role of regionalization in achieving it.
2. Analyze the financial-economic viability of regional utilities using a cash flow analysis and evaluate the tariff break-even point to support costs and investments to achieve universal access by 2033 (coverage: 99% water supply and 90% sanitation).
3. Evaluate the social impacts, namely the household commitment to WSSs (affordability), and identify the need for direct or cross subsidies.

After this brief introduction, we present the methodology used to assess the viability of regional entities, followed by an empirical analysis, in which the institutional and legal framework is outlined and the results are presented. We conclude with key policy implications and brief remarks, focusing on the importance of establishing an enabling environment through context-appropriate water governance and financing pathways.

2. Methodology

2.1. The Framework: General Remarks

To evaluate the contribution of regionalization of WSS utilities towards achieving universal access, it is crucial to establish an integrated framework that comprehensively assesses their financial-economic and social sustainability. This integration allows us to go beyond the "recovery of recurring opex to keep operations running" [30] and ensure the long-term feasibility of regional utilities while promoting equitable and affordable access to WSSs. The following outlines the key components of the framework:

1. Financial-economic sustainability assessment:
    - Evaluate the financial viability of utilities over a timeframe, considering revenue streams/collection, operational costs, and investment requirements;
    - Analyze the economic viability of services, including cost-effectiveness of service provision and pricing mechanisms;
    - Analyze strategies for revenue diversification, cost optimization, and resource allocation to enhance financial stability.
2. Social sustainability assessment:
    - Evaluate the inclusiveness and equity of WSS provision, considering access across geographic areas, income groups, and marginalized populations;
    - Assess WSS affordability for different income segments.
3. Integrated evaluation:
    - Integrate findings into political decision making, covering strategic planning and policy formulation, to foster improvements (e.g., universal access tows).

By employing this comprehensive framework, regional utilities can assess and strengthen their financial, economic, and social sustainability, ultimately working towards achieving universal coverage of water and sanitation services in an equitable, affordable, and sustainable manner.

2.2. The Financial-Economic Evaluation: Assumptions and Criteria

To effectively attain universal access to WSSs, it is essential to foster diverse revenue streams as part of the enabling environment. Relying solely on traditional funding sources may prove insufficient to meet the substantial investment requirements in infrastructure, maintenance, and service provision. By exploring and promoting alternative revenue streams, we can bolster the financial sustainability of WSS systems. This multi-faceted approach to revenue generation ensures more resilient and robust funding, supporting the long-term viability of "WSSs for all".

Establishing a strong connection between different costs and diverse revenue sources is vital in creating sustainable WSSs [31]. It is crucial to align the costs associated with infrastructure development (and other capital charges), operation, maintenance, and possible opportunity costs and externalities with the corresponding revenue streams [32]. This ensures a balance between financial obligations and available resources. By carefully analyzing cost structures and exploring revenue opportunities, we can establish a coherent financial framework that supports the quality and the affordable accessibility of WSSs for all segments of society. There is a need to ensure revenue from sources such as tariffs, taxes, and transfers (the 3 Ts of OECD, 2019), as well as other streams, e.g., for investment flexibility, such as loans. However, the devil is in the details; the role of cross-subsidization, the characteristics of loans (e.g., soft loans have better interest rates, grace periods, or a combination of both), fund allowances, subsidies, grants, and targeted charges will play a large role. Figure 1 highlights the role of different revenue streams of a financing pathway to achieve water SDGs, e.g., universal access to WSSs.

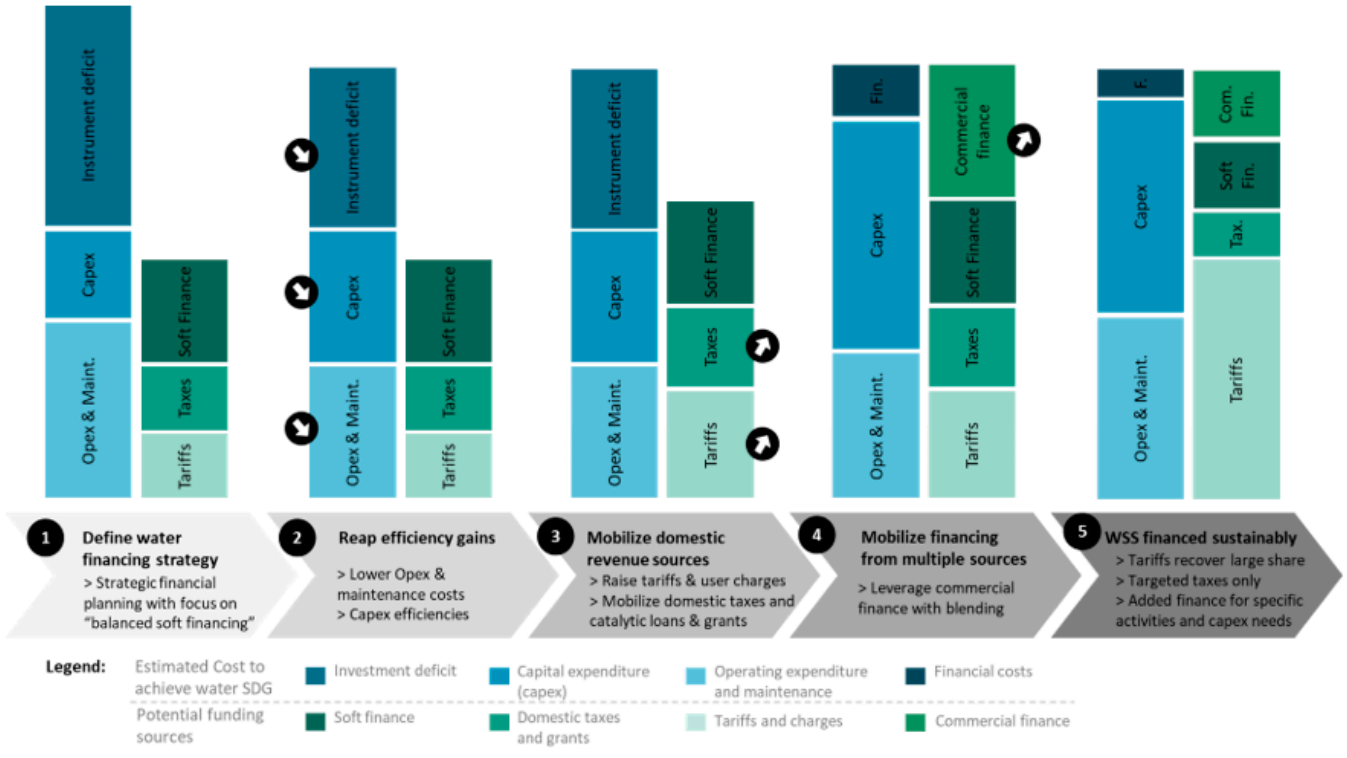

Figure 1. Financing pathway to achieve universal access to WSSs (adapted from [2]).

The financial-economic evaluation relies on a cash flow analysis, considering nominal or current-year prices by default. This approach ensures that relative price changes and price level changes are appropriately accounted for. In specific instances, such as cost–benefit measurements, all values are deflated to a chosen year's price level [33] to maintain consistency. Additionally, a "stock and flow" thinking is employed, utilizing balance sheets and financial statements to enhance transparency and enable accurate tracking of progress and outcomes.

To adequately evaluate a utility's financial position, it is crucial to select appropriate financial-economic indicators from a comprehensive set of financial dimensions. These indicators aim to provide insights into efficiency and operational performance, creditworthiness, and liquidity, as well as profitability. It is important to note that while the selected indicators offer valuable information and highlight areas for further investigation, they do not alone provide definitive answers regarding the financial condition of a utility.

In Table 1, we outline the various dimensions of financial analysis and their underlying rationale [34]. Depending on the context of each case study, such as the availability of information, a suitable set of indicators needs to be chosen. To foster a more representative picture, certain indicators, which may exhibit high volatility from year to year, might be calculated using median or average values extracted from the balance sheets and financial statements over a defined period. Ultimately, the approval of the utility's financial condition will depend on a comparison of each indicator against its respective reference value.

Table 1. Financial dimensions and their rationale.

Dimension	Rationale	Examples
Efficiency	A company's ability to convert their production into cash or income. Provides insight into areas such as collections, cash flow, and operational results.	Working ratio, operating ratio, accounts receivable/collection period, percentage contribution to investment.
Leverage	The overall debt level, the ability to repay new and existing loans, and the dependence on debts as a method of finance.	Debt service coverage ratio, debt to equity ratio.
Profitability	The profit generated by the utility to its sales, equity, or assets. May reflect the efficiency of liquidity, assets, and debt management in operating revenues.	Return on net fixed assets, return on equity, return on sales ratio.
Liquidity	The utility's ability to meet its short-term financial obligations in a timely manner.	Current ratio, quick ratio.

The cost assumptions are contingent upon the investments required to be made within a defined timeframe, particularly to achieve the targets of universalization. The coverage target must be established by considering population projections over the defined timeframe. These projections allow us to estimate the connected and unconnected households, defining the investment needed to achieve the coverage targets. This estimation accounts for the necessity of expansion to accommodate for demographic growth and the extension of coverage to areas where WSSs do not yet reach. In cases in which the population growth rate is zero or negative, a constant population is assumed.

In general, the reference standards respect the assumptions of financial-economic balance of contracts and projects, that is, the required total revenue (TR*) of a certain period is the sum of total costs/expenses (TC), taxes (T), and investment (I). The free cash flow (FCF) is defined as the cash balance available to a company after considering its investments. It serves as an indicator of the company's financial position. The FCF model relies on three key categories of variables to project the cash flow: (a) revenues, (b) operating costs and taxes, and (c) investments. The analysis of the financial-economic model adopted shows the following.

The net present value (NPV) of the project is the sum of cash flows (at present values) over the lifetime of the project [35]; thus, it allows us to determine the present value of

future payments discounted at an appropriate interest rate, minus the cost of the initial investment. NPV represents the present value of an investment and its income [36].

It is the calculation used to measure how much future payments plus an initial cost would currently be worth without neglecting the concept of the time value of money. In this regard, the cost of capital is also an important factor in the regulation of WSSs. Regulators determine the cost of capital provided by investors to the utility and then set tariffs designed to allow the company to earn its cost of capital [37].

The financial-economic balance of a contract or project is achieved when the sum of actual FCF, discounted over time by the predetermined rate of return, equals zero. In other words, it is when the NPV reaches zero. This indicates that the TR generated is sufficient to cover all costs, expenses, taxes, and investments. If the NPV is greater than zero, it means that the expected returns from the project or contract exceed the established benchmarks. If the NPV is less than zero, it indicates that the expected returns fall below the projected/contracted requirements.

2.3. The Affordability Evaluation: Assumptions and Criteria

Performing a comprehensive social impact evaluation of regional utilities is crucial in the pursuit of universal and equitable access to safe, adequate, and affordable WSSs. To effectively assess the social implications of the required investments, it is important to identify the key social dimensions that are relevant to WSS access. In general terms, this covers aspects such as coverage, affordability, service quality, equity, and customer satisfaction. These components should be addressed ex ante when defining the "required investments" and ex post through appropriate self- or third-party regulatory activity. Thus, at this stage, a key factor to assess is the affordability of these investments for the users or the potential downstream costs they may incur.

Affordability, in this context, aims to guarantee that all individuals can access an adequate amount of safe water and adequate sanitation while paying a fair and reasonable price. This justifies providing special support (e.g., subsidies) to low-income households to meet their basic needs [38]. This issue is significant in developing countries characterized by wide income disparities and severe poverty challenges.

In this initial assessment of affordability, we evaluate how the average income of families corresponds to the potential increase in tariffs required for expanding investments and achieving universal access goals. To begin, we calculate the tariff review index (TRI) based on the current average tariff and the required one (to allow us to attain universal access to WSSs under the defined timeframe), which helps us determine the requirements to achieve financial-economic balance. This allows us to establish the average tariff required to achieve universalization. By using this information, we can calculate the disposable income commitment to WSSs. The results of this calculation, specifically the percentage of income commitment, are then compared to the affordability thresholds set by the United Nations (UN). The UN recommends that the portion of disposable income allocated to WSSs for a standardized amount of water should be below 5% [39]. Comparing the results to established affordability benchmarks helps us assess the financial burden on households (according to their income level) and determine if additional measures, such as subsidies, are needed to ensure affordable and equitable access to WSSs.

Based on the findings, specific strategies, policies, or programs can be proposed to enhance affordability. These recommendations can inform future decision making and guide the utility's efforts to improve its social impact.

3. Empirical Analysis: State of Santa Catarina, Brazil

3.1. The Legal, Institutional, and Operational Context

Federal Law n.º 14026/2020 established targets for providing 99% of the population with drinking water and 90% with sewage collection and treatment by 2033. However, this is an audacious goal for the state of Santa Catarina, which currently has 90% water supply coverage and 25% sewage network coverage (of which 94% is treated) [28]. This section

is dedicated to presenting the legal and institutional context in the state of Santa Catarina for achieving these goals. The effective responsibility for implementing and promoting access to services lies with the municipality and the service holder, which can provide these directly or through delegation. Regarding regulators, their functions are established by Article 22 of Law No. 11445/07, namely, creating standards and norms and ensuring compliance with the conditions and goals defined in contracts and WSS plans. In addition, they must define reasonable tariffs that balance the financial and economic sustainability of operators. Specifically, for the universalization of services, in accordance with Law No. 11445/07, the service holder must prepare a Municipal WSS Plan (MWSSP), which should include investment plans and the expansion of service coverage. If the municipality delegates the provision of services, the contracts must include these goals. In this context, the role of regulatory agencies is to require service providers (directly or through delegation) to comply with the goals, investments, and indicators set out in contracts or in the MWSSP.

Regarding the legal status of service providers (Figure 2), most (62.7%) of the 295 municipalities in the Metropolitan Regions (MR) of the state of Santa Catarina are supplied by a mixed-capital company, Casan (Catarinense WSS Company, headquarters in Florianópolis, Brazil). The second largest group of municipalities are delivered through direct public administration (18.01%) or indirect public administration (14.47%). Finally, there are those supplied by private companies (4.5%) or public companies (0.32%). However, there are changes in these proportions when looking at the actual population covered. Mixed-capital companies supply 43% of the population, direct public administration supplies 10%, indirect public administration supplies 27%, private companies supply 12%, and public companies cover 8%.

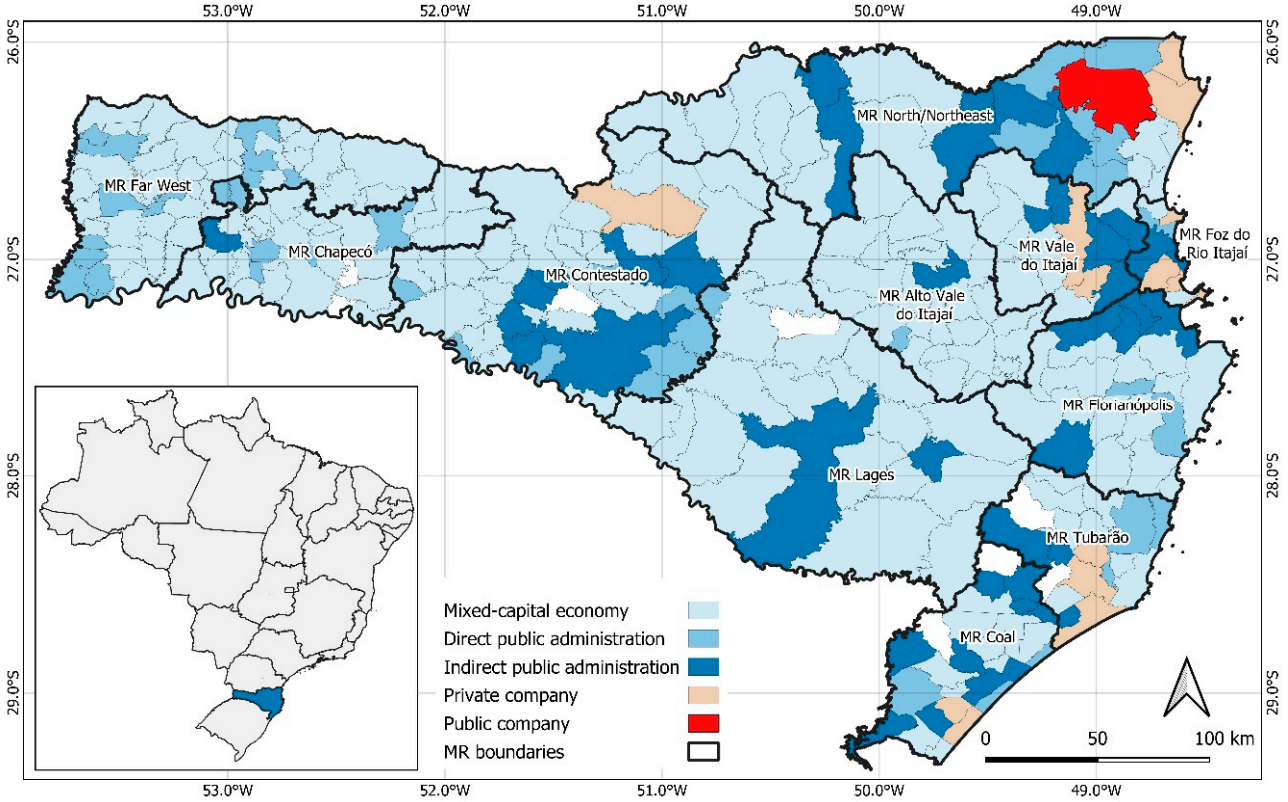

Figure 2. WSS utilities in the state of Santa Catarina per MR.

In Santa Catarina, 99% of the municipalities have a regulatory agency responsible for monitoring the water supply and sewage systems (Figure 3). The state has six regulatory agencies: (a) Agência Reguladora de Serviços Públicos de Santa Catarina—ARESC (state agency), which is responsible for 15% of the municipalities and 25% of the population;

(b) Agência Reguladora Intermunicipal de Saneamento—ARIS (intermunicipal consortium), which is spread out throughout the state, serving 70% of the municipalities and 53% of the population; (c) Agência Intermunicipal de Regulação do Médio Vale do Itajaí—AGIR (intermunicipal consortium), which is responsible for 5% of the municipalities and 11% of the population; (d) Consórcio Intermunicipal de Saneamento Ambiental—CISAM (intermunicipal consortium), which regulates the operators of 13 municipalities in the idwest region, which represents 3% of the population; and € the Agência Reguladora de Saneamento de Tubarão—AGR (municipal agency), which is responsible for the regulation of Tubarão city's utility.

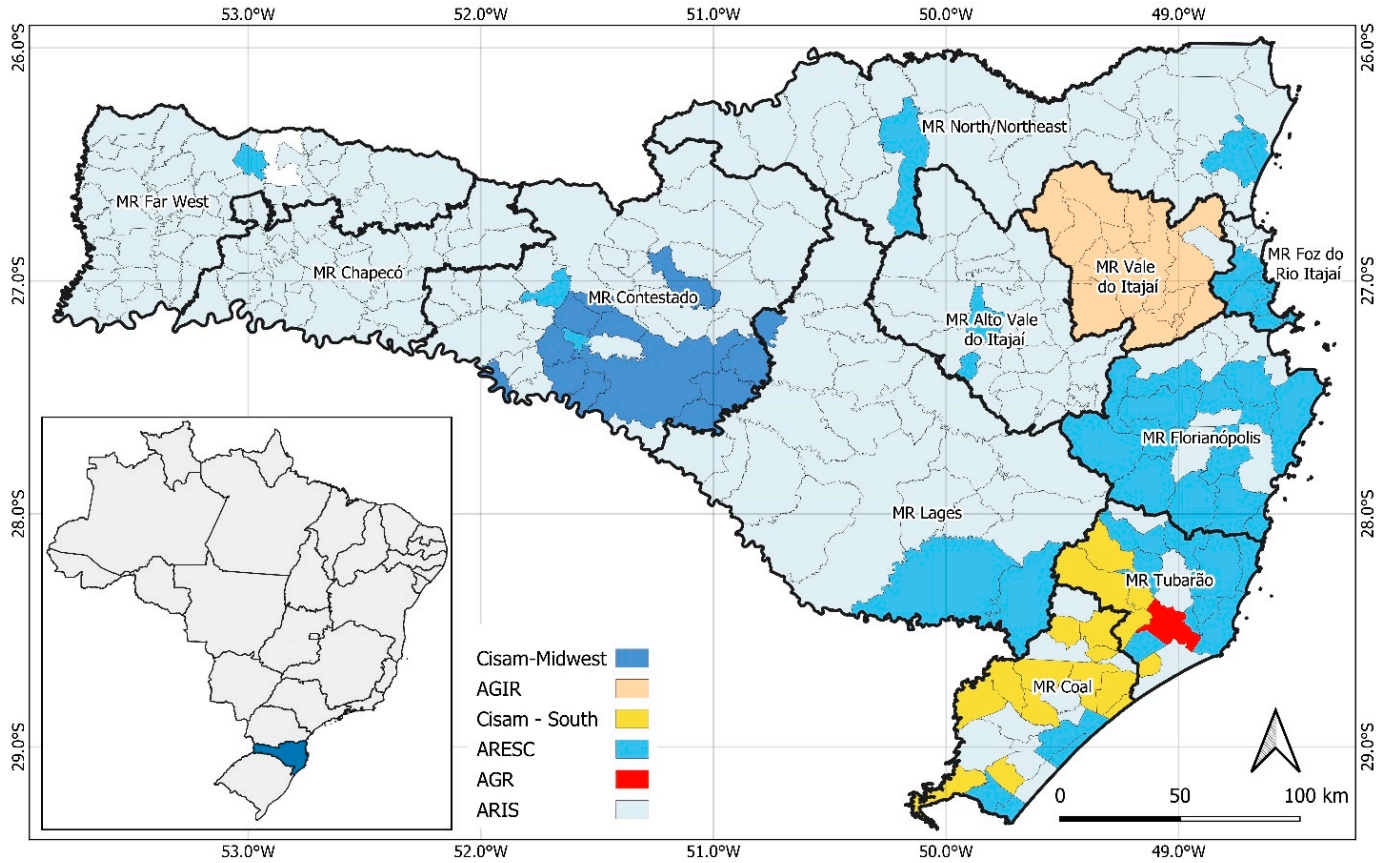

Figure 3. WSS regulatory entities in the state of Santa Catarina.

A criticism of regulation in the state is that a share of the regulators do not effectively exercise all the functions delegated to them (their role is reduced to tariff definition/revision). One of the main factors is the lack of a technical structure to monitor all contracts and the MWSSP. Regarding the decision-making independence of these regulators, it is observed that there is a formal autonomy (de jure) guaranteed by the adopted public administrative models, which provides administrative and financial autonomy. However, in practice (de facto) there are significant concerns regarding political interference [40]. The frequent changes in personnel and positions within the governing body, coupled with financial limitations, contribute to a sense of distrust.

Finally, specific to Santa Catarina is the attempt to promote regional WSSs (Santa Catarina established the regionalization of WSSs through State Decree No. 1372/2021). The regional WSS units were aggregated by MR, according to Complementary Law nº 495, 2010 and Complementary Law No. 636, 2014. The 11 MRs have different characteristics related to their territories, population density, and level of WSS coverage. Only two regions have more than one million inhabitants, the MR North/Northeast of Santa Catarina and the MR of Florianópolis. Nonetheless, to keep the analysis simple and comparable, these MRs were used as territorial blueprints for the regional WSS utilities.

The population dynamics in urban areas demonstrate an average urban population of around 85%, with the highest concentration reaching 96% and the lowest at 58%. To further understand the scope of the challenge of achieving universal access, only "improved" WSSs are considered (as in [41]), including full-network and decentralized (e.g., septic tanks) systems. On average, the territory has a 90% coverage rate for water services (households supplied), with the highest index being 98% and the lowest at 73%. Regarding sanitary sewage services provided through networks, the average coverage stands at approximately 40%, with the best level at about 74% and the worst around 18%. For detailed information on each of the regional utilities, please see Table 2, which provides comprehensive data on the WSS coverage rates and population, emphasizing the proportion of urban residents.

Table 2. Average coverage rate of WSSs and total population per regional utility.

Regional Utility (per MR)	Total Water Service (%)	Urban Water Service (%)	Total Sanitation Service * (%)	Urban Sanitation Service * (%)	Total Population (Src.: IBGE)	% Urban Population (Src.: IBGE)
Coal	87	95	23	31	617,630	84
Foz do Rio Itajaí	98	99	48	49	688,442	96
Chapeco	82	97	32	48	486,044	78
Florianopolis	95	99	45	53	1,209,818	92
Lages	87	100	52	62	355,723	84
Tubarão	85	96	50	61	391,658	79
Alto Vale Itajaí	75	99	74	99	297,821	65
Contestado	85	97	41	50	535,756	77
Far West	73	98	18	33	339,966	58
North/Northeast	93	99	27	29	1,419,518	89
Vale do Itajaí	94	99	20	22	822,412	90

Notes: * The data for sanitation services are frequently inaccurately filled in, which can lead to variations in the estimates.

3.2. Financial-Economic Viability of Regional Utilities

The assessment of the financial-economic viability of regional utilities should be conducted by considering a set of indicators, as outlined in Table 1. The specific indicators chosen for evaluation depend on the context and may vary from case to case, depending on the objective at hand. For instance, if the goal is to evaluate the perspective of stakeholders, the selection of indicators may be facilitated through decision conferences. However, if the objective is to comply with applicable legislation and standardize the analysis, the indicator selection is inherent to the process. Thus, for comparability purposes, the selection will be made through the indicators proposed in Decree 10710/2021 (defined in Table 3) which sets a methodology for evaluating the financial-economic viability of utilities to achieve universal access to WSSs (which is particularly useful for public–private partnerships, PPP). Thus, as defined in Section 2.2, the indicators are calculated through the median values of the data extracted from the balance sheets and statements over the last five financial years. The evaluation is conducted with the reference values for each indicator.

Table 3. Indicators for proof of financial-economic capacity.

Index/Ratio	Dimension	Definition	Factor
Net margin without depreciation and amortization	Profitability	Division between net income (without depreciation and amortization) and operating income.	>0
Indebtedness level	Leverage	Sum between current liabilities and non-current liabilities, divided by total assets.	≤1
Return on equity	Profitability	Division between net income and equity.	>0
Cash sufficiency	Efficiency	Division between the total collection and the sum of exploration expenses, interest expenses, debt charges and amortization, and tax expenses.	>1

Notes: Source: prepared by the authors from Decree 10710/2021.

The cost assumptions, including the required investments to achieve the targets defined in Section 3.1, follow the estimations published by the Ministry of Cities in 2011, duly updated to present values through the National Construction Cost Index (INCC, until 19 December). Thus, it is possible to establish reference values to estimate the required investments to universalize WSSs by 2033. Table 2 presents the average values of the investments to expand the coverage of services.

Since the values in Table 4 depend on the population and the number of households of each region in 2033 (the target date), the values are estimated considering the data available in the National WSS Information System (in Portuguese, SNIS) [28], e.g., the WSS coverage data, and the population growth rate is from the Brazilian Institute of Geography and Statistics (in Portuguese, IBGE). For cases in which the population growth rate is equal to (or less than) zero, a constant population was considered. Depending on the assumptions made regarding population growth projections and the estimated investment requirements for achieving universal access in all cities by 2033 (point 2, Section 1), cash flow projections are made for a 30-year time frame. Thus, using the available information from 2019, projections are made until 2051, and the net present value for each municipality is calculated using a discount rate of 10% per year. The selection of the discount rate is based on two constraints: the recommended national value for infrastructure projects in Brazil (8.5% per annum, as per [42]) and the legal maximum of 12%. As mentioned in the same report, the value of 10% is associated with an average pessimistic scenario, even though it is the most common.

Table 4. Average CAPEX values.

Population	Water Production (BRL/inhab.)	Water Distribution (BRL/Household)	Sewage Collection (BRL/Household)	Sewage Treatment (BRL/inhab.)
5000	386.8	1283.94	2527.02	214.37
50,000	366.9	1283.94	2577.85	203.65
200,000	388.8	1283.94	3357.64	457.21
1,000,000	419.7	1283.94	2682.57	694.83
>1,000,000	398.1	1283.94	2736.52	660.09

Note: The premise established by the Ministry of Cities, 2011, was used and brought to present values (INCC, until 19 December), according to Apud [43].

In a preliminary analysis of the current situation of each regional utility (by aggregating all the respective local utilities), the available information allows us to observe that only four out of the eleven regional utilities are in surplus over a five-year cycle (from 2015 to 2019), as outlined in Table 5.

The required investments to universalize access to WSSs are then compiled into three phases for each regional utility (Table 6). The project is divided into three phases: the first phase spans 5 years, the second phase lasts for 4 years, and the final phase covers a duration of 3 years. These phases are designed to demonstrate the financial resources that each utility must secure for investment purposes. The three phases were defined according to the average short-, medium- and long-term investment requirements for all regional utilities, which determined their duration (i.e., linking the scope of these investments and their time requirements). In the short term, investments focus on expanding infrastructure networks to underserved areas. Medium-term investments involve expanding infrastructure networks to reach more remote regions and marginalized communities, as they require previous licensing initiatives. In the long term, sustainable investments are needed to ensure the ongoing operation, maintenance, and management of WSS systems.

Table 5. Financial results of each regional utility for the 2015–2019 cycle.

Regional Utility (MR)	Total Costs with WSS (M BRL)	Total Revenue with WSS (M BRL)	Balance, without Investments (M BRL)	WSS Investments Undertaken by the Utility over 5 Years (M BRL) *
Coal	843.23	804.00	−39.23	151.37
Foz do Rio Itajaí	1042.33	1465.03	422.70	438.10
Chapecó	583.78	568.33	−15.45	53.02
Florianópolis	2321.59	2535.38	213.79	391.63
Lages	500.20	463.74	−36.46	149.61
Tubarão	456.84	452.70	−4.15	175.46
Alto Vale Itajaí	341.64	315.19	−26.45	108.46
Contestado	624.42	594.62	−29.80	145.22
Far West	356.76	295.66	−61.10	22.04
North/Northeast	1751.79	2070.99	319.20	591.56
Vale do Itajaí	1017.80	1109.78	91.98	245.34

Notes: * There are further investments undertaken by the municipality itself, by the state, or even by the federal government; however, the investments undertaken by the utility cover almost 100%.

Table 6. Projection of investments to universalize access to WSSs in each regional utility.

Regional Utility (MR)	Investments Needed in Water (M BRL)	Investments Needed in Sanitation (M BRL)	Total Investment (M BRL)	Investments between 2022 and 2026 (M BRL)	Investments between 2027 and 2030 (M BRL)	Investments between 2031 and 2033 (M BRL)
Coal	145.73	757.12	902.86	376.19	300.95	225.71
Foz do Rio Itajaí	245.48	1003.63	1249.11	520.46	416.37	312.28
Chapecó	133.44	540.92	674.36	280.99	224.79	168.59
Florianópolis	299.71	1343.53	1643.23	684.68	547.74	410.81
Lages	45.01	324.56	369.57	153.99	123.19	92.39
Tubarão	87.86	474.56	562.42	234.34	187.47	140.60
Alto Vale Itajaí	94.06	401.46	495.52	206.47	165.17	123.88
Contestado	107.96	574.63	682.59	284.41	227.53	170.65
Far West	99.75	422.77	522.52	217.72	174.17	130.63
North/Northeast	311.74	1598.22	1909.96	795.82	636.65	477.49
Vale do Itajaí	189.74	966.81	1156.55	481.90	385.52	289.14

For the investments estimated in Table 6, considering similar operational efficiencies and revenue streams (i.e., no increase in tariffs, direct subsidies, or others), the NPV of each regional utility, under a discount rate of 10%, is negative. Hence, without revising the initial conditions, there is no financial-economic balance within the utilities, and thus, the indicators in Table 3 are used as the constraints (to be fulfilled) when assessing the required revenue increases.

3.3. The Affordability Impact of Regional Utilities

The analysis undertaken to assess the financial and economic feasibility of each utility used a "business-as-usual" approach (no tariff increases were considered). To achieve a financial-economic balance, the revenue requirement was used as an adjustment tool, employing a TRI and demanding compliance with the indicators highlighted in Table 3. This index represents a revenue multiplier over the project horizon that ensures the NPV equals zero, while considering a discount rate of 10%. The aim was to identify the necessary revenue adjustments that would establish a balanced financial and economic outcome for each utility.

The results obtained are shown in Table 7, which presents the TRI required to achieve financial-economic balance. The results achieved show significant tariff increase requirements for some regional utilities. Thus, it is important to assess whether these increases

can be solely absorbed by the tariffs, or if additional sources of finance (Figure 1) are required. To promote such an analysis, the state-wide minimum wage (for 2021: BRL 1281) for a two-person household without dependents was used. The standardized amount of water to be included in the affordability measurements was 10 m^3 (a two-fold increase for WSSs), due to the usual tariff structures employed in Brazil, which include a consumption (guaranteed volume) of 10 m^3 [19].

Table 7. Tariff review index for each regional utility and household (HH) income commitment.

Regional Utility	TRI (%)	Average Rate Charged (2019, BRL) *	HH Income Commitment (%)	HH Income Commitment with univ. Investments (%)
Coal	17.23	4.76	3.71	4.35
Foz do Rio Itajaí	1.48	5.03	3.92	3.98
Chapecó	26.78	4.66	3.64	4.62
Florianopolis	27.60	4.46	3.48	4.44
Lages	46.34	5.41	4.23	6.18
Tubarão	21.53	4.16	3.25	3.95
Alto Vale do Itajaí	29.13	5.47	4.27	5.51
Contestado	36.50	4.65	3.63	4.96
Far West	34.40	5.02	3.92	5.27
North/Northeast	13.27	4.90	3.82	4.33
Vale do Itajaí	31.54	5.08	3.96	5.21

Notes: * Depending on the tariff structure.

4. Discussion and Policy Implications

The analysis conducted helped us evaluate whether regionalization could serve as a viable solution to achieve universal access to WSSs. Through a case study that considered the legal, institutional, and operational context, as well as a financial-economic viability analysis and affordability evaluation, it was possible to determine the presence of an enabling environment, the necessary investment amount, and the affordability for users. However, one limitation of this analysis is the selection of financial-economic indicators, which, while legally required, may not adequately compare the efficiency/productivity of WSS utilities, which is an important regulatory activity.

The results achieved highlight a considerable need for investments to achieve universal access to WSSs. To face the negative financial-economic balance derived from a previous fragile standing and the mentioned investments, there is a need to optimize operating costs to generate greater efficiency and increase financing sources. These funding requirements may be absorbed significantly by WSS tariffs; nonetheless, further sources, such as soft financing and subsidies, are required to maintain affordability.

The achievement of these WSS coverage goals, as well as other water SDGs, require an enabling environment through context-suitable water governance and financing pathways to reach universal access to WSSs. The case of Santa Catarina highlights a complex legal environment with disaggregated regulatory standards that may constrain the regionalization of WSSs.

Restructuring the sector while promoting scale efficiencies and gaining access to improved human resources seems to be a promising endeavor; however, there is also a need to consider transaction costs. In fact, among the many delivery models devised to cope with the financial hurdles of local governments, there may be a latent opportunism that may hinder their application. The PPPs are such an example, in which the operational efficiency gains are balanced out by the political willingness to promote concession fees (to finance other political initiatives), which will have to be recovered through tariffs, as highlighted in [44]. In Brazil, there are several examples of PPPs with varying outcomes, and the topic of "concession fees" has often been a point of controversy and debate among stakeholders. (PPP initiatives in Brazil can be found at: https://www.ppi.gov.br/projetos/, accessed on 25 May 2023).

The requirement for further financing sources and, perhaps, cross-subsidization is also a challenging topic. Overall, as highlighted in Figure 1, there is a requirement to improve the opex, maintenance, and capex efficiencies throughout the whole financial strategic pathway to enable better financing conditions (e.g., relationships with lenders and other organizations). Regarding the different funding possibilities, in Brazil and certainly in most developing economies, there is a high risk related to exchange rate exposure on external loans and financing as these countries' currencies fluctuate highly. During the renowned scarcity event in São Paulo (Brazil) in 2014–2016, the reliance on external finance escalated the problem [19]. Cross-subsidization may also be a challenging topic, as depending on who subsidizes whom, there may be reduced business incentives to water-intensive industries (when the industry subsidizes domestic customers), or there may be a particular case of "double taxation" (when domestic customers subsidize other domestic customers). Effectively targeting cross-subsidies through tariff structures is a complex task that demands a thorough understanding of customer characteristics, such as their consumption patterns and disposable income [45]. If accurate data are not obtained, there is a risk of misallocating subsidies, potentially benefiting the wrong customer categories [46]. Furthermore, this can have adverse effects on the entire income distribution of customers, especially those who are near the cutoff line for subsidies. Some authors highlight that this may not be the best or even a suitable way to accomplish this [47].

Lastly, there is the case of informal settlements. Universalizing access to WSSs in informal settlements presents significant challenges due to the unique characteristics of these areas. Informal settlements are often characterized by their unplanned nature, lack of basic infrastructure, and absence of legal recognition, which excludes these local communities from official data. Thus, assessing the size of the problem and estimating the costs of developing WSS infrastructure in informal settlements pose significant challenges. Often, informal settlements are located in hazardous zones, such as flood-prone areas or steep slopes, making it essential to consider the relocation of these households or develop temporary solutions. Overall, there is a requirement to mitigate risks when designing and implementing WSS solutions. To address these challenges, urban planning, regularization efforts, and local community engagement are crucial. Legalizing informal settlements and providing secure land tenure can facilitate the integration of these areas into the formal urban fabric, enabling targeted investments in infrastructure, including WSSs. Engaging local communities in the decision-making process ensures that solutions are tailored to their specific needs and priorities, fostering a sense of ownership and long-term sustainability. Community-based solutions have emerged as an alternative; nonetheless, this alternative has several critical characteristics that may harm the sustainability of WSSs. The most critical factors are related to the community level, such as inadequate capacity and ineffective systems. Sustainability strategies refer to the local level as the one requiring action to promote effective community involvement and post-construction support. Community-based solutions have emerged as an alternative, namely in Latin America and Caribbean countries (e.g., for Colombia, see [48], for Peru, see [49], and for Brazil, see [50]), but they possess certain critical characteristics that can hinder the sustainability of WSSs. Key factors are associated with the community level, including inadequate capacity and ineffective systems. To ensure sustainability, strategies should focus on the local level, emphasizing the need for proactive community engagement and ongoing support beyond the construction phase [51]. Indeed, achieving universal access to WSSs in informal settlements requires a comprehensive and multi-dimensional approach that addresses legal, financial, technical, and social complexities.

5. Concluding Remarks

Achieving universal access to WSSs in developing countries is an undertaking that requires a favorable and coherent legal, political, and institutional environment, as well as a clear and strategic financial pathway. It is evident that territories facing local disparities, marginalized communities, economic inequalities, and disaggregated governance struc-

tures encounter greater challenges in this regard. Therefore, regionalizing WSS services is crucial to improve and promote various aspects. Regionalization offers the potential for economies of scale, allowing for the more efficient use of resources and cost savings. It facilitates the sharing of expertise and resources among different areas, promoting collaboration and knowledge exchange. Additionally, regionalization strengthens institutional capacity by establishing or reinforcing regional governance structures, enabling better coordination and decision making. It also allows for risk diversification, ensuring service continuity in the face of shocks or crises. Furthermore, regionalization enhances policy coordination, enabling alignment between regional development strategies, service delivery plans, and national development goals. It fosters integrated and sustainable approaches to WSSs. Additionally, it provides opportunities for stakeholder engagement and participation, involving local communities and civil society.

The cornerstone of regionalization will be ensuring the financial-economic viability of utilities, considering the social impacts in terms of affordability. This means striking a balance between cost effectiveness and the ability of communities to afford these services.

Using the state of Santa Catarina (Brazil) as a case study, an assessment was conducted to understand the present condition of both individual municipalities and their aggregated regional utilities. The analysis revealed that only four regional utilities generate revenue exceeding their costs, but this revenue is insufficient to meet the investment requirements. This indicates the necessity of reviewing the design parameters to address this shortfall. For regions where utilities do not demonstrate financial and economic viability in terms of customers' ability to pay, technical and financial support from the federal level, the states, and/or municipalities will be required to ensure commitment to the universal access goal, i.e., introducing additional sources of finance (Figure 1).

The results achieved indicate that each regional utility has the potential to achieve universal access to WSSs by adjusting tariff structures, and in particular cases, additional finance adjustments. These adjustments must be made in a way that ensures affordability for families, without surpassing their ability to pay for WSSs.

Author Contributions: Conceptualization, W.N., D.N. and F.S.P.; methodology, W.N., D.N. and F.S.P.; investigation, W.N., D.N., F.S.P. and T.C.; writing—original draft preparation, W.N., D.N., F.S.P. and T.C.; writing—review and editing, F.S.P.; supervision, F.S.P. All authors have read and agreed to the published version of the manuscript.

Funding: F.S.P. and D.N. are grateful for the Foundation for Science and Technology's support through funding UIDB/04625/2020 from the research unit CERIS.

Data Availability Statement: The data used in this research were obtained from the references cited, and also from the Brazilian water and sanitation information system—SNIS, available at: http://app4.mdr.gov.br/serieHistorica/, accessed on 21 March 2023.

Acknowledgments: The authors are grateful to the three anonymous reviewers, as well as the managing and academic editors for their insightful suggestions. Any errors and omissions are the responsibility of the authors. The usual disclaimer applies.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Hutton, G.; Varughese, M. *The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene*; Summary report; World Bank: Washington, DC, USA, 2021.
2. Kolker, J.E.; Kingdom, B.; Trémolet, S.; Winpenny, J.; Cardone, R. *Financing Options for the 2030 Water Agenda*; World Bank: Washington, DC, USA, 2016.
3. Nagpal, T.; Malik, A.; Eldridge, M.; Kim, Y.; Hauenstein, C. *Mobilizing Additional Funds for Pro-Poor Water Services*; School of Advanced International Studies, Johns Hopkins University: Washington, DC, USA, 2018.
4. Perard, E. Financial and economic aspects of the sanitation challenge: A practitioner approach. *Util. Policy* **2018**, *52*, 22–26. [CrossRef]

5. Mathieu, E. Policy coherence versus regulatory governance. Electricity reforms in Algeria and Morocco. *Regul. Gov.* **2022**, *17*, 694–708.
6. Mumssen, Y.; Saltiel, G.; Kingdom, B. *Aligning Institutions and Incentives for Sustainable Water Supply and Sanitation Services. Aligning Institutions*; World Bank: Washington, DC, USA, 2018.
7. Manghee, S.; Berg, C.V.D. *Public Expenditure Review from the Perspective of the WSS Sector—Guidance Note*; World Bank: Washington, DC, USA, 2012.
8. Lindberg, S.; Lührmann, A.; Mechkova, V. *From de-jure to de-facto: Mapping Dimensions and Sequences of Accountability, Background Paper for the World Development Report*; World Bank: Washington, DC, USA, 2017.
9. Machete, I.; Marques, R. Financing the WSS sectors: A hybrid literature review. *Infrastructures* **2021**, *6*, 9. [CrossRef]
10. OECD. *Making Blended Finance Work for WSS: Unlocking Commercial Finance for SD G6*; OECD Studies on Water; OECD: Paris, France, 2019.
11. GWSP. *Global Water Security & Sanitation Partinership*; World Bank: Washington, DC, USA, 2020.
12. Bolognesi, T.; Pinto, F.S.; Farrelly, M. (Eds.) *Routledge Handbook of Urban Water Governance*; Taylor & Francis: Abingdon, UK, 2022.
13. OECD. *Report on the Governance of Drinking Water and Sanitation Infrastructure in Brazil*; OECD Publishing: Paris, France, 2017; p. 61.
14. Akhmouch, A. *Water Governance in OECD Countries: A Multi-Level Approach. The "Water Crisis" Is Largely a Governance Crisis*; OECD Water; IWA Publishing: London, UK, 2014; pp. 1–4.
15. Marques, R.C.; Pinto, F.S.; Miranda, J. Redrafting water governance: Guiding the way to improve the status quo. *Util. Policy* **2016**, *43*, 1–3. [CrossRef]
16. Cetrulo, T.B.; Marques, R.C.; Malheiros, T.F.; Cetrulo, N.M. Monitoring inequality in water access: Challenges for the 2030 Agenda for Sustainable Development. *Sci. Total. Environ.* **2020**, *727*, 138746. [CrossRef]
17. Mitlin, D.; Walnycki, A. Informality as Experimentation: Water Utilities' Strategies for Cost Recovery and their Consequences for Universal Access. *J. Dev. Stud.* **2020**, *56*, 259–277. [CrossRef]
18. UN. *WSS—United Nations Sustainable Development*; United Nations: New York, NY, USA, 2020.
19. Pinto, F.S.; de Carvalho, B.; Marques, R.C. Adapting water tariffs to climate change: Linking resource availability, costs, demand, and tariff design flexibility. *J. Clean. Prod.* **2021**, *290*, 125803. [CrossRef]
20. Elleuch, M.A.; Ben Hassena, A.; Abdelhedi, M.; Pinto, F.S. Real-time prediction of COVID-19 patients health situations using Artificial Neural Networks and Fuzzy Interval Mathematical modelling. *Appl. Soft Comput.* **2021**, *110*, 107643. [CrossRef]
21. Novaes, C.; Silva Pinto, F.; Marques, R.C. Aedes Aegypti—Insights on the Impact of Water Services. *Geohealth* **2022**, *6*, e2022GH000653. [CrossRef]
22. Lieberherr, E.; Hüesker, F.; Pakizer, K. Rethinking urban water governance and infrastructure in Europe: Challenges and opportunities of regionalization and organizational autonomy. In *Routledge Handbook of Urban Water Governance*; Routledge: New York, NY, USA, 2022; pp. 272–283.
23. Narzetti, D.A.; Marques, R.C. Access to water and sanitation services in Brazilian vulnerable areas: The role of regulation and recent institutional reform. *Water* **2021**, *13*, 787. [CrossRef]
24. Cetrulo, T.B.; Ferreira, F.C.; Marques, T.B.; Malheiros, T.F. Water utilities performance analysis in developing countries: On an adequate model for universal access. *J. Environ. Manag.* **2020**, *268*, 110662. [CrossRef] [PubMed]
25. MDR. *Plano Nacional de Saneamento Básico. Brasília: Secretaria Nacional de Saneamento*; Ministério do Desenvolvimento Regional: Brasília, Brasil, 2019.
26. KPMG; ABCON. Quanto Custa Universalizar o Saneamento No Brasil? ABCON: São Paulo, Brazil, 2020.
27. ExAnte. *Benefícios Econômicos e Sociais da Expansão do Saneamento No Brasil. Report*; Instituto Trata Brasil: São Paulo, Brazil, 2018.
28. MDR. *26° Diagnóstico dos Serviços de Água e Esgotos*; Ministério do Desenvolvimento Regional: Brasília, Brazil, 2022.
29. UNDP. *Atlas Brazil*; UNDP: New York, NY, USA, 2022.
30. Pinto, F.S.; Tchadie, A.M.; Neto, S.; Khan, S. Contributing to water security through water tariffs: Some guidelines for implementation mechanisms. *J. Water Sanit. Hyg. Dev.* **2018**, *8*, 730–739. [CrossRef]
31. Cetrulo, T.B.; Marques, R.C.; Malheiros, T.F. An analytical review of the efficiency of water and sanitation utilities in developing countries. *Water Res.* **2019**, *161*, 372–380. [CrossRef] [PubMed]
32. Boukhari, S.; Pinto, F.S.; Abida, H.; Djebbar, Y.; de Miras, C. Economic analysis of drinking water services, case of the city of Souk-Ahras (Algeria). *Water Pract. Technol.* **2020**, *15*, 10–18. [CrossRef]
33. Jenkins, G. Inflation and Cost-Benefit Analysis. JDI Executive Programs Development Discussion Papers. 1978, Volume 8, pp. 1–23. Available online: https://ideas.repec.org/p/qed/dpaper/333.html (accessed on 21 March 2023).
34. Yepes, G.; Dianderas, A. *Water & Wastewater Utilities: Indicators*, 2nd ed.; Water and Sanitation Division, The World Bank: Washington, DC, USA, 1996.
35. Damodaran, A. *Finanças Corporativas: Teoria e Prática*; Bookman Companhia: São Paulo, Brazil, 2004.
36. WORLD BANK; IFC; ASSOCIADOS, GO. *Water Utilities Performance-Based Contracting Manual in Brazil-WAUPBN*; International Finance Corporation and World Bank Group: Washington, DC, USA, 2013.
37. Brigham, E.F.; Ehrhardt, M.C. *Administração Financeira: Teoria e Prática*; Cengage Learning: São Paulo, Brazil, 2012; 328p.
38. Pinto, F.S.; Marques, R.C. Tariff suitability framework for water supply services: Establishing a regulatory tool linking multiple stakeholders' objectives. *Water Resour. Manag.* **2016**, *30*, 2037–2053. [CrossRef]

39. UN. *The Human Right to WSS Media Brief*; United Nations: New York, NY, USA, 2011.
40. Narzetti, D.A.; Marques, R.C. Isomorphic mimicry and the effectiveness of water-sector reforms in Brazil. *Util. Policy* **2021**, *70*, 101217. [CrossRef]
41. Pinto, F.; Figueira, J.; Marques, R. A multi-objective approach with soft constraints for water supply and wastewater coverage improvements. *Eur. J. Oper. Res.* **2015**, *246*, 609–618. [CrossRef]
42. ME. *Taxa Social de Desconto para Avaliação de Investimentos em Infraestrutura: Atualização pós Consulta Pública*; Technical report SEI nr. 19911/2020/ME; Ministry of Economy of Brazil: Brasilia, Brazil, 2020.
43. SEMADS-MG. *Nota Técnica: Metodologia de Construção das Unidades Regionais de Saneamento Básico Estado de Minas Gerais*; Secretaria de Meio Ambiente e Desenvolvimento Sustentável, Governo do Estado de Minas Gerais: Belo Horizonte, Brazil, 2021.
44. Vajdic, N.; Mladenovic, G.; Queiroz, C. Enhancing the feasibility of airport PPP projects with hybrid funding. *Transp. Res. Procedia* **2023**, *69*, 600–607. [CrossRef]
45. Estache, A.; Laffont, J.-J.; Zhang, X. Universal service obligations in LDCs: The effect of uniform pricing on infrastructure access. *J. Public Econ.* **2006**, *90*, 1155–1179. [CrossRef]
46. Angel-Urdinola, D.F.; Wodon, Q. Does increasing access to infrastructure services improve the targeting performance of water subsidies? *J. Int. Dev.* **2012**, *24*, 88–101. [CrossRef]
47. Barraqué, B. Is Individual Metering Socially Sustainable? The Case of Multifamily Housing in France. *Water Altern.* **2011**, *4*, 223–244.
48. Domínguez, I.; Oviedo-Ocaña, E.R.; Hurtado, K.; Barón, A.; Hall, R.P. Assessing Sustainability in Rural Water Supply Systems in Developing Countries Using a Novel Tool Based on Multi-Criteria Analysis. *Sustainability* **2018**, *11*, 5363. [CrossRef]
49. Calzada, J.; Iranzo, S.; Sanz, A. Community-Managed Water Services: The Case of Peru. *J. Environ. Dev.* **2017**, *26*, 400–428. [CrossRef]
50. Gasmi, H.; Kuper, M.; Martins, E.S.P.R.; Morardet, S.; Burte, J. Sustaining community-managed rural water supply systems in severe water-scarce areas in Brazil and Tunisia. *Cah. Agric.* **2022**, *31*, 21. [CrossRef]
51. Machado, A.V.M.; Oliveira, P.A.D.; Matos, P.G. Review of Community-Managed Water Supply—Factors Affecting Its Long-Term Sustainability. *Water* **2022**, *14*, 2209. [CrossRef]