INVESTIGATING THE STATE OF RURAL WATER SUPPLY IN RIO GRANDE DO SUL, BRAZIL

OM TILLSTÅNDET FÖR LANDSBYGDENS VATTEN-FÖRSÖRJNING I RIO GRANDE DO SUL, BRASILIEN

   

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ABSTRACT

In Rio Grande do Sul (RS) in Brazil, more than one million residents rely on small-scale water supply solutions without conventional treatment. This study aimed to investigate water services in rural areas of RS through case studies and interviews with authorities, researchers and support organizations within RS. Microbiological contamination is widespread, while non-compliant fluoride levels exist locally. Lack of economic self-sufficiency, community scepticism towards chlorination, insufficient funding of water and sanitation projects, and limited technical and administrative capacity in municipalities constitutes the main socioeconomic and political challenges. Technical and educational improvements are needed, but also substantially more collaboration between municipalities, authorities, local operators and users to develop safe and sustainable water services.

KEYWORDS: Sustainable development goal 6; Rural water supply; Drinking water safety; Rio Grande do Sul

SAMMANFATTNING

Mer än en miljon invånare i delstaten Rio Grande do Sul (RS) i Brasilien får sin vattenförsörjning från småskaliga lösningar utan omfattande beredning. Denna studie hade som mål att undersöka hur tillståndet såg ut för dessa genom fallstudier och intervjuer med myndigheter, forskare och regionala utvecklingsorganisationer i RS. Mikrobiell påverkan på dricksvattnet är omfattande, medan fluoridhalter överstigande gränsvärden förekommer lokalt. Brist på ekonomisk självförsörjning, skepsis hos användare mot klorering, otillräckligt ekonomiskt stöd till investeringar i va-projekt och begränsad teknisk och administrativ förmåga i kommuner och hos huvudmän är de viktigaste socioekonomiska och politiska utmaningarna. Tekniska och kompetenshöjande åtgärder behövs, liksom betydligt mer samverkan mellan kommuner, myndigheter, lokala utförare och användare för att utveckla säker och uthållig vattenförsörjning.

1. INTRODUCTION

Brazil has already reached a high nominal coverage of water supply services and 93.7 % of the population had access to piped water as of 2015. However, wastewater management is lacking behind (Scott et al., 2017), which commonly causes pollution of water sources. Brazil presently lacks enough data for estimating the amount of people consuming water, which is free from contamination, and thus the amount of people consuming safely managed water (UN, 2018).

This project aimed to describe the state of drinking water supply in rural areas of RS and discuss the current endeavour of reaching sustainable water supply and provision of clean water for all in the region. Through comprehensive literature studies and interviews with authorities and researchers, as well as a multiple case study of eight small-scale water supply systems including field inspections and interviews, the aim was to produce an overall picture where technical, socioeconomic and political aspects were considered in the investigation and analysis. Three research questions were asked:

1. How are water supply services generally organized in rural areas of Rio Grande do Sul, and what problems exist?

2. What issues can be observed directly through a multiple case study of rural water supply services in Rio Grande do Sul?

3. What could be possible ways forward to ensure clean and affordable water for all in Rio Grande do Sul?

Rio Grande do Sul (RS) is the southernmost state in Brazil – a relatively prosperous agricultural state. According to the last demographic census of 2010, it was estimated that 85.3 % of the population in RS were connected to a "public water supply system" (Atlas Socioeconômico RS, 2019). The remaining part obtain water from individual solutions or through small-scale water supply organizations.

2. MATERIALS AND METHODS

Field visits to eight system and interviews with local stakeholders were performed. Literature review, processing of information from the national database SISAGUA and interviews and meetings with researchers and authorities were also used. The term "rural" includes the central settlements of the small municipalities with less than 5000 inhabitants and their countryside, unless otherwise stated.

Political objectives and legislation related to water supply on federal and regional level were provided from the constitution of Brazil, the main sanitation Law nº 11.445/2007 (Brasil, 2007), the national sanitation plan PLANSAB (Ministério das Cidades, 2013), the drinking water regulation (Portaria de Consolidação MS no 5/2017, Anexo XX, Brasil, 2017) and supplemental documents from authorities. The current state of water supply and water quality in the state is described based on data and documents from IBGE (Instituto Brasileiro de Geografia e Estatística), the socioeconomic atlas of RS, regional authorities and reports. The database Sistema de Informação de Vigilância da Qualidade da Água para Consumo Humano (Information System of Surveillance of drinking water quality) (SISAGUA, 2019) holds information about water supply system characteristics, water sources and water quality records for all registered drinking water supply systems in Brazil.

The two first authors spent about 10 weeks in RS at Instituto de Pesquisas Hidráulicas (IPH) of Universidade Federal do Rio Grande do Sul (UFRGS) in Porto Alegre for field investigations, interviews and data collection. For each of the eight case studies, the water supply system configuration in terms of capture, treatment and distribution was described as well as the organizational structure of the water supply service. The criteria set for the case systems were the following:

- Systems situated in small municipalities with total population less than 5000 persons
- Systems serving a maximum of 2500 people
- Systems known to have had recent issues according to SISAGUA, vulnerability assessments or commentary from the project Support System

Table 1. *Indicators and criteria used to evaluate adequacy of water service characteristics.*

Indicator	Adequacy	Criteria
Water resources availability	• Not adequate • Partially adequate • Adequate	• Annual occurrence of water scarcity • Water scarcity has occurred during the last five years • Water scarcity has not occurred during the last five years
Water source	• Not adequate • Partially adequate • Adequate	• Unprotected water source • Partially protected water source • Protected water source
Water quality	• Not adequate • Partially adequate • Adequate	• Coliforms present regularly, or levels of fluorine/turbidity regularly exceeding drinking water standards • Coliforms rarely present, but taste/odour/colour issues and/or no residual chlorine • Full compliance with water quality regulations
Level of treatment	• Not adequate • Partially adequate • Adequate	• Treatment not appropriate for given raw water quality • Treatment partially appropriate for given raw water quality • Treatment appropriate for given raw water quality
Distribution network	• Not adequate • Partially adequate • Adequate	• Interruptions due to leaks or malfunctioning equipment occurring frequently and/or no monitoring of non-revenue water • Interruptions due to leaks or malfunctioning equipment occurring intermittently and/or no monitoring of non-revenue water • Interruptions due to leaks or malfunctioning equipment occurring rarely, and non-revenue water is monitored
Operation & maintenance	• Not adequate • Partially adequate • Adequate	• Frequent issues due to lack of O&M • Irregular and/or insufficient O&M • Regular and sufficient O&M
Economic sustainability	• Not adequate • Partially adequate • Adequate	• Financing through tariffs not sufficient for adequate water supply • Financing through tariffs partially sufficient for adequate water supply • Financing through tariffs sufficient for adequate water supply
Surveillance and monitoring	• Not adequate • Partially adequate • Adequate	• No surveillance or monitoring • Surveillance and monitoring performed, but not in coherence with guidelines • Surveillance and monitoring performed in coherence with guidelines
Participation of beneficiaries	• Not adequate • Partially adequate • Adequate	• No community involvement in planning and decision-making regarding water supply • Some community involvement in planning and decision-making regarding water supply • Community driven planning and decision-making regarding water supply

for Basic Sanitation (Sistema de Apoio ao Saneamento Básico) (SASB, 2018)

Three data collection methods were used; direct observations, interviews and document studies (Yin, 2011). During each field visit, a thorough semi-structured interview was done with the municipal representative responsible for water and sanitation in the municipality, see details in Häggqvist and Larsson, 2020. During each interview, the municipality was also asked about the plans for water services in the municipality, and in which way they plan to address the current issues relating to water supply. Additional data was also collected through seminars, meetings and interviews with professionals of the State Centre of Health Surveillance (Centro Estadual de Vigilância em Saúde (CEVS)) and officers of the Drinking Water Quality Surveillance of the state (Vigilância da Qualidade da Água para Consumo Humano, VIGIAGUA).

Interviews with local beneficiaries were also carried out when possible. The field visits included a technical inspection of the water supply systems, which mainly consisted of a visual inspection on the state of source protection, wells, treatment and reservoirs. Reports and basic sanitation plans were also consulted. Nine indicators were identified to evaluate the adequacy of the system and services (see Table 1), developed from Debiasi (2016).

3. RESULTS AND DISCUSSION

According to Law nº 11.445/2007 (Brasil, 2007), municipalities are accountable for the provision of basic sanitation services, including water supply, wastewater disposal, solid waste management and stormwater management.

Municipalities can outsource services to third parties such as associations or companies, through formal contracts. According to the law 11.445/2007, a basic sanitation plan (Plano Municipal de Saneamento Básico (PMSB)) is also to be drafted by every municipality in Brazil. Originally, 2014 was set as deadline for the adoption of a PMSB for each municipality in Brazil. However, only 31% of the municipalities had been able to produce a PMSB according to a review from 2015 (Akhmouch et al., 2017). This is not only an issue since sanitation problems are more likely to remain uncharted and unsolved without a PMSB, but can also make the municipality unable to apply for public funding, as is the case within the state of RS (Lei nº 11.445/2007; Estado do Rio Grande do Sul, 2015).

The National Basic Sanitation Plan (Plano Nacional de Saneamento Básico (PLANSAB)) published 2013 outlines the goals of water and sanitation since 2014 (Ministério das Cidades, 2013). Long-term goals until 2033 include that 99% of the households in Brazil should be reached with safe, piped water supply; that 100% of water supply services will be covered by tariff structures (aiming to ensure economically sustainable services); the average water loss index (i.e. non-revenue water level) should decrease from 39% (as of 2010) to 31% (as of 2033); 92% of the households in Brazil should by 2033 have wastewater collection systems or adequate septic tank systems; 93% of the wastewater that is collected will be adequately treated.

Registered water supply systems are divided into three categories according to article five of Portaria de Consolidação MS no 5/2017, Anexo XX (BRASIL, 2017):

- Water supply systems (of large scale) (Sistemas de Abastecimento de Água para consumo humano (SAA))
- Alternative collective solutions – (Soluções Alternativas Coletivas de água para consumo humano (SAC))
- Alternative individual solutions (Soluções Alternativas Individuais de água para consumo humano (SAI))

SAA and SAC systems must have disinfection and a free residual chlorine content of at least 0.2 mg/L at all points in the distribution system (Brasil, 2017), to ensure inactivation of microorganisms, and also pursue a minimum of surveillance and control of the water quality (Ministério da Saúde, 2016). The latter is performed through VIGIAGUA and in RS the municipalities are responsible for creating sampling plans and making sure that they are followed (CEVS, 2019a). Potability

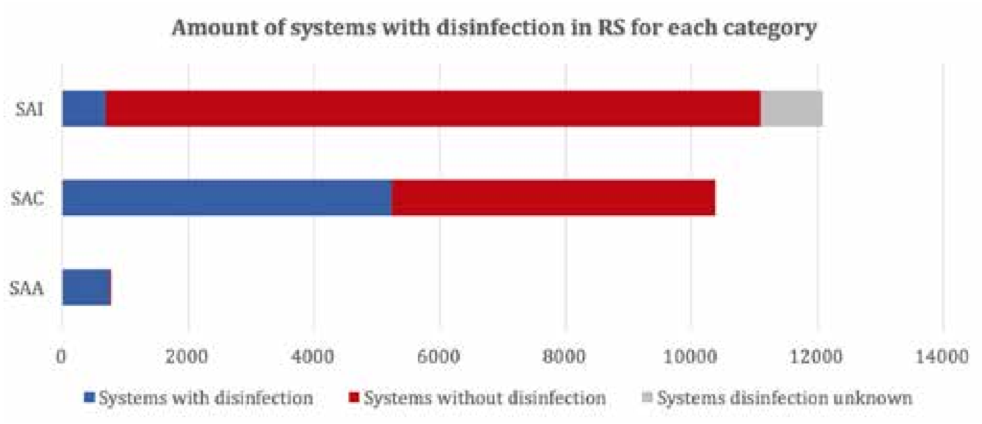

Figure 1. *Amount of SAI, SAC and SAA systems with and without installed disinfection systems in RS (SISAGUA, 2019).*

limits for drinking water are set on a national level through Portaria de Consolidação MS no 5/2017, Anexo XX (BRASIL, 2017), which mainly follows the WHO guidelines for drinking water.

SISAGUA is a database in which all water supply systems in Brazil should be registered by the municipalities. Upon registration, all systems are classified as SAA, SAC or SAI. In total 764 SAA systems, 10375 SAC systems and 12083 SAI systems are listed for RS in SISAGUA.

The 764 large-scale SAA systems are estimated to provide water to 86 % of the population in RS, or 9.8 million people. The 10 375 SAC systems are estimated to provide water to 9 % of the population, roughly 1 million people (SISAGUA, 2019). Figure 1 shows the amount of systems in each category utilizing disinfection. Disinfection is lacking in almost all SAI systems, and in about half of the SAC systems.

Several organizational forms are possible for SAA and SAC systems – for example directly by the municipality, by community organizations, by small local companies or by large state-level water and sanitation companies. In RS, the state-owned water and sanitation company CORSAN is present in the 317 of the 497 municipalities (CORSAN, 2019). Their activity is usually limited to the central settlements of each municipality and not the more remote rural areas. Municipalities which have a contract with CORSAN typically also have SAC systems managed by community associations in the peripheral areas of the municipalities. In Appendix, Table A, the distribution of water supply solutions in urban and rural areas of RS are presented (Estado do Rio Grande do Sul, 2015). The percentage of households estimated to be served by "public water supply networks" (including SAA systems and some SAC systems) is about 85%. Granting of federal funds for water and sanitation projects in municipalities generally require that the municipalities have a basic sanitation plan (PMSB) (Lei nº 11.445/2007), which many smaller municipalities lack. There is no comprehensive summary of existing PMSB.

In RS, it is estimated that 74.6 % of households with water closets are connected either to a sanitary sewer or storm sewer, or to a septic tank (Atlas Socioeconômico RS, 2019). For the households with wastewater disposal solutions in rural areas, septic tanks are the predominant solution (Atlas Socioeconômico RS, 2019), which are known to cause risk for environmental degradation and contamination of drinking water sources (Withers et al., 2014).

Brazil is the largest consumer of pesticides in the world, and several of the chemicals used in agriculture in Brazil are potentially carcinogenic, mutagenic and teratogenic (Rocha and Grisolia, 2018). Brazil has water potability limits for 27 pesticide parameters according to Portaria de Consolidação MS no 5/2017, Anexo XX (BRASIL, 2017), and RS has added 46 additional parameters on state-level through the Portaria SES RS 320/2014 (CEVS, 2019b; Estado do Rio Grande do Sul, 2014). RS is an agricultural state, and the state uses about twice the annual amount of pesticides per inhabitant than the national average (Pessoa, 2017). Several studies have confirmed presence of pesticides in water sources in RS (Marchesan et al., 2007; Bortoluzzi et al., 2006).

The main issue of geogenic contamination concerns fluorine in some regions of RS, exceeding the potability limit of 1.5 mg/L (Luiz et al., 2016), but high iron and manganese levels are also a concern (Reginato et al., 2005).

RS has a large water availability due to great density of water bodies, rivers and important subterranean reservoirs (Pessoa, 2017), and an average precipitation of 1300 mm per year . Regional water scarcity in RS exists however and is largely caused by great irrigation demands (Flach et al., 2016), which have been estimated to constitute as much as 78% of the total water abstractions in RS

Table 2. *Visited water supply systems and population served*

Municipality	Population	System	Population served
Tabaí	4719	SAC Cabriúva	76
		SAC Trevo Tabaí	1571
Fazenda Vilanova	4120	SAC ASSODEC Tristão	757
		SAC Samambaia	105
Vilanova do Sul	4280	SAC Laranjeiras	225
		SAC Cambaí	73
Turuçu	3438	SAA Turuçu	1875
		SAC São Domingos	40

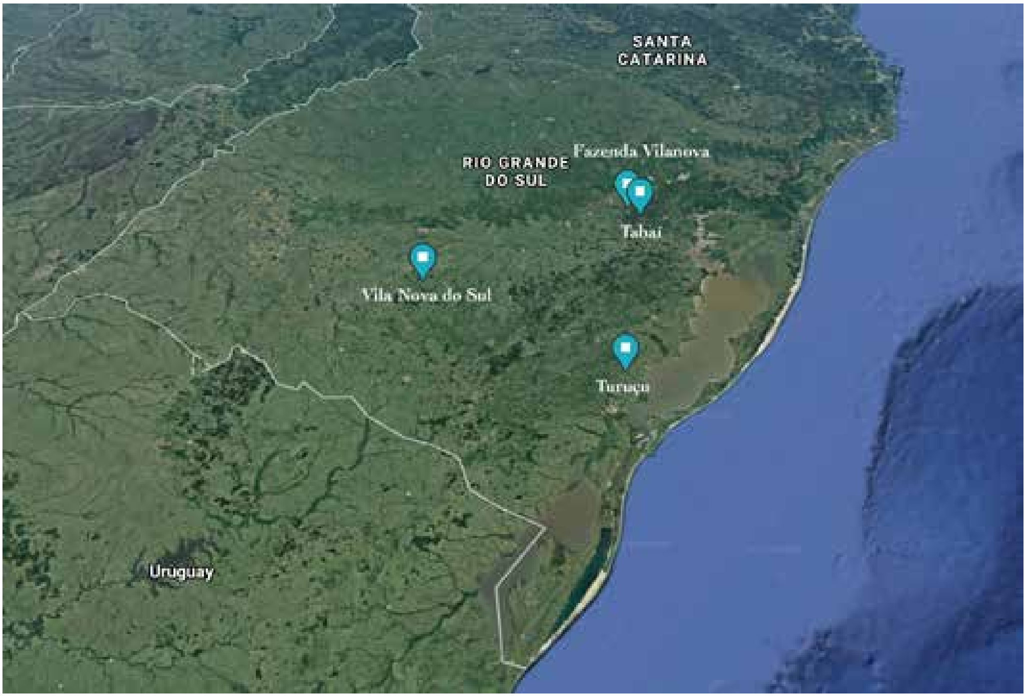

Figure 2. *The municipalities visited during the case studies in RS, adapted from google maps imagery (Google maps, 2020).*

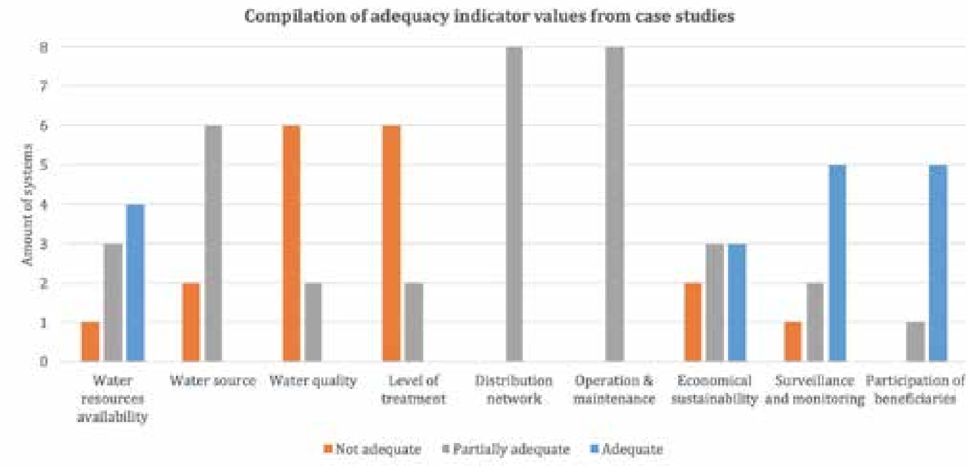

Figure 3. *Compilation of adequacy indicator values from case studies. The "participation of beneficiaries"-indicator only amounts to six systems, since information was lacking for two systems.*

(Pessoa, 2017). The state suffers extensive droughts from time to time, the latest in the summer of 2020, when more than 328 municipalities were in state of emergency due to water shortage (Defesa Civil, 2020).

For the case studies, 7 SAC systems and 1 SAA system were visited in four municipalities (Figure 2). Table 2 presents the type of system and the population served by each of the visited systems.

In Tabaí, a municipality with 4719 inhabitants, two SAC water supply systems were visited and examined; one serving 76 people and the second 1571 people. In Fazenda Vilanova, with 4120 inhabitants, two SAC-systems were visited; one providing 757 people and the other 105 people. Vila Nova do Sul has 4280 inhabitants . In this municipality two SAC systems were visited; one supplying 225 people with water and the other 73 people. Turuçu has a population of 3438 people. Two systems were visited there; one SAA-system serving 1875 persons and one SAC-system supplying 40 persons with water. All population numbers are from (IBGE, 2019).

Based on the analysis in Table 1, the adequacy indicators for eight case studies can be summarised, as shown in Figure 3. The water resources availability indicator showed mixed results, with half of the systems performing adequately. The water source indicator was mostly ranked as partially adequate. In seven out of the eight cases, groundwater was the main water source. Generally, the groundwater was extracted from drilled wells with partial protection, but without sanitary sealing. In some cases, groundwater wells were in areas where the risk of contamination from agricultural and domestic activities was high. In one case, unprotected spring water was used as a water source and for replenishing groundwater. None of the eight systems which were visited ranked as "adequate" in this category. No considerable differences were detected between the visited municipalities regarding this indicator.

Water quality and level of treatment were the indicators most often ranked as "not adequate". None of the eight systems were ranked as "adequate" in these categories, since no system consistently showed water quality records in line with regulations. Many of the systems did not have any disinfection or other treatment installed, and the ones that used chlorination systems often had problems with inactivation of microorganisms, meaning that the treatment did not function as intended. Problems with fluoride also need to be addressed.

The indicators distribution network and operation & maintenance (O&M) were ranked as partially adequate for all the visited systems, based on the interviews. None of the systems had frequent issues with interruptions according to the municipal representatives, but there was no monitoring of non-revenue water for any system, and in some cases, there were reports of interruptions. None of the systems were completely lacking in O&M, but since none of the water supply systems continuously produced water of adequate quality, O&M was not considered completely adequate in any of the cases. No considerable differences were detected between the visited municipalities regarding this indicator.

Economical sustainability showed mixed results. In some cases, SAC associations were reported to be economically self-sufficient and cover costs of O&M. This was especially true for the SAC systems run by ASSODEC in the municipality of Fazenda Vilanova. In most of the other cases, associations and communities were struggling to cover the costs. This was especially true for the SAC of Laranjeiras where about half of the connected households did not pay for the water use, and the SAC of São Domingos where the community relied heavily on municipal support for water provision.

Surveillance and monitoring also showed mixed results, although most of the systems were reported to have adequate frequency of water quality surveillance and control, i.e. according to regulations. Some differences were observed between the municipalities, where the SAC systems in Fazenda Vilanova appeared to perform water surveillance and control in coherence with regulations. For some other systems, water quality monitoring was not performed as often as regulation demands. For example, no regular monitoring was performed for the SAC of Sociedade Abastecedora de Água de Cabriúva in the municipality of Tabaí,

Participation of beneficiaries mainly showed adequate results, since many of the SAC systems were reported to have associations with regular meetings, and/or informal associations with community driven planning. However, this does not necessarily mean that the water supply service is adequately managed, since scepticism towards treatment still can cause mismanagement of the water supply systems. For the systems in Turuçu this indicator was not estimated due to lack of information, otherwise no considerable differences were detected between the visited municipalities regarding this indicator.

About 20 participants at the VIGIAGUA meeting on the 22nd of October 2019 were interviewed with the aim of providing an overview of the current issues and development of rural water supply in RS (Seminar RS I, 2019). Resistance against chlorination of drinking water was common but the excessively high chlorine concentration was the main issue, not the chlorination process itself. If the systems were operating properly this resistance would be less of an issue since the taste of chlorine is not as strong at the lower end of the legislated concentration spectrum. A lack of awareness and education regarding the importance of disinfection contributes greatly to the resistance against it. Some municipalities have worked with informing the public in various ways. However, they report that it is hard to convince people that disinfection may be needed due to local traditions and habits. There is also a lack of rigorous local-level evidence which show a clear correlation between contaminated water and disease, since these studies are difficult to perform. UV-disinfection had been tested by one municipality, but that it was deemed too expensive for further implementation.

Federal funding for municipal basic sanitation plans and for implementing water and sanitation projects was hard to access due to lack of administrative and technical capacity in municipalities. Insufficient or inexistent water tariffs make the SAC vulnerable to costs. Municipalities often have to step in with economic support for capital costs and maintenance. Economic self-sufficiency of water and sanitation services cannot be reached for these systems without some type of water tariff. Municipalities can be fined for not making sure that SAC water is chlorinated – however this is rarely done by the surveillance since it is hard for the municipalities to enforce chlorination when there is strong resistance amongst the SAC water users. There are errors in SISAGUA registration since some of the municipalities only have samples from SAA CORSAN systems and skipped surveillance of SAC systems, leading to false statements. Microbiological re-contamination of chlorinated water during storage in tanks has been observed in many systems in the state, including many SAC systems.

A successful experience of implementing disinfection in SAC systems from 2016 to 2019 in the small municipality of Fagundes Varela in RS was described (Seminar RS II, 2019). In 2016, only 3/19 SAC systems in the municipality were using disinfection actively, but as of 2019 all 19 SAC systems were using disinfection. During these years, technical responsibility delegations and water quality control for the systems also improved significantly. This was done through diligence from the municipality, with help from CEVS in gathering the 19 SAC association presidents for an awareness meeting and discussing the advantages of treatment and the requirements stipulated in law (Seminar RS II, 2019).

There is a correlation between increased investments in basic sanitation and decreased hospitalizations due to sanitation-related diseases. This decreased from about 1.5/1000 inhabitants in 2009 to 0.5/1000 inhabitants in 2018 in the southern region of Brazil (including the states of RS, Santa Catarina and Paraná) (Seminar RS II, 2019).

Water researchers from IPH-UFRGS and a representative of the rural support organization EMATER were also interviewed. Municipalities can contract third-parties to provide water services, but they often lack staff (in quantity and capacity) able to prepare basic sanitation plans, terms of reference and other technical documents needed to access financing opportunities. In the rural areas, municipality planning is often absent. There is also a lack of integration between the sanitation sector and water resources management at the watershed levels (Interview IPH I, 2019).

The SAC associations have limited technical and administrative capacity. Municipalities must assist to solve these issues since they are responsible for basic sanitation services, but the municipalities do not always acknowledge this (Interview IPH II, 2019). Policy changes result in that basic sanitation has not been prioritized for investments (Interview EMATER, 2020). Awareness must be spread regarding the importance of preservation of springs and riparian forests, proper disposal of solid and liquid waste from households and industries, cautionary use of pesticides etc. (Interview EMATER, 2020).

In rural areas, piped water is commonly accessible on premises and available when needed, although interruptions in distribution systems occur occasionally, and water scarcity has occurred in some regions. Water protection is often inadequate, and poor wastewater solutions often cause contamination of water sources. Microbiological contamination is common in SAC systems, but disinfection is often lacking even though it is required by law. When disinfection is performed, chlorination is the predominant method. Community resistance towards chlorination is common, and a main challenge for the implementation of disinfection in SAC systems. Problems with water source protection and water quality issues including coliform bacteria, turbidity and/or fluorine was observed in all municipalities. This also includes unprotected shallow wells in close vicinity to agricultural fields and unprotected spring water sources with water quality issues. Non-revenue water is not continuously monitored in any of the systems visited, and longer interruptions have occurred in some systems. No municipalities are reported to perform continuous monitoring of pesticides, even though agricultural areas are situated close to many of the water sources. Water losses in distribution networks should be monitored to decrease non-revenue water and decrease the risk of infiltration of contaminated water into pipes. Where needed, filtration or other treatment steps should be used to combat high concentrations of fluorine, turbidity and other contaminants exceeding the legislated levels. Pesticides need to be monitored further to assess the health risks, and watershed committees must work to minimize dispersal of pesticides and other contaminants to water sources within the catchments. Due to interruptions in water supply, households need simple yet safe ways to store and maintain water quality inside the home, to minimize recontamination.

In order to decrease the presence of microbiological contamination, wastewater disposal must be managed adequately. This includes collection and treatment of wastewater where possible, and modernization of septic tank systems. Groundwater wells must be properly protected using sanitary seals and well caps and freshwater springs must be protected.

Community resistance towards chlorination was observed in all the visited municipalities. Disinfection should be installed in all SAC systems which currently is lacking such a solution and residual chlorine should be monitored on-line on treated water. Proper operation would lead to suitable chlorine concentrations to avoid causing an unpleasant taste and reduce the opposition against chlorination.

Collaboration concerns technical improvements, generation of a demand for clean and safe water amongst the population, an effective enabling environment, and increased investments in water and sanitation. The above suggested adequacy indicator values could be used to give a general overview of the status of the supply systems for all stakeholders involved. Water Safety Plans (WSPs) could be implemented in RS state law, relating to the standard WSP framework designed by the World Health Organization (WHO, 2012). This would mean increased focus and higher standards of preventive risk assessment and management for SAA and SAC systems.

Information and education campaigns on safe water aimed towards communities and schools have yielded very positive results in many cases across the globe. Such examples also exist in RS, where organizations such as EMATER have had success in such campaigns. There are also examples of educational "awareness meetings" regarding the importance of water quality and treatment, which have convinced many SAC associations to implement disinfection (Seminar RS II, 2019). There are cases of municipalities which have managed to widely implement disinfection through municipal diligence and educational initiatives, not least in school campaigns (Interview IPH II, 2019). Such endeavours must be reproduced throughout the state to spread this awareness.

Economic self-sufficiency can be ensured through solidary and sustainable tariff structures, which make sure water is affordable for all while also creating an incentive against overconsumption.

It clearly constitutes a great loss for the Brazilian population that financial resources allocated to water and sanitation remain unspent, and this must be addressed. Since there is a recurring issue with delayed or even abandoned projects, it seems as if the current lack of (transparent) selection and prioritization criteria for funding constitutes an issue. As long as eligible projects are too few to spend the allocated resources, perhaps the remaining funds should be invested in capacity building in weak municipalities, creation of PMSBs and in educational efforts.

Municipalities must invite SAC associations to sit down together and discuss pathways to ensure water security and determine clear responsibility delegations between the municipality and the associations. Simultaneously, precaution must be taken to avoid top-down enforcements which are not demand-driven. If there are sociocultural obstacles such as scepticism to novelties and treatment, focus must be on non-forcing educational efforts in the early stages.

Participatory approaches are important to make sure that all voices are heard and facilitate communication. Although community resistance to novelties and treatment may be a common opinion expressed in participatory meetings, it is of crucial importance that generation of demand (through education efforts etc.) precedes project implementations. Projects which are not demand-driven are unlikely to be appreciated by beneficiaries, and likely to be unsuccessful (as seen through abandoned chlorination systems etc.). In other countries, service companies are funded to give technical support to small scale drinking water systems. The assistance is not only technical, but also in management, finance, education, compliance with monitoring requirements, project and budget preparation and access to funding agencies. The federal and state funds in Brazil could possibly be allocated to increase the capacity of the municipalities of the country. The limited, yet existing capacity building offered by professional schools and universities could also be supported from federal and state agencies to expand education of municipal officers for water services.

4. CONCLUSIONS

The main issues observed regarded water source protection, water quality, community resistance to disinfection, monitoring and surveillance of water quality, monitoring of water losses, economic self-sufficiency of services, drafting of PMSBs and access to external support. Proper disinfection must be introduced at all treatment plants with known presence of microbial contamination. Fluoride must be removed with treatment or diluted through mixing of different waters with different fluoride content. All stakeholders need to join forces and work together to achieve safe and sustainable water services for all, and make sure that no one is left behind, which calls for more extensive water policies from state and federal authorities. Institutional rationalization is needed to provide an effective enabling environment, where funds allocated for water and sanitation are used efficiently, focusing on cost-effective solutions in vulnerable communities. Resources must be funnelled into the municipalities which are lacking in technical and administrative capacity, to assist with the creation of PMSBs and improvement of water and sanitation.

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APPENDIX

Table A. *Water supply solutions for urban and rural households in RS, adapted from the last IBGE census of 2010 (Estado do Rio Grande do Sul, 2015).*

Water supply solution	Urban households	Rural households	Total households
Public water supply network	2 881 428	190 287	3 071 715
Well or spring on property	164 809	240 450	405 259
Well or spring off property	24 988	78 527	103 515
Water truck	1 256	378	1 634
Rainwater harvesting with tank storage	263	841	1104
Rainwater harvesting with other storage	238	364	602
River, dam, lake or stream	277	2 178	2 455
Other form / Uncategorized	10 956	2 364	13 320
Total	**3 084 215**	**515 389**	**3 599 604**