

SURVEILLANCE ON THE DRINKING WATER QUALITY IN RIO DE JANEIRO STATE

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Introduction

Environmental integration into health surveillance actions is a result of a historical process. It is concurrent to the very creation of the environmental surveillance concept as it entails discussions on the environmental issue as a whole. The Environmental Surveillance on Health (or Environmental Health Surveillance), which was added to the Unified Health System (SUS), can be defined as a set of actions which raise awareness on what determines and conditions the environmental factors on human health, aside from detecting changes in them (BRASIL, 2004). Its integration into the field of public health policies is a relatively recent demand in Brazil. The program embraces the creation of the National Drinking Water Quality Surveillance Program (VIGIAGUA) (QUEIROZ et al., 2012).

It must be emphasized the importance VIGIAGUA indicators should have in the decision making-process made by SUS managers in order to improve drinking water quality surveillance standards. Thus, health can be promoted through risk management applied to water supply. According to Queiroz et al. (2012), there is still a gap between basic document presumptions and the adopted measures due to VIGIAGUA's technical/operational holdbacks.

The skills of Drinking Water Quality Surveillance services created by Brazilian counties have demonstrated different structuring and organization ways, which involve a whole variety of professionals and training profiles (BELIVACQUA et al., 2014). According to the literature (Queiroz et al., 2012; Freitas;Freitas, 2005), counties still find it difficult to carry out basic actions such as compliance with the sampling plan regulated by

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the Ministry of Health Ordinance nº 2914/11. Therefore, studies like theirs are essential to evaluate the carrying out of the program.

The goal of this study is to analyze the performance of VIGIAGUA Program in Rio de Janeiro State through its compliance with the 2014 municipal sampling plan.

Drinking Water Quality Surveillance (VIGIAGUA).

Despite having its own drinking water standards legitimized by the Decree 79.367 since 1977 (BRAZIL, 1977), the Drinking Water Quality Surveillance was only established in Brazil as a program after the National System of Environmental Surveillance on Health was launched (BRASIL, 2004).

The Ministry of Health has worked on the drinking water quality surveillance system (VIGIAGUA) since 2000. It consists of a set of ongoing actions taken by public health authorities to assure public access to water in sufficient quantity and quality based on the drinking water standards established by the current regulation (Ministry of Health Ordinance nº 2914/2011). The program is the integral part of the health promotion and preventive actions taken against waterborne diseases by the Unified Health System (DANIEL, 2013; FREITAS; FREITAS, 2005). Actions are developed by Municipal, State and Federal District organs and by the Ministry of Health through the General Coordination of Environmental Health Surveillance (GURGEL et al., 2013).

The VIGIAGUA program consists of continuing actions taken by public health authorities in order to assure its compliance with the current legislation norms — Ministry of Health Ordinance nº 2914/11 (BRAZIL, 2011) and to assess the risks that water from public systems and/or alternative solutions may pose to human health (QUEIROZ et al., 2012). It is up to the city managers to make decisions on preventive and corrective actions, as well as to spread out information to public agencies and to the organized civil society (FRAZÃO et al., 2013).

Data on the characterization of water supply types and water quality monitoring carried out by local surveillance (local public authorities) and water control (water supply systems) are included in the Drinking Water Quality Surveillance Information System (SISAGUA). The information is submitted into a database which describes physicochemical, chemical and microbiological aspects, as well as the quality, flow, population supplied and location of supply systems and alternative solutions -whether collective or individual ones (FREITAS; FREITAS, 2005). SISAGUA provides the quantitative analysis to be performed by the surveillance program. Data insertion in the database makes it possible to follow the achievement rates. The VIGIAGUA Program uses data provided by SISAGUA as a base to monitor the drinking water standards established by the Ministry of Health Ordinance nº 2914/11; therefore, it became a tool on decision-making. Thus, this system is used by the VIGIAGUA management as an instrument that aims to systemize water quality data in the states, counties and in the Federal District. Reports provide the information needed for surveillance actions (MINISTÉRIO DA SAÚDE, 2012; SES/RJ, 2014).

The Basic Sampling Plan establishes the minimum monthly number of analyses of three essential water quality monitoring parameters: residual free chlorine, turbidity and total coliforms / *Escherichia coli*. Basic sampling plan parameters were defined based on the already consolidated and on specific literature of the microbiological quality indicators of drinking water (MINISTÉRIO DA SAÚDE, 2012). The number of analyses is defined according to population ranges and represent a single quantitative value that should be assigned to the water quality monitoring based on the water supply types mentioned before (Water Supply System — WSS, Collective Alternative Solution — CAS and Individual Alternative Solution — IAS).

The information interpreted above is mainly important for the monitoring of VIGIAGUA's indicators in their different management instruments, as well as to the analysis of health conditions coming from the drinking water supply system in the country. Thus, the risks related to water consumption patterns that do not comply with the drinking water standards established by the Ministry of Health should be reduced (MINISTÉRIO DA SAÚDE, 2016).

Methodology

This study introduces a literature review on the subject, which identifies the relevance of discussing the VIGIAGUA's establishment in Rio de Janeiro State and its evolution over time.

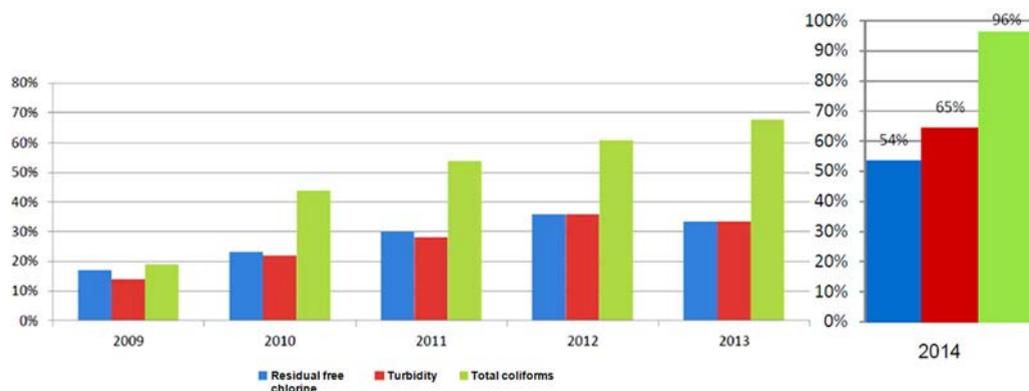
Data from each county in Rio de Janeiro State was collected in 2014. The rates established by Ordinance nº 2.914/11 of the Ministry of Health were assessed to express the acceptance of the sampling plan analyses applied to residual free chlorine, turbidity and total coliforms / *Escherichia coli*. Since public unrestricted access to SISAGUA is not allowed, the water sampling compliance rate was granted by the Water Quality Surveillance State Program Coordination (VIGIAGUA) in association with the Environmental Health Surveillance Coordination / State Health Department - RJ.

The water sampling compliance rates were obtained through access to the Water Quality Surveillance Information System (SISAGUA). The system enables counties to make data entries on each analysis performed throughout the year through the VIGIAGUA Program.

Data obtained through SISAGUA of each county were: sampling plan (quantitative annual analyses), total of analyzed samples (residual free chlorine, turbidity and total coliforms / *Escherichia coli*) and sampling plan acceptance rates. The parameters were the same for all types of data.

The results were divided into health-service regions defined by the State Health Department - RJ for Rio de Janeiro state (Figure 1) - as follows: Metropolitan I, Metropolitan II, South Coast, Middle Paraíba Region, South Central, Highland, Coastal Region, North and Northwest.

Figure 2 - Historical series (2009 - 2013) of the percentage of compliance with the three basic water analyzes in the State of Rio de Janeiro, according to the epidemiological and environmental bulletin - BEA (SES / RJ, 2014) and the percentages reached in 2014 this study).



The highest total coliform rate of residual free chlorine and turbidity analysis is possibly related to the fact that the Central Laboratory Noel Nutels (LACEN), located in Rio de Janeiro City, performs the analysis of this microbiological indicator for the counties. The delivery of samples collected by the VIGIAGUA staff must be scheduled on a monthly basis by the counties. The process works as follows: counties gather water samples and forward them on the same day to LACEN, which performs the colorimetry (checks the presence or absence of total coliforms and *Escherichia coli*). The laboratory then sends the reports electronically through the Laboratory Environment Data System (LEDS), so the counties can have access to their respective reports. In reality, not all counties in the state have access to this service, since the long distance from LACEN makes it impossible for many counties to collect and send samples to the state capital - an issue that seems most severe to the Northwest Region, as 5 of its counties do not carry out any analysis (Table 1).

Table 1 - Quantitative and water sampling plan acceptance rate of counties that did not carry out physicochemical analysis (residual free chlorine and turbidity) and of the ones that did not carry out any analysis, including total coliforms (2014).

Health Services Regions	Quantitative of counties	did not carry out physicochemical analyses	did not carry out any analysis
M. PARAIBA	12	1 (8.3%)	0 (0%)
SOUTH COAST	3	0 (0%)	0 (0%)
SOUTH-CENTRAL	11	3 (27.3%)	1 (9.1%)
METRO I	12	5 (41.7%)	1 (8.3%)
METRO II	7	1 (14.3%)	0 (0%)
COASTAL REGION	9	4 (44.4%)	1 (11.1%)
NORTH	8	2 (25.0%)	1 (12.5%)
NORTHWEST	14	5 (35.7%)	5 (35.7%)
HIGHLAND REGION	16	5 (31.3%)	1 (6.3%)
TOTAL	92	26 (28.3%)	10 (10.9%)

Source: Prepared by the authors based on SISAGUA data.

Besides its long distance from LACEN, the Northwest region can be analyzed in a historical context. As the coffee-growing monoculture declined, the next agricultural activities failed to prevent the economic and demographic downfalls which came following. These factors, together with a weak industrial expansion restricted the production of job positions and a better income in the region (CEPERJ, 2015). Therefore, the geographical distance of the region together with its economic fragility are reflected by the actions carried out by local VIGIAGUA Programs.

Counties are responsible for acquiring field equipment (turbidimeter and photometer) to measure the turbidity and residual free chlorine parameters. In 2014, 28 out of the 92 counties in Rio de Janeiro State (30%) had not carried out residual free chlorine and turbidity analyses. This number proves the difficulty faced by municipal VIGIAGUA programs to acquire such equipment even if they are not expensive. Managers do not see the information that they provide as beneficial. Thus, many counties end up simply collecting and sending water samples to LACEN for colorimetry assessment and do not test for residual free chlorine and turbidity. Only a small number of counties (9) did not carry out any colorimetry tests.

Figure 3 compares the achievements recorded between 2013 (SES/RJ, 2014) and 2014 (this study) by the region of state health-services. There was a significant increase in all water sampling acceptance rates in the region, showing significant improvement in the municipal VIGIAGUA and logistic program arrangements to carry out physico-

chemical and colorimetry analyses. Moreover, the Middle Paraiba Region surpassed the targets set for the three parameters in 2014, followed by the South Coast (turbidity and colorimetry), South Central, Coastal Region and Highland Region (colorimetry). On the other hand, the Northwest Region stood out as the region recording the lowest rate, mainly due to its almost incipient residual free chlorine.

Figure 3 - Comparative profile of achievements in the three basic water analyses between 2013 (SES-RJ, 2014) and 2014 based on the present study by health-service region.

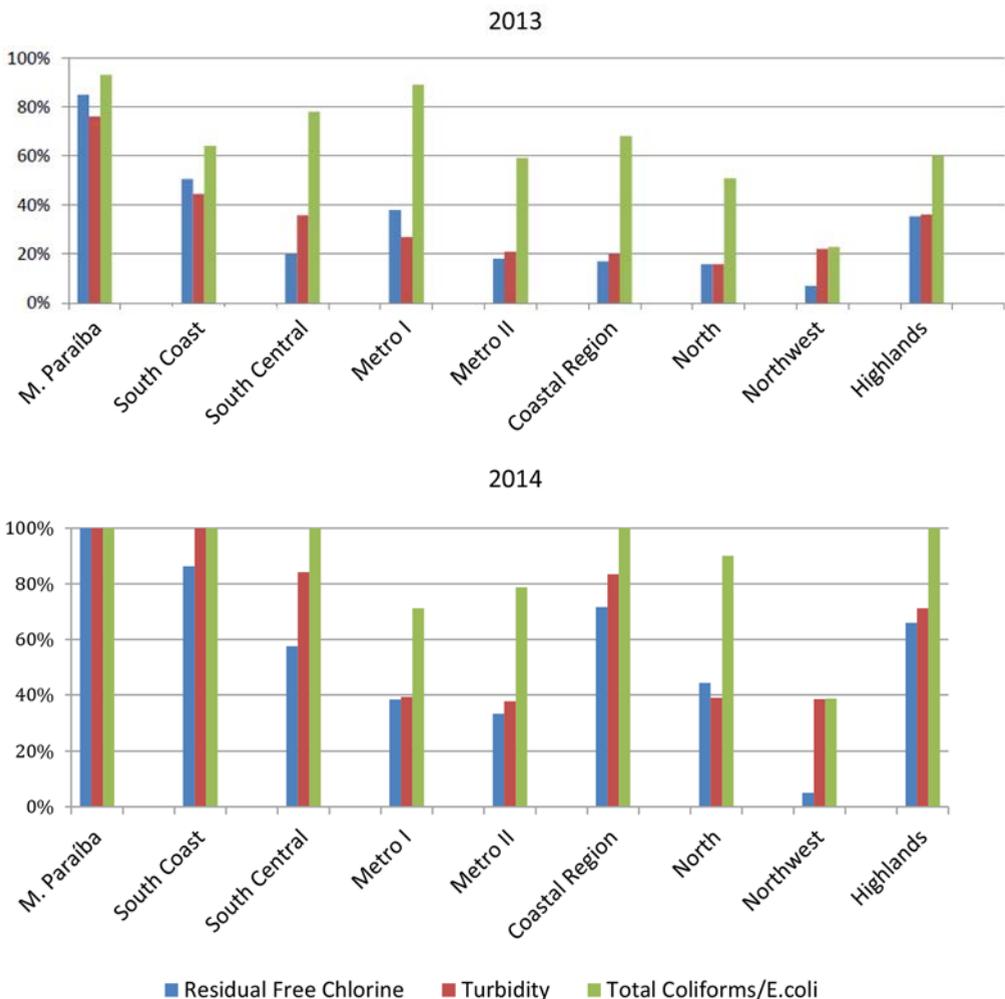


Table 2 indicates how many/ the number of counties that have achieved the goals for the three assessed parameters set by health-services region. Some state regions such as Northwest (7), Highland Region (5) and Coastal Region (4) recorded the largest number of counties that did not carry out such analyses.

Health Services Regions	Number of Counties	Residual Free Chlorine	Turbidity	Total Coliforms / <i>E.coli</i>
M. PARAIBA	12	9	11	11
SOUTH COAST	3	2	2	3
SOUTH-CENTRAL	11	3	5	8
METRO I	12	2	2	5
METRO II	7	1	1	2
COASTAL REGION	9	1	2	5
NORTH	8	2	2	5
NORTHWEST	14	0	2	2
HIGHLAND REGION	16	2	2	6
TOTAL	92	22	29	47

Source: Prepared by the authors based on SISAGUA data.

Most counties in the Middle Paraíba Region complied with the sampling plan. However, only 2 out of the 12 counties met the targets set for the physicochemical parameters and only 5 of them met the targets established for colorimetry in Metropolitan Region I — the most structured and rich region of the state, which is composed of counties such as the capital and others in Baixada Fluminense. Thus, the comparison between regions proves that greater access to funds does not necessarily translate into greater structuring ability for concerted actions and for actions that counties must take. Such outcome demonstrates the lack of political interest in drinking water quality surveillance actions.

The Middle Paraíba Region, which is followed by the Metropolitan Region, is the most industrialized region of Rio de Janeiro State, besides presenting the best growth rates. The Volta Redonda – Barra Mansa – Resende axis stands out in industrialization: Volta Redonda and Barra Mansa have direct influence on most of the region, as well as on the Southern portion of South-Central Fluminense, due to the conurbation of these counties, which is represented by two headquarters and by Companhia Siderúrgica Nacional (CSN). This company had a multiplier effect on the regional industrial activity, which was followed by an increase in the service sector. These centers benefit from highways that connect many cities such as Rio de Janeiro, São Paulo and Minas Gerais – mainly Presidente Dutra Highway and BR-393 Road - both connected to the BR-040 Road between the cities of Rio de Janeiro and Belo Horizonte (CEPERJ, 2015).

The city of Resende is home to several industries such as Volkswagen's bus and truck plant. It exerts influence on Itatiaia, Quatis and Porto Real. Its privileged position

in the Rio – São Paulo axis and land availability are important factors which attract new business ventures. Valença, Barra do Pirai and Porto Real are also important industrial poles. Peugeot stands out in Porto Real, apart from the glass and galvanizing industries. There has been noticeable urban growth in Quatis and Penedo due to the industrial activities in Porto Real. Industrial and service companies in Pirai are spatially concentrated and have noticeable local impact (CEPERJ, 2015).

Recent analyses of the Medio Paraíba region growth and why VIGIAGUA's municipal actions led to the best sampling plan achievement rates in Rio de Janeiro State with success can be explained by three main factors: The recent growth history in the Middle Paraíba Region, its logistical position in the SP – RJ – MG axis and the strong intermunicipal ties from industrial pole development.

Human intervention has caused notorious depreciation to water quality and quantity in surface and groundwater springs over the past decades. This depreciation has led to serious environmental and public health issues. As consequence, the public sector ended up raising funds to recover the degraded environment and to treat the water in order to meet the drinking water and water quality standards established by the legislation. Apart from meeting the goals of the sampling plans, a key aspect of this issue is the need of having counties and the State taking measures based on result analysis, local solution proposals, and more effective public policies to improve water quality, mainly in recurrently contaminated points.

In theory, the Environmental Health Surveillance diagnosis allows managers to make decisions on supply systems and alternative solutions in order to require appropriate interventions when disturbances affect the quality of the water. This diagnosis also enables the mapping of environmentally vulnerable areas or systems, which help in defining the priority areas. However, there are some obstacles in effective water quality surveillance which have influenced the proposal of the health surveillance model. These obstacles have political origins, specifically: managers' indifference towards the technical issue, the absence of monitoring technicians and equipment; and the intersectoral monitoring which the Health Surveillance is barely involved in, who also is weakly present in environmental discussions and makes little effort to provide explanations to the population.

Data in this study points out to progress when it is compared to descriptions made by Freitas and Freitas (2005) 10 years ago and to the historical series provided by the 2009 environmental epidemiological report (SES/RJ, 2014) -when Rio de Janeiro State went through hardships to comply with the VIGIAGUA regulations. Despite the notorious medium-term progress, some long-standing problems continue to exist since Freitas and Freitas (2005) work. Difficulties in: performing audits for concession activities; registering alternative supply solutions; making surveillance data available to the population; keeping water quality records updated and systematized; and in carrying out risk assessments involving human health. The authors point out that these difficulties are due to the Brazilian public fund management carrying out the decentralization of actions taken by the Unified Health System (SUS). The relevance of the health sector in intra sectoral and intersectoral areas and the actions taken out by other members of sanitation, environment and water resources fields are also worth mentioning. Strategies

should be discussed in order to improve the sanitation conditions of the water supply system in Rio de Janeiro State and to implement VIGIAGUA Program actions for public health promotion (MINISTÉRIO DA SAÚDE, 2012).

Now, 25 years after SUS was launched (BRAZIL, 1990), the budget of the Ministry of Health to enable environmental health surveillance actions remains a huge challenge due to lack of skilled managers. The health councils are also unable to act in a more technical way in order to supervise expenses and manager actions. The difficulty in keeping technical professionals trained, not only for the VIGIAGUA program, but also for governmental spheres as a whole is another issue. This scenario was pointed out by coordinators and by people in charge of the Environmental Health Surveillance actions in 88 counties investigated by a survey carried out in 2003 by Freitas and Freitas (2005) in Rio de Janeiro. This issue is observed in counties where technicians often lack minimum working conditions (adequate physical space, computer with internet access, vehicle and driver, equipment for physicochemical analyses, basic inputs, etc.), professional training incentives and decent income. There are also problems regarding regular political agreements that lead to high a turnover which makes it difficult to implement mid and long-term actions. Consequently, technicians are often pressured by managers and end up limiting themselves to the established sampling plan, so that the country is paid back for the fund transfers. Funds should be used to strengthen VIGIAGUA, but they end up being used for much more politically visible programs.

Conclusions and Proposals

There is a noticeable lack of studies in drinking water quality surveillance field. More studies on VIGIAGUA and on its program — Environmental Surveillance on Health — need to be carried out in the country. Further research may bring wider understanding and in-depth insights, as well as broaden the critical view of undermining factors of robust water quality surveillance throughout Rio de Janeiro State and Brazil. A structured and autonomous Environmental Surveillance on Health will fully enhance the population's health and quality of life through the most important natural life resource: Water.

Despite the actions taken by VIGIAGUA in Rio de Janeiro State, the minimum monitoring plan conditions for colorimetry, turbidity and residual free chlorine indicators have not yet been met by all counties, as there are significant regional discrepancies within the state.

The Northwest region still has serious VIGIAGUA structural issues. The state intervention is a proposal to address this issue: it could be suitable for discussing and managing a partnership among counties through Paraíba Valley's ideas, since it presented the best test results among all regions, despite its distance from Rio de Janeiro's state capital. Therefore, Paraíba Valley works as a role model for other regions in Rio de Janeiro State.

Counties must be able to hire and keep suitable technicians, as well as acquiring equipment for residual free chlorine and turbidity tests. The state should provide training and refresher courses administered by the Regional Interagency Commission – RIC (also

attended by managers) for municipal technicians, due to their high turnover. Thus, the ties among counties, will strengthen the state and federal level of the VIGIAGUA program.

The Ministry of Health should discuss new targets for VIGIAGUA aside the sampling plan. Other targets, such as the Environmental Health Surveillance elaboration and actions beyond the addition of the analysis data to SISAGUA, should be taken into account. Another proposal lies on the enforcement of Federal level VIGIAGUA, which should force local governments to spend the total VIGIAGUA in this program.

Although compliance with the sampling plan is essential to achieve VIGIAGUA goals, surveillance on drinking water quality needs further actions in order to be effective. Intersectoral actions are accordingly required for interventions capable of providing public access to water in appropriate quantity and quality, such as epidemiological data processing, waterborne disease-risk mapping and, most importantly, viable solution proposals according to each local situation. This goal shall only be achieved through greater joint intersectoral actions - mainly in association with public service concessionaires of water supply - and greater popular engagement in the process.

Finally, breaches to drinking water standards, regarding target achievement and water quality data, should be addressed in a clear manner. Therefore, a database based on reliable, complete and functional public access to data should be implemented.

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SURVEILLANCE ON THE DRINKING WATER QUALITY IN RIO DE JANEIRO STATE

Abstract: Despite the significant improvements in water quality surveillance, irregular settlements and poor sanitation conditions have increased the impact and risk of health grievances over the past few decades. The aim of this study is to assess the development of the Drinking Water Quality Surveillance Program in Rio de Janeiro State, Brazil, by measuring the compliance with water sampling and 2014 analysis plans such as the residual free chlorine, turbidity and total coliforms / *Escherichia coli* tests (Health Ministry Ordinance, No. 2.914/11). Results have shown variation between counties and regions. The Middle Paraíba Region has shown the best results and the North and Northwest regions presented the worst ones. Since 2009, there has been improvements in the conducted quantitative analyses. These analyses indicate better program implementations, mainly focused on the test to measure the number of Coliforms / *E. coli*. An action plan based on intersectoral approach with the aim to assure high-quality access to the entire population was proposed to overcome the current problems in the program.

Keywords: Vigiagua; drinking water; Rio de Janeiro State, sampling plan, quality of the water.

Resumo: Nas últimas décadas, embora tenha havido melhora significativa no controle e vigilância da água, a ocupação irregular e as condições deficitárias de saneamento intensificaram os riscos de agravos à saúde. Este trabalho faz uma análise do desenvolvimento do Programa de Vigilância da Qualidade da Água para Consumo Humano no Estado do Rio de Janeiro, através do percentual de cumprimento dos planos municipais de amostragem em 2014, considerando as análises de cloro residual livre, turbidez e coliformes totais/*Escherichia coli* (Portaria MS No. 2.914/11). Os resultados demonstram variações entre os municípios e regiões, com melhores resultados na Região do Médio Paraíba e piores nas Regiões Norte e Noroeste. A partir de 2009 observa-se uma evolução no quantitativo de análises realizadas, indicando uma melhor estruturação dos programas, especialmente referente ao parâmetro coliformes totais/*E.coli*. Para superação dos problemas são propostas ações e articulações intersetoriais para melhorar o programa, garantindo água de qualidade para a população.

Palavras-chave: VIGIAGUA; Estado do Rio de Janeiro; água para consumo humano; plano de amostragem; qualidade da água.

Resumén: Aunque con un aumento significativo en el control de la calidad del agua, la ocupación desordenada y las malas condiciones sanitarias aumentaron los riesgos a la sa-

lud. Este trabajo evalúa el desarrollo del Programa de Control de Calidad del Agua para el consumo humano en el Estado de Rio de Janeiro, Brasil, midiendo las metas de los planes de muestreo del agua en 2014, a partir de los parámetros de turbidez, cloro y Coliformes Totales/*Escherichiacoli*. Los resultados demostrarán una variación entre las municipalidades y regiones, con mejores índices para la región del Medio Paraíba y los peores en las regiones Norte y Noroeste. Desde 2009, el número de pruebas de calidad especialmente Coliformes Totales/*E.coli* está creciendo, hecho que indica una mejor implementación del programa. Para la superación de los problemas se proponen una colaboración intersectorial buscando la mejoría del programa, garantizando así agua segura para la población.

Palabras clave: Vigiaqua, agua potable; Estado de Rio de Janeiro; plan del muestreo; calidad del agua.
