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Dissemination of information related to water, health and sanitation in Brazil: institutional and technological aspects of the development of the water Atlas

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Abstract

The present study developed indicators produced from various information systems that present the general condition of water, sanitation and health in Brazil. A total of 94 variables were selected, which supported the development of 73 indicators according to three axes: water quality, sanitation conditions and health disorders related to water. These indicators were appropriate for use in the form of tables and Geographic Information Systems (GIS) web maps. The possibility of visualising these data through maps may help health and sanitation managers both improve these services and complete the information systems. People have used the information available to support civil actions in the fight for sanitation rights. The site has been visited both to assess local conditions by consulting the listings of the indicators in a single municipality and to map large areas by consulting the maps and graphs for a single indicator. The large number of times that the glossary of technical terms and legislation was accessed indicates that the site has an educational application and is not used simply as a source of data.

Keywords: Information systems; Health indicators; Sanitation; WebGIS; Monitoring

In Brazil, the majority of the urban population has gained access to water through the expansion of supply networks; however, the appropriate collection and treatment of sewage and garbage have not been promoted. The combination of these factors raises a new challenge for the public health system, which should expand its outlook regarding the issue of sanitation beyond service coverage to include monitoring and taking effective actions related to the quality of water and the vulnerability of supply systems. The process of urbanisation and the growing population density increasingly produces risks that are characteristic of large urban centres, which have vulnerable water sources and distribution networks (Andreazzi et al., 2007; Ezzati et al., 2005). There have been several reports of outbreaks of waterborne diseases transmitted by the water distribution system (e.g., Godoy et al., 2003; Schuster et al., 2005). The expansion of these systems, in these cases, may also act as a means of amplifying the risks and coverage of the water supply system rather than representing a health protection measure.

For a more contextualised evaluation of sanitation problems, the coverage of the sewage system, the contamination of water in the supply network, the possible contamination of the water sources, the inadequate or insufficient treatment of water, the irregularity of the supply and the interaction between water and sewage in the soil around the home should also be taken into account. The combination of these indicators may reveal particular contexts within which health problems occur and may provide clues for the establishment of specific and focused policies for each social group and region.

The integrated analysis of indicators that evaluate climatic, housing, poverty and water quality conditions can reveal specific contexts in which these health problems occur and can substantiate specific policies for social groups and regions. According to Borja and Moraes (2001), several decisions are necessary to make regarding the construction of a system of environmental indicators, and this decision-making requires an integrated perspective of the environment, in addition to an interdisciplinary approach. Moreover, according to the authors' point of view, for this process, it is necessary to define the objectives of the system of indicators, the theoretical/conceptual framework, the subjects who will participate in the evaluation, the techniques and data collection instruments, and the methods for weighting and aggregating the indicators.

The main objective of the atlas of the quality of water, health and sanitation (also known as ÁguaBrasil, www.aguabrasil.cict.fiocruz.br) is to collect a set of indicators and data on health, basic sanitation and water quality conditions in Brazil to identify the conditions of the sanitation systems, the water quality and waterborne diseases in Brazilian municipalities. In turn, this process allows for geographic information to be provided that is relevant for analysis of the control and monitoring of the quality of consumed water and of the risks related to general sanitation conditions. This information can be used by managers to minimise the risks to the population and to elaborate public policies for sanitation and water resources by providing information to interested parties, whether they are the general population or governmental agencies.

Indicators that express the general conditions of sanitation, water quality and waterborne diseases were selected and developed. These indicators are available in the form of maps, tables and graphs for the creation of a database on sanitation and health in Brazil and may be used as a baseline for the evaluation of the future impact of sanitation and water resources policies on health conditions.

The criteria for the selection of the indicators, in addition to the manner in which they are shown in maps, tables and graphs, were established by a working group composed of professionals and researchers from the Federal University of Bahia (Universidade Federal da Bahia – UFBA), the Ageu Magalhães Research Centre (Centro de Pesquisas Ageu Magalhães – CpqAM/Fiocruz), the Health Surveillance Agency (Secretaria de Vigilância em Saúde - CGVAM/SVS), the Department of Urban Centres, the Brazilian National Water Agency (Agência Nacional das Águas – NWA) and the state and municipal health agencies of Rio de Janeiro and São Paulo, in addition to the team of the ICICT/Fiocruz project. This group compiled a list of information systems that could be used to obtain data on water quality, sanitation and related diseases.

The data necessary to calculate the indicators were obtained from the following databases:

- Demographic censuses from 2000 and 2010 – data on the conditions of the supply, sewage and garbage collection of households, population and demographic density (available at www.ibge.gov.br);

- National Survey of Basic Sanitation (Pesquisa Nacional de Saneamento Básico – PNSB) from 2000 and 2008 – data on water and sewage catchment, supply and

treatment, as reported by local managers (available at www.ibge.gov.br);

• The Hospital Admission Information System (Sistema de informações sobre Internações Hospitalares – SIH-SUS) beginning in 2000 – data on admissions in SUS or partner hospitals according to the year of occurrence, the municipality of residence and the cause for admission (available at www.datasus.gov.br);

• The Mortality Information System (Sistema de Informações sobre Mortalidade – SIM) beginning in 2000. Data on deaths per year, municipality of residence and basic cause of death, organised by the Department of Health Situation Analysis (Departamento de Análise de Situação de Saúde – DASIS) of the Health Surveilance Agency (Secretaria de Vigilância em Saúde – SVS), together with state and municipal health agencies (available at www.datasus.gov.br);

• The Information System for Notifiable Diseases (Sistema de Informação de Agravos de Notificação – SINAN) – data on the notification and investigation of cases of diseases and ailments, per year and municipality of residence, which are found on the national list of diseases that require compulsory notification, organised by the Health Surveillance Agency (Secretaria de Vigilância em Saúde – SVS), together with state and municipal health agencies (available at www.datasus.gov.br);

• The Information System for the Surveillance of Water Quality for Human Consumption (Sistema de Informação de Vigilância da Qualidade da Água para Consumo Humano – SISAGUA) – data on water supply systems and on collective and individual alternative solutions, surveillance and control of the quality of water for human consumption, organised by the General Coordination for Environmental Health Surveillance (Coordenação-geral de Vigilância em Saúde Ambiental – CGVAM/SVS/MS), along with state and municipal health agencies; and

• Water Information Systems (Sistema de Informações Hidrológicas – Hidro) – data on the water quality in the major rivers of the country, maintained by the National Water Agency (Agência Nacional de Águas – ANA) (available at http://hidroweb.ana.gov.br).

Table 1 lists the main characteristics of the information systems and the databases that were used.

Table 1: Characteristics of the information systems and databases used in the water, health and sanitation atlas of Brazil.

Bases de dados	Atualização	Instituição	Unidade de registro	Unidade espacial de referência
Sistema de Informações Hospitalares				
SIH-SUS	Mensal	DataSUS/MS	Internação	CEP, endereço*
Sistema de Notificação de Agravos				
SINAN	Mensal	SVS/MS	Agravo à saúde	Bairro, endereço*
Sistema de Informação de Mortalidade				
SIM	Anual	DataSUS/MS	Óbito	Município, endereço*
Sistema de Informação de Atenção Básica				
SIAB	Mensal	SAS/MS	Família e micro-área	Município, área
Censo Demográfico				
CD	Decenal	IBGE	Domicílio	Setor censitário
Sistema de informação sobre qualidade da água				
SIS-Água	Mensal	SVS/MS	Amostra	Endereço
Pesquisa Nacional de Saneamento Básico				
PNSB	Decenal	IBGE	Sistema de saneamento	Distrito
Sistema Nacional de Informações sobre Saneamento				
SNIS	Anual	SEDU	Companhia de saneamento	Município
Sistema de Informações Hidrológicas				
SIH	Mensal	ANA	Estação	Coordenadas

To facilitate the consultation, the indicators were organised into three themes: water quality, structure and functioning of the sanitation systems as well as the incidence of illness (diseases) related to sanitation, taking into account the availability of these data and their ability to indicate the general sanitation conditions. The following illnesses related to the quality of the water were selected as event markers: cholera, salmonellosis, amebiasis, helminthosis, giardiasis, hepatitis A, leptospirosis, dengue fever, schistosomiasis and mortality attributable to diarrhoea in children younger than 5 years (Heller, 1997).

In the second organisational phase, the information was integrated using Geographic Information Systems (GIS), which allowed for the production of tables, thematic maps and graphs related to the indicators for visualisation at different levels of aggregation (municipalities and states). Other cartographic information (rivers, roads, basins, etc.) was selected to facilitate the visualisation and analysis of the particular contexts, and this information was incorporated into the system in the form of additional layers for the thematic maps.

The system was completely developed using free software. To manage the database, two database management systems (DBMSs) were used: MySQL, due to its versatility, and PostgreSQL/PostGis, which is different because it allows for the use of geographic data to generate dynamic maps of the indicators. The programming of the system was developed in php, javaScript, ajax, dom and mapScript. To dynamically generate the maps, I3Geo was used; this software was created by the Department of the Environment based on a set of other free software applications, primarily Mapserver (available at the free software portal www.softwarepublico.gov.br).

The Atlas allows for relationships to be established among data, generating graphs and maps, and allows the search for information and maps on another server, making it possible to aggregate data and superimpose the layers of information over the maps. Several searches can be performed, such as a consultation of all of the indicators in a town or state, from a single indicator for all municipalities or states to up to seven indicators per state. It is also possible to produce graphs, such as the historical series of an indicator per municipality. The main pages of this atlas are shown below:

Figure 1a: Homepage for the water, health and sanitation atlas.

Figure 1b: Graph showing the evolution of the indicators of the water, health and sanitation atlas (incidence of schistosomiasis in the municipality of Abreu e Lima, PE, between 2001 and 2008).
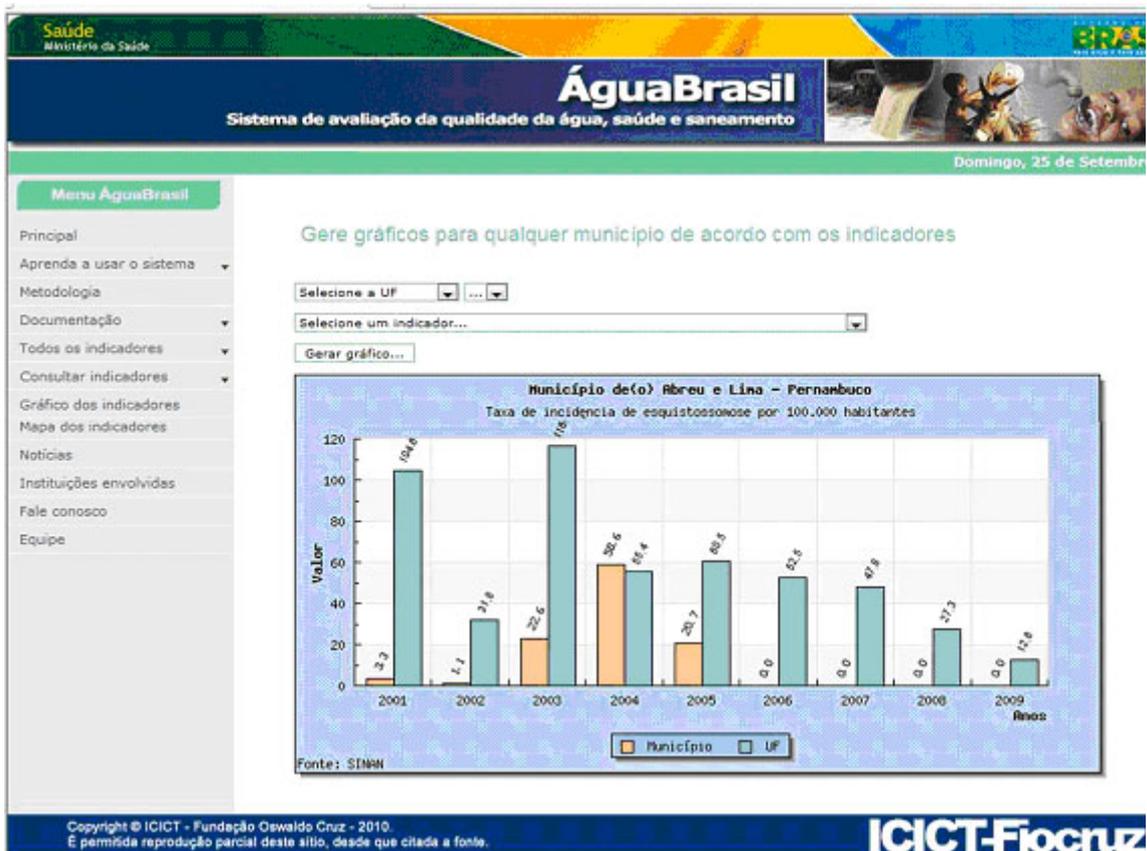
Figure 1c: Map showing the spatial distribution of the indicators of the water, health and sanitation atlas (proportion of districts supplied with road tankers, according to the PNSB of 2000).
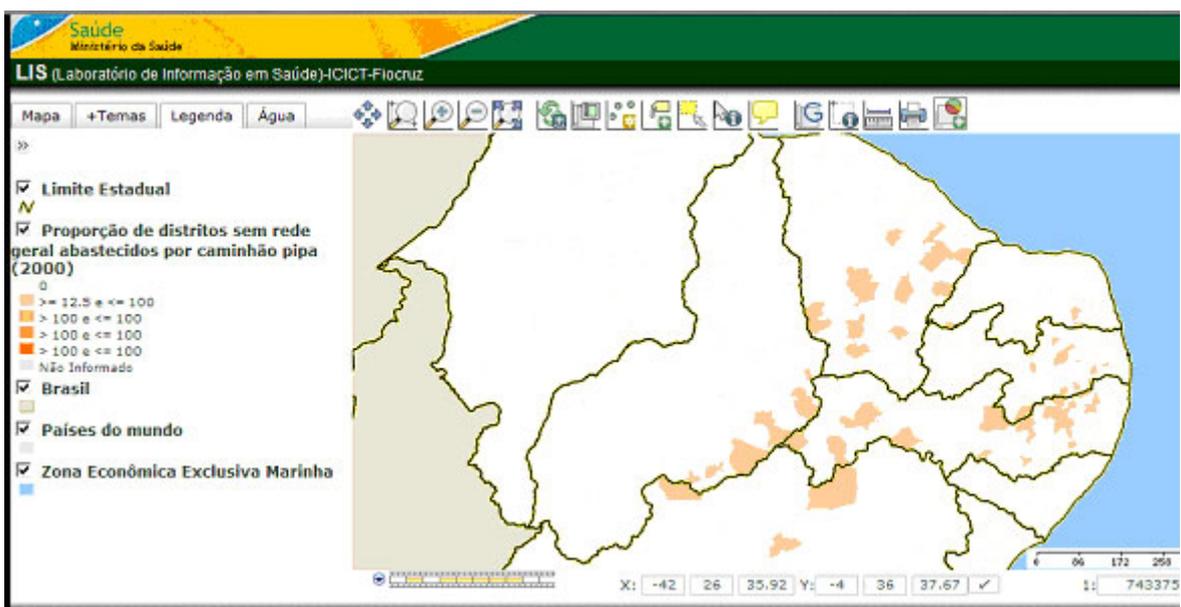
The maps that were produced allow for the identification of the areas with the highest incidence of waterborne diseases. Although all of these health hazards are related to sanitation problems, the distributions of these illnesses are somewhat heterogeneous, with leptospirosis concentrated in the municipalities of Southern Brazil, cholera and schistosomiasis in the coastal area of the northeastern region and hepatitis A in the northern region.

The interaction among risk factors, such as the lack of water distribution networks, the lack of sewage collection networks and the high demographic density, represent a summary of the risk of disease transmission. The distribution of the combined risk index shows that the most vulnerable concentrations of municipalities are in the northernmost part of the northeast and in the state of Pará, in the southern plateau of Southern Brazil and along the Atlantic forest area of the northeast. In the latter area, the combined index for transmission risk indicates the possible areas of schistosomiasis transmission with high precision. The majority of the Brazilian population resides in municipalities with high coverage of the water distribution network. However, it should be stressed that there is a considerable portion of this population that receives untreated water or that does not have a bathroom or an internal water supply at home.

The site was launched in May 2008, and as of April 2010, it had received approximately 8,000 hits, more than 25,000 page accesses. The majority of the users (75%) come from search engine sites (Google, Yahoo, Cadê, Aonde, etc.). The percentages of visits attributable to direct traffic and links from other sites are 12.6% and 12.3%, respectively, which highlights the importance of maintaining updates of the system. The most visited pages of the system were the glossaries (of waterborne diseases and technical terms for sanitation and the environment), the tables and graphs and related maps (in decreasing order). The indicator system has been used for local diagnosis of sanitation conditions, allowing for the social control of public policy.

Systems for divulging the indicators, such as the water, health and sanitation atlas, are observation spaces (observatories) that provide the ability to track and monitor trends and serve specific users. Such systems do not share the same goal as other online health situation rooms, which offer a quick response and an analysis of emergency situations. In addition, observatories require thematic profiling; they use various sources of information, some with a low frequency of updating (such as PNAD, censuses and surveys), and they contain analytical text, not only numerical values. These initiatives seek to cover the entire information cycle, from the production of data and its statistical treatment, considering hypotheses and theories, to the generation of information, which involves communication and information instruments and concepts.