Chapter 9 / Capítulo 9

Education for Health: A Successful Experience in the Applicability of the Galbraith Model

Educación para la salud: una experiencia exitosa en la aplicabilidad del modelo Galbraith

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Abstract

This research was conducted by a multidisciplinary group from various institutions including Universidad Cooperativa de Colombia, Universidad Mariana (schools of Medicine and Engineering), Empresa de Obras Sanitarias de Pasto (Empopasto), Laboratorio Clínico Especializado (Unibac), and the Municipal Ministry of Health (Galbraith model).

An information-collecting instrument fed the database and facilitated the analysis of the variables established, as well as the dissemination of educational information on tank maintenance and prevention of gastrointestinal diseases. The microbiological study was conducted in the Microbiology Laboratory at Universidad Mariana, and for quality control purposes the reference sample was analyzed by a Unibac, a private laboratory duly accredited by the Nariño Departmental Health Institute. Applying the recommendations of the Colombian Institute of Hydrology, Meteorology, and Environmental Studies (Ideam) and the Ministry of Environment, Housing, and Regional Development, the water available in residential reserve tanks was found to be unfit for human consumption due to its sanitary quality; the analysis isolated bacterial groups that, according to World Health Organization (WHO) guidelines on contamination criteria, are to be strictly monitored, namely, total coliforms, fecal coliforms and *Escherichia coli*. The acceptable values of these can be found in Resolution 2115 of 2007.

Keywords: drinking water, sanitary quality, total coliforms, Galbraith model, intestinal parasitosis.

Resumen

Para el desarrollo de esta investigación se contó con un grupo multidisciplinario e interinstitucional que involucró a la Universidad Cooperativa de Colombia, la Universidad Mariana (facultades de Medicina e Ingeniería), la Empresa de Obras Sanitarias de Pasto (Empopasto), el Laboratorio Clínico Especializado (Unibac) y la Secretaría Municipal de Salud (modelo Galbraith). Un instrumento colector de información alimentó la base de datos y facilitó tanto el análisis de las variables establecidas, como la socialización de aspectos educativos para el mantenimiento de los tanques y la prevención de enfermedades gastrointestinales. El estudio microbiológico se realizó en el Laboratorio de Microbiología de la Universidad Mariana, y como control de calidad la contramuestra fue analizada por un Unibac, un laboratorio privado debidamente habilitado por el Instituto Departamental de Salud de Nariño. Aplicando las recomendaciones del Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia (Ideam), y del Ministerio de Ambiente, Vivienda y Desarrollo Territorial, fue posible observar que la calidad sanitaria del agua disponible en los tanques de reserva residencial no era apta para el consumo humano, puesto que se aislaron grupos bacterianos de estricto seguimiento según las directrices de la Organización Mundial de la Salud (oms) en cuanto a criterios de contaminación como son coliformes totales, coliformes fecales y *Escherichia coli*, cuyos valores permisibles se encuentran sustentados por la Resolución 2115 de 2007.

Palabras clave: agua potable, calidad sanitaria, coliformes totales, modelo Galbraith, parasitosis intestinal.

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Technological dependence

The interrelationships between University-Company-State (UCS) strengthen the science-technology system responsible for regional development. In our field it is common to see university research conducted in the area of basic sciences that does not respond to the needs of the productive sector. Furthermore, the State does not provide spaces for stakeholders in the process to interact and create first-class projects. Initiatives such as business conferences and knowledge fairs, however, also offer opportunities for UCS integration. The Nariño Regional Competitiveness Commission (CRC) is a similar effort, as are the four primary projects structured and formulated in the Regional Competitiveness Plan (PRC, 2008), which include: applied research on priority production chains (coffee, dairy, fruit and vegetables, cacao, arts and crafts, tourism, *carnaval*), IT and communications, training of human talent, and building technology centers.

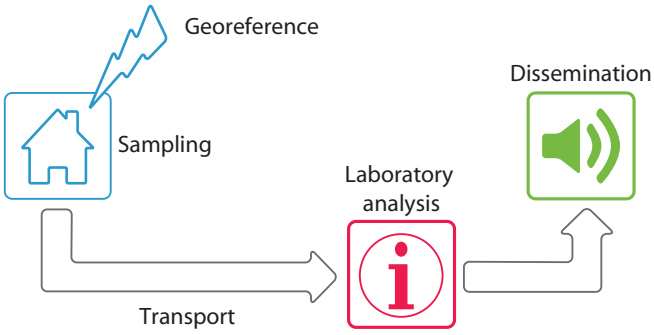
The PRC is a tool that must be consulted when formulating new development plans at the local, departmental, and national levels, as it is the product of integration between institutions in the public, private, and academic sectors, as well as citizen participation, all of which have identified what is needed to improve quality of life and levels of competitiveness in the region. Unfortunately, topics such as health are not included, even though it is a cornerstone of development, since a sick population is not productive. An agenda to prioritize health problems was thus put forward and is now under construction. But the health of the population is so important and so directly tied to the development of a region, that water—an issue of global concern, and the theme of the Week of Science, Technology, and Innovation 2012 proposed by Colciencias at the national level—became the focus of an effort to solve the public health problem of intestinal parasitosis, without further specification, with the integration of the UCS.

This successful experience brought together two private universities, Universidad Cooperativa de Colombia and Universidad Mariana, along with private companies such as the Unibac laboratory and Obras Sanitarias de Pasto (Empopasto), with the support of the Nariño Departmental Health Institute (ISDN), making it possible to identify the possible cause of this public health problem. The success story centers on Sábato's triangle, a model that interrelates the three points of the triangle: State-science/technology infrastructure-productive sector. According to Guzmán Cuevas (2006), this model of technological dependence was proposed by John Kenneth Galbraith (renowned economist born in Iona Station, Ontario, Canada in 1908) and developed by Jorge Alberto Sábato (physicist and technologist born in Rojas, a province of Buenos Aires, Argentina in 1924). The model posits that for a science-technology system to exist, the following assumptions

must be met: The State designing and executing the policy; science-technology infrastructure, as a sector of supply and technology; and the productive sector, as demander of the technology. These three items must be strongly and continuously linked. Accordingly, each point of the triangle must have solid interrelationships with the varied institutions that they consist of. Guzmán Cuevas (2006) concludes that there are also "extra-relationships," that is, relationships between the points of the triangle and external entities.

During the period from August 15 to September 26, 2012, 26 residences were sampled across the 12 districts that the municipality of San Juan de Pasto is administratively divided into. All are supplied with water from the Drinkable Water Treatment Plant (PTAP) Centenario, which covers 81% of the users of the water and sewage system run by the Empopasto company. Information on cases of intestinal parasitosis in the month of August was collected in six health centers to observe the behavior of associated morbidity. Figure 9.1 summarizes the methodology applied in the study in general terms.

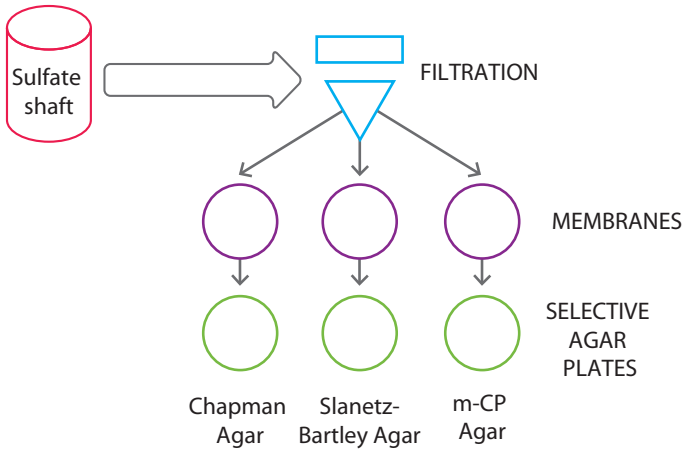
Figure 9.1 Summary of general methodology



Source: The authors.

Applying the recommendations of Ideam and the Ministry of Environment, Housing, and Regional Development (2007), it could be observed that the sanitary quality of the water available in residential drinking water storage tanks made it unfit for human consumption; the analysis isolated bacterial groups that, according to World Health Organization (WHO) guidelines on contamination criteria, are to be strictly monitored, including total coliforms, fecal coliforms, and *Escherichia coli* (WHO, 2004). The permissible values of these can be found in Resolution 2115 of 2007. Figure 9.2 shows the procedure established for bacteriological analysis of the water.

Figure 9.2 Bacteriological analysis of water sample



Source: The authors.

Intestinal parasitosis, without further specification, is responsible for diarrhea, especially in the 4-15 age group; it may be associated with not only the sanitary conditions of the storage tank, but also the distribution networks, food and hand hygiene (López et al., 2002; Ezzati, López, Rodgers, & Murray, 2004), and with airborne material from landfills (García & Agudelo, 2005), among other things.

The report from the World Health Organization (WHO) Third Global Meeting of the Partners for Parasite Control, held in Geneva in 2005, indicates that more than 2 billion people in the world suffer from some form of intestinal parasitism, which is considered one of the main causes of morbidity in developing countries; it is linked to poverty and related to poor hygiene, healthcare services, the drinking water supply, and fecal contamination of the environment (WHO, 2005).

Specifically, the *Boletín Epidemiológico de Nariño 2009* (Nariño Epidemiological Journal) shows a growing increase of morbidity due to acute diarrheal disease (ADD): from 69,000 cases in 2007 to 98,000 cases in 2009, placing it among the 15 primary causes of morbidity in 2009. There were 64,000 cases of intestinal parasitosis (IP), without further specification, and 21,000 cases in the department in 2009 of diarrhea and gastroenteritis that were suspected to be of infectious origin (D&G). Likewise, in the municipal capital, San Juan de Pasto, there were 18,000 cases of IP and 5,000 cases of D&G for the same year (Instituto Departamental de Salud de Nariño (IDSN), 2009).

University-Company-State partnership, a research alternative

It is essential to allocate resources and promote the University-Company-State partnership for research into high-priority issues such as epidemiology, health care provision, and cost-effective intervention against diseases with an especially high burden among underserved populations (Hotez et al., 2005).

This research was conducted with a multidisciplinary group from various institutions including Universidad Cooperativa de Colombia, Universidad Mariana (schools of Medicine and Engineering), Empopasto, Laboratorio Clínico Especializado Unibac, and the Municipal Ministry of Health. An information-collecting instrument was designed to feed the database and facilitate the analysis of the variables established. The microbiological study was conducted in the Microbiology Laboratory at Universidad Mariana, and for quality control purposes the reference sample was analyzed by a Unibac, a private laboratory duly accredited by the Nariño Departmental Health Institute. Samples were taken daily from October 2012 until September 2013, covering the urban area of the municipality of Pasto (twelve districts), in order to observe the behavior of the wind and rain in different seasons, as well as report cases from different health centers (six in total) and hospital outpatient departments.

Drinking water has a marked influence on users' health

Approximately 800,000 lives could be saved each year through more hygienic food storage and preparation, as well as promoting education, providing good nutrition and ensuring adequate weight gain (Hotez et al., 2005, p. 91).

In developing countries, diarrheal diseases are one of the five causes of avoidable morbidity and mortality in children under 5 (Anand & Hanson, 1998; Clason et al., 2006; Aiello et al., 2008), and approximately 90% of deaths are in children under 2. "On average, a child suffers 3.2 episodes of diarrhea per year, although deaths have fallen from 6 million in 1979 to 2.6 million per year in the nineties" (Hotez et al., 2005, p. 89; Brooker, Clements, & Bundy, 2006; López et al., 2002).

The causes or etiologic agents of diarrheal disease include a wide variety of microorganisms such as viruses, bacteria, protozoa, and helminths, as stated by Sierra (as cited in Rojas & Sarmiento, 2003), which are found in sedimentation, a natural factor in water distribution (Magaró, 2005; Hotez et al., 2004; Hughes et al., 2004; Ocampo, Pradilla, & Méndez, 2008; Rojas & Sarmiento, 2003).

These agents are generally transmitted via the fecal-oral route, often through the ingestion of contaminated water or unwashed food. This causes intense episodes of diarrhea, alters the immune system, weakens the organism's ability to extract

nutrients from food, and can also cause severe dehydration. Acute watery diarrhea, caused mainly by the enterotoxigenic *Escherichia coli* and *Vibrio cholerae* rotoviruses, produces rapid dehydration and can result in death. Persistent diarrhea is accompanied by malnutrition and triples the likelihood of fatality compared with watery diarrhea. Bloody diarrhea is often accompanied by intestinal lesions and worsened nutrition, some dehydration, and fever. Implementation of hygienic food practices, vaccination, improvement of water storage and sanitation, along with better medical attention for cases, are the main interventions to prevent and treat diarrheal diseases, as established by the United Nations Development Programme (PNUD, 2006).

The public service provider Empopasto S.A. has three drinking water treatment plants (PTAP) dedicated to producing water of excellent quality (as established in Law 142 of 1994 and Law 373 of 1997). After it is filtered, the water enters a contact chamber where an automatic dispenser adds chlorine gas, a powerful disinfectant. Once the water is chlorinated, it is stored in the plant's tanks; additionally, quality tests are conducted as per Resolution 2115 of 2007 issued by the Ministry of Environment, Housing, and Regional Development, which indicates the characteristics, basic instruments, and frequency of the control and monitoring system for water quality suitable for human consumption (Barendregt et al., 2003).

Although water quality markedly influences users' health, other factors are involved that affect microbiological quality, such as: distribution networks (500 km of pipes with 15 hydraulic sectors in Pasto, according to the Efficient Use and Saving of Water Program [PUEAA]) and residential storage tanks, where age and construction materials are important factors in their deterioration. For example, tubes may be made of asbestos cement, polyvinyl chloride (PVC), or cast iron, with necessary care and duration varying among them; and the accumulation of impurities, dirt, suspended particles, and airborne contaminants from the tanks are factors that alter the quality of residentially-used water.

Information and monitoring are pillars of the health system and a starting point for all debate on how to improve the current conditions of a process; those responsible for adopting decisions in the health sector should therefore ask many questions about what it is happening. Regarding the continued rise in morbidity related to intestinal parasitosis, without further specification, questions to be asked include: Should this be considered an endemic situation? Are we approaching 90% of children under 5 being covered by the schedule of recommended vaccinations? In the coming 10-20 years, will this be a major cause of death among the population? What social behavior is contributing to sustained morbidity? Where will spending on public sector health stop? Which investments are effective in

combatting intestinal parasitosis, without further specification? Are there other more cost-effective methods?

Information and communications technology is changing and offering more methods for collecting, storing, and generating information, as well as allowing the results obtained to be rapidly transmitted and thus instantly shared with the rest of the world. By collecting, analyzing, and using research data in promotion and prevention campaigns, it is possible to improve quality of life by helping people recognize etiologic agents as well as appropriate handling and treatment. As the generation and application of information and knowledge is systematized and standardized, faster progress can be made in improving human health and eliminating inequality in service provision (Hotez et al., 2005; Anand & Hanson, 1998; Ezzati et al., 2004; Barendregt et al., 2003).

The instrument designed to register information and create the database also seeks to establish the level of knowledge of the city's inhabitants with respect to hygienic and health aspects of residential storage tank maintenance. This takes demographic, socioeconomic, cultural, and health factors into account through simple yes or no questions. Using georeferencing, it is possible to observe the distribution of findings, link them to individual healthcare records, and identify the source of the water and possible environmental contamination agents present, direction of the wind, rain, etc.

In Pasto, the highest morbidity for intestinal parasitosis

The city of Pasto is the capital of the Nariño department. It is located at latitude 1°13" north and longitude 77°17" west of Greenwich, its altitude is 2,543 MASL, and its average temperature is 57.2°F. Lying at the foothills of the Galeras volcano, the city is located in the Atriz valley, in the Nudo de los Pastos.

The public service provider Empopasto S.A. has three PTAPs dedicated to producing water of excellent quality for the city of Pasto (PTAPs Centenario, Mijitayo, and San Felipe). It also has a distribution system that runs water through a vast network of pipes, approximately 500 km long with 14 hydraulic sectors providing water to 62,028 users of the aqueduct.

The average life of the distribution networks depends on the material they are made of: asbestos-cement lasts 21 years on average, PVC 14, and cast iron 44.

The company has 13 storage tanks for drinking water, each with a different storage capacity according to the needs of the sector it services.

Coverage of safe drinking water in the city is 92.61%; the population without this service totals 23,000 people. Meanwhile, Pasto's health sector is administered by the Municipal Secretariat of Health, which includes six health centers (see Table 9.1).

Table 9.1 Health centers by district in Pasto

Health center	District
Pandiaco	District II
San Vicente	District III
Tamasagra	District IV
La Rosa	District V
Lorenzo de Aldana	District VI
Calvario	District VIII

Source: Empopasto-PUEAA, 2008.

The primary health infrastructure consists of the Hospital Universitario Departamental de Nariño (HUDN), the Hospital Infantil Los Ángeles (HILA), the Fundación Hospital San Pedro, the Hospital Mental San Rafael, the Hospital Mental Perpetuo Socorro, and four private clinics: Fátima, Oftalmológica Unigarro, Palermo, and San Juan de Pasto.

Although mortality due to ADD is low—22 children under the age of 5 in 2006, and three children under the age of 5 in 2009 (Empopasto S.A. E.S.P., 2008)—morbidity due to intestinal parasitosis, without further specification, was 88,455 in 2006, and 98,165 in 2009. It is estimated that 20% of cases were children under the age of 4 (IDSN, 2009).

The total number of people affected by intestinal parasitosis, without further specification, is considerable and represents the most common diagnosis for outpatient consultations in 28 of the 64 municipalities in the Nariño department, with Pasto contributing the largest number of cases (IDSN, 2009)

In the search for factors that contribute to these continued levels of morbidity, this study diagnosed the current situation based on bacteriological analyses of drinking water in residential storage tanks, which can be linked to the behavior of the aqueduct's users in the face of this particular situation. This information came from the information-registering instrument and data analysis (Ideam, 2007; Empopasto S.A. E.S.P., 2008; PNUD, 2006).

Quality water in the home: reducing diarrhea across all ages

The Millennium Development Goals (MDG) are based on the United Nations Millennium Declaration, which was approved in 2000 by the largest congregation of heads of state in history. High-income countries as well as middle- and low-income countries (LMIC) made a commitment to do everything possible to eradicate poverty, promote human dignity and equality, and achieve peace, democracy and environmental sustainability before 2015 (Cairncross & Valdmanis, 2006). This involves protecting water resources, building aqueducts and sewage systems, and making safe drinking water available to citizens. Latin American and Caribbean countries, however, had the highest mortality rates due to diarrhea, and the majority of cases were related to inadequate water and sanitation. In high-income countries, on the other hand, the estimated mortality from the same cause was 6,802, eight times less than in middle- and low-income countries, according to the latest report on global disease burden in 2004.

The 2008 PUEAA shows the same trend between 1999 and 2003—three infant deaths per year—and categorizes mortality due to ADD as low. However, the death of even one child is a concern and warrants investigation; indeed, the joint goal of the institutions associated with public health is that no deaths should occur because of these diseases. Accordingly, the public service provider Empopasto S.A. helps achieve the goal of guaranteeing water in accordance with treatment guidelines demanded by the competent authorities; if the municipality's drinking water is of high quality, it complies with the requirements of Resolution 2115 of 2007 (Ley 142, Secretaría del Senado, 1994; Ideam, 2007; OMS, 2004). What, then, is the cause for the high number of cases diagnosed with intestinal parasitosis, without further specification?

It should be noted that the factors that affect the continuity and quality of safe drinking water include: systems that work only intermittently; inefficient treatment plants; lack of or problems with water disinfection; distribution networks in precarious conditions; illegal, poorly set-up residential connections; and problems with residential installations. It is estimated that 60% of the world's population (approximately 219 million people) have intermittent water services (WHO/Unicef, 2011; Wright, Gundris, & Conroy, 2004; Fewtrell et al., 2005).

Consequently, the hydraulic infrastructure of the storage system in the Pasto municipality must be analyzed according to the information in the 2008 PUEAA. The Pasto River lateral intake that supplies the Centenario PTAP was built in 1936 and underwent restoration in 1979 (33 years ago). The Centenario canal for the Centenario PTAP was built in 1981 (31 years ago). The Centenario drinking water treatment plant was built in two stages, in 1940 and 1957 (the latter 55 years

ago). In 1977 and 1987 upgrades were carried out in two stages, respectively. The Mijitayo PTAP was built in 1969 and improved in 1986. The distribution system is a vast network of pipes approximately 500 km long consisting of various types of material: asbestos-cement, including sections that have been operating for 30 years; PVC, including sections that have been operating for 25 years; and cast iron, with some sections that have been operating for 50 years.

Add to this observed phenomenon the lack of knowledge or lack of education regarding methods of storing water in the home, such as cleaning and maintenance of storage tanks, and it can be seen that there is a latent risk that must be investigated (see Figure 9.3).

Studies based on meta-analysis suggest that the bacteriological quality of water declined at point of use in homes. Interventions aimed at improving water quality in the home may therefore have greater impact in reducing diarrhea across all ages (Curtis & Cairncross, 2003; Mandegari, 2012).

A review of the literature within Colombia and abroad shows agreement that not only is it necessary to have safe drinking water, but also that hygiene is a protective factor in the face of the stages of diarrhea (Fewtrell et al., 2005; Wright, Gundris, & Conroy, 2004).

Figure 9.3 Turbid water available in storage tank

Source: The authors.

Promoting good habits such as washing hands after coming into contact with feces (Cairncross & Valdmanis, 2006; Cochrane Handbook for systematic reviews of interventions, 2011) and washing food before eating it are both preventative measures (Góez, Vásquez & Pena, 2005).

It is worth noting that the contamination criteria set by the WHO since 1993 establish that coliform organisms will only be analyzed as indicators of the effectiveness of treatment and the integrity of the distribution system, not as indicators of the presence of pathogens. Thermo-tolerant coliform organisms, in this case *E. coli*, on the other hand, will be analyzed as indicators of fecal pollution (OMS, 2004). However, following the suggestions of the European Community in the new contamination criteria of 1995, although all laboratories determine total coliforms and fecal coliforms, it is necessary to monitor *Coli*, *Citrobacter*, *Klebsiella*, *Enterobacter*, and *Serratia*, microorganisms (bacteria) that will be reported if observed in the study (Góez, Vásquez, & Pena, 2005).

Conclusion

Inadequate maintenance of storage tanks for residential drinking water can be noted in the presence of impurities, dirt, suspended particles, airborne contaminants, virus-harboring elements, bacteria, protozoa, and helminths. A microbiological study supported by bacteriological identification, and not disregarding other microorganisms of interest such as microfungi, protozoa, helminths, and algae, reveals the risk of suffering diarrheal diseases, a situation associated with high parasitosis-related morbidity in the population. Of the samples analyzed, 88% contained total coliforms, fecal coliforms, and *Escherichia coli*, bacterial groups that indicate contamination, and therefore water which is unfit for human consumption. This is caused by the common habit of impeding circulation of water in the tank by leaving the tap off and using the water when supply cuts occur.

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