SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

Qualitative analysis of water quality deterioration and infection by Helicobacter pylori in a community with high risk of stomach cancer (Cauca, Colombia)

Análisis cualitativo del deterioro de la calidad del agua y la infección por Helicobacter pylori en una comunidad de alto riesgo de cáncer de estómago (Cauca, Colombia)

***Acosta**, Claudia Patricia[1]; **Benavides**, John Alexander[2]; **Sierra**, Carlos Hernán[3]*

[1]Ph.D. in Environmental Sciences. Professor, Researcher, Human Genetics Laboratory, Department of Physiological Sciences, Faculty of Healthcare Sciences, Universidad del Cauca, Popayán, Colombia. cpacosta@unicauca.edu.co

[2]Master's degree in Occupational Health and Safety. Professor, Researcher, Universidad EAN, Bogotá, Colombia. johnbena1@gmail.com

[3]Ph.D. in Molecular Epidemiology. Professor, Human Genetics Laboratory, Department of Physiological Sciences, Faculty of Healthcare Sciences, Universidad del Cauca, Popayán, Colombia. hsierraphd@gmail.com

ABSTRACT This study looks at aspects of the environmental health of the rural population in Timbío (Cauca, Columbia) in relation to the deterioration of water quality. The information was obtained through participatory research methods exploring the management and use of water, the sources of pollution and the perception of water quality and its relation to Helicobacter pylori infection. The results are part of the qualitative analysis of a first research phase characterizing water and sanitation problems and their relation to emerging infectious diseases as well as possible solutions, which was carried out between November 2013 and August 2014. The results of this research are discussed from an ecosystemic approach to human health, recognizing the complexity of environmental conflicts related to water resources and their impacts on the health of populations. Through the methodology used, it is possible to detect and visualize the most urgent problems as well as frequent causes of contamination of water resources so as to propose solutions within a joint agenda of multiple social actors.

KEY WORDS *Helicobacter pylori;* Perception; Water Supply; Colombia.

RESUMEN Este estudio aborda aspectos de la salud ambiental de la población rural de Timbío (Cauca, Colombia) con relación al deterioro de la calidad del agua. La información se obtuvo mediante métodos de investigación participativa, relacionadas al manejo y uso del agua, fuentes de contaminación y percepción de la calidad del agua y su relación con la infección por Helicobacter pylori. Los resultados forman parte del análisis cualitativo de una primera fase de caracterización de la problemática hídrica y sanitaria y su relación con enfermedades infecciosas emergentes y soluciones comunes, llevada a cabo entre noviembre de 2013 y agosto de 2014. Los resultados de esta investigación se discuten desde un enfoque ecosistémico de la salud humana, que reconoce la complejidad de los conflictos ambientales relacionados con el recurso hídrico y su impacto en la salud de las poblaciones. A través de la metodología empleada, este estudio permitió conocer y visualizar los problemas prioritarios y las causas frecuentes de la contaminación del recurso hídrico, para postular algunas soluciones a través de una agenda compartida con los actores sociales.

PALABRAS CLAVES *Helicobacter pylori*; Percepción; Abastecimiento de Agua; Colombia.

.

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

INTRODUCTION

As part of the ecosystem, humankind has maintained strong dynamic relationships with the environment.[1] These relationships have enabled the establishment of communities, their social and cultural behaviors, and economic development. However, there is a growing environmental crisis as a consequence of the production model and its adverse effect on ecosystems and human health.

The health-disease process is determined by interactions with the environment, within the framework of social, cultural, economic, and political structures, which are organized in a specific region.[2] In this context, the development model and its consequences on the environment also impact human health. According to the World Health Organization (WHO), environmental conditions account for 23% of the global burden of disease; and the rate is 25% in developing countries.[3] In terms of deaths worldwide, 3.1% (1.7 million) can be attributed to environmental sanitation, water, and hygiene.[4]

In Colombia, it is estimated that environmental conditions account for 17% of the burden of disease, with 46,000 deaths per year. This burden of disease is partially caused by inequity in access to public services, lack of income, and the fast growth of the industrial sector. These are factors that increase the levels of vulnerability and exposure of the population, with their adverse impact producing significant levels of disease burden.[5]

The environmental factors that contribute most to premature deaths in Colombia are air pollution and water conditions, sanitation, and hygiene. While Colombia is the country with the sixth largest water supply in the world, the Ministry of Environment and Sustainable Development estimates that half of Colombia's water resources have quality problems. It is estimated that industrial and agricultural sectors and domestic water produce 9,000 tons of organic waste that pollute aquifers.

The poor quality of water for human consumption and the inadequate management of chemicals have become the most expensive problems for the Colombian economy[6]: nearly 70% (0.77% of GDP) can be attributed to the impacts on health (mortality and morbidity), and the remaining 30% can be attributed to prevention costs (consumption of bottled water, domestic water filtration and boiling for its potabilization).[5]

At a regional level, the department of Cauca is one of the richest in water resources in Colombia, where the practices for water use and management are related to the cultural identity of several ethnic groups living in this region. Nevertheless, according to the 2005 census carried out by the National Administrative Department of Statistics (DANE) [*Departamento Administrativo Nacional de Estadística*], there are unsatisfied basic needs in 46.4% of the households in this region. The sewage system does not even cover half of the households in the rural area and the water supply service in municipal centers covers scarcely 66%. In some municipal centers, there are problems related to both the continuity of the service and the quality of supplied water, as well as inadequate sanitary conditions. This is the case of the municipality of Timbío, where gastrointestinal diseases, diarrhea, and gastritis, among other conditions, are the primary causes of medical consultation.[7] In addition, Timbío is one of the municipalities with high frequency of infections by pathogens such as Helicobacter pylori (85%), which is related to the development of stomach cancer, the leading cause of death by cancer in the department of Cauca.[8] Therefore, it can be stated that water problems are a clear expression of the environmental health status of a given region.

These problems that closely link the environment, health, and work have been addressed by researchers using an ecosystem approach to health (ecohealth).[9-12] This approach provides theoretical-conceptual and methodological tools that comprise actions to change the determinants of environmental or health degradation along with the communities involved[9,13]; thus, one of the essential pillars is community participation.[12] The aim of this approach, which was conceived as a tool of social transformation, is that community actions contribute to improving the conditions affecting health and environment, by including the social actors, researchers, and government officials in the analysis of problems involving political and social aspects.[12,14]

Furthermore, according to Lebel,[12] community participation in the ecosystem approach is established by a methodological approach related

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

to research processes as a tool of social transformation. In this context, participation is a constitutive element in the identification and approach to the problem, as well as part of the assessment and action within the research framework. This participation allows to propose participatory works involving the creative interaction of several actors, promoting the exchange among the knowledge systems that come into play in the process of eco-health intervention and research.

Community participation also becomes a space in which the transformations of political, cultural, and social aspects are given priority for the overall purpose of social democratization. This model, which was developed under *participatory action research* (PAR), seeks the construction of knowledge that help communities understand their complex reality in order to transform it.[15] From this viewpoint, three groups of participants are identified: academic and scientific experts; actors interested or affected; and, lastly, decision-makers at different levels (formal and informal).[16] The social and political relationships established by participatory and collaborative methodologies can be determined for each of the involved groups, taking into account their interests and powers as they relate to this issue.[17] Furthermore, it is possible to define the desired changes (scope), a strategy to achieve them, and a follow-up method that enables to check the progress achieved.

This study aims to promote changes using evidence collected by a participatory method, understanding that community cooperation links research to actions, which turns participation into a central principle.

Taking into account the failure of strategies based on the biomedical model to change the determinants of the health-disease process in the communities, it is necessary to produce joint actions among researchers, political actors, and grassroots organizations to highlight the status of environmental and sanitation conditions, and the perception of water quality in order to produce sustainable actions, carried out by communities, for the transformation of the reality of health-disease processes and their relationship with ecosystems in the region.

For these reasons, within the framework of the project known as "Use and management of water and its relationship with emerging infectious diseases in eight municipalities of Cauca," the first phase of qualitative research was conducted in order to problematize, by means of the articulation between popular and scientific knowledge, the significance for community users of water supplies in regards to sources of pollution and conditions of water-related sanitation, perception of water quality, and the relationship among health, environment, and the State. In addition, the aim was to set a political agenda for change which could comprehensively ensure the rights to a healthy environment and to health in the participating communities.

METHODOLOGY

Participatory action research was the methodology used in this study in order to gain insight into the current situation in this field of study in connection with the degradation of water resources and its impact on community health, and to implement actions to transform this situation.[5,18,19] An interdisciplinary team was created, including eleven professionals and community and institutional leaders at a local level.

This study was carried out in the communities served by seven rural water supplies in the municipality of Timbío. These water supply services have been historically and voluntarily built and maintained by these communities (Table 1).

Three stages were designed to construct the knowledge necessary for the communities to understand the complex relationship between health-work and environment, and to produce transformation actions. In the first stage, known as "call for participation," a strategy of community and institutional outreach under the main topic of "Water and Health" was implemented, in which institutional actors, social and grassroots organizations, and community leaders interacted. The purpose of this strategy was to promote the active participation of the different social sectors, with the aim to develop the engagement of each social group, enabling them to express their disputes based on economic, developmental, and power-related principles, and the demand to improve living and environmental conditions. Furthermore, key social actors, who were related to the

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

Table 1. Water supplies from the municipality of Timbío, Department of Cauca, Colombia, between November 2013 and August 2014.

Water supply	Families supplied	Users
El Saladito	1,300	6,500
Las Cruces	800	4,000
Aires del Campo	350	1,600
Las Yescas	180	900
Brisas del Paramillo	70	350
El Placer	30	120
Distrito de Riego	1,500	307

Source: Own elaboration.

management of the environment, water resources and health, were included along with community leaders and community members in general.

In the second stage, known as "problematization for social transformation," two workshops were held in each area served by water supplies in order to understand the internal logic behind the communities. In the first workshop, the research team designed a questionnaire (Table 2) which aimed to problematize three central topics: a) the perceptions regarding water quality; b) the social, environmental and cultural problems connected with water quality degradation; and c) the relationship between health-work and environment in local contexts. The purpose of this workshop was to address the different perceptions concerning the relationship between health-work and environment, to encourage a critical appropriation of reality.

Focus groups were created for each workshop, as a tool to make the collective construction of knowledge possible.[20,21] Thirteen focus groups, consisting of six to eight participants each, were created with leaders from Community Action Boards (JAC) [*Juntas de Acción Comunal*], Rural Water Supply Boards (JAR) [*Juntas de Acueductos Rurales*], mothers in charge of the United Network program [*Red Unidos*], and the Municipal Secretariat of Health. Moreover, five groups composed of boys and girls from rural schools of this region were formed.

The work with focus groups was aimed at obtaining an extensive description of the knowledge and actions of the leaders organized in communities. Data was collected in all the regions to the point of data saturation, understood as the point when new data did not add new information. The point of data saturation was agreed upon by the research team.[22] Furthermore, while working with the focus groups, key actors from the regions were identified, and 36 in-depth interviews were conducted with them. These interviews were focused on the issue of water quality degradation and health-disease processes. To record this data, digital video and audio recordings as well as notebooks were used, which were later transcribed into text files and uploaded to Atlas.ti software (version 4.1) for their coding. The discourse from the transcripts was analyzed,[23] and the data was originally coded into the following categories for each region: *water quality, perceptions of health, and sources of pollution*. During the discourse analysis, new categories were created, such as *actions of community participation* as well as subcategories related to the working processes associated with agroindustrial production affecting water, which built the analysis framework depicted in Figure 1.

Table 2. Guided questionnaire designed for the group workshop. Municipality of Timbío, Department of Cauca, Colombia, between November 2013 and August 2014.

1	What perception do you have regarding the quality of water that you drink or that is supplied to your household?
2	What are the main water-related problems? Which are the productive activities performed in your community? how do you think these problems and activities affect water quality?
3	What are the main problems related to the management of wastewater and sewage systems?
4	What are the possible sources of environmental pollution associated with the sources of water supply?
5	Do you think there is a relationship between diseases and the water you drink?
6	What do the community and regional organizations do to preserve water quality?
7	Who are the main people and which are the main institutions involved in water problems? Which activities would help to solve these problems?
8	Which activities should each person change to solve these problems?

Source: Own elaboration.

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

Similarly, a workshop was organized by using social mapping as a dialogue technique, which encouraged reflection, organization and action around the region.[24] The community leaders who had knowledge about the water-related problems in their regions identified the main sources of pollution shown in the map (Figure 2). This recognition of the communities' interactions between work and environment helped determine the status of water supplies to draw the maps that were uploaded to a Geographical Information System (GIS), as shown in Figure 2. This step facilitated the development of a broader approach to reality and to a comprehensive acquisition of knowledge in the region by using technical tools along with popular knowledge.

Finally, in the stage known as "action," a summary of the problematization from the viewpoint of quantitative variables (not shown in this study) and qualitative variables was presented to the participants, and by using this data, a joint working agenda was set within and outside the framework of this project. The importance of these actions, which are currently being carried out within the framework of this project, is related to popular education based on the approach to the rights to health and environmental protection. The social organizations made use of local political spaces for these actions and created spaces for organizational strengthening as regards health and environmental protection, with the technical support of the project professionals.

Data processing and analysis

Data processing was carried out through a critical analysis and a search for essential categories in the facts mentioned, inquiring into a deep understanding of the settings involved. For data analysis, the transcripts and discourses of the population were read in depth and were compared with theoretical references of human health and critical approaches to the relationship between health-environment-work, with the purpose of collecting data proving, through the articulation of popular and scientific knowledge, the processes contributing to the degradation of lifestyles, health, work and environment.

This study was ethically supported by the Ethics Committee at Universidad del Cauca, as per Provision No. 008430 of 1996, by which scientific, technical and administrative rules are issued for health research in Colombia.

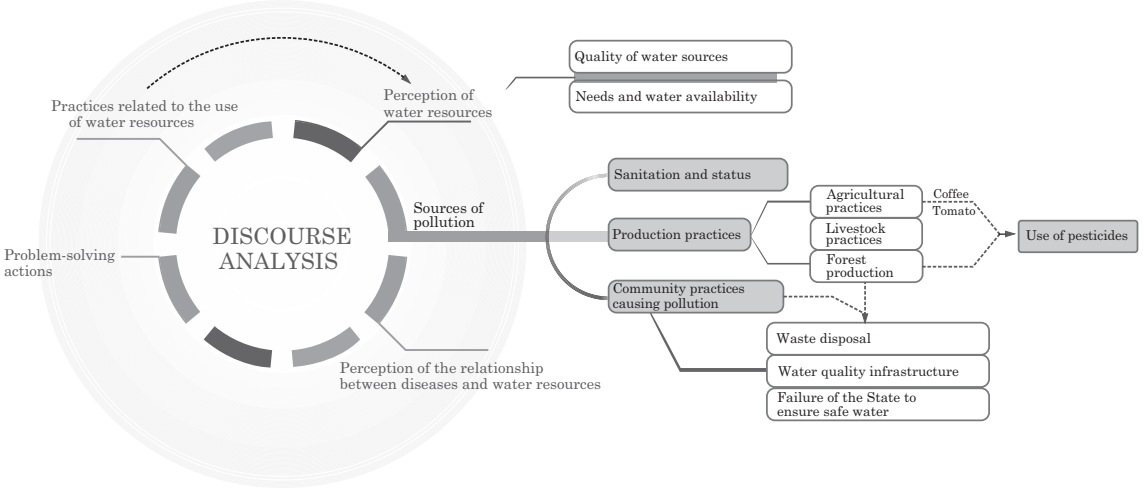

Figure 1. Concept map of discourse analysis using the transcripts of the interviews carried out with community members from the municipality of Timbío, Department of Cauca, Colombia, between November 2013 and August 2014.

Source: Own elaboration.

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

RESULTS AND DISCUSSION

The ecosystem approach to problems related to the environment and human health seeks to define strategies to improve its control. This intention demands a reconciliation between humankind and nature that contributes to improving community health, a connection between people's activities – typical of their culture – and the impact on the environment, between the ecosystem status and people's health.

Although this study does not seek to rebuild the humankind-nature relationship, because that would involve a more in-depth research study, it certainly aims to demand transdisciplinarity as a method, that is to say, to recover the popular

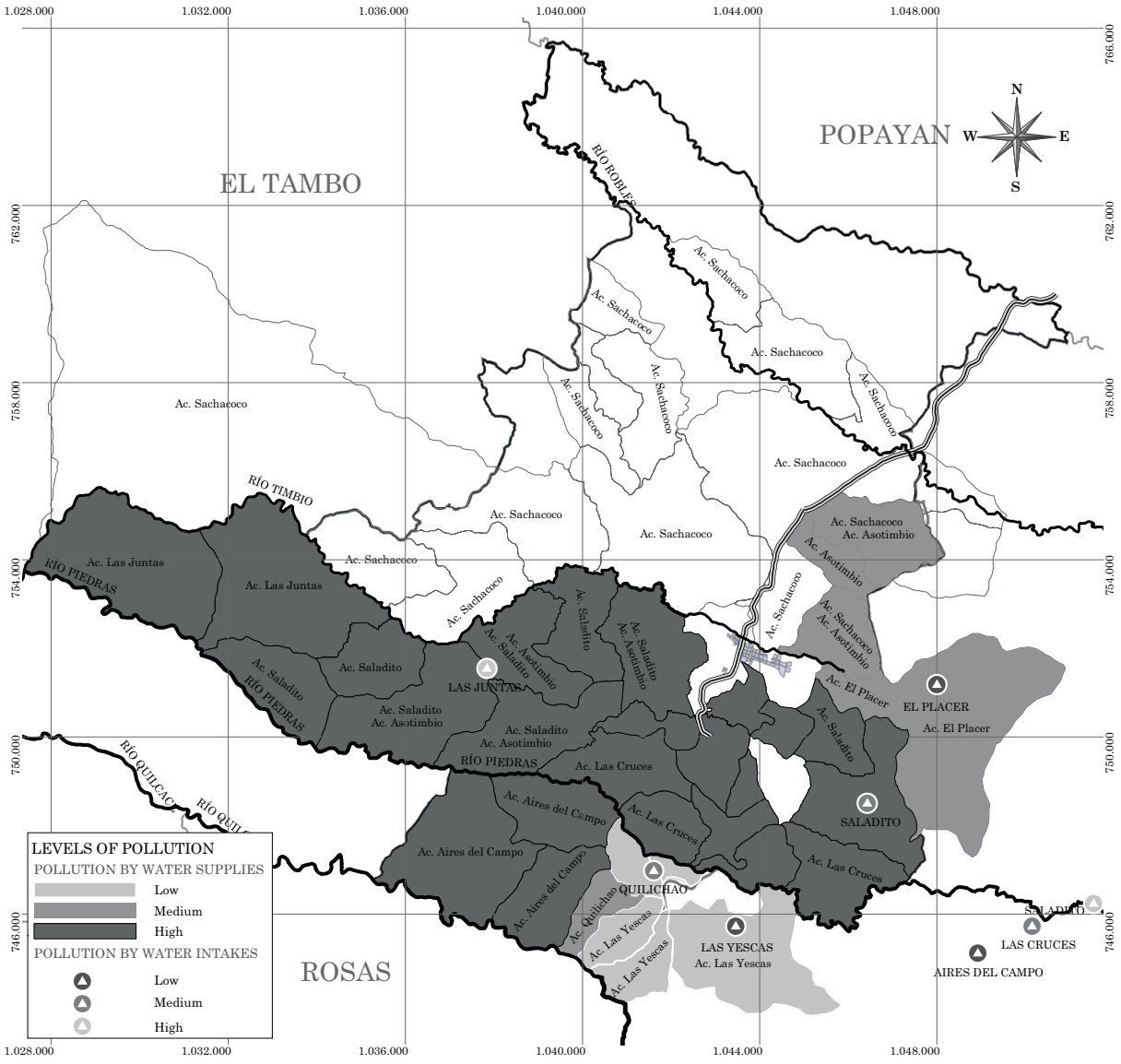

Figure 2. Risk map drawn by social mapping, based on the sources of pollution in connection with the rural water supplies in the municipality of Timbío, Department of Cauca, Colombia, between November 2013 and August 2014.

Source: Own elaboration using data provided by communities.

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

knowledge to construct new knowledge through the dialogue of knowledge (scientific and popular knowledge) instead of masking popular answers within our own categories. We started with an understanding of the social actors' viewpoint, from an interpretative perspective, attempting to code their viewpoints and actions; that is to say, to bring about changes by means of evidence constructed by a participatory method, understanding that individuals' cooperation links research to action.

To analyze the communities' perceptions, a system to code qualitative data was developed. The perception of water quality in the communities is usually associated, in their discourses, with its smell and appearance. Thus, it is closely related to the sources of pollution and the lack of treatment plants to purify water in all the rural water supplies. Accordingly, the communities strive to implement actions to purify the water they drink, as demonstrated by similar results obtained in other research studies addressing the local perceptions in connection with water, its environment, and uses.[25,26] Generally, the community members notice poor quality in their drinking water: *"when you turn the tap on, the water comes out dirty*." There is also another part of the community members that considers that water quality is low because people get sick. The community leaders also indicate that water quality is poor because *"during the rainy season, water comes out murky and full of hair"* and, for this reason, people decide to drink water from alternative sources such as mountain streams, rivers, and springs. Similar explanatory studies have shown that the perceptions of water quality in the communities may condition the election of different sources for its use and, therefore, some communities prefer drinking water from water cisterns, household wells, among others.[26]

Processes of rural production and their relation to water degradation

As the humankind-nature interaction has been intensified, this relationship has deteriorated and unhealthy environments have developed. A clear example of this situation is the historical evidence of water use and management in connection with activities closely related to agricultural production, the social economic mainstay of this region.[27] During this analysis, one of the factors emerging from environmental change – especially in water degradation and availability – is related to the productive processes associated with the category of work in this region. Agroindustrial production, especially wood production, is among these processes, and is clearly identified by women and men in the community as follows:

> *They are causing too much damage to the water because they are planting trees very close to the water sources, these trees consume lots of water and thus, water is running out.* (Adult woman, leader of El Saladito water supply)

One of the main problems about water management and use in Timbío is brought about by impacts on water availability since this resource is affected by wood production. However, this is not only the community members' perception. Several research studies on water conducted in other regions of the world have observed impacts on water availability in regions where there are agroindustrial crops of eucalyptus and pine, just as those found in Timbío.[28] It is believed that the productive processes themselves affect the water resources and their availability in the water supplies. In this process, the use of heavy machinery for wood processing is emphasized:

> *Dirty water is coming down because there is machinery cutting wood up there, so when the water flows through the water course, it moves the mud along and this is why it comes down muddy.* (Adult man, leader of El Saladito water supply)

In other research studies, the integration of popular knowledge and subjectivity, by acknowledging wisdom, beliefs, and lifestyles in connection with the use of agricultural pesticides, have problematized the complexity of the social historical processes that define the health-work relationship. The construction that emerges from the dialogue of different knowledges creates new strategies for ensuring occupational health and safety of the populations.[29]

The use of agricultural pesticides necessary for controlling pests in monoculture crops is part of the perceptions regarding water degradation:

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

> *We suppose that the water we are drinking is polluted. What is also extremely serious and sensitive is that we are surrounded by Carton Colombia factories, which are constantly using agricultural chemicals and dumping this polluting waste into our water source.* (Adult man, leader of the community of Barro Blanco)

The popular imaginary and, in general, the world imaginary have brought to light the destructive relationship resulting from the use of pesticides in the local communities thanks to scientific research studies showing that health degradation is related to pesticides, especially the use of pesticides such as glyphosate.[30] Although research studies were conducted and reports were made in connection with the side effects of pesticides, both on people and the environment, the consequences of such effects on rural communities and how these communities are affected by the use and management of water as a natural resource have not been deeply studied:

> *Eucalyptus is such a huge tree that it is planted on the banks of the water course, so when the crops are sprayed, pesticides fall into the water that flows into the water supply. All weed is sprayed with glyphosate and it is dangerous.* (Adult woman, leader of El Saladito water supply)

Use of pesticides

> *There are strawberry fields in which plastic pesticide containers are used and found in the "water course."* (Adult man, plumber at the water supply, community of Camposano)

> *"Tick-killers" are nearly used every month on cattle, so if we take into account every tick-killer container, we eventually expect a large number of them.* (Adult man, leader of the community of Cristalares)

Since the 1960s, this model of agroindustrial production has been developed, which, according to the environmental management plan, has reached 169 kilometers of monoculture crops of forest species in this municipality. Nevertheless, not only wood agroindustrial production processes, but also livestock breeding, and small crops are considered factors of water quality degradation. Excreta from workers in the wood companies, specifically human feces, pollute the upper part of the water basins from where water for the supply service is subsequently obtained:

> *Despite having latrines, not all workers use them, resulting in fecal pollution in certain periods of time. This is why whenever it is harvest time, the sources of pollution increase.* (Adult man, leader of irrigation district Asotimbio)

Pollution of water resources by livestock feces

In Colombian rural regions, the population estimated by the United Nation Development Program (UNDP) is 32%. This program also highlights the fact that 75% of Colombian municipalities are rural rather than urban municipalities and, in the case of Timbío, the majority of the population is rural.[31] Most of these populations are engaged in agricultural activities as owners or as workforce in large agroindustrial processes. The production methods in this municipality are influenced by several public policies based on essential market principles, which determine social relationships and the competition among individuals as a dynamic force of progress. As a technical and rural work expression, this is materialized in monoculture production on a small and large scale where technologies such as mechanization and pesticides are necessary for obtaining agricultural products.[32]

These techniques of destructuring these methods of typical rural production in this region have contributed to wealth concentration and environmental degradation.[33] The structures of rural production have caused an imbalance in the agricultural ecosystems, which affects the water quality through numerous sources of pollution (e.g. pesticides, agricultural machinery, human waste, and waste from the production processes).[34,35] The communities in Timbío coexist with multinational companies and several small

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

agricultural producers that adversely affect the ecological status and determine the processes of environmental resource concentration, particularly the water resources. This results in degradation of the health-disease processes of the communities.[36] In the analysis proposed for this research study, the relationship between work and environment was essential because the category of work is the conscious act performed by the community members to change the environment, and to obtain, in this case, agricultural products as a means of sustenance that, in turn, transform the living and health conditions of human beings. This relationship closely links the environment to the productive system of the region because it provides the means of production, the raw materials to be transformed, and the environmental conditions for the social reproduction of the workforce. All of these factors are essential for human development and health.[37]

> *The animals that are grazing go to the river to drink water, especially in the lowest part of the river, where water is channeled for the water supply, so it is said that these animals are polluting the water.* (Adult man, leader of the community of San Pedrito)

> *A neighbor told me that he talked to sanitation agents, but they only come to see what happens and don't take matters into their hands, so when people pass by the pig farms, there is a horrible smell.* (Adult man, leader of El Saladito water supply)

The State and the protection of environment and health

When social and environmental problems arise as a result of the interrelation among community members in urban and rural areas, the State is directly held responsible for the well-being of the different community sectors. The struggle with the centralized governments for the right to water takes place when external agents supported by the State get involved to extract natural resources and carry out other activities within the areas where there are natural resources, despite the prevailing regulations (derived from the Constitution). Pursuant to Colombian Law No. 99 of 1993, the Ministry of Environment and Sustainable Development was created and the National Environmental System (SINA) [*Sistema Nacional Ambiental*] was organized. In regard to the water resources, Section 1 of this law sets forth that "areas of paramos, subparamos, water sources, and groundwater recharge shall have special protection," and that "regarding the use of water resources, human consumption shall be a priority over any other use".[38] In Colombia, The National Council of Economic and Social Policy (CONPES) [*Consejo Nacional de Política Económica y Social*], by CONPES document 3343 "Guidelines and strategies for sustainable development for the fields of water, environment, and regional development,"[39] in connection with water, specifies the topics that should be included in the Water Law: the right to water use, water quality standards, and pollution control.[40] However, the State fails to manage the water resources in rural areas, and this failure is perceived by the communities.

The processes of environmental degradation determined by the productive processes, and thus, the processes of health degradation in the communities from Timbío, are partly caused by the failure of the State to protect the water resources, water potabilization, as well as their actions to control the basic sanitary conditions and the prevention of environmental degradation:

> *It is the government's fault. It is said that we have rights but they are violated because we are denied these rights. There are entities which have to control the status of the environment and ensure no more pollution. When we, as an association, ask for help, we have to comply with government proceedings. However, when a multinational company comes to Colombia, this is quite the opposite.* (Adult man, leader of the community of Buenos Aires)

This perception of the protection of the right to a healthy environment on the part of the State is expressed by different institutions:

> *It is said that the Ministry of Environment on behalf of the State has to be in charge of all these issues.* (Adult man, leader of El Placer

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

water supply)

> *It is always said that the Communications Regulation Commission (CRC) has to deal with the environment and every related issue. This is why I think it is the most appropriate entity*. (Adult man, leader of El Placer water supply)

> *People have to know the difference between politics and politicking. There are policies, known as development policies, which are aimed at doing things right to produce and not to affect, let's say, the environment. I understand that politics refers to the decision we make, but many people think politics is the politicking of traditional politicians but, in the end, what these politicians do is to take advantage of a vote to do what they want with the public treasury. So, we have to solve these problems and demand the State to address the root cause of these problems*. (Adult man, leader of El Saladito water supply)

Moreover, water resource degradation is affected by factors such as inadequate waste disposal, dumping, and human settlements. The only method used in the municipality of Timbío for the final disposal of solid waste is open dumps, known as "sanitary landfills" by the local communities. This is a site for the disposal and degradation of waste in both urban and rural areas. It is a process in which several types of polluting emissions are produced. Due to the production of such polluting substances, this type of site must be located away from the residential areas and away from the water sources used for human consumption. Nonetheless, in the municipality of Timbío, these landfills are located 700 metres away from one of the intakes of "El Saladito" water supply. Water pollution may be produced by leachate resulting from the decomposition of organic matter or by vector animals such as dogs and prey birds. According to the *Regional Health Plan* of this municipality, the diseases caused by the inadequate disposal of solid waste have had an impact on the public health of this region.[7]

Pollution of water resources caused by sanitary landfills is a situation that is clearly problematized by the leaders of the community water supplies:

> *Well, the sanitary landfill is located nearly 800 metres away, but I think this landfill was supported from the start. There is always uneven ground and we are affected because the water intake is uphill and the landfill is downhill. This landfill has been working for years, but statistics don't show that death was caused by diseases resulting from drinking this water*. (Adult man, leader of El Saladito water supply)

> *The landfill has been in a bad condition since this mayoress is in office. It is an open-air disaster. Bones from butcheries are brought to this place and the prey birds go there to eat and then fly to the water course to take a bath and this is how the water is polluted.* (Adult man, leader of El Saladito water supply)

Lack of purification plants

The processes of environmental degradation and the failure by the State to protect the environment are shown by the poor drinking water coverage and the basic sanitation conditions. Although 56% of the rural population has access to some type of water supply, only 12% has access to treated water. In connection with the sanitary services, only 34% of the rural population has some type of sewage disposal system. Further, 29% has on-site individual systems, such as latrines and septic tanks, and 5% uses traditional sewage systems. The remaining 66% has no access to any sewage system.[41-43]

In Cauca, the situation is similar. The sewage system does not even cover half of the households in the rural area and the water supply service in municipal centers accounts for scarcely 66%.

> *For example, the expenses arising from the building of the water supply should have been borne by the State rather than by the community, as the case was. This is why the State has the duty to teach people and to ensure cultural campaigns for us to avoid mistakes related to water treatment, especially*

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

in the rural areas. (Adult man, leader of the community of Cristalares)

The national government as well as the municipal government have to ensure the building of water treatment plants and the community is also responsible because people have to protect the water sources and avoid polluting the water. (Adult man, leader of the community of Cristalares)

Guaranteeing the right to health

The right to health is not only guaranteed by properly and suitably addressing the issues related to water pollution. The right to health comprehensively addressed includes essential elements, such as the access to healthy food and proper nutrition, appropriate housing, safe drinking water, adequate sanitary conditions, and a healthy environment.[44] Therefore, the reemergence of the State in the recovery and promotion of water conservation must be considered a priority, in which community actions are interrelated as a mechanism of human rights enforcement.

In Latin America, governments characterized by clientelism where the exercise of social rights is partially subject to political favors, there is a weakening and a lack of surveillance, monitoring, and control processes by both the State and the citizens.[45] Under these circumstances, the most vulnerable population groups are the most affected sectors. The environmental protection and the reduction of environmental adverse effects on health have become indispensable requirements of the efforts to create an effective and sustainable process of economic and social development.[46] Nevertheless, there is no much progress on the design, organization, and implementation of actions aimed at preventing or reversing the environmental adverse effects on human health, especially in rural areas:

It is the State who has to solve the problem here and ensure whether or not the water is safe. For example, the Secretariat of Health and different related institutions have to work together to help us purify the water. (Adult man, leader of the community of San Pedrito)

The knowledge about health is an essential factor in many literacy and basic education programs. However, many of these programs are focused on women and include nutrition, hygiene, and family planning. Education about health is generally combined with other measures to improve the well-being of the community and encourage its development.[47] The access to education and information about health and community participation throughout the decision-making process is one of the factors emerging from the communities:

We need a health brigade to check the level of pollution in the community. I have been thinking about actions on water treatment since the beginning of this meeting. I wish you could train us in this respect and we thank you for that. I wish all the children, our children and our grandchildren, could get this training too, because we are old. We want to have the water treated. Besides, when we are taken to hospital, we aren't well cared for. I wish the doctor present in this meeting could help us with this problem. (Adult man, leader of the community of Cristalares)

Until we make a decision, changing the situation doesn't only depend on the mayoress, but also on our management. If, for example, we can manage to develop policies, show their results and formulate policies to improve the environment and the water quality, we will have achieved our goal. We need to show evidence. We are going to do an analysis on the quality of water, and also on some people to check if they have any diseases and, with all this information and your help, we will be ready to work on management. (Adult man, leader of the community of Cristalares)

Water, health, and disease

In 2011, regarding health and disease, the municipality of Timbío reported major public health concerns, such as foodborne diseases (FBD), both in children and the elderly. According to statistical data collected and reported by the Health Center

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

in Timbío, among the first ten causes of morbidity include intestinal parasitosis, not otherwise specified, diarrhea and gastroenteritis of presumed infectious origin and acute infection of the upper respiratory airways, and pneumonia, not otherwise specified, which is the leading cause of morbidity in 96 cases. These causes may be related to the possible role of water as a natural reservoir of emerging pathogens like *Helicobacter pylori*, the etiologic agent of stomach cancer, known as the first cause of death by cancer in this population.[48]

In the community workshops, the leaders clearly recognized the existing relationship between the presence of medical disorders such as diarrhea, allergy, skin rashes and the poor quality of the water they drink:

> *Many adult people live there, and children are always sick or undernourished because of the quality of water.* (Adult woman, leader of the community of San Pedrito)

> *The water is always dirty and muddy when it reaches our homes. Sometimes it smells and tastes horribly... People are terrified by this situation. Sometimes water brings along maggots and earthworms... It isn't advisable to drink this water without boiling or treating it with some chemical.* (Adult woman, leader of the community of San Pedrito)

> *We also saw dead animals in the water sources and once a human corpse was taken from river Pambío. Crop sprayers are always washed in the water sources.* (Adult woman, leader of the community of San Pedrito)

It is clear that the fecal-oral route is a quite probable way for *Helicobacter pylori* transmission, as water plays an important role as vector. However, the communities fail to recognize the relationship between water polluted with feces and the possible transmission of this pathogen. In this respect, there are concerns among the community leaders, who ask themselves about the role of water in the transmission process and develop beliefs or "intuitive theories."[49] Their knowledge is close to the medical viewpoint and is related to gastric disorders, even to stomach cancer. Nonetheless, the leaders recognize the failure by the health sector to work on related educational programs. According to community beliefs, there are two theories in connection with the causes of diseases in the community: the first theory indicates that diseases are caused by water, and the second theory suggests that diseases are directly caused by polluted food. Both theories hold that water is the cause of gastric diseases. This assumption raises questions about the role of *Helicobacter pylori* and its transmission; questions that the leaders would like to answer but cannot explain. In this construction of community theories about the relationship between the health-disease status and water, popular and scientific knowledge are also integrated:

> *Gastric cancer is one of the most common diseases in this municipality. In my family, many members of the Muñoz family have died of gastric cancer, in the community of Hato. On one occasion, some children there had gastric problems. In my opinion, the problem was due to polluted water.* (Adult man, community leader of the community of La Alfonsa)

> *My daughter is 11 years old. Once she got sick and had a strong stomachache. So, I took her to hospital because her stomach was swollen. She was hospitalized, but in Popayán, there was no pediatric gastroenterologist, so she was sent to Cali. There, she underwent an endoscopy. Helicobacter pylori was detected, and she was diagnosed with chronic gastritis. Some medicines were prescribed, and I gave them to her. This treatment kept her under control for a while. She got sick not only by drinking polluted water, but also by food, because the food is also treated with many chemicals. Besides, in our community, we heard about cases of diarrhea and parasitic diseases.* (Mother from the community of La Alfonsa)

The analysis of the complex matrix of health problems, such as water problems, and the methodological correlation performed by a transdisciplinary approach, highlight the ecosystemic character of this environmental health study. Moreover, an intercultural health approach is put forward as well as the need to work on actions for the prevention

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

and promotion of health to enable a proper use of the water sources. In addition, knowledge integration and the training of sanitary agents and health workers are suggested as well as the development of strategies along with community participation as a choice to improve water quality (e.g. to boil water, use chlorine, make homemade water filters). Finally, the participation in political spaces to demand the right to health and drinking water is emphasized.

CONCLUSION

The interrelationship of researchers, community members, and sector representatives in the joint analysis during the development of the project stages contributed to establishing connections among several complementary fields, and strengthened knowledge integration and the adoption of a common language. This process had a synergistic effect on its change into a transdisciplinary team. In addition, it is clear that community participation becomes an uncertain field, and also a field to comprehensively address reality by having access to knowledge exchange and the joint analysis of problems affecting the communities. This approach helped identify the transformation of actions in social, ecological, and political contexts. The root causes of water-related problems, the actions to control these problems, and the time needed to implement these actions were determined.

During the development of this stage, knowledge integration and the adoption of a common language were strengthened. Although it was shown that knowledge itself does not produce any changes in attitude or behaviors, it paves the way to change actions and provide feedback about knowledge. Processes of interaction, discussion, and drafting of agreements were observed. These processes determined the knowledge, attitudes, and beliefs associated with the health status, the existence of pollution sources related to the main sources of drinking water, sanitation conditions as well as the features of different geographic areas.

Political spaces were opened in the search of supporting strategies from an institutional and political framework. This action highlights the fact that participatory research practices may also be understood as a political phenomenon in which the social actors may transform their daily life and politically link themselves to the State, struggling for power in order to promote the protection of rights, improve their living conditions, and prevent environmental degradation and its effects on health in the context of the current production model.

The social mapping perspective helped recognize and include in this research study the interest and the political viewpoints of the community members and the social organizations, who expressed their opinions through the specific instructions that participants drew in the mappings. This mapping exercise was focused on the reflection and definition of human actions related to water pollution. These actions also helped to highlight the conflicts over the presence of private organizations having an interest in agricultural production. The communities perceived polluting emissions in the water sources caused by these private organizations, with a few concrete actions for mitigating and/or preventing this problem.

ACKNOWLEDGEMENTS

The authors would like to thank the local communities from the municipality of Timbío for their participation in the research study, and for their willingness to provide their knowledge. They would also like to thank the Research Vice-Rectory at *Universidad del Cauca*, the InnovaGen foundation, and *Universidad EAN* for their support while conducting this research study. This study was funded by the National Program of Health Sciences and Technologies of *Colciencias* [Colombian Department of Science, Technology and Innovation], Code 110356934947.

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

REFERENCES

1. Parkes M, Horwitz P. Water, ecology and health: ecosystems as settings for promoting health and sustainability. Health Promotion International. 2009;24(1):94-102.

2. Álvarez A, García A, Bonet M. Pautas conceptuales y metodológicas para explicar los determinantes de los niveles de salud en Cuba. Revista Cubana de Salud Pública. 2007;33(2).

3. Organización Mundial de la Salud. Agua para la salud: un derecho humano [Internet]. Ginebra: Organización Mundial de la Salud; 27 Nov 2002 [cited 19 Dec 2011]. Available from: http://goo.gl/9MjeNx.

4. Prüss-Üstün A, Bonjour S, Corvalán C. The impact of the environment on health by country: a meta-synthesis. Environmental Health. 2008;7(7):1-10.

5. Consejo Nacional de Política Económica y Social. Lineamientos para la formulación de la política integral de salud ambiental con énfasis en los componentes de calidad de aire, calidad de agua y seguridad química (Documento Conpes 3550). Bogotá: Ministerio de Salud y Protección Social; 2008.

6. Soto-Moreno JA, Ballester-Díez F. Contaminación del aire de interiores en hogares en situación de pobreza extrema en Colombia. Revista de Salud Pública. 2013;15(1):80-89.

7. Alcaldía Municipio de Timbío. Plan Territorial de Salud 2008 [Internet] 2008 [cited 24 Nov 2011]. Available from: http://goo.gl/qT0bVc.

8. Adrada JC, Calambás FH, Díaz JE, Delgado DO, Sierra CH. Características sociodemográficas y clínicas en una población con cáncer gástrico en el Cauca, Colombia. Revista Colombiana de Gastroenterología. 2008;23(4):309-314.

9. Charron DF. Ecosystem approaches to health for a global sustainability agenda. EcoHealth. 2012;9(3):256-266.

10. Basso C. Abordaje ecosistémico para prevenir y controlar al vector del dengue en Uruguay. Montevideo: Universidad de la República; 2010.

11. Betancourt O, Barriga R, Guimarães JRD, Cueva E, Betancourt S. Impacts on environmental health of small-scale gold mining in Ecuador. In: Charron DF, editor. Ecohealth Research in Practice: Innovative Applications of an Ecosystem Approach to Health. New York: Springer; 2012. p. 119-130.

12. Lebel J. Salud: un enfoque ecosistémico. Bogotá: Centro Internacional de Investigaciones para el Desarrollo, Alfaomega Colombiana; 2005.

13. Dakubo CY. Ecosystems and human health: a critical approach to ecohealth research and practice. New York: Springer Science & Business Media; 2010.

14. Mertens F, Saint-Charles J, Mergler D. Social communication network analysis of the role of participatory research in the adoption of new fish consumption behaviors. Social Sciences & Medicine. 2012;75(4):643-650.

15. Ortiz M, Borjas B. La investigación acción participativa: aporte de Fals Borda a la educación popular. Espacio Abierto. 2008;17(4):615-627.

16. Fals-Borda O. Antología. Bogotá: Editorial Universidad Nacional de Colombia; 2010.

17. Chevalier J, Buckles D. Guía para la investigación colaborativa y la movilización social (SAS2). México DF: Plaza y Valdés, Centro Internacional de Investigaciones para el Desarrollo; 2009.

18. Leal E. La investigación acción participación, un aporte al conocimiento y a la transformación de Latinoamérica, en permanente movimiento. Revista de Investigación. 2009;(67):13-34.

19. González Rey F. Investigación cualitativa y subjetividad: Los procesos de construcción de la información. México DF: MacGraw-Hill; 2007.

20. Vallejo M, Martínez JD. Tarea y competencia comunicativas: reflexiones desde un grupo focal. Íkala. 2011;16(28):161-197.

21. Tomat C. El 'focus group': nuevo potencial de aplicación en el estudio de la acústica urbana. Athenea Digital. 2012;12(2):129-152.

22. Martínez-Salgado C. El muestreo en investigación cualitativa: Principios básicos y algunas controversias. Ciência & Saúde Coletiva. 2012;17(3):613-619.

23. Minayo MCS. La artesanía de la investigación cualitativa. Buenos Aires: Lugar Editorial; 2009.

24. Borda OF. Participatory (action) research in social theory: Origins and challenges. In: Reason P, Bradbury H. Handbook of action research: Par-

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

ticipative inquiry and practice. London: SAGE; 2001. p. 27-37.

25. Dolnicar S, Schäfer AI. Desalinated versus recycled water: public perceptions and profiles of the accepters. Journal of Environmental Management. 2009;90(2):888-900.

26. Martínez GJ, Beccaglia AM, Llinares A. Problemática hídrico-sanitaria, percepción local y calidad de fuentes de agua en una comunidad toba (qom) del Impenetrable (Chaco, Argentina). Salud Colectiva. 2014;10(2):225-242.

27. Montico S. El manejo del agua en el sector rural de la región pampeana argentina. Theomai. 2004;(1):7.

28. Hofstede R, Lips J, Jongsma W. Geografía, ecología y forestación de la Sierra Alta del Ecuador: Revisión de literatura. Quito: Abya-Yala; 1998.

29. Piracón JAB, Lozada MA. Prácticas de fumigación en cultivadores de papa, saberes y creencias sobre los plaguicidas y la salud. Tempus Actas de Saúde Coletiva. 2014;8(2):93-108.

30. Castro FG, Agudelo SMG, Vera MEB. Efecto de la aplicación de glifosato en la flora y microflora asociada a arvenses en el cultivo de café (Coffea arabiga L) en el municipio de Santa Rosa de Cabal, departamento de Risaralda. Cultura y Droga. 2010;8(10):225-254.

31. Bruno M. Hechos de Paz: La hora de la Colombia rural. Bogotá: PNUD; 2012.

32. Breilh J. Aceleración agroindustrial: peligros de la nueva ruralidad del capital. En: Brassel F, Breilh J, Zapatta A. ¿Agroindustria y soberanía alimentaria?: hacia una ley de agroindustria y empleo agrícola. Quito: SIPAE; 2011. p. 171-190.

33. Breilh J. Despojo, ecosistemas y salud. Ponencia presentada en: III Seminario Nacional sobre Ambiente y Salud. 20-22 Sep 2004; Rio de Janeiro, Brasil: Fundação Oswaldo Cruz.

34. Neumann F. Cultivo de la papa. México: Iberoamericana; 2001.

35. Henríquez G. Panorama de los conflictos ambientales en la región del Biobio. Santiago: Observatorio Latinoamericano de Conflictos Ambientales; 2003.

36. Lozada M, Muñoz A. Experiencias de investigación en salud y seguridad en el trabajo. Bogotá: Universidad Nacional de Colombia; 2012.

37. Rothman H. La barbarie ecológica: estudio sobre la polución en la sociedad industrial. Barcelona: Fontamara; 1980.

38. Colombia. Ley 99 de 1993 [Internet] 22 Dec 1993 [cited 15 Sep 2014]. Available from: http://goo.gl/O4zDQb.

39. Consejo Nacional de Política Económica y Social. Lineamientos y estrategias de desarrollo sostenible para los sectores de agua, ambiente y desarrollo territorial (Documento Conpes 3343) [Internet]. 2005 [cited 15 Aug 2014]. Available from: https://goo.gl/MKCCx5.

40. Quiñonez Rizo EA. Gerencia ambiental en Colombia. Ambiente y Desarrollo. 2014;18(34):43-56.

41. Smits S, Tamayo SP, Ibarra V, Rojas J, Benavidez A, Bey V. Gobernanza y sostenibilidad de los sistemas de agua potable y saneamiento rurales en Colombia. Bogotá: BID; 2012.

42. Ministerio de Ambiente, Vivienda y Desarrollo Territorial. Política pública de abastecimiento de agua y saneamiento básico para la zona rural de Colombia. Bogotá: Ministerio de Ambiente, Vivienda y Desarrollo Territorial, Dirección de Agua Potable, Saneamiento Básico y Ambiental; 2004.

43. Departamento Administrativo Nacional de Estadísticas. Gran Encuesta Integrada de Hogares. Bogotá: Dirección de Metodología y Producción Estadística; 2008.

44. Paredes N. El derecho a la salud en Colombia. En: Franco-Agudelo S, editor. La salud pública hoy: Enfoques y dilemas contemporáneos en salud pública. Bogotá: Universidad Nacional de Colombia; 2003. p. 287-342.

45. Ospina JM, Manrique FG, Ariza NE. Salud, ambiente y trabajo en poblaciones vulnerables: los cultivadores de papa en el centro de Boyacá. Revista Facultad Nacional de Salud Pública. 2008;26(2):142-152.

46. Ordóñez GA. Salud ambiental: conceptos y actividades. Revista Panamericana de Salud Pública. 2000;7(3):137-147.

SALUD COLECTIVA. 2015;11(4):575-590. DOI: 10.18294/sc.2015.796

47. Perea R. La educación para la salud, reto de nuestro tiempo. Educación XXI: revista de la Facultad de Educación. 2002;(4):15-40.

48. Nurgalieva ZZ, Malaty HM, Graham DY, Almuchambetova R, Machmudova A, Kapsultanova D, et al. Helicobacter pylori infection in Kazakhstan: effect of water source and household hygiene. American Journal of Tropical Medicine and Hygiene. 2002;67(2):201-206.

49. Bar AR, Oscherov EB, Milano AM. Hábitos y creencias sobre parásitos y enfermedades parasitarias en habitantes de Santa Ana de los Guácaras, Corrientes, Argentina. Boletín de Malariología y Salud Ambiental. 2009;49:127-133.

CITATION
Acosta CP, Benavides JA, Sierra CH. Qualitative analysis of water quality deterioration and infection by *Helicobacter pylori* in a community with high risk of stomach cancer (Cauca, Colombia). Salud Colectiva. 2015;11(4):575-590.

Received: 23 Feb 2015 | Modified: 17 Jul 2015 | Accepted: 20 Aug 2015

https://doi.org/10.18294/sc.2015.796

The translation of this article is part of an inter-departmental and inter-institutional collaboration including the Undergraduate Program in Sworn Translation Studies (English < > Spanish) and the Institute of Collective Health at the Universidad Nacional de Lanús and the Health Disparities Research Laboratory at the University of Denver. This article was translated by Leonardo Guaymás under the guidance of María Victoria Illas, reviewed by Andrea Anderson and Julia Ratchford under the guidance of Julia Roncoroni, and prepared for publication by Laura Antonella Del Vecchio, Micaela Ailén Calvezere Moriondo, and Aldana Micaela Schöenfeld under the guidance of Vanessa Di Cecco. The final version was approved by the article author(s).