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A COMPREHENSIVE APPROACH TOWARD WATER MANAGEMENT IN THE RURAL AREAS OF ANTIOQUIA

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Premise

***"Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life in human dignity. It is a pre-requisite to the realization of all other human rights."* —UNESCO**

Some countries have abundant, untapped stores of water to support population growth, while others are already using most of their available water. Water is also becoming increasingly polluted and although several countries have the technology and can afford to clean their water, the majority of the world cannot. In September 2000, 189 UN Member States adopted the Millennium Development Goals (MDGs), setting clear, time-bound targets for making real progress on the most pressing development issues we face. In 2000, world leaders at the United Nations Millennium Development Goals (MDGs) Summit set a target to cut in half the proportion of people without access to clean water by 2015. In 2002, at the World Summit on Sustainable Development, access to basic sanitation was included. Recognizing the critical need to meet the water and sanitation target and its impact on all the other MDGs, 2005–2015 was designated as the 'Water for Life' decade. Access to safe water is a basic human right and everywhere it has to be recognized as such. It can improve the health, economy and social well-being of a community. Everybody must use water wisely and responsibly to ensure that in the future everyone will have access to drinking water that is affordable and safe. (Source: 12.). The human right to safe drinking water and sanitation is explicitly recognized in a number of international conventions and treaties, articulated in CESCR General Comment No. 15 of 2002 and affirmed by resolutions of the UN General Assembly and the UN Human Rights Council in 2010. The right obliges States to provide for its progressive realization and entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for essential personal and domestic uses. (Source: 22.).

1. INTRODUCTION: The global water access and rights

1.1 THE SEVENTH MILLENIUM DEVELOPMENT GOAL (MDG)

Millennium Development Declaration (2000) called for the world to halve, by 2015, the proportion of people without access to safe drinking water as well as the proportion of people who do not have access to basic sanitation. It called upon the international community to combat desertification and mitigate the effects of drought and floods; to develop integrated water resources management and water efficiency plans by 2005; and to support developing countries and countries with economies in transition in their efforts to monitor and assess the quantity and quality of water resources. (Source: 28.)

GOAL 7
"ENSURE ENVIRONMENTAL SUSTAINABILITY"

Target 7.A ***"Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources"***

Currently, water scarcity affects more than 40 per cent of people around the world, and it is projected to increase. Scarcity can be physical (lack of water of sufficient quality), economic (lack of adequate infrastructure, due to financial, technical or other constraints) or institutional (lack of institutions for a reliable, secure and equitable supply of water). Water scarcity already affects every continent and hinders the sustainability of natural resources as well as economic and social development. (Source: 24.). Poor people's livelihoods are more directly tied to natural resources, and as they often live in the most vulnerable areas, they suffer the most from environmental degradation.

Target 7.C ***"Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation"***

In the lasts twenty-five years, thanks to the worldwide commitment, the global situation has improved, however, there is still much to do to guarantee safe drinking water and basic sanitation to a growing segment of poor people. Between 1990 and 2015, the proportion of the global population using an improved drinking water source has increased from 76 per cent to 91 per cent, surpassing the MDG target, which was met in 2010. Since 1990, the proportion of the population without access to improved drinking water has been cut in half in Eastern Asia, Latin America and the Caribbean, South-Eastern Asia, Southern Asia and Western Asia. However, in 2015, it was estimated that 663 million people worldwide still use unimproved drinking water sources, including unprotected wells and springs and surface water (Source: 24.). The proportion of water resources a country uses is affected by national water policies and water scarcity. Major sectors that withdraw water include agriculture (irrigation, livestock and aquaculture), industries and municipalities. Despite on other continents, South America has the privilege to have abundant water resources. However, a large part of population who lives in the rural areas still suffer of water scarcity and contamination.

1.1.2. Definition

Drinking water is defined as water used for ingestion, food preparation and basic hygiene purposes.
The indicator is expressed as a percentage and it is defined as the proportion of population using an improved drinking water source and the proportion of population using an improved sanitation facility. The **proportion of population** using an improved drinking water source is the share of the population that uses any types of improved drinking water supplies and sanitation facilities.
Access to safe drinking water is estimated by the percentage of the population using improved drinking water sources. Similarly, access to sanitary means of excreta disposal is estimated by the percentage of the population using improved sanitation facilities (Source: 26.). An improved drinking water source is a **facility** that, by nature of its construction, is protected from outside contamination in particular from contamination with faecal matter. Improved drinking water **technologies** are those more likely to provide safe drinking water than those characterized as unimproved. An improved sanitation facility is defined as a facility that hygienically separates human excreta from human, animal and insect contact. Improved sanitation facilities are those more likely to ensure privacy and hygienic use.
The figure 1.2.1. represents the improved/unimproved categories according to UN.

1.1.2.1. Sources of drinking-water

"Improved"

- Piped water into dwelling, also called a household connection, is defined as a water service pipe connected with in-house plumbing to one or more taps (e.g. in the kitchen and bathroom).
- Piped water to yard/plot, also called a yard connection, and is defined as a piped water connection to a tap placed in the yard or plot outside the house.
- Public tap or standpipe is a public water point from which people can collect water. A standpipe is also known as a public fountain or public tap. Public standpipes can have one or more taps and are typically made of brickwork, masonry or concrete.
- Tube well or borehole is a deep hole that has been driven, bored or drilled, with the purpose of reaching groundwater supplies. Boreholes/tube wells are constructed with casing, or pipes, which prevent the small diameter hole from caving in and protects the water source from infiltration by run-off water. Water is delivered from a tube well or borehole through a pump, which may be powered by human, animal, wind, electric, diesel or solar means. Boreholes/tube wells are usually protected by a platform around the well, which leads spilled water away from the borehole and prevents infiltration of run-off water at the well head.
- Protected dug well is a dug well that is protected from runoff water by a well lining or casing that is raised above ground level and a platform that diverts spilled water away from the well. A protected dug well is also covered, so that bird droppings and animals cannot fall into the well.

- Protected spring. The spring is typically protected from runoff, bird droppings and animals by a "spring box", which is constructed of brick, masonry, or concrete and is built around the spring so that water flows directly out of the box into a pipe or cistern, without being exposed to outside pollution.
- Rainwater refers to rain that is collected or harvested from surfaces (by roof or ground catchment) and stored in a container, tank or cistern until used.

“Unimproved"

- Unprotected spring. This is a spring that is subject to runoff, bird droppings, or the entry of animals. Unprotected springs typically do not have a "spring box".
- Unprotected dug well. This is a dug well for which one of the following conditions is true: 1) the well is not protected from runoff water; or 2) the well is not protected from bird droppings and animals. If at least one of these conditions is true, the well is unprotected.
- Cart with small tank/drum. This refers to water sold by a provider who transports water into a community. The types of transportation used include donkey carts, motorized vehicles and other means.
- Tanker-truck. The water is trucked into a community and sold from the water truck.
- Surface water is water located above ground and includes rivers, dams, lakes, ponds, streams, canals, and irrigation channels.
- Bottled water is considered to be improved only when the household uses drinking-water from an improved source for cooking and personal hygiene; where this information is not available, bottled water is classified on a case-by-case basis.

1.1.2.2. Sanitation

“Improved"

- Flush toilet uses a cistern or holding tank for flushing water, and a water seal (which is a U-shaped pipe below the seat or squatting pan) that prevents the passage of flies and odours. A pour flush toilet uses a water seal, but unlike a flush toilet, a pour flush toilet uses water poured by hand for flushing (no cistern is used).
- Piped sewer system is a system of sewer pipes, also called sewerage, that is designed to collect human excreta (faeces and urine) and wastewater and remove them from the household environment. Sewerage systems consist of facilities for collection, pumping, treating and disposing of human excreta and wastewater.
- Septic tank is an excreta collection device consisting of a water-tight settling tank, which is normally located underground, away from the house or toilet. The treated effluent of a septic tank usually seeps into the ground through a leaching pit. It can also be discharged into a sewerage system.
- Flush/pour flush to pit latrine refers to a system that flushes excreta to a hole in the ground or leaching pit (protected, covered).

- Ventilated improved pit latrine (VIP) is a dry pit latrine ventilated by a pipe that extends above the latrine roof. The open end of the vent pipe is covered with gauze mesh or fly-proof netting and the inside of the superstructure is kept dark.
- Pit latrine with slab is a dry pit latrine whereby the pit is fully covered by a slab or platform that is fitted with either a squatting hole or seat. The platform should be solid and can be made of any type of material (concrete, logs with earth or mud, cement, etc.) as long as it adequately covers the pit without exposing the pit content other than through the squatting hole or seat.
- Composting toilet is a dry toilet into which carbon-rich material (vegetable wastes, straw, grass, sawdust, ash) are added to the excreta and special conditions maintained to produce inoffensive compost. A composting latrine may or may not have a urine separation device.
- Special case. A response of "flush/pour flush to unknown place/not sure/DK where" is taken to indicate that the household sanitation facility is improved, as respondents might not know if their toilet is connected to a sewer or septic tank.

“Unimproved"

- Flush/pour flush to elsewhere refer to excreta being deposited in or nearby the household environment (not into a pit, septic tank, or sewer). Excreta may be flushed to the street, yard/plot, open sewer, a ditch, a drainage way or other location.
- Pit latrine without slab uses a hole in the ground for excreta collection and does not have a squatting slab, platform or seat. An open pit is a rudimentary hole.
- Bucket refers to the use of a bucket or other container for the retention of faeces (and sometimes urine and anal cleaning material), which are periodically removed for treatment, disposal, or use as fertilizer.
- Hanging toilet or hanging latrine
- Shared sanitation refers to sanitation facilities although of an improved kind, but shared between two or more households and all public facilities.
- No facilities, bush, or field includes defecation in the bush or field or ditch; excreta deposited on the ground and covered with a layer of earth (cat method); excreta wrapped and thrown into garbage; and defecation into surface water (drainage channel, beach, river, stream or sea).

Fig1.2.1.: improved/unimproved drinking water sources and Improved/unimproved sanitation according to UN.(Source: 29.)

1.1.3. Global rural-urban disparities have decreased but large gaps remain

The disparities between rural-urban populations to access to drinkable water is still evident in many areas of the world. People living in rural areas and those from poor and marginalized groups are less likely to have access to improved water and sanitation facilities and less likely to enjoy piped water on premises. Progressive elimination of inequalities in access and service levels will continue to be an important focus for the post-2015 agenda.

The proportion of the global rural population without access to improved drinking water has declined by more than half since 1990, from 38 per cent to 16 per cent in 2015. Since 1990, the proportion of the global rural population without access to improved sanitation has declined by nearly a quarter, (from 38 per cent to 16 per cent in 2015), and open defecation rates in rural areas have fallen from 38 per cent to 25 per cent in 2015. Still, nearly half of people living in rural areas do not have improved sanitation facilities, and one in four still practice open defecation (*Figure1.3.1.)*. (Source: 24.)

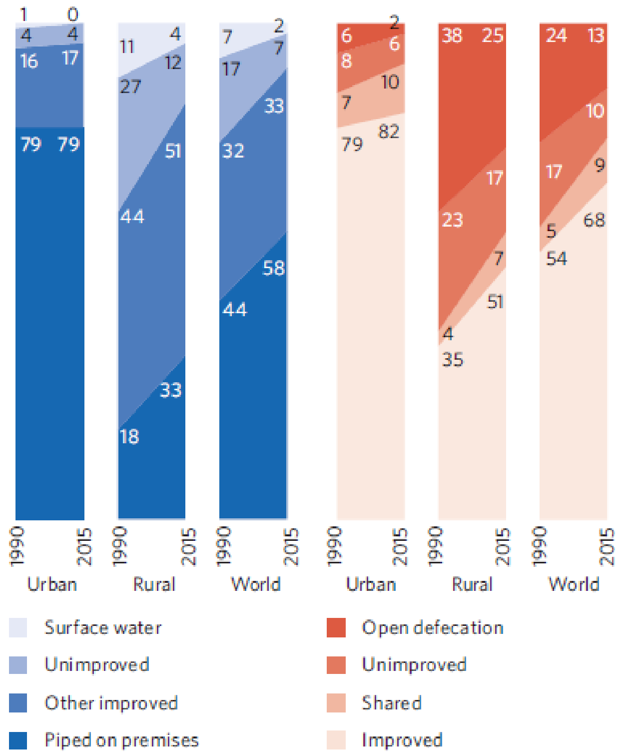


Figure1.3.1.: Proportion of population using improved and unimproved drinking water sources and sanitation facility, urban, rural and world, 1990 and 2015 projection (percentage). (Source: 24.)

Environmental sustainability is a core pillar of the post-2015 agenda and a prerequisite for lasting socioeconomic development and poverty eradication.

Healthy, well-managed and diverse ecosystems and resources can play a strong role in mitigating future environmental challenges and improving livelihoods everywhere. Therefore, it is crucial to ensure that the development agenda for the future reflects the links between socioeconomic and environmental sustainability, protects, and reinforces the environmental pillar. (Source: 24.)

1.2. FROM MDG TO SDG: THE WATER COMMITMENT

In year 2000, all UN Member States committed to the UN Millennium Declaration and the achievement of its eight Millennium Development Goals (MDGs) by 2015, focusing on poverty reduction.

Water was included in the seventh goal on ensuring environmental sustainability:

- Target 7.C "Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation", corresponding to 88 % of world population for water, and 75 % for sanitation.
- Target 7.A "Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources" also included an indicator on water resources used.

How it is written above, the target on drinking water was reached already in 2010, and in 2015, 90 % of the world's population had access to an improved drinking water source. The target on sanitation was one of the most lagging among all of the MDG targets, with 40 % of the population still using unimproved sanitation facilities in 2015. (Source: 30.) However, these percentages have to be understood better, because they refer to a global average and do not consider the difference between and within countries, between rich and poor, and between rural and urban areas. Indeed, discrimination and inequality in access to water and sanitation still remained by the end of the MDG period.

1.3. SUSTAINABLE DEVELOPMENT GOALS (SDGs): Water at the core of 2030 sustainable agenda

The new set of goals, the Sustainable Development Goals (SDGs), aims to end poverty and hunger by 2030. World leaders, recognizing the connection between people and planet, have set goals for the land, the oceans and the waterways (Source: SDGs Booklet by UNDP). The SDGs include 17 goals and 169 targets. The Goals and targets will stimulate action over the next fifteen years in areas of critical importance for humanity and the planet. (Source: 31.)

"We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations."

"We are determined to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature."

Water and sanitation are at the very core of sustainable development, critical for thriving people, planet and prosperity. Water is needed for domestic purposes, for agricultural, industrial and energy production, these uses are highly inter-linked, potentially in competition, and they generate wastewater that may cause pollution. Water is central to climate change, linking the climate system to the environmental and socio-economic systems; climate change severs water scarcity in some parts of the world, and the risk of flooding in others. Water is a key factor in managing risks such as famine, epidemics, migration, inequalities and political instability. Integrated water resources management is essential to harness synergies as well as to manage potential trade-offs across sectors and regions, to ensure availability and sustainable management of water and sanitation for all. (Source: 30.)

The 2030 Agenda for Sustainable Development includes a dedicated goal on water and sanitation (SDG 6) that sets out to "ensure availability and sustainable management of water and sanitation for all." With water at the very core of sustainable development, SDG 6 does not only have strong linkages to all of the other SDGs, it also underpins them; meeting SDG 6 would go a long way towards achieving much of the 2030 Agenda. (Source: 30.)

GOAL 6
"CLEAN WATER AND SANITATION: ENSURE AVAILABILITY AND SUSTAINABLE MANAGEMENT OF WATER AND SANITATION FOR ALL"

"Everyone on earth should have access to safe and affordable drinking water. That is the goal for 2030. While many people around the world take clean drinking water and sanitation for granted, many others do not. Water scarcity affects more than 40 percent of people around the world, and that number is projected to go even higher as a result of climate change. If we continue the path we are on, by 2050 at least one in four people are likely to be affected by recurring water shortages. But we can take a new path—more international cooperation, protecting wetlands and rivers, sharing water-treatment technologies and more—that leads to accomplishing this Goal." (Source: 16)

The Sixth SDGoal contains six targets on outcomes across the entire water cycle, and two targets on the means of implementing the outcome targets.

Target 6.1 ***"By 2030, achieve universal and equitable access to safe and affordable drinking water for all"***

Target 6.1 is more ambitious than the MDG target 7.C but consistent with resolutions on HRTWS (The recognition of the human right to water and sanitation by the United Nations General Assembly) and the SDG ambition of ending extreme poverty by 2030. Note that experts consider universal access to a basic water service achievable by 2030, but universal access to "safe and affordable" unlikely to be achieved in all countries.

Target 6.2 ***"By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations"***

Target 6.2 is more ambitious than the MDG target 7.C but consistent with resolutions on HRTWS and the SDG ambition of ending extreme poverty by 2030. Note that experts consider ending open defecation and ensuring universal access to a basic water service achievable by 2030, but universal access to "adequate" is unlikely to be achieved in all countries.

Target 6.3 ***"By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and increasing recycling and safe reuse globally"***

Target 6.3 is consistent with the outcomes of recent high-level summits such as Rio+20 (2012) and UNEP's Manila declaration. It supports but does not duplicate other targets and the different components of the target (water quality, wastewater treatment, and wastewater recycling and safe reuse) are specific, measurable and action-oriented and strongly support the implementation of the Basel, Rotterdam and Stockholm conventions.

Target 6.4 ***"By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity"***

Target 6.4 builds on existing international agreements and is consistent with the outcome of recent high-level summits such as Rio+20. The target contains three elements oriented towards addressing the environmental (water withdrawals), economic (water-use efficiency), and social aspects (suffering people) of water scarcity.

Target 6.5 ***"By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate"***

Target 6.5 on integrated water resources management (IWRM) builds on agreements such as Agenda 21 (1992) and the Johannesburg Plan of Implementation (2002) by moving forward from plans to implementation. The second component on transboundary cooperation builds on the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (the Water Convention). The target is specific, measurable and action-oriented. It is a foundation for all other water targets, including 6a and 6b, as well as many targets of the other goals.

Target 6.6 ***"By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes"***

Target 6.6 is not less ambitious than, builds on and is consistent with among others the Aichi Biodiversity Targets of the Strategic Plan for Biodiversity 2011-2020, the Convention on Wetlands, Rio+20, and the UN Convention to Combat Desertification. The target is specific, action-oriented and measurable using existing monitoring frameworks for specific ecosystem types. It reinforces other targets in that functioning ecosystems underpin the sustainability of other targets, but does not duplicate.

Target 6.a ***"By 2030, expand international cooperation and capacity-building support to developing countries in water and sanitation related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies."***

Target 6.b "*Support and strengthen the participation of local communities in improving water and sanitation management"*

1.3.2. The twelve Sustainable Development Goal

GOAL 12: ENSURE RESPONSIBLE AND SUSTAINABLE CONSUMPTION ANDPRODUCTION

"Some people use a lot of stuff, and some people use very little—in fact, a big share of the world population is consuming too little to meet even their basic needs. It does not have to be this way. We can have a world where everybody gets what they need to survive and thrive. We can consume in a way that preserves our natural resources so that our children can enjoy them, and their children and their children after that. The hard part is how to achieve that goal. We can manage our natural resources more efficiently and dispose of toxic waste better. Cut per capita food waste in half globally. Get businesses and consumers to reduce and recycle waste. And help countries that have typically not consumed a lot to move towards more responsible consumption patterns".

Target 12.2 "*By 2030, achieve the sustainable management and efficient use of natural resources"*

Target 12.4 ***"By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment"***

Target 12.6 ***"Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle"***

Target 12.8 ***"By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature"***

1.4. DIFFERENCES BETWEEN MDG AND SDG:

SDGs benefit from the valuable lessons learned from MDGs. They reflect continuity and consolidation of MDGs while making these more sustainable by strengthening environmental goals.

There are seven major differences in MDGs and SDGs:

1. MDGs were drawn up by a group of experts in the 'basement of UN headquarters' whereas SDGs have evolved after a long and extensive consultative process including 70 Open Working Groups, Civil Society Organizations, thematic consultations, country consultations, participation of general public through face-to-face meetings and online mechanisms and door to door survey.
2. While MDGs were focused with only 8 goals, 21 targets and 63 indicators, SDGs include 17 goals with 169 targets.
3. MDGs had a focus on developing countries with funding came from rich countries. All countries, developed or developing, are expected to work towards achieving SDGs.
4. The pillars of human development, human rights and equity are deeply rooted in SDGs and several targets seven explicitly refer to people with disabilities, six to people in vulnerable situations, and two to non-discrimination. These were not even mentioned in the MDGs.
5. MDGs had 3 direct health goals, 4 targets and 15 indicators with emphasis on child, maternal mortality and communicable diseases. SDGs have one comprehensive goal emphasizing well-being and healthy living including NCDs.
6. MDGs had a time span of 25 years though adopted in 2002 baseline data for the year 1990 was used and some of the baselines were revised subsequently which shifted 'the goal post'. For the SDGs, the baseline is from 2015 estimates. It may be revised as data that is more recent becomes available.
7. SDGs include a vision of building vibrant and systematic partnerships with private sector to achieve sustainable development. [It builds on, UN Compact which was launched in year 2000 and IMPACT 2030;]
8. MDGs had no concrete role for the Civil Society Organizations (CSOs), whereas SDGs have paid attention to this right from the framing stage itself with significant engagement of civil society actors. (Source: 32.)

1.4.1. DIFFERENCES BETWEEN MDG AND SDG IN WATER COMMITMENT:

SDG 6 expands the MDG focus on drinking water and sanitation to now cover the entire water cycle, including the management of water, wastewater and ecosystem resources.

- Targets 6.1 and 6.2 build on the MDG targets on drinking water and basic sanitation, providing continuity while expanding their scope and refining definitions.
- Targets 6.3 to 6.6 address the broader water context that was not explicitly included in the MDG framework, but whose importance was acknowledged at the Rio+20

Conference, such as water quality and wastewater management, water scarcity and water-use efficiency, integrated water resources management, and the protection and restoration of water-related ecosystems.

- Targets 6.a and 6.b acknowledge the importance of an enabling environment, addressing the means of implementation and aiming for international cooperation, capacity building and the participation of local communities in water and sanitation management. (Source: 30)

1.5. COLOMBIA MDG REPORT

About progress of seventh goal: this goal is detailed. Some of the goals consist of integrating environmental sustainability in policies and programs; reverse the loss of environmental resources; increase the number of people who have safe water and sanitation; and significantly improve the lives of 100 million slum- dwellers. Fig. 1.5.1.

The millennium goal was to halve the percentage of people without access to improved water. In Colombia, 92% of the population has improved drinking water and 90% of the population has improved sanitation facility access (Source: 33).

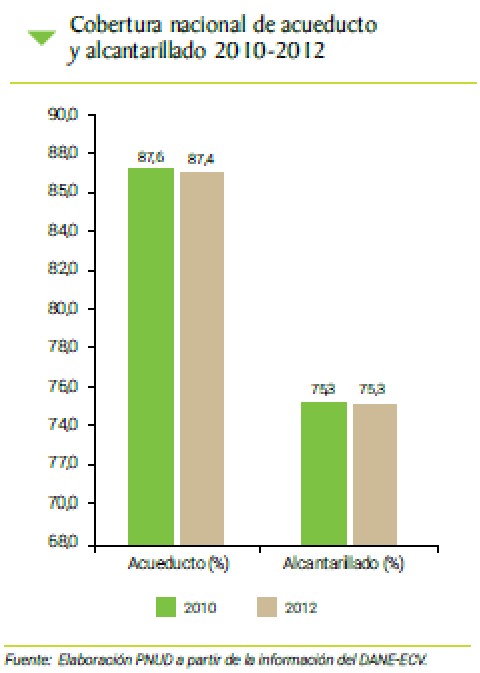
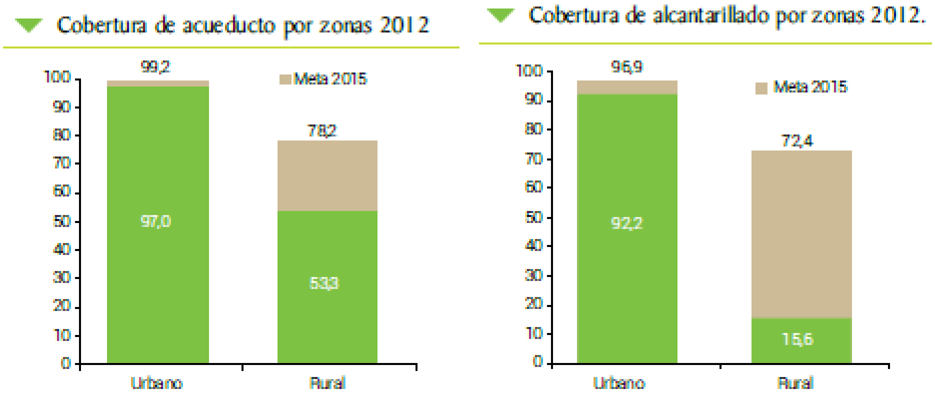


Fig. 1.5.1.Colombian national coverage of aqueduct and sewerage 2010-2012 (source: 8)

The percentage of people with access to improved water services shows social development's inequality in the country. Colombia has progressed considerably reaching universal access in urban areas. At the rural sector on the other side, the picture is bleak. In 2000, 97.3% of the cities' population can consume drinkable water, while just between 47.6 and 71% of population at the rural areas can do it, depending on the provinces. Urban areas have met universal access by 2015 but rural ones are behind. It means that although there is not equal access (Fig.1.5.2.) to drinkable water in Colombia, the universal goal was met in the country. There are also big differences in the rate of progress among provinces. The higher proportion of people with access to improved water services are found in Bogotá, Atlántico, Valle, Quindío and Risaralda. On the other side, Chocó has one of the lowest percentages of people consuming drinkable water (47.2%) (Source: 9)

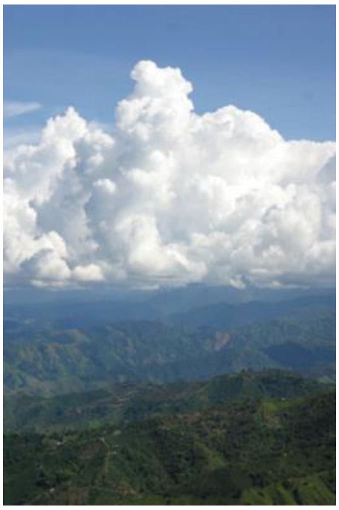
In the 2014 Colombia MDG report, has been stressed the need to expand the sewer and aqueduct coverage in the country because it was detected that the 40% of the country's municipalities has not sewerage fully functioning.

According to the Public Service Superintendence, in 2009 only the 35% of the wastewater generated in the country received some kind of treatment. The efforts to bring water and sewage infrastructure in the rural areas have to be double. Indeed, while the rest of the country had made progress in the provision of aqueduct and sewer infrastructures, the graphic shown that in rural areas it still represented a great challenge.



(Fig.1.5.2. Zoned aqueduct and sewerage coverage in 2012 (Source: *Elaboración PNUD a partir de la información de el DANE-ECV.)*

In 2012, the country registered 2'100'000 of people without sanitary services in their home. The most of which are located in the rural areas of Caribbean regions. The current situation reflects also the rate of poverty in the country. In some areas, the poverty rate is about 11%, while in others it is above the 60%. (Source: Colombia MDG report, 2014)
Huge economic and social inequalities between rural and urban areas characterize Colombian development. The UN Human Development Report (UNDP, 2010) revealed that 16% of Colombians still live with less than US$ 1.25 per day. The social tensions and presence of various armed groups have agglomerated the terrorized rural population into towns. The rural areas have also witnessed an increasing number of illegal plantations of coca. Only 26% of the 45.6 million Colombians live in the rural areas. In spite of a gradual reduction of poverty over recent years, the Colombian statistics department, DANE, estimates that in 2006, at least 62% of the rural population lived in poverty. (Source: 7).



2. THE CONTEXT: The use of water in the Antioquia rural areas

The Department of Antioquia is one of the 32 departments of Colombia, located in the northwest part of the country (Fig2.1). It extends from the Caribbean region, in the far north to the northern strip of the Western and Central Cordilleras. Most of its territory is mountainous with some valleys, much of which is part of the Andes mountain range. The department covers an area of 63.612 km² (corresponding to 5.44% of the total area of the country), and has a population of 6.534.764 people. It is the 6th largest department of Colombia, and the most populous. (Source: 36)

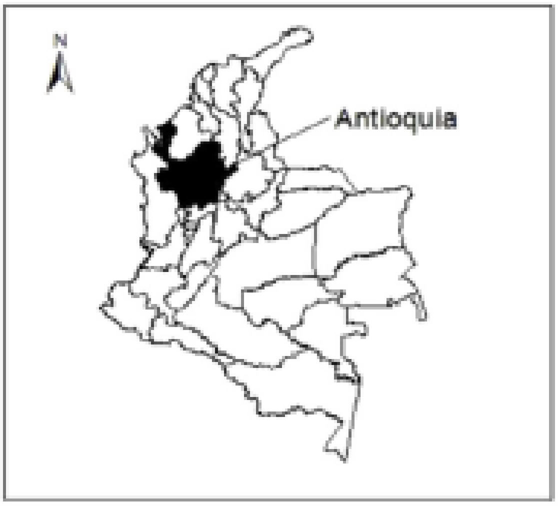


Fig2.1: Antioquia department of Colombia
(Source: 11.)

Medellin is the capital of the Antioquia department. It consists of nine sub regions defined as follows: Aburrá Valley, Bajo Cauca, Magdalena Medio, Northeast, North, West, East, West and Urabá, which bring together the 125 municipalities that make up this department. As to the topographical conditions, Antioquia has approximately 37,913 km^2 of mountainous terrain corresponding to 60.33% of the total area of the department, and 24,296 km^2 in flat territory and alluvial valleys corresponding to 39.76%.

The department has a great water wealth; its hydrographic system (Fig2.2) is comprised of six main basins: Magdalena River, Cauca River Atrato River, San Juan River, Mulatos River, Leon River, and 436 micro-watersheds. Cauca and Magdalena are located in the Northeast and Bajo Cauca regions of Antioquia. These basins play an essential role in the Colombian hydrological system since downstream, where the mountainous topography from the Northeast of Antioquia turns into an alluvial valley, the River Cauca flows into the River Magdalena creating several wetlands and swamps that control flooding in the North of Colombia. Furthermore, the Bajo

Cauca region in Antioquia has a mixture of geological, hydrogeological and geomorphological conditions that create valuable unconfined and confined aquifers. Due to these conditions there is an abundant water supply for both regions, where the main economic activities are agriculture, livestock, fishing and mining operations.

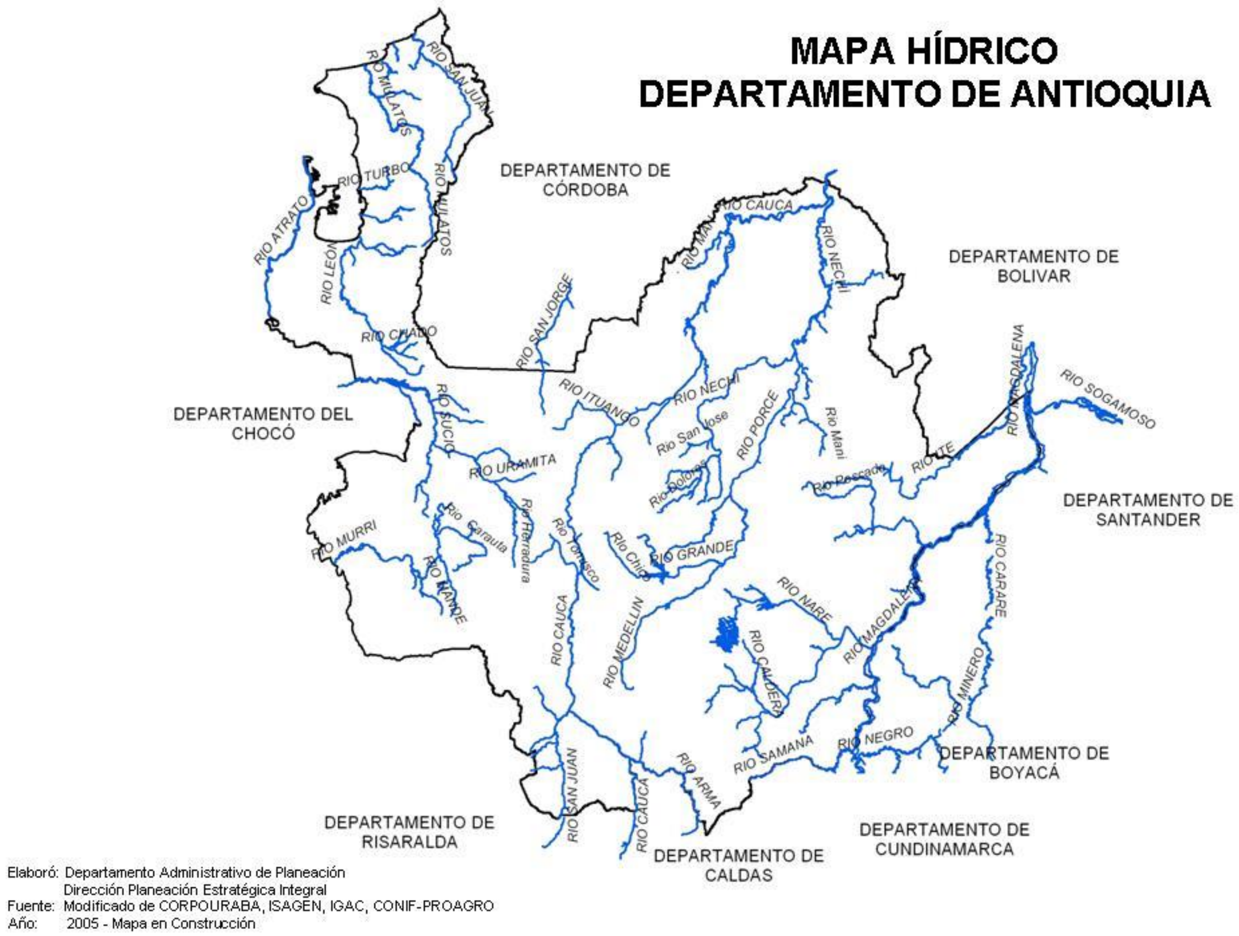


Fig2.2: Hydrographic map of Antioquia Department.

Colombia is one of the richest countries in water resources and Antioquia department is rich of rivers and many streams. However, a large percentage of people who lives in the rural areas still doesn't have access to potable water: according to the Government of Antioquia, water supply coverage in rural areas is 53.9%, but only the 17.9% of population, receive drinking water. (Source: **2.)**

Although the aquifers (Fig.2.3.) represent the largest reserve for times of drought and regions with supply difficulties in several areas of the Colombia, they are overexploited and polluted. For example, in the Bajo Cauca region (Antioquia) informal gold mining activities that have been carried out for decades in this region are one of the main practices contributing with polluted loads to this aquifer. Other principal sources of pollution are faecal pathogens, heavy metals, acid drainages and toxic microorganisms. (Source: 5.)

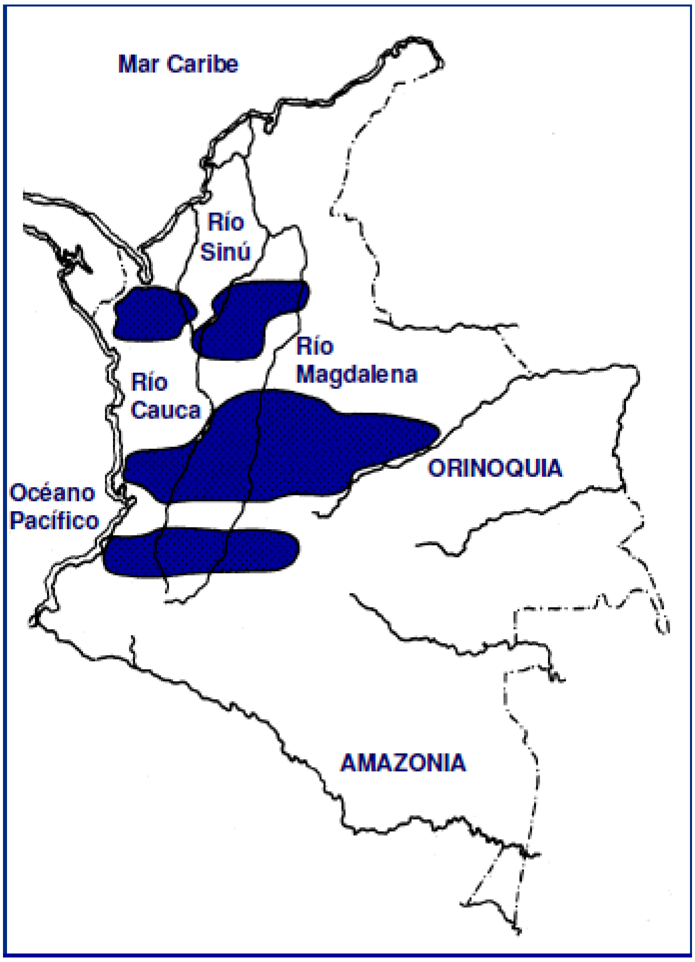


Fig2.3. Areas in Colombia where reservoirs are builded up (Source: 18.)

The biggest problem is that the communities use the aquifers, streams and rivers, to satisfy their needs because the current access to potable water in this region is deficient due of the absence of water supply networks. Therefore, the inhabitants have been indiscriminately using this resource to supply their necessities and to develop their economic activities. Despite, there are numerous compounds that are discharged into rivers without treatment, which are not well understood in terms of their concentrations, distributions and effects. (Source: 5.).

Except on the source, the most of the rivers and the streams are polluted with influent consequences on environment and people health. The contaminants include, among others, residual chlorine, microorganisms, E. coli, and coliform bacteria among others. This pollution comes from a number of sources including mining activities, the discharge of human and industrial waste, wastewater from agricultural activities (pesticides and fertilizers), and livestock waste. The hydric resources contamination in Antioquia department depend on the different uses of water: industrial, agricultural, domestic.

The principal industrial activity in Antioquia is the gold extraction in the numerous gold mines (many of them are informal) present on the territory. Gold mining is thus a natural option for the rural inhabitants in Colombia. Without technical assistance, gold mining started in a very rudimentary fashion and has been generating huge environmental and health impacts. There is concern about the health of rivers, since many local mines discharge untreated waters and tailings directly to waterways with dramatically effects on the water quality/environment and the people health.

The agricultural activity (Fig2.4.) is the second most important in the region and it's intended primarily for household consumption. However, it has, as well, a strong impact on the hydric resource because of the intensive use of pesticides that affect the soil, the aquifers and every waterbody connected to them.

The lack of water supplies means, besides, that a high percentage of wastewater is not collected or treated. This issue could damage directly the population who lives in the area. In fact, the lack of a properly sewage system improves the possibility contact with wastewater and a greater chance of contracting diseases related on low hygienic/sanitary conditions.

The garbage collection coverage in the rural areas is very low. In the absence of an appropriate system collection, people uses to dump rubbish in the environment around them. Especially, streams and rivers are in many cases converted in garbage dumps. This problem has also to do with the attitude and the behavior of the people.

Fig 2.4.: Afro-American communities in Colombia, combining artisanal mining of gold with farming activities, (corn, banana, cocoa and yucca), commerce, tourism and forestry.

This situation has awakened awareness in the communities of Antioquia. Water is essential to carry out daily activities and for their society and economy. It is the essential part of the industrial, agricultural and domestic processes where the potential risky chemical elements are waterborne. The negative impacts could be both direct and indirect when their promulgation is runaway and the capacity of the environment to absorb or reduce the adverse effects of waste is unsatisfactory.

3. GENERAL FACTS:

Problem A: Artisanal gold mining and mercury pollution in Antioquia

3. A.1. SMALL SCALE AND ARTISANAL GOLD MINING

Artisanal mining is characterized by rudimentary extraction methods. In more than 70 developing countries, there are 30 million individuals extracting more than 30 different minerals in artisanal way, (Source: 25). As the price of gold tripled in the last 10 years, the number of artisanal gold miners increased substantially in the rural areas all over the world mainly in Africa, Asia and South America (Fig.3.A.1. and Fig.3.A.2).

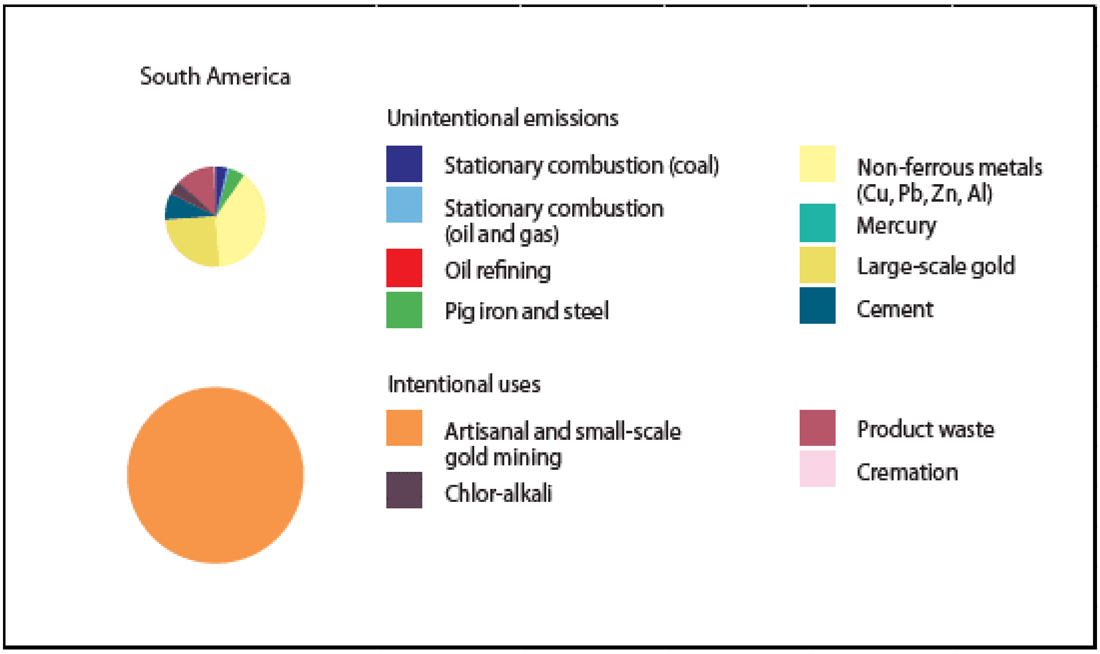


Fig3.A.1: Estimates of 2010 anthropogenic mercury emissions to air from different main sectors in different regions. ASGM is shown separately to highlight its geographic distribution and better allow regional comparisons to be made for other sectors. (Source: 23)

According to UNEP –United Nation Environment Programme, 2013-, artisanal gold mining is the largest source of anthropogenic mercury emissions (727 tonnes/a). (Source: Artisanal gold mining in Antioquia, Colombia: a successful case of mercury reduction). ASGM is the largest sector of demand for mercury because it is used to separate the metal from the ore. Artisanal and small-scale gold miners used an estimated 1,400 metric tons of mercury in 2011. Around 16 million people are directly involved in this activity, producing 380-450 tonnes of gold annually, and releasing and emitting 1400 tonnes/an of mercury to land, water, and air. About one-third of the mercury used is believed to go into the air while the rest goes into soils and waterways. (Source: 25.)

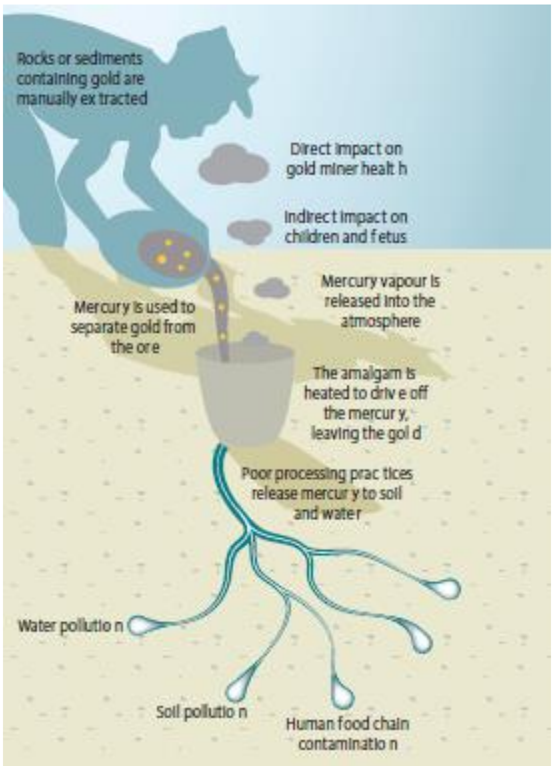


Fig.3.A.2.Artisanal and gold scale miners (Sources: 23.)

3. A.1.1.Why mercury is used ?

For centuries, miners have used mercury to trap particles of precious metals. Artisanal and small-scale gold miners use mercury to extract gold in developing nations worldwide, contributing an estimated 25% of global gold production and 30% of global mercury emissions annually. (Source: 25.)

Mercury offers several benefits in gold processing:

•It is easy to use, and it works quickly.
•It can be used by one person independently.
•It effectively extracts gold in most field conditions.
•It is cheaper than most alternative techniques
•It facilitates precise transactions.
•It permits custom processing of small individual ore batches.

3. A.1.2.Steps in small scale and artisanal gold mining

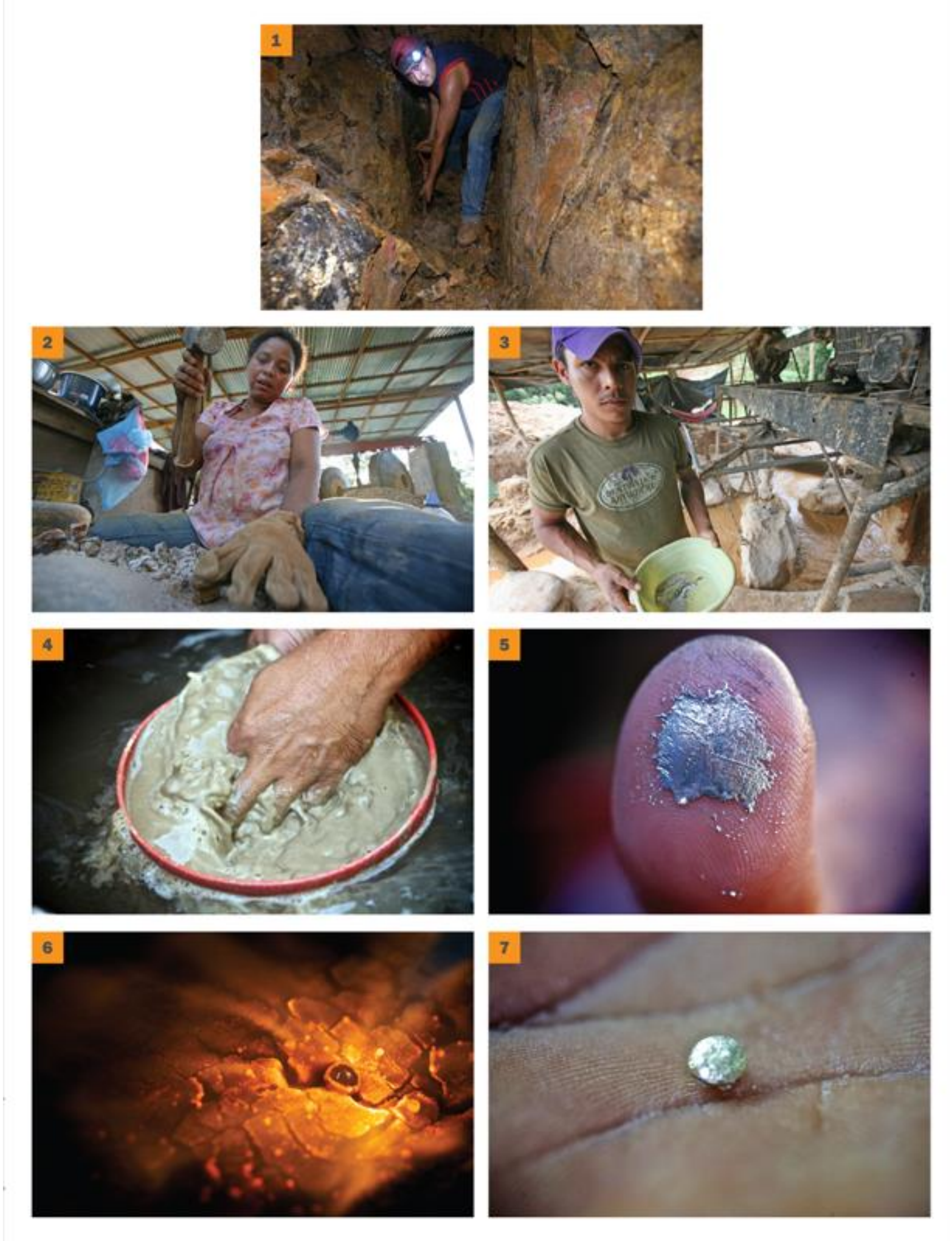


Fig. 3.A.1.2. Steps in Small-Scale Gold Mining

1) Miners excavate gold ore from the ground or from rivers. 2) Ore is broken aboveground and tested for gold content. 3) Broken ore is put into the mills. Mercury is added to the mill to bind the tiny gold particles together. The mercury–gold amalgam is heavier than crushed rock particles and sinks to the bottom of the mill. Gold particles that don't come into contact with mercury in the mill can be caught on a mercury-covered plate at the runoff. 4) The muddy mixture of rock particles that is left in the bottom of the mill is washed and the amalgam separated out. 5) Excess mercury is either squeezed out of the amalgam by hand (which saves the mercury for further use) or burned off. 6) Amalgam is burned with a blowtorch to burn off the mercury. 7) The resulting low-purity "doré" gold is sent to refineries to be further purified. (Fig. 3.A.1.2), (Source: 25)

3.A.2.ARTISANAL GOLD MINING IN COLOMBIA:

Colombia is one of the largest producers of gold in Latin America and it has recently increased its production through the lasts years. It grew by 16,5% for the period 2009-2013, from 47.8 tonnes to 55.7 tonnes, reaching 57 tonnes in 2014. So that, Colombia became the 5th largest gold producer in Latin America. (Source: 5.)

The artisanal gold mining sector in Colombia has 200,000 miners officially, producing 30 tonnes Au/a. (Source: 7)
Despite the regulations on artisanal mining in Colombia, the sector has a large number of informal and illegal miners due to poor law enforcement in rural areas. For that reason, most of the gold production comes from artisanal and Small-Scale Gold Mining (ASGM). In many cases, the groups lack government authorization to extract gold (illegal mining) and/or lack environmental licences that certify that sustainable practices are carried out (informal mining).

According to Guiza and Aristizabal (2013), 87% of 4134 Colombian gold mining operations are illegal and 95% of all the gold mines have no environmental permit. The artisanal and small-scale sector produced 72% of the country's gold or around 40 tonnes/an of gold in which 66% were illegal.
In fact, illegal and informal mining together represent 86% of mining operations in the country.

3.A.2.1.Principal methods of extracting gold

In Colombia, there are two main methods of extracting gold; one is through underground mining where the mineral is confined into veins beneath the surface. The other way to mine gold is placer mining where gold is found in alluvial deposits. In this type of mining, gold has flowed from an original source such as a vein until it reaches parts of the river where the water flow slows. The gold accumulates at the base of placer deposits because of its density. In Colombia, the majority of mining activities are carried out by placer mining (51%) and underground mining (30%). Both methods are very dangerous to the environment and the human health because they use a lot of mercury (Hg) in their processes. However, without technical assistance gold mining started in a very rudimentary fashion and has been generating huge environmental and health impacts. Gold that comes from underground activities is further processed near the pithead, which in the informal sector is characterised by the absence of adequate mechanisms and technologies to manage water on the site. Meanwhile, placer mining activities are carried out in alluvial terraces beside rivers or into river benches, pumping water from the nearest stream. Both processes involve the use of mercury and the first one includes also cyanide to recover gold, and the processing machinery uses fuels and lubricants, all of which may be discharged directly to water bodies without treatment. (Source: 5.).
During this operation, a large amount of Hg is accidentally or intentionally discharged to the environment and eventually reaches nearby fresh water bodies where, together with the significant amounts of mercury supplied by wet atmospheric deposition, it is subjected to methylation and subsequently bioaccumulation in aquatic fauna.

Therefore, informal mining activities are carried out through underground or alluvial mining. The absence of legal and formal procedures combined with the dearth of appropriate and clean technologies to mine gold have left a legacy of contamination in surface waters as well as in aquifers.

In many cases, amalgamation (Fig.3.A.2.1.) is the only gold recovery technology available to artisanal miners. As a result, artisanal miners are themselves the population group most exposed to all related health and environmental risks by being in daily contact with mercury. In several countries, artisanal miners trying to escape the poverty trap are further criminalized by laws banning amalgamation and extorted by markets selling mercury legally for dental amalgams. Amalgamation is carried out in two steps; first, the mineral or gravel is brought in contact with mercury in order to get the gold trapped as amalgam and second, the gold is separated from the mercury. In order to reduce mercury emissions, it is important to minimize the amount of ore brought in contact with the mercury and to recover and recycle mercury throughout the process. (Source: 13.).

Fig.3.A.2.1. "Amalgam, gold and mercury losses" (Source: 13)

3.A.2.2. Quantity of water needed for the gold extraction

Gold mining activities demand high volumes of water to obtain the metal and this leads to surface and underground water bodies being altered in several ways. In Colombia, to produce 1 g of gold between 0.45 m^3 and 1.06 m^3 of water is needed. The quantity of water used by this sector is unknown, as well as the kind of practices that might be adopted to reuse water and control water discharges to meet environmental requirements (Source: 5.).

3. A.3.THE ANTIOQUIA CASE STUDY:

The Departments of Antioquia, was the area selected for this investigation because it has one of the record to be the highest gold producers. Most of this production comes from ASGM. Simultaneously, the same department is one of the highest consumer of mercury in Colombia due to his gold production. ASGM is the largest sector of demand for mercury. Mercury is used to separate the metal from the ore.The practice threatens the health of the workers and their families, and the people downstream who eat mercury contaminated fish or drink the water. It can also cause environmental damage that may persist for decades after the mining has stopped. (Source: 1.)

Varieties of entities have studied this problem; one of the most important was the Global Mercury Project by UNIDO and La Corporación Autónoma Regional de el Centro de Antioquia (Corantioquia), -UNIDO e United Nations Industrial Development Organization joined forces with the Government of Antioquia, National University of Colombia and University of British Columbia to start The Colombia Mercury Project to reduce mercury use and losses-.

In the Department of Antioquia (Fig. 3.A.3.1), it is estimated that there are 17 mining towns and between15,000 to 30,000 artisanal gold miners, most of them are located in the Lower Cauca River and in the Northeast region of Antioquia where gold has been mined since pre-colonial times (Source: 25). The majority of Antioquia's gold production comes from 5 municipalities: Segovia, Remedios, Zaragoza, El Bagre and Nechi with population of 162,000 inhabitants. (Source: 11.)

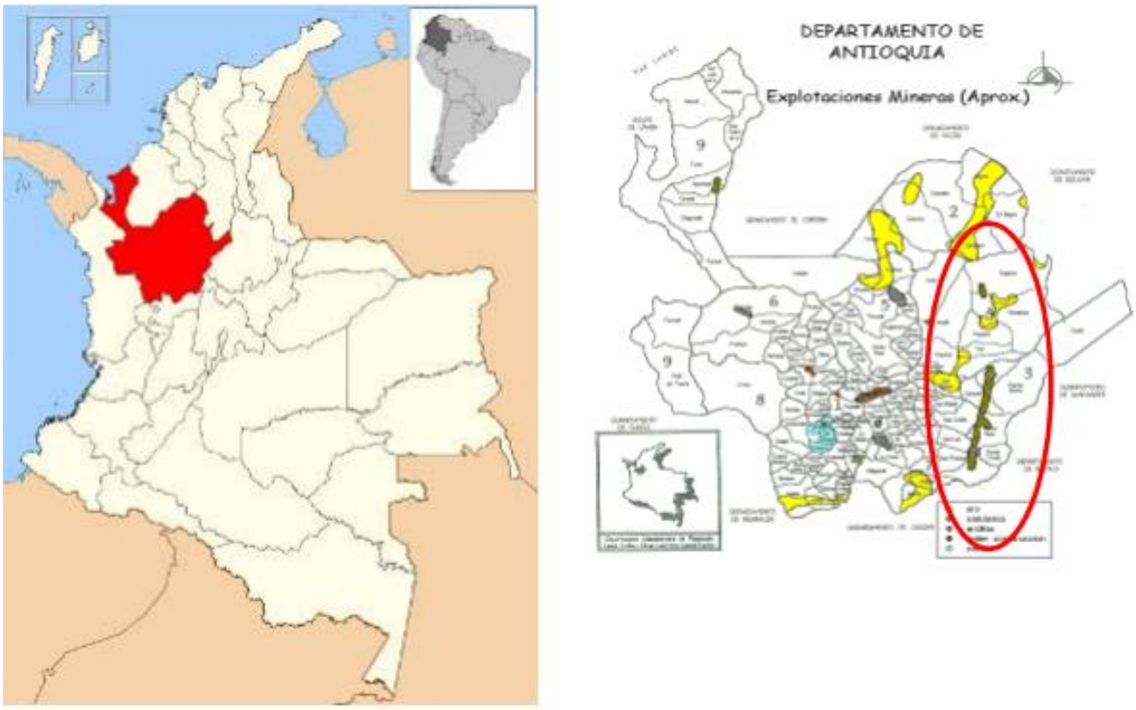


Fig 3.A.3.1.Map of Antioquia indicating the gold districts selected by UNIDO (Source: 25)

Gold mining is thus a natural option for the rural inhabitants in Colombia and in Antioquia Department, mining has greatly influenced the development of the region, where between 65 and 70% of the population dependent directly of the mining, generating between 20 and 25 thousand direct jobs (Fig). Only the department of Antioquia, has the 39.9% (1,526 MPUs) of Mining Production Units (MPUs) in Colombia (Fig.3.A.3.2)

Fig.3.A.3.2. "Miners" (Source: 13.)

3.A.3.1. The governance problem:

Lack of governmental control: Mining practices are the directly responsible for affected river systems. Poor mining practices have been causing water pollution and overburden of sediments in waterways. Most of these problems are caused by the absence of formal governance of numerous mines where immediate economic benefits are not balanced with the benefits of sustainable practices.

3.A.3.2. Environmental and water access problem

3.A.3.2.1Water pollution

Water quality is a big concern in many communities downstream of mines. Mercury levels are found in hydrological and biological systems including humans. There are scarcities of studies that assess environmental problems caused to the local ecosystems from mercury, cyanide and chemical loads. There are any studies that track their mobility with tailings in waterways. Some researches indicated that mining activities caused great destruction to the water environment. The heavy metals are difficult to clear away from the natural environment or even from a secondary pollution.
There is concern about water management in these regions, particularly because once the Cauca and Magdalena Rivers reach Antioquia, they receive polluted loads caused by mining activity from tributaries from the Northeast and Bajo Cauca regions.
The Colombian Government has recently launched a decree to reduce and control mercury use, especially in the gold mining industry. In addition, it is working on a database of sources of mercury.
The department of this investigation suffer from water pollution since informal mining operations use different products to recover gold and to operate equipment. These elements are directly discharged to waterways without treatment generating high changes in the natural state of rivers. Whilst there are many water pollutants associated with informal mining, suspended sediment, organic matter, acid drainage, metals, grease, oils and fuels. One of the biggest concerns in recent years is pollution by mercury in air and waters. In the case of Antioquia, the total amount of mercury used in the Northeast and Bajo Cauca regions is around 93.4

tonnes/annum. This fact has ranked these regions with the shameful first position as the largest world's mercury polluter per capita from artisanal gold mining.
The effect of alluvial mining in those regions creates a research opportunity to evaluate the effect on river dynamics. Once material is moved from river benches or banks, the natural river morphology is modified triggering a change in hydraulic patterns. These activities have consequences on flooding and erosion of banks in these regions and downstream of them. Watersheds have been largely affected by sedimentation because of mining activities. (Source: 11.)

3.A.3.2.2.Aquifers contamination:

There is a high or extreme risk of underground water pollution in Bajo Cauca's unconfined aquifer. It has been estimated that more than 26,000 m3 of underground water is daily pumped in approximately 2,000 wells located in the Bajo Cauca region [56]. Bajo Cauca's unconfined aquifer is recharged by three sources; one is direct infiltration, second is through the hydraulic connection between the main rivers in the area such as Cauca River and the third is the indirect recharge from the regional metamorphic rock system. Consequently, underground water quality in Bajo Cauca's free aquifer depends from the water input upstream in the Northeast region since they are in the same hydrological system. Mining activities often require dewatering to lower groundwater levels. These activities in the majority of cases have altered underground water levels, modifying its flow and its capacity to supply water into surface waterways. (Source: 11)

3.A.3.2.3.Sediment related issues:

An important number of informal mines are located nearby or within rivers. In the Northeast and Bajo Cauca regions in Antioquia there are approximately 1,011 backhoes that carry out alluvial mining. The most of bulk of tailings from the informal mining end up in rivers, modifying their natural hydro morphology and increasing the load of sediments in rivers downstream. This can trigger water damming, increasing flooding risk, reducing capacity of water storage dams and contamination water with suspended solids. The change in sedimentation patterns, also alter biological communities that in many cases disappear.
Water contamination is not the only concern. There is another issue with alluvial mining in which the use of dredgers and backhoe loaders remove material from the river bottom and banks. This

directly alters the natural hydrodynamics as well as, indirectly through erosion and deposition. Therefore, the informal mining sector has impacted water quality and landscape modification (Fig. 3.A.3.2.3.), (Source: 11).

Fig. 3.A.3.2.3, Landscape modification due to gold extraction.

3.A.3.3.Health problems:

Mercury vapour impacts on public health most directly, causing problems with the respiratory tract in short-term exposure to high levels of mercury vapour. Symptoms include chest pains, dyspnoea, cough, haemoptysis, impairment of pulmonary function and interstitial pneumonitis. Inhalation of Hg vapour is the primary exposure pathway for miners, gold shop workers and people living near areas where mercury and amalgams are handled in the municipalities studied in Antioquia, Colombia. (Source: 7.) Rural communities living in towns that depend on artisanal gold mining activities have also little interest in ending the sole economic activity of the region, even if this activity is polluting the whole town. Miners often are not aware of the risks involved in using mercury, and/or they may not have a choice in the matter. Those miners who are aware often do not afford or have access to safer alternatives. Mercury is a heavy metal that is harmful when inhaled, ingested or touched. Mercury poisoning is transmittable from mother to foetus and can damage the brain and central nervous system. (Source 37.)
Some freshwater systems, however, are important sources of fish for human consumption, especially for subsistence and recreational fisheries, often among indigenous peoples. Artisanal and small-scale gold mining (ASGM) communities may also be affected through fish consumption and drinking water, if those are contaminated by local releases (Source: 38).

PROBLEM B: Fertilisers and pesticides used for agriculture and breeding activity

3. B.1.WATER CONTAMINATION DUE TO AGRICULTURE PRODUCTION:

The central and western *cordilleras* (mountain ranges) cross the department. This fertile area is ideal for raising livestock and for growing bananas and coffee beans, which are the two major agricultural productions in the country, as well as a wide variety of crops such as rice, yucca, sorghum, beans, sugar cane and cocoa. Agricultural production involved a great percentage of farmers in the Antioquia department (Fig.3.B.1.1) since, together with mining activity, it is one of the most important activity in this region, especially for people who lives in the rural areas. "Production of beans and other crops offer rural people an alternative avenue to escape from poverty." The recent fast urbanization in Antioquia has generated an amount of demand for these crops. To meet this growing demand, farmers have transformed mountainous landscape into a patchwork quilt of small, well-tended plots. Given these strong demand, farmers have the possibility to make a decent living through more intensive crop production. "Large number of growers have adopted modern variety of crops and the use of agrochemical to meet the demand of urban markets". At the same time, this escape route from poverty is filled of hazards. It represents a threat for the environment and human health.

Fig. 3.B.1.1. Wheat field in Antioquia.

Growers, usually buy cheap and low quality products to fertilize their fields and protect their cultivation from the pest attack. They do not have knowledge about the negative effects of the runaway use of these products on the hydric resources quality and as a consequence on their heath.

The overuse of pesticides in Antioquia, as any other aspect of culture, is now customary. As a result, insecticides use has become remarkably commonplace. Not only farmers spray regularly

on a calendar basis to provide insurance against the possibility of damage, but also in some seasons they spray more often than the necessary. In the west Antioqueno, for example, farmers refers to spray as "bathing the crops". In this area, the excessive use of chemical products is fostered by habits and rooted in fear. Understandably, farmer panic at the thought of losing a crop. Not surprisingly, communitywide destruction of crop residues is one of the practises that farmers have adopted more easily. Therefore, the inadequate and excessive toxic pesticides use, play a key role in the increase the hydric resources pollution. The ones that deserve particular attention for their risks are: organochlorine compounds, organophosphorus and carbamate. According to scientific literature, pesticides used for a long period, generate on the human health toxic effects that could bring about malformations, carcinomas, paralysis, nerve damage, mutations, infertility, teratogenicity and seizures. Thanks to many water samples analysed during a research, led by the Laboratory Water Analysis Sanitary and Environmental Engineering, of the Faculty of Engineering of the University of Antioquia in 2010, the related studies have assess that the water is definitely not suitable for human consumption.
Rising incidence of death and injury from pesticide intoxication were documented by toxicological analysis lead by… Other studied have shown that 13 to 30 % of farmers in the study area, have suffered illness from exposure to these products within the last 10 years. (Source: 14.) To outline, it is important to stress that in Antioquia rural areas, the situation shown is particularly critical because of the compliance of the territory.
In fact, Antioquia department territory is characterized by the presence of many rivers and connected micro basins, and streams. For these features, all the agricultural activities that take place upstream have relevant repercussions on the water quality, downstream.

<u>3. B.2.WATER CONTAMINATION DUE TO BREEDING ACTIVITY</u>

Stock raising is a major activity and source of wealth. Colombia ranks fourth among Latin American countries in cattle raising. Poultry raising has expanded quickly, as a result of the application of modern techniques, and has grown faster than other livestock enterprises. Cattle production systems in the inter-Andean valleys are more variable than in the eastern savannas, reflecting a different endowment of resources and a different socio-economic context. Farm and ranch properties tend to be significantly smaller. Throughout the valleys, cattle production, although pasture-based, is more intensive that in eastern Colombia. (Source: 39.) In addition to the negative impact of the pesticides and fertilisers used in agriculture, also the breeding activity, spreading in this area, represent a concrete threat for water contamination. The water contamination is given by more two factors: direct discharge of wastewater as the results of productive infrastructure washing, direct discharge of solid waste as the result of pig, cattle and poultry production.
The results of some surveys explained in the "Water pollution caused by pesticides in an area of Antioquia" article, have shown that agricultural, pig and poultry production in the Antioquia villages have been producing a negative impact on water resources due to its reduced availability and pollution. It has been affecting the environment by generating compaction and soil pollution, erosion, air pollution, solid waste production and proliferation vectors. In numerous tract was observed a consistent presence of slime and mold, two unhealthy water indicators. The water from the samples analysed here was definitely not suitable for human

consumption. Microbiological testing is an indicator of faecal contamination in water with a high risk of microbial contamination and destined to the human being consumption. It helps to reveal the presence of Coliform bacteria and other heat resistant germs. Coliform bacteria are present in the normal microbial flora of the intestinal tract of warm-blooded animals (including birds and mammals). These microorganisms are used as indicators of faecal pollution in the water. If their presence appear in the water sample analysed, the state of water is defined not appropriate to the human beings consume. The possible causes of this pollution are: stool from cattle, pigs and sheds, that runoff to the streams tributaries that represent the water sources for many houses downstream. This unhealthy dynamic is caused by the absence of adequate infrastructures to transport breeding wastewater and any kind of treatment facilities. It has consisting in a serious risk for the health of the communities living nearby.

Problem C: Lack of water supply networks and wastewater facilities

"Poorly managed water resources are also a source of conflict—over scarce access in water distressed regions—and environmental degradation. So addressing water needs can have a huge development payoff that reaches beyond health. From protecting watershed ecosystems to water supply management, investing in water and sanitation has a payoff that goes beyond just the infrastructure. As communities learn to manage their water resources, access can often promote critical economic activities, from gardening to food production to industry". —Mark Malloch Brown, Former Deputy Secretary-General of the United Nation

3.C 1.WATER ACCESS IN RURAL COMMUNITIES:

In developing countries, especially rural communities have to face issues with water distribution and quality. Many of them, lack the water infrastructure, the facilities they need to supply, treat and delivery water to consumers as well as remove and treat wastewater. In rural areas is too costly to build water infrastructure with private involvement. However, even communities with existing water infrastructure face inequalities in water. In many case, existing water distribution systems are inefficient or unmaintained. This situation lead to the overall decrease in water access. The deterioration of the old pipes leads to increases in water losses. As a result, the number of people that have access to drinkable water decrease. Additionally, rural communities often lack the capital, expertise, and sufficient infrastructure to increase and rehabilitate their water systems. In developing countries, 80 percent of the people that lack access to potable water live in rural areas. (Source: 40.)

3.C.2. WATER AND SANITATION SERVICE IN COLOMBIA:

By 2008 the global coverage drinking water in Colombia is estimated at 91.5% and 87.4% sewerage, indicating that the population should already meet with aqueduct are 3.7 million inhabitants and 5.8 million with sewerage. In urban areas, coverage estimated at 97.6% for water and at 92.9% for sewerage, while in the rural area such indicators would be 72.0% and 69.6%, respectively. (Source: 2). These averages mask a gap between regions. Although consolidation scheme organizational and business achieved in the last decade, the sector has a high dispersion of providers, reflecting the municipal decentralization. Like Colombia's domestic wastewater, most of the country's industrial wastewater is not treated.

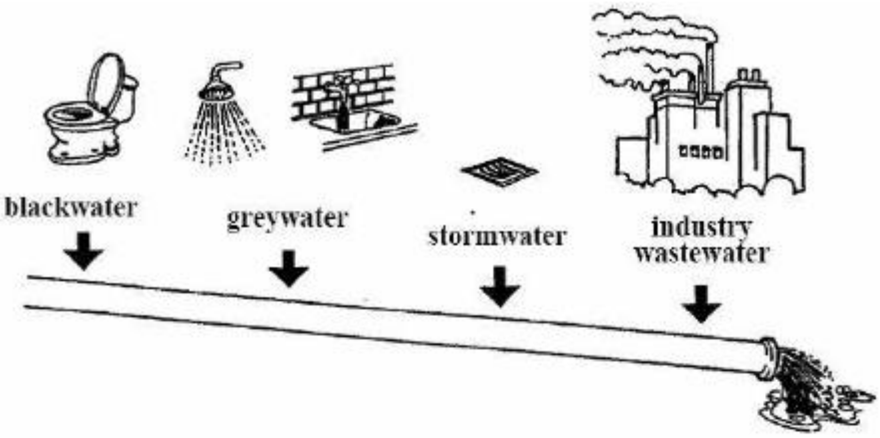
3.C.2.1 The sectorial structure

The responsibility for ensuring the efficient delivery of potable water and sanitation in Colombia, including rural areas, lies with the municipalities, directly or through loan companies; in the rural communities, the supplying is commonly performed by grassroots organizations Community. To the Departments and the Nation are assigned functions of technical, administrative and financial support. The institutional and legal framework is defined in Law 142 of 1994 "Board of Public Utilities", that establishes a clear functional division. The Vice Ministry of Water and Sanitation (VAS), holds the responsibility to establish national policies, plans and programs, to define technical standards and technical assistance to urban and rural operators. The regulatory functions are assigned to the Regulatory Commission of Water and Basic

Sanitation (CRA), while control and surveillance sector lies in the SSPD (Superintendencia de Servicios Públicos Domiciliarios). (Source: 2).

3.C.3.REDUCED ACCESS TO POTABLE WATER IN ANTIOQUIA IS A COUNTRY PROBLEM:

The problem of water in Antioquia is very conflictive. There is concern about the health of rivers, since many local mines discharge untreated waters and tailings directly to waterways. This situation has awakened awareness in the communities of Antioquia. Water is essential to carry out daily activities and for their society and economy. Water pollution in Colombia affects many of Colombia's most important rivers—including the Bogotá, Cali, Cauca, Medellín, de Oro, and Lebrija—that are severely polluted (IDEAM 2002a). Among point sources, the domestic sector, not the industrial sector, is the leading contributor to water pollution. In 1999, the domestic sector generated over three-quarters of the total biochemical oxygen demand (BOD) discharged from all point sources (IDEAM 2002a). The domestic wastewater problem has several dimensions. First, a significant percentage of this wastewater is not collected into municipal sewer systems. Many of Colombia's wastewater treatment plants operate poorly. Cost is another component of Colombia's urban wastewater treatment problem. In fact, MMA estimated that $US 2.5 billion would be need for municipal wastewater treatment between 2001 and 2010 (IDEAM 2002b). On average, nationwide samples of water reveal contamination of residual chlorine, microorganisms, E. coli, and coliform bacteria. (Source: 4.)



Source: *Werner, Ch., Mang H.-P., Klingel, F. Bracken, P. (2004): General overview of ecosan. PowerPoint-Presentation. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH ecological sanitation programme.*

3.C.4. INADEQUATE WATER SUPPLY NETWORKS AND SEWAGE INFRASTRUCTURE IN ANTIOQUIA:

According to the figures from the Government of Antioquia, water supply coverage in rural areas is 53.9%, but only the 17.9% of population, receive drinking water; sewage condition is even worse, since only 21% of the rural population is connected to sewer toilet; 29.1% toilet without connection to sewer or septic tank; the 22.1% of rural population are unserved, 21.6% are served toilets connected to septic tank and 5.9% use latrines. (Source: 2.). The lack of water supply infrastructure and of sewage treatment plants is still a huge problem in the most of rural areas of Antioquia department in Colombia, where, as a result, people is obliged to keep water directly by the rivers and the streams, nearby their villages. These water sources are at "high risk" because suffer strong contamination. The implications are dangerous for human health and for environment.

3.C.5.HEALTH IMPLICATIONS:

The inadequate water supply networks and sewage infrastructure highly expose to the effects of unsafe drinking-water and bad hygienic conditions the rural population of Antioquia department (Fig.3.C.5.). Unhygienic conditions and practices at the household level create a dangerous environment with immediate health risks. Also, lack of sanitation facilities in helps transmit diseases. (Source 41) Human and animal waste (urine and faeces) can cause serious and long-lasting illnesses when:

- there is not a good way to get rid of human and animal wastes.
- water supplies are not protected and kept clean.
- there is not enough clean water to wash and cook.

As it is written in this final report, there are many sources of water contamination, including naturally occurring chemicals and minerals (for example, mercury, but also arsenic, radon and uranium are very common in the water), local land use practices (fertilizers, pesticides, and concentrated feeding operations), manufacturing processes, and sewer overflows or wastewater releases. The presence of all these contaminants in water can lead to adverse health effects, including gastrointestinal illness, reproductive problems, and neurological disorders. Infants, young children, pregnant women, the elderly, and people whose immune systems are compromised because of AIDS, chemotherapy, or transplant medications, may be especially susceptible to illness from some contaminants. (Source: 42)

Unsafe water expose at high risk when it contains germs, worms, or toxic chemicals. Drinking unclean water causes millions of deaths each year from diseases such as diarrhoea, hepatitis, cholera, typhoid and parasites. The public health importance of diarrhoea among lies partly in the high mortality rates (among children) as well as in the interactions between malnutrition, recurrent diarrhoea and impaired child development and adults lives. Germs and worms, such as whipworm, hookworm, and roundworm, cause many serious illnesses. Some of the illnesses they cause, such as cholera, spread quickly and can cause many deaths. Other illnesses from germs and worms can cause years of sickness and lead to other health problems such as dehydration, infections, anaemia (weak blood), and malnutrition. Because the most common sign of illnesses from germs and worms is diarrhoea, these illnesses are sometimes called diarrhoea diseases. (Source: 17.).

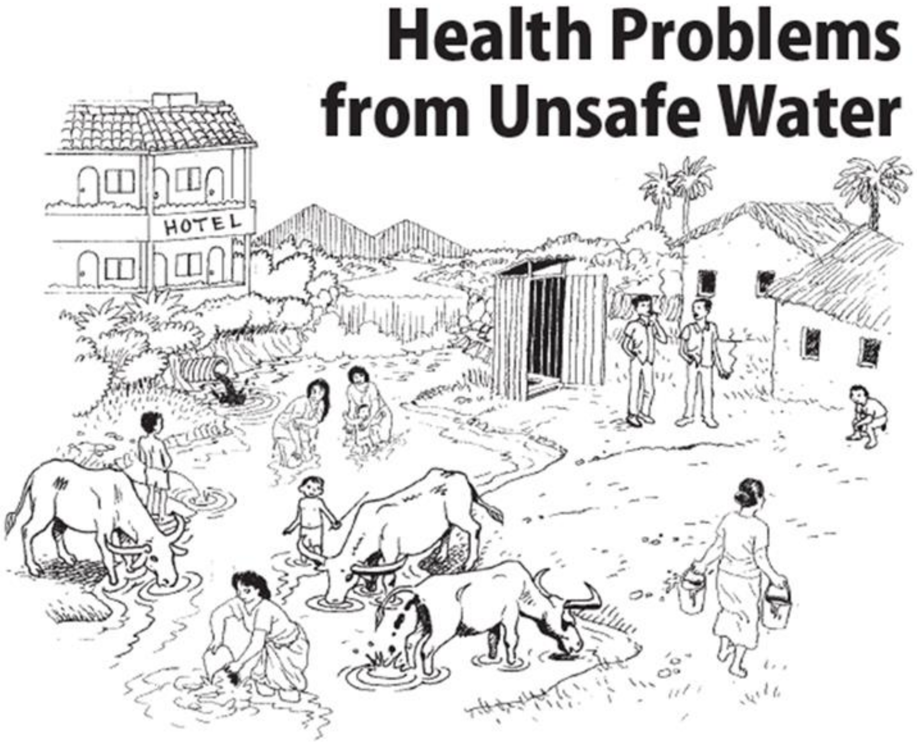


Fig.3.C.5 Risk exposition from unsafe water uses (Source: 17).

4. A COMPREHENSIVE APPROACH TOWARD WATER MANAGEMENT

Rationales:

Water is essential to our lives. We need water to drink, to bathe and to grow and cook food. In developing countries, lack of clean water is a devastating and often deadly problem. Many rural communities do not have the capital, expertise, or water infrastructure to increase their water access.

In the Antioquia department, access to potable water is low for communities in a region recognized by the potential of its resources. According to the Observatorio de Paz Integral de el Magdalena Medio, water for human consumption is taken out from rivers, streams and channels in 52% of the cases.

Many times people are forced to draw water from a dirty pond or contaminated river, contributing to poor health and disease. Water that people has available by the rivers is generally contaminated with a lot of mud, many bacteria, organic matter of all kinds and so on, then the consequences are epidemics and disease outbreaks.

These conditions identify the issue of water as a priority. The environmental and health implications, directly affect the quality of life of the communities in the region.

Water is an essential element in the agriculture production and its quality influence directly on the quality of the foodstuffs. Water has to be free by pesticides and fertilizer toxic elements that could be accumulate in plants and animals, affecting the food chain.

In addition, Miners use liquid mercury to separate gold from river sediments, a process during which a very toxic compound, mercury-cyanide, is formed and then dumped into local creeks. According to the Environmental Police, every gram of extracted gold requires two grams of mercury, about 80% of which is discarded with other excess waste. Mining pollution in aquatic ecosystems can also expose downstream communities to methylmercury and other toxic elements through their diet.

Indeed, some of the inorganic mercury that reaches aquatic ecosystems also gets converted by microbes into organic methylmercury, which accumulates in fish.

The environmental problems caused by this huge release of mercury and cyanide with tailings to the local aquatic systems have not been evaluated yet but all creeks in the Antioquia municipalities visited are silted with tailings and likely have no aquatic life.

All these issues trigger public health problems, since in these regions communities need potable water for domestic and economic activities such as agriculture and fishery.

Objectives:

Main objective: improve the management of water resources as a top priority in terms of social, health and environmental

Ob1) Increase population with access to potable water in the rural areas.

Ob1.1) Provide sustainable access to basic water supply services in the poorest and most vulnerable areas of rural Antioquia.

Ob2) Reduce the negative effects of productive water use on environment and Antioquia rural communities

Ob2.1) Reduce the water pollution in rivers and guarantee the aquifers protection

Ob 2.2) Protect the environment

Ob3) Reduce water losses

Ob4) Provide sustainability through appropriate sanitation service in the poorest and most vulnerable areas of rural Antioquia

Ob5) Make people conscious about water saving and environmental conservation through educational programs.

Who needs to act?

***"We need a global approach to this from all sides. We need to educate people, we need the scientists to create new technologies, we need the engineers to create the networks, we need every human being to be aware of how precious water is and save it. Do not waste it. Everybody has to be involved in a very firm and assertive way".*—Isabel Allende, writer and environmentalist.**

With the aim to achieve the objectives, is necessary to increase collaboration between different stakeholders such as **intergovernmental and non-governmental institutions**, such as NGOs, local and foreign universities and environmental corporations in order to support sustainable development of informal mining, agricultural and breeding production.
The role of NGOs on development projects is to facilitate the planning process and, once a plan is established, to support communities to access funds from Governments or sponsors for implementation. They also have to support **governments** in their efforts through the provision of technical assistance, capacity-building and mobilization of resources. **Local authorities** are closely involved and responsible achieving the objectives, to assure commitment, ownership and endorsement.
Communities who plan water use and manage water projects in a participatory, responsible and socially inclusive way. **Local service providers** support communities and committees in the social and technical work. The proposals should be financially and economically viable and socially acceptable.

For this study, the priorities for the department of Antioquia, are:

4.1. WATER ACCESS AND SANITATION

4.1.1. Possible solutions to provide access to basic water supply and reduce water losses

Many possibilities and options exist to try to ensure that everyone can access safe water. For instance, adopting the decentralized water distribution systems. Promote "decentralized" water management instead of the "conventional" one, presents some substantial benefits, like less investment and Organization & Methods costs and Low Tech use. Decentralized water distribution systems (Fig. 4.1.1.) also facilitate reuse of water and nutrients. It means that requires, among people, a change in mind-set. It needs a specific and participatory approach. Several options of decentralized water distribution systems could be adopted to enhance the access to clean water.

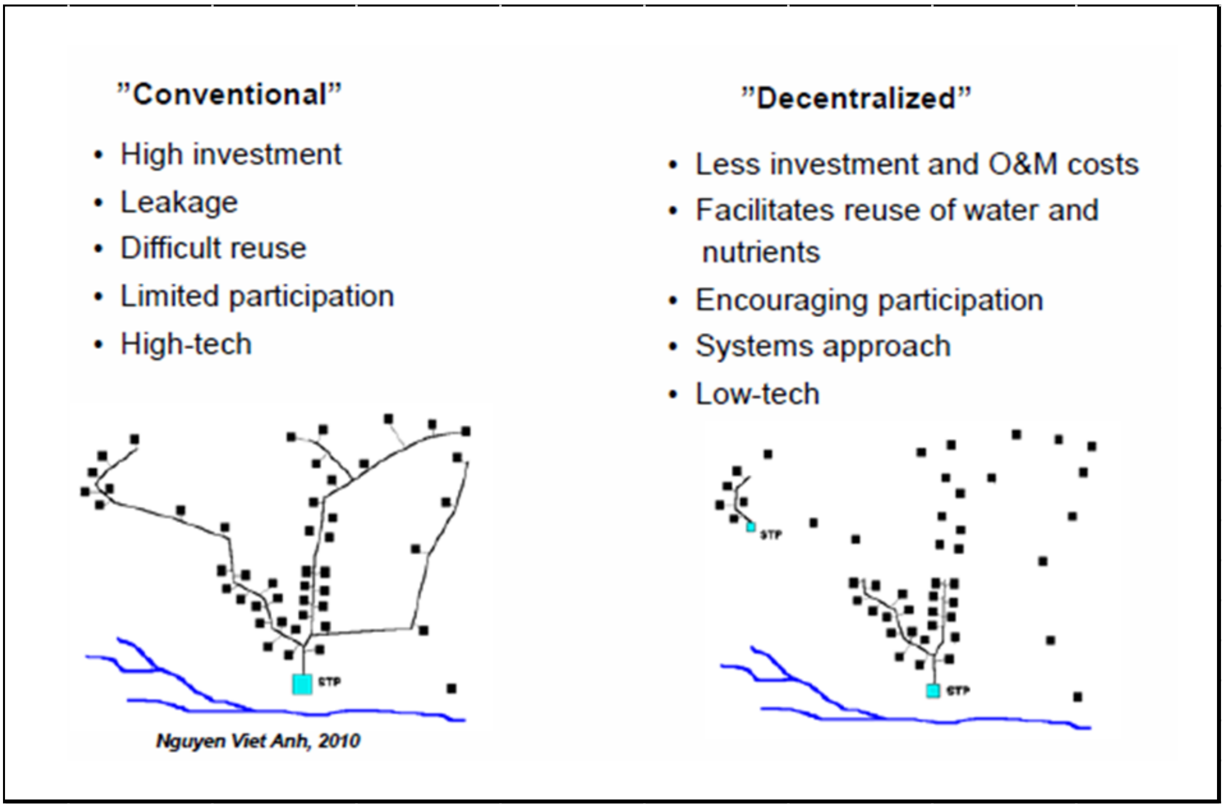


Fig. 4.1.1. A paradigm shift in wastewater management (Source: 3.)

The following concrete actions can be initiated by rural communities:

WATER CONSERVATION: Enhanced water conservation will allow water supplies to be used more effectively. By educating people to retrofit their faucets and showerheads, displace water in their toilet tank, and fix water leaks, millions of litres of water could be saved.

WATER RECYCLING: Water recycling is the process of reusing treated wastewater for valuable, nondrinking purposes such as irrigation, industrial processes, and toilet flushing. By recycling water, it could be possible to reduce water losses.

RAINWATER HARVESTING**:** Rainwater harvesting means catching and using rainwater where it falls. People can build cisterns or wells in order to help capture the rainwater. This system saves, water, time, costs and energy. This action can only be used in areas with abundant rainfall as Antioquia. It is very important, however, that the water does not become contaminated in the holding areas and that it is sanitized before drinking.

WATER PURIFICATION: Considering that water located the closest distance from people's homes, such as water found in rivers is not safe for drinking, it shall be necessary to purify these water sources, to allow more people to have access to clean water. Sand and clay filters can be an effective, affordable, and a simple alternative instead using chemicals or boiling water.

WATER WELL: Wells can be constructed by digging or drilling into the earth to extract groundwater. Groundwater is naturally stored 20–600 feet below the earth's surface (but can be over 3,000 feet deep in some areas). Although constructing wells can be very inexpensive, many communities do not have enough resources to provide drills, fuel, electricity, or solar power needed to reach water buried deep below the surface.

4.1.2. Provide sustainable sanitation services through a reuse approach

According to the 7th MDG goal objective, an adequate treatment and disposal of wastewater contributes to better ecosystem conservation and less pressure on scarce freshwater resources. Careful use of water resources prevents contamination of groundwater and helps minimize the cost of water treatment (Source: MDG definition of indicators, PDF). Appropriate sanitation and wastewater management systems through:

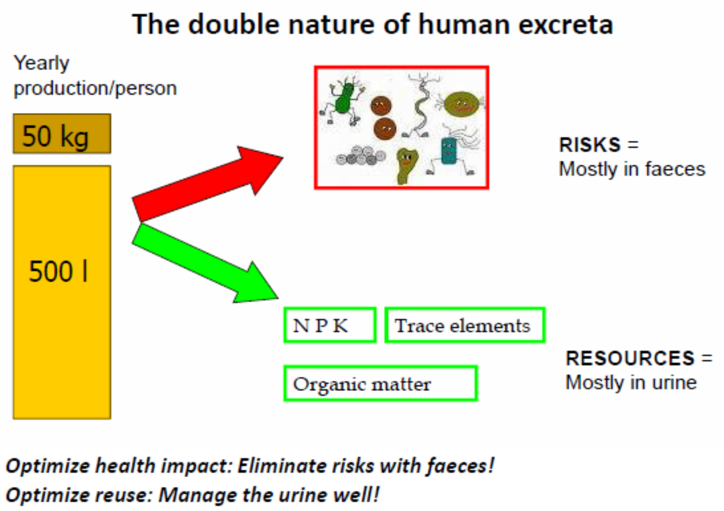
- Small scale and decentralized water and wastewater treatment and management systems: decentralized sanitation with reuse approach is particularly useful in specific conditions as: high groundwater levels, practicing open defecation, improving hygiene and health, protection of environment and public health, water saving, lack of public sewage system, need of organic and economical fertilizers, and lack of financial resources.
- Water reuse, recycle and conservation at household, decentralized wastewater collection and reuse systems: decentralized reuse system requires a change in mind-set. Apart from the technical solutions, there is a great need of awareness raising and education to achieve acceptance.
- Rudimental sludge treatment and reuse technologies: an example of cheap and simple method useful for an appropriate sanitation and wastewater management is the urine collection. Urine and faeces separation entails hygienic (like less odours, less flies) as well as practical benefits (easier treatment and handling separately, high degree of nutrient retention). In Philippine, single vault dry toilet with movable containers and double vault dry toilet – off the ground have been used successfully. The composting toilet (Fig. 4.1.2.) is another simple technology for a reuse approach, it is easily to adapt to different context. The composting toilet, called also Fossa Alterna, consist in a shallow reinforced pit toilet. It is very adaptable in all rural contexts and it contributes to the soil composting. It unit cost is about 20 USD including materials and labours.

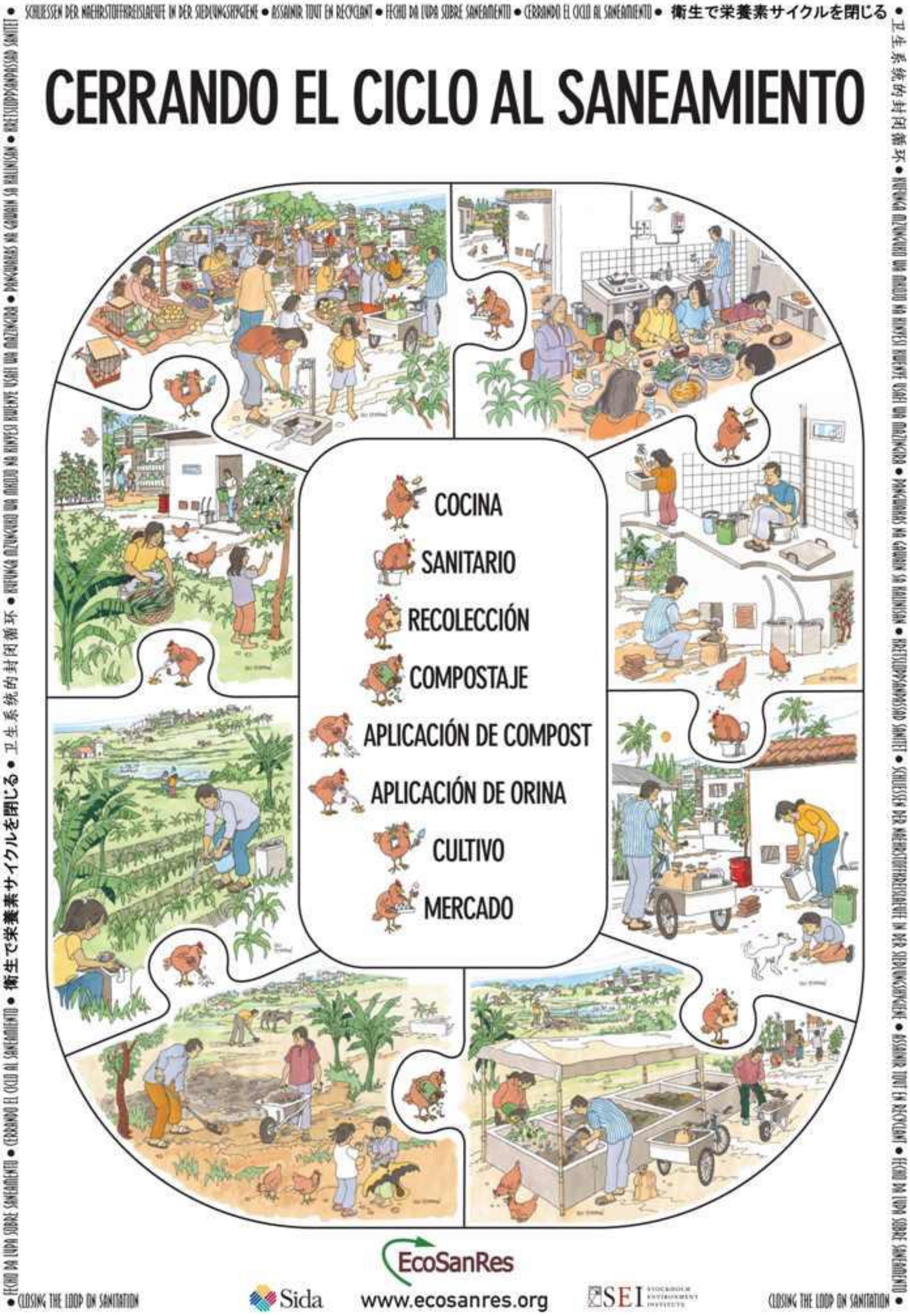
It operation is very simple. The shallow pit has to be 60-80 cm wide and 1 metre deep. Concrete slab and super-structure are put in place. Soil and ash are added regularly to the pit in addition with excreta. When it is nearly full, slab and structure are moved to another pit and tree is planted in soil fills up to the pit.

Fig.4.1.2. Composting Toilet example and its application in an indigenous community in Colombia (Source: 3.)

Need of planning and systems thinking:

"The idea that human excreta are wastes with no useful purpose is a modern misconception. It has led to the development of so-called "drop and store" or "flush and forget" sanitation solutions, where precious drinking water is used to transport excreta into the water cycle misusing our rivers, oceans and aquifers as a sink for untreated waste." (Source: 3.).




SCHLIESSEN DER NAEHRSTOFFKREISLAEUFE IN DER SIEDLUNGSHYGIENE • ASSAINIR TOUT EN RECYCLANT • FECHO DA LUPA SOBRE SANEAMENTO • CERRANDO EL CICLO AL SANEAMIENTO • 衛生で栄養素サイクルを閉じる
CERRANDO EL CICLO AL SANEAMIENTO
COCINA
SANITARIO
RECOLECCIÓN
COMPOSTAJE
APLICACIÓN DE COMPOST
APLICACIÓN DE ORINA
CULTIVO
MERCADO
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4.2. ENVIRONMENTAL PROTECTION

4.2.1. Protect the environment and natural resources from wastewater:

Another great challenge in order to guarantee better living conditions is the waterbodies protection from greywater contamination. One of the way to achieve this important objective is to improve the existing conventional sanitation with small-bore sewer system and combined it with natural treatment systems as constructed wetlands and bio ponds (Fig.4.2.1). The bore sewer system is a method to improve sludge management. The constructed wetlands is a treatment of depuration of wastewater that exploits the natural self-cleansing capacity of wetlands. A key role is played by aquatic macrophytes, which favor the creation of microhabitats suitable for the growth of microbial flora, actual responsible for the biological treatment. The wetlands treatments in fact, take place thanks to the concomitance of plants and bacteria that grow on their own root and rhizomatous systems. The removal of pollutants occurs through physical, chemical and biological processes including filtration, absorption, assimilation, by plant organisms and bacterial degradation.

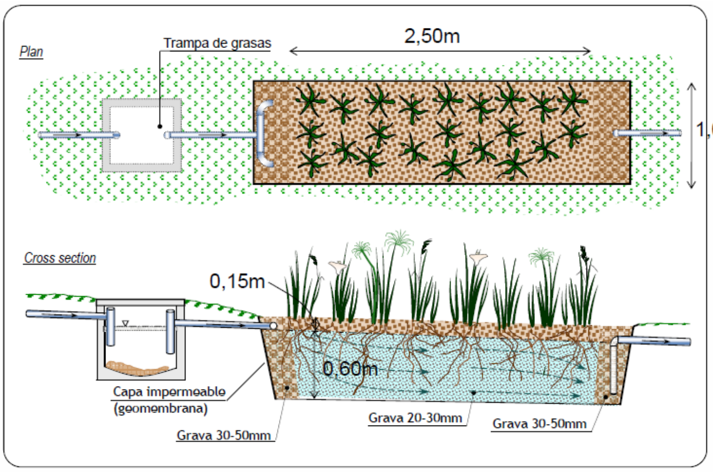


Fig.4.2.1. Bore sewer system -on the left- and a sub-surface flow wetland -on the right-. (Source: 3.)

Promote environmental protection through:

- Nutrient and micro pollutants control, recovery and removal (upstream work)
- Environmental study in loco
- Analysis of water bodies (monitoring of physical and chemical parameters, microbiology and population dynamics).

4.2.2. Reduce water contamination from agriculture production and breeding activities

In the agricultural sector, some important actions should be adopted to try to decrease the water pollution linked to this activity. First, entrust to universities and researchers of competent authorities the quality assessment of waterbodies from which rural communities collect water for their needs. In order to reach this aim is necessary to start an investigation of the toxic elements discharged into the environment and periodical monitoring of them. Moreover, control and evaluation of Enterobacteriaceae in drinking water and raw water use should be a primary objective research on the quality of them.

With the aim of reduce the runaway use of pesticides, farmers could be provided by simple means – technical tools and knowledge- by which they can determine when insect population have reached levels that justified pesticides applications.

Another solution is the development of ecologically methods that farmers would be easy to adopt. Some example of sustainable weapon to combat the pests are:

- By destroying crop residue, it is possible to remove a primary tool by which whitefly and leaf miner infest neighbouring crops.
- Simple trap made of yellow plastic sheeted coated with engine oil, further reduce the population of these insects.

By adopting such measures, farmers could reduce insecticide applications by as much as 60 to 70 percent. Obviously is not possible to stop the use of pesticides suddenly and still get reasonably good yields.

An alternative way to lower the pollutants and excess nutrients concentration in waterbodies is starting with constructed wetlands little basins close to the breeding productive infrastructure. These low environmental impact solutions contribute to the purification of wastewater before it reaches the tributaries immediately downstream. If the constructed wetlands work efficiently this method could be considered as a way to recover wastewater.

Reuse the wastewater is a method, which will implement a rational and sustainable management of water resources. In this way farmers could reduce the use of some fertilisers as well considering that wastewater coming from breeding production are rich of elements necessary for agriculture as Phosphorus and Potassium. To reuse nutrients coming from breeding production wastewater, small scale constructed wetlands are necessary in order to remove the main loan micro pollutants. Once it works efficiently, water and excreted N, P, K could be reused for crop production (Fig.4.2.2.1). To make a sustainable reuse of greywater and wastewater is fundamental to monitor the pathogen amount and manage the eutrophication. Both, pathogens and eutrophication are indicators of water quality depending also on flow streams.

Some guidelines for farmers to fertilize with urine and other sub products by scientific institute like SEI (Stockholm Environment Institute) are available (Fig.4.2.2.). Translation in Spanish and spreading within rural Antioquian communities shall be a good next step.

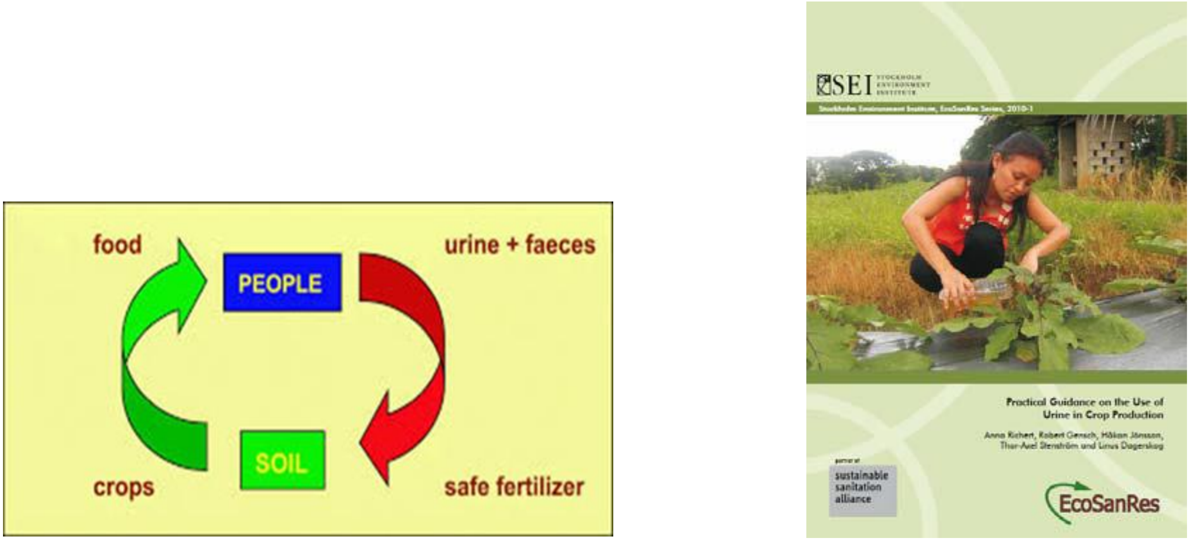


Fig.4.2.2. Practical guidance for the use of urine in the crops production (Source 3)

Fig.4.2.2.1. Application of treated urine in corn cultivation -Liquid fertiliser-. Application of treated faeces in banana plantation - soil conditioner-(Source 3)

To save water should be indispensable to convert cattle farms in chicken flocks, goats and sheep. These livestock breeding, needs less quantity of water than the cattle ones.

4.2.3. Protect the environment from ASGM

4.2.3.1. Reduce the water pollution in rivers and guarantee the aquifers protection

Significant reductions in mercury releases from ASGM can be obtained by introducing mercury-free techniques and low cost mercury capturing devices that allow a high rate of recycling. Take-up of such techniques will depend on training miners that will need to take account of the wider socio-economic and development contexts of the sector.
To restrict the large amount of mercury discharged in the waterbodies should be essential to better control its excessive use. This is possible through the construction of community retorts for recovery of mercury.
COMMUNITY RETORT: This is a low cost technology and in the meantime a simple and easy maintenance. It ensures a centralized separation of gold amalgam mercury and also allows parallel organizational strengthening community around the retort. The system consists in building a deposit box heating in bricks with a cavity inside, where the amalgam will be burned, connected to a side steel tube where mercury vapours will be conducted outside. The steel pipes will be submerged in a tub with water storing capacity at ambient temperature condensing steam inside the tubes. These tubes pass through the sidewall of the tub where the condensed mercury is collected into a container. This method is already used in Peru and it is easily applicable in all regions.
To limit mercury negative impact on the environment produced by mining activity, it is necessary to promote the technological improvement of gold extraction process. Some innovative, appropriate and sustainable technologies for the extraction are the sedimentation systems of sludge contaminated with mercury and the process water recirculation.
WORKED WATER AND SLUDGE TREATMENT PROCESS: This methodological proposal is based primarily on improving small boxes or on existing clarifiers in producing mines sand. Water is accumulated to be recycled, ensuring that it not flows into water bodies.
Another important step to reduce mercury contamination in water bodies is the implement of sustainable practices to manage water at informal mining sites. Especially, adopting methods such as constructed wetlands to treat worked water in gold mining sites.
RECOVERY OF SOIL AND WATER CONTAMINATED WITH MERCURY: This initiative uses appropriate methodologies for the decontamination of water and soils contaminated by mercury via phytoremediation as a practical and feasible method from environmental, biological, economic and social point of view. The plants bio accumulative capacity is used to treat contaminated soils.
The first step determines the levels of contamination in water and soil of the interested area. It starts with the process of training and awareness in communities affected, for the proper management of mercury and good management of their waste. In parallel, appropriate plant species are identified to treat water and soil in the defined area. The next phase on the field, tests and monitors the development and growth of plant species, verifies the efficiency of purifying capacity of the plant and the performance of contaminated soil and water treated.

Nevertheless, mercury is also well known for its toxicity and every effort should be made to reduce and substitute its use. From an environmental and occupational health standpoint, amalgamation is no longer an acceptable technology, but it is also necessary to consider that for the artisanal miner whose daily survival depends on the sale of a few grams of gold, it remains the best available technology (Source: 13.).

In conclusion, the solution could be to introduce not expensive sustainable practise in order to compete with the cheap and rudimental informal technologies used. By concentrating ores with basic separators or more expensive industrial centrifuges, miners can reduce the amount of mercury needed for amalgamation by up to 90%, Veiga says.
To guarantee water protection from mercury pollution, industries collaboration is needed. They should invest in cleaner and more effective techniques that do not require mercury, resulting in a better control of releases of mercury and other pollutants. Nevertheless, the industries must invest and commercialize alternatives to mercury-added products.

4.2.3.2. Reduce the changes in natural sedimentation in rivers

First of all it is necessary to measure and monitor metals, mine acid drainage and sediment suspension in mining sites waters in order to reduce the changing of natural state in surface and underground waters caused by these elements.
A future challenge should be to invest more in studies, researches and analysis that allow knowing better these phenomena.
For instance:

- To develop studies and plans to assess the state of watersheds that have been affected by high sedimentation due to mining and evaluate changes in hydro-morphology over years.
- To promote analysis of watersheds strained by the increase of sediments and undermining activities that are changing the natural dynamics of rivers.
- To enhance the number of scientific research to evaluate presence or circulation of pollutants in watershed systems.
- To invest more in studying the behaviour of elements used for mining operation within the hydrological and ecological systems as well as in a plan for proper management of backhoes.

4.3. HEALTH AND SAFE

4.3.1. PROMOTE HEALTH AND HYGIENE:

Access to safe water is a basic human right. The WHO (World Health Organization) is convinced that interventions in water supply, sanitation and hygiene are estimated to reduce diarrhoeal incidence, on average, by a quarter (25%) and child mortality by 65%. (source: 41.)

Health protection could be leading through:

- Integrated WASH approach
  Health aspects of WASH systems: A model is being given by the WHO (World Health Organization) Guideline for the Safe Use of Wastewater, Excreta and Greywater. WHO has recognized the potential of using excreta in agriculture. It promotes a flexible multi-

barrier approach for managing the health risks and series of measures/barriers along the entire sanitation system from 'toilet to table'. Each of the barriers has a certain potential to reduce health risks associated with the excreta use. This guideline also recommended to put in place several of these barriers (if needed) in order to reduce the health risk to an acceptable minimum. Exist different ways to treat sanitation products. Some of them are written afterword:

- Drying (faeces)
- pH increase using ash (faeces)
- Digestion (sludge)
- Composting (faeces with or without urine)
- Storage (urine, faeces, sludge)
- Lactose-fermentation (faeces)
- UV (faeces/sludge)
- Ammonia/pH (addition of urea to faeces/sludge)
- Burning (faeces/sludge)

(Source: 27.)

- <u>Sanitation Safety Planning (SSP)</u>

Sanitation Safety Planning (SSP) is a step-by-step risk based approach to assist in the implementation of the 2006 WHO Guidelines for Safe Use of Wastewater, Excreta and Greywater in Agriculture and Aquaculture. The approach can be applied to all sanitary systems to ensure the system is managed to meet health objectives. SSP assists the users to: systematically identify and manage health risk along the sanitation chain; guide investment based on actual risks, to promote health benefits and minimize adverse health impacts; provide assurance to authorities and the public on the safety of sanitation-related products and services.

The SSP manual is targeted at a variety of users at different levels including; health authorities and regulators, local authorities, wastewater utility managers, sanitation enterprises and farmers, community based organizations, farmer's associations and NGOs. SSP brings together actors from different sectors to identify health risks in the sanitation system and agree on improvements and regular monitoring and underscores the leadership role of the health sector.

Function based sanitation planning should be useful to decrease the risks of diseases through several actions:

- Contain excreta and faecal matter reducing pathogen vectors, odours and promoting hand-washing facilities.
- Encourage accessible latrines (private or public) for users. They have to be 24 h access to facility year-round, safe and sheltered.
- Promote greywater management uprooting stagnant water in compound, stagnant water in streets, pathogens vectors.

Implement pilot programmes based on reuse methods quali metodi for the reduction of pathogens, organic material, nutrients and micro-pollutants in greywater that reach the downstream creeks.

5.3.2. Reduce the health problem linked to ASGM

A priority must be given to stop the insane practice of bringing mercury to the urban (with urban is intended in the workplace in the villages where informal miners work without any kind of protection) environment, either to amalgamate the whole ore in cocos or to burn amalgams in gold shops.
MERCURY CONDENSING SYSTEM OR FILTER is able to reduce the levels of mercury in the Colombian communities if tonnes of mercury continue being burned and dispersed into workplace atmosphere. Retorts are badly needed and have been introduced in Antioquia by the UNIDO* Colombia Mercury Project to be used in the field. Condensing systems for gold shops must be installed to trap only residual mercury (around 2–5%) when retorted gold is melted. Efforts to lower mercury emissions should aim to support miners and their livelihoods by supplying access to better technology. (Source: 25)
Spread a practical guide for how to reduce mercury uses in ASGM published in 2011: UNEP recommends a two-step approach: 1) by limiting mercury uses with improved practices, 2) move toward mercury-free technologies that either boost or maintain miner income while protecting health and the environment.
*UNIDO (United Nations Industrial Development Organization) Colombia Mercury Project, that, in partnership with the Government of Antioquia, are assessing the gold production and mercury pollution in the region in order to demonstrate cleaner production technologies.

In order to reduce health problem linked to the consume of contaminated water, crops and fish, should be useful to spread filtering systems to breakdown the amount of Hg into the water.
In conclusion, to realize research programs that reveal the state of the environment in the affected areas would be an indispensable step to improve quality of life of Antioquia rural communities.

4.4. GOVERNANCE ACTIONS

4.4.1. How can get the funds to build, maintain and update water service

Water access can be improved with the addition of centralized water distribution systems within each community. The construction and/or rehabilitation and funding for these new water systems can often effectively be done through a Public-Private Partnership (PPP), social action funds and democratic cooperatives. A PPP is a relationship between a local government and a private operator to provide a service to the community that would be too difficult for the local government to perform alone. In the case of water, a private operator would build, maintain, and update and help fund water services for people living in rural towns. Social action funds are large development programs that help local governments and communities build infrastructure. The local community can form democratic cooperatives with an elected board of officials to decide on the implementation and financing of water systems. Additional funding would come from community members, nongovernmental organizations, and/or social action funds (see Water Management Systems). With funding from their contracts with the local governments and grants, loans, or funds from international organizations, local banks, businesses, and/or social funds, private operators of the PPPs will be expected to actively maintain, rehabilitate, and expand the water distribution systems under their contracts. (Source: 40.)

4.4.2. For a sustainable agriculture and breeding activity

Colombian government shall finance control measures to reduce water contamination caused by pesticides and fertilisers use. Investment in agriculture is essential and sustainable practises and technologies that conserve resources while leading to improvement in food productivity need to be developed, assessed and promoted. *("family farming in Africa, overview of good agricultural practices in sub saharan Africa").* An Environmental Management Plant must be implemented with special emphasis on the proper handling of the effluents, on the conservation of water sources, on the treatment plant installing and modernizing, according with the current legislation on environmental matters.

More generally, environmental policy and legislation are needed. Municipalities must take control of all micro and macro basins suppliers for drink water.

4.4.3. Reduce the informal mining activity: take holistic approach for ASGM

Informality is one of the most serious barriers to development, benefitting only intermediaries and corrupt bureaucracies. Legislation is controlled by each individual country and as a result is difficult to be externally influenced. However, several countries have started to enact legislations enabling ASGM and are experiencing positive effects from integrating artisanal miners into the formal economy. Large sector restructuring programs, usually supported by the World Bank, Regional Development Banks or the European Community, can be most effective in providing legal advice to governments when based on Poverty Reduction Strategies that include a realistic baseline assessment of the ASMG sector. Good governance is also progressively becoming a central issue of bilateral development cooperation. *(Source: 13).*

Local government has the role to ensure regulatory frameworks that promote the transition to mercury-free products, and investment in best available techniques by mines continuing to use or release mercury. The great issue to work on is to stop informal mining activity. One of the way is to focus International community attention on this topic. Under pressure, Colombian government would really act to fight informal gold extraction.

Low-mercury and mercury-free methods are available, but socio-economic conditions are often barriers to the adoption of better practices (UNEP, 2012). Persuading miners to change the way they work because mercury is a threat to them and their families can be difficult, but some good examples exist. The Sustainable Artisanal Mining project in Mongolia, supported by the Swiss Development Cooperation, is one such initiative, involving the Mongolian Government in working with miners to develop policies and technical solutions to eliminate mercury use. The Global Mercury Partnership promotes the establishment of national action plans and reduction targets, encourages collaboration and the sharing of best practices to reduce mercury use, and helps the take-up of innovative market-based approaches. *(Source: 1).*

Circumstance and strategies to reduce mercury use and the resulting water contamination for Antioquia department are explained below.

- IMPROVE THE AUTHORITY CONTROL starting an effective control system implemented by government to reduce the informal extraction. In addition, support informal miners by the Colombian government and environmental corporations to promote sustainable and controlled mining activities.

- ESTABLISH LAW and apply the existence ones to limit mercury use: A local example is being given by the New Colombian Law prohibiting the use of mercury in gold mining. In July 2013, the Colombian Congress prohibited the use of mercury in gold processing to be effective in June 2018 (Semana, 2013). It is a new federal law would forbid the use of mercury created more awareness on the miners. How effective the enforcement of this law will be and how the artisanal miners will change their techniques remains to be seen. Under pressure from the United Nations, most governments of developed countries have signed a new international agreement to limit mercury trade called the Minamata Convention (Selin, 2013).

- INCREASE THE PRICE OF MERCURY: Due to the limitations on the accessibility of mercury, the mercury price is increasing worldwide. The law mentioned above, together with international regulations on mercury trading has increased the price of metallic mercury. In September 2007, mercury was sold in Antioquia for US$ 35/kg and started increasing until July 2014 when one kg of mercury has been sold for US$ 150. This makes the mercury users more cautious regarding the use and losses of mercury in the amalgamation process. Mercury is simply not as easy or inexpensive to obtain as it was in 2010. (Source: 11.)

- ESTABLISH MECHANISM AND COSTS to rehabilitate affected basins in the near future.

- INCORPORATE CURRENT PLANS: the informal mining sector in Colombia needs to be supported by the government to promote sustainable mining. This presents an opportunity to build sustainable concepts in this sector through programs to teach informal miners ways to protect their water while continuing to generate profits. One of them is assisting them to develop their own mine plan that must include water and tailings management. This plan has to be elaborated according too specific environmental, social and technical necessities of each job site where the current Water Resources Plan and Environmental Plan Management of Aquifers of the regions should be incorporated.

Moreover, the elaboration of these plans needs interdisciplinary teams such as: government, academia, technical experts, stakeholders and the community involved (miners). The development of this program must be connected with current water management plans in the regions and with the Environmental Plan Management of Aquifers that the government and environmental corporations and universities are working on after have assessed the mining risk for the aquifers. The main aim of this current plan is to create a sustainable use of water resource. (Source: 5.)

- PROMOTE RESEARCHES AND STUDIES ON THIS TOPIC: the number of international studies, researches, reports on the ASGM related problems in Antioquia area attract the global attention. The "Improving water management for informal gold mining in Colombia" review has identified that the three priority areas for the departments of Antioquia in Colombia are water pollution, aquifer protection and changes in natural sedimentation in rivers. Most of these problems are caused by the absence of formal governance of numerous mines where immediate economic benefits are not balanced with the benefits of sustainable practices. Different institutions including Government of Colombia, Universidad Nacional de Colombia, Universidad de Antioquia, Corantioquia, ONUDI and BioRedd have been working on research and support programs to reduce pollution impacts left by poor mining practices that deal with the care of natural and social resources. Affected areas in these regions need to be measured through research programs that reveal the state of the environment. These studies can involve the current effect of certain contaminants on water quality, human health and ecosystems. Furthermore, they should include the analysis of watersheds strained by the increase of sediments and undermining activities that are changing natural dynamics of rivers. These studies are an important tool for planning, monitoring and designing strategies to enhance the current Regional Water Resources Plan to achieve a sustainable balance between meeting human needs and those of the environment. Moreover, enhance research programs and to support informal mining in the improvement of their mine plans, including development of water management and tailings management plans are further important step for a water management plan in the informal mining sector.

4.5. EDUCATIONAL PROGRAMES

4.5.1. Participation and education

The future challenge is to make Antioquia people conscious about environmental protection, water saving, health protection through educational programs. In fact, a part from the technical solutions, there is a great need of raising awareness, training and organization and education to achieve acceptance of new sustainable approaches. Acceptance and participation are resolutely required from the outset, to make the system sustainable (Fig.4.5.2). It can contribute to community autonomy and strengthen them to address environmental problems. It is important for the realisation of decentralized project. An example is given below (Fig.4.5.1):

Fig.4.5.1. Example of decentralized project lead by SEI in Mexico. (Source 3).

Capacity-building efforts should be geared towards strengthening the enforcement of existing environmental regulations on water quality and resource protection. This requires also close monitoring of drinking-water quality at the local service level through practical and cost-effective methods. (Source: 41).

Fig.4.5.2. Participatory project lead by SEI in Colombia. (Source: 3)

4.5.2. Changes of chemical culture are needed

The "chemical culture" must to change among farmers, in order to avoid the runaway use of pesticides. Need of a "chemical culture" to protect the environment and the natural resources essential for living and for the socio-economical activities, in the first of place, water. The goal of the "chemical culture" programme should be to help the farmers to use chemical products in a more sustainable way. Engage farmers in the research, giving to them key role and encouraging them to commit in these goals, as the participation does give rise to commitment. To limit water pollution and to reduce water losses during the gold extraction process could be possible through some concrete actions that promote a more responsible water use needed for the extraction:

- Engage communities, informal and formal miners, government and researchers in order to create consciousness of the importance of water in Colombia.
- Teach to the miners how to reuse process and dispose water at mine sites.
- Help informal miners to create an understanding of the connection between surface and underground waters.
- Teach to miners about cleaner procedures.
- Promote and finance educational programmes for informal workers.
- Start a strong educational intervention in Antioquia showing how "new" cleaner mercury-free techniques can increase the gold production.
- Create consciousness between miners to avoid pollution in surface waters and to plan the underground's water use for their mining activities.

4.5.3. Promote a more responsible water use

The core point is to earn miners and farmers' confidence. In fact, they will accept more sustainable changes in their lifestyle and productive activities if they will trust in the new means. It will be possible training and involving local people. After their training they could share knowledge with farmers and miners helping them to become more aware about water saving, health and environmental protection. An example is being given by the PRA approach.
P.R.A. (Participatory Rural Appraisal) is an approach that involves project staff learning together with villagers about the village. PRA is intended *to enable local communities to conduct their own analysis and to plan and take action* (Chambers R. 1992). The aim of PRA is to help strengthen the capacity of villagers to plan, make decisions, and to take action towards improving their own situation.
Chambers (1992) has defined PRA as an approach and methods for learning about rural life and conditions from, with and by rural people. PRA closely involves villagers and local officials in the process and this represents it strength.
PRA is mentioned especially because its experience shows that a small interdisciplinary team consisting of three persons is the best for conducting PRA methods. Furthermore, the team is considered the best if it consists of a sociologist/anthropologist and an agriculturist for conducting the study on natural resource management since, usage of water, forest and agriculture resources are fundamental to rural life. Similarly, a basic understanding of the society in relation to resource uses/practices is necessary. The three roles are the facilitator, the note-taker and the team-leader. The main objective of PRA is gathering information about rural communities and how they lead their productive activities. Information are used to develop plans that will improve local community's lives. This structure could be adopted for the training of a community representative chosen among native local people. This contributes to increase rural people confidence to her/him. The main role shall be gather information by water use and spread among people good sustainable practise to protect it, the environment and their health. The community representative has to be in good faith and in contact with local authorities in order to assure efficient results, (Source: 6).

Another example to making possible the proposal written above is the adoption of WUMP model. The WUMP (Water Use Master Plan) model is a planning tool and process that can be adapted to different contextual situations. A WUMP has to be practical, adapted to the local and national institutional framework, sensitive to cultural and social conditions and technologically appropriate. It is a response to the widely felt need for an instrument for local actors to address water management issues properly. WUMP is not developed around a particular project or for a specific water sector (e.g. irrigation or sanitation project) but looks at water resources, water demands and potential uses in a broad and integrating way. The planning unit is the local community, which through the planning process acquires and obtains ownership over the plan and responsibility for its implementation.

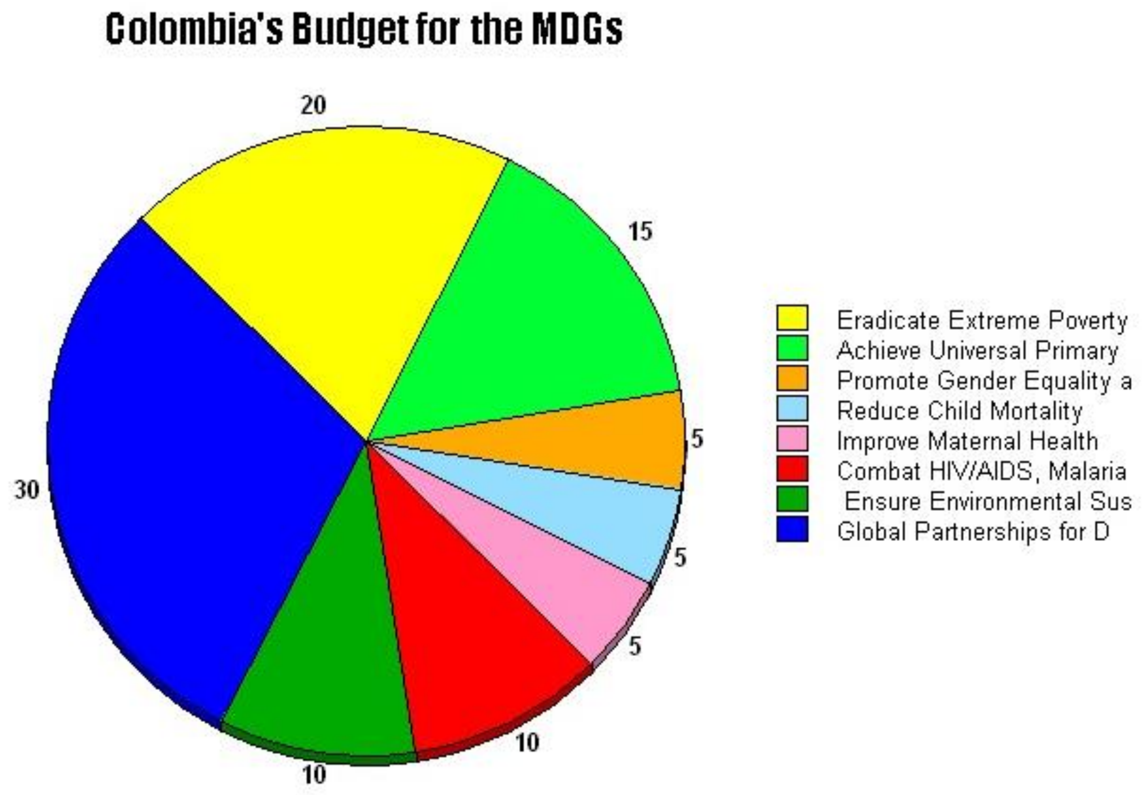
Based on an Integrated Water Resources Management (IWRM) approach, a WUMP is developed through a participatory, mainly bottom up planning process. It stresses consensus building among community members and between communities that water resources need to be shared equitably and fairly in a sustainable manner for different uses. WUMP adheres to the following principles:

- Community management
- Bottom-up process
- Inclusive process
- Strengthened local capacities
- Enhanced awareness on key issues
- Balancing water supply and demands

WUMP OUTCOMES: The development and use of WUMP has been tested so far mainly in Nepal. Therefore, the concept needs to be piloted elsewhere. The main product of the panning process is a master plan owned by local stakeholders who are committed to put it properly into practice. The plan contains a water budget (supply/demand) and includes agreements on the allocation and the use of the available water. It specifies how to minimise water losses and how to increase productive water use without negative effects on the environment and downstream communities. The plan provides also guidelines for annual and periodic planning and prioritization of activities by local bodies/authorities. It enables stakeholders to easily and regularly update the inventories of water resources and water related infrastructure/facilities. It is also a tool to approach donors and Government agencies to cooperate and to contribute or invest. On the social level a local platform for water planning is set up to ensure equal access to water resources for legitimate and basic needs. Besides the plan itself, there are important outcomes of a WUMP process, both on technical as well as on social level. Few examples, more relevant to this final report project are mentioned: WUMP process make people aware of the social as well as the economic value of water, realizing that supplying water and maintaining the system creates costs. However, water also provides opportunities for generating income, (e.g. through irrigation, or small scale economic activities). Also for this reason, it has to be protected. WUMP process contributes to the need for environmental sustainability and source protection is recognized. Water losses are identified and possible measures are proposed to improve efficiency and productive use (as often large volumes of valuable water are lost due to improper use, illegal connections from the main line, leakages in pipes and by not using excess and run-off water). Improper use of water is not only a technical issue. Often it is caused by lack of awareness, inappropriate behaviour and lack of ownership. Preparing a WUMP may involve local NGOs. A knowledge base is created where information is stored in an appropriate form for further development of the plan and for other development activities. As a highly participatory method around water, a crucial and common good, WUMP will not only improve the management of water but also the mechanisms of good local governance. (Source: 7).

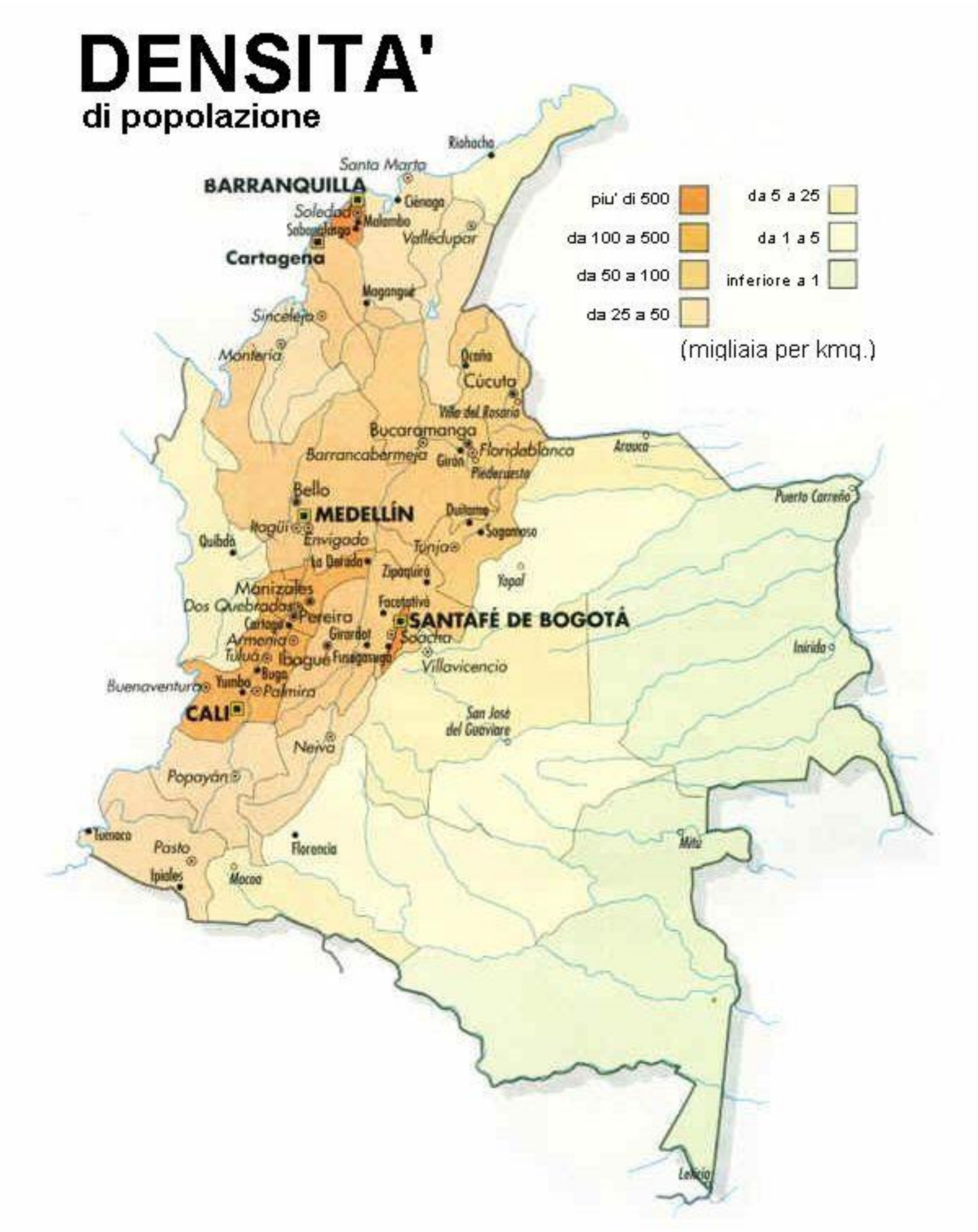
6. APPENDICES

MDG Analysis: the budget for Colombia is $10 a person for a population of 45,745,783 people. In total the budget is $457,457,830. This budget is made to invest in each of the Millennium Development Goals. Below is a pie chart of how the money would split up:

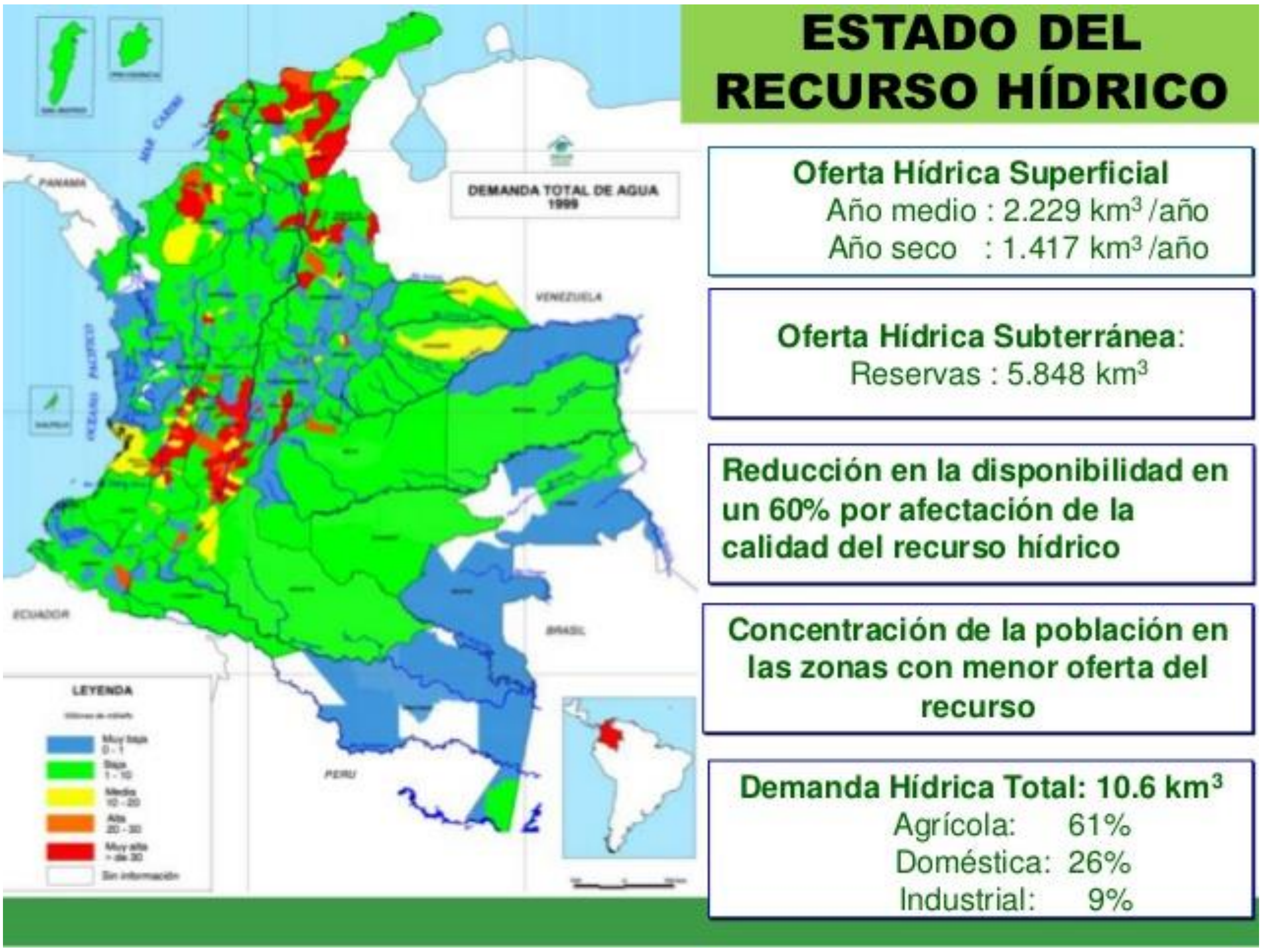


The numbers on the Pie chart are percents out of 100 percent.
- Eradicate Extreme Poverty and Hunger= 20% ($91,491,566)
- Achieve Universal Primary Education=15% ($68,618,674)
- Promote Gender Equality and Empower Women = 5% ($22,872,891)
- Reduce Child Mortality = 5% ($22,872,891)
- Improve Maternal Health= 5% ($22,872,891)
- Combat HIV/AIDS, Malaria and Other Diseases = 10% ($45,745,783)
- Ensure Environmental Sustainability=10% ($45,745,783)
- Global Partnerships for Development = 30% ($137,237,349)

Appendix 1: Colombia's Budget for the MDGs. Dark green indicates the 7th goal.



Appendix 2: Colombian population density.



Legend:

Blue: Very low 0-1

Green: Low 1-10

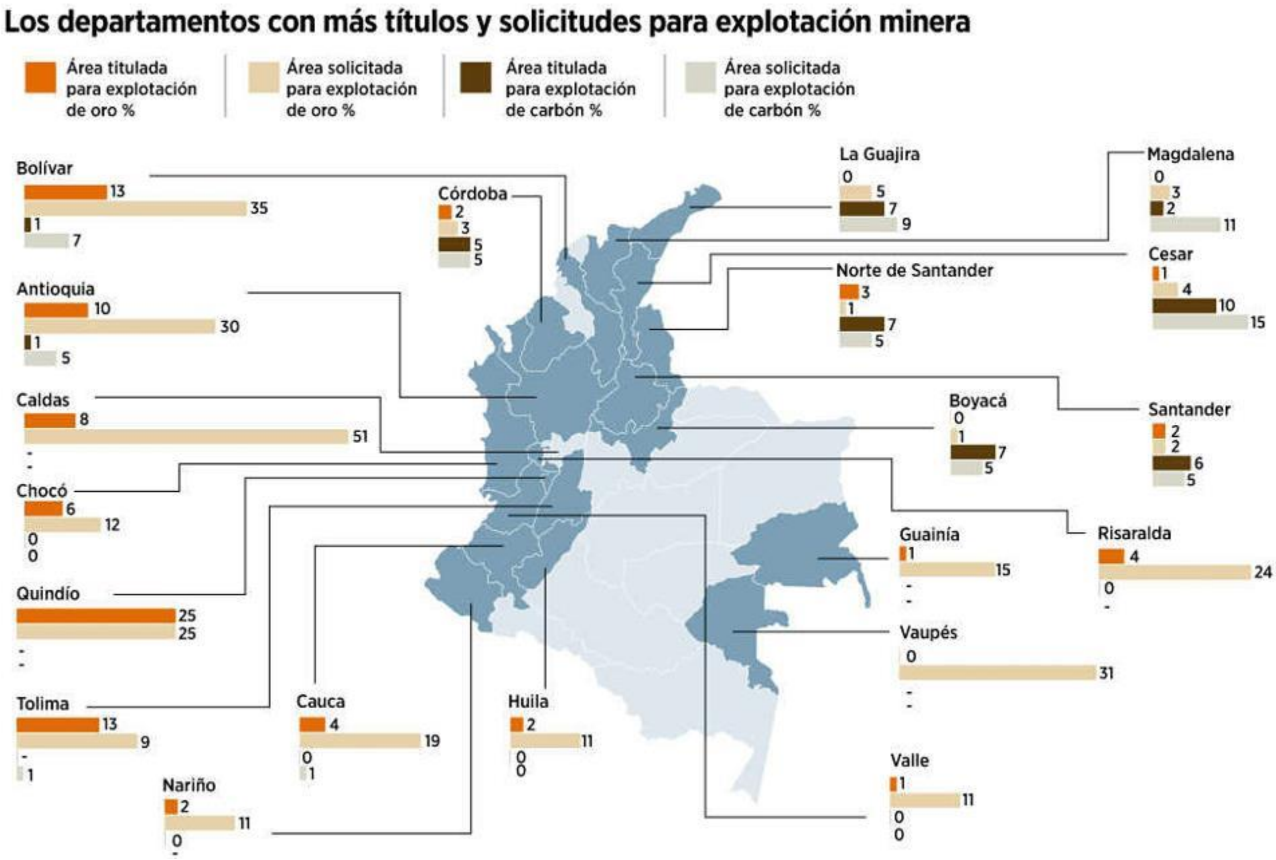
Yellow: Medium 10-20

Orange: High 20-30

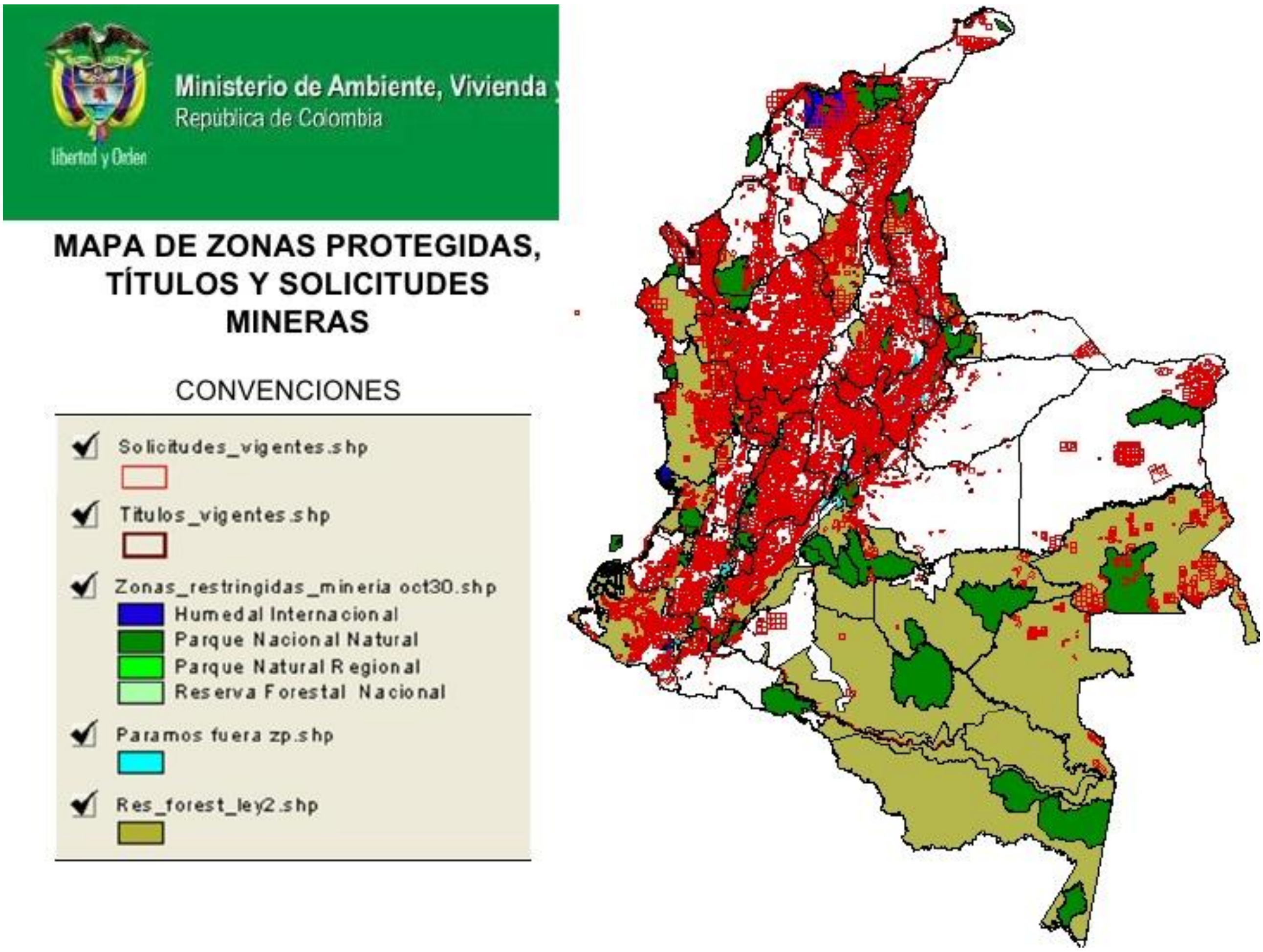
Red: > 30

White: No information

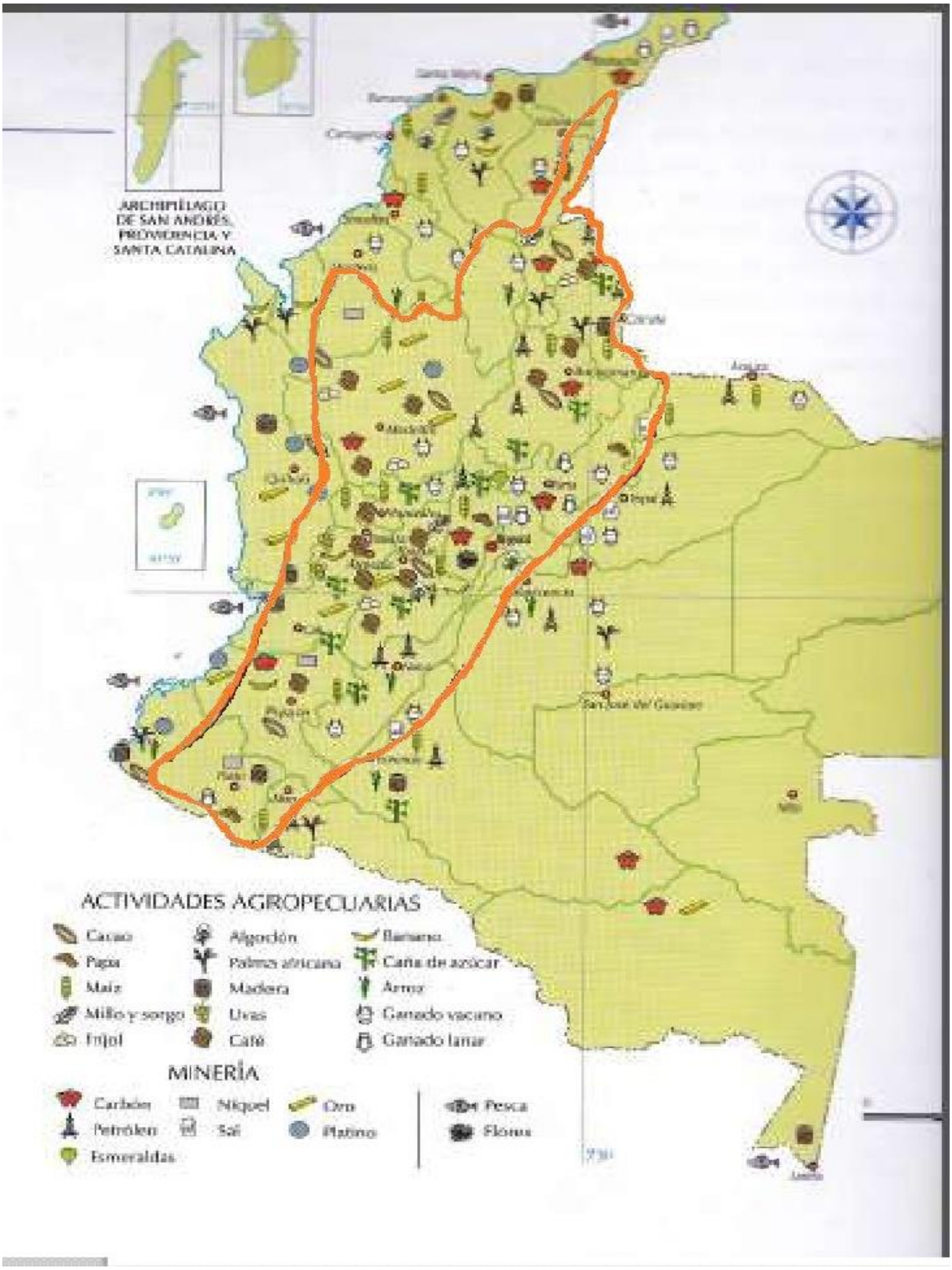
Appendix 3: State of water resources.



Appendix 4: Colombian departments with more titles and applications for mining activity.



Appendix 5: map of protected areas, titles and mining application.



Appendix 6: map of agricultural activities and mining.

Appendix 7

Policy	Initiative	Priority Action	Target			Timescale			Who act						
			Farmers	Miners	Rural people	short term	medium term	long term	environmental corporations	Communities	Government	Universities	Local service providers	NGOs	Local authorities
Managing pressures on water resources *Vision* : Supply sufficient potable water to meet wider community needs	OB) 1 Increase population with access to potable water in the rural areas	Promote concrete actions to collect water through rainwater harvesting, well constructing.	X	X	X	X				X			X	X	
		Construction and funding of new water distribution	X	X	X			X	X		X			X	X
		Implement, rehabilitate, expand of existing water distribution	X	X	X			X	X		X				X
		Improve /add centralized and decentralized water distribution			X			X	X		X				X
	Ob3) Reduce water losses	Make Antioquia rural people conscious about water saving through educational programs	X	X	X		X			X			X	X	
		Promote concrete actions to collect and save water as conservation, recycling, rainwater harvesting, well constructing.	X	X	X	X				X			X	X	
		Invest in mantainace of existing and future water distribution systems	X	X	X			X	X	X	X			X	X
		convert cattle farms in chicken flocks, goats and sheep to reduce the quantity of water needed for the productivity		X		X	X		X				X	X	
		Engage communities, informal and formal miners, government and researchers in order to create consciousness of the importance of water in Colombia	X	X	X	X			X	X		X	X	X	

Appendix 8

Policy	Initiative	Priority Action	Target			Timescale			Who act						
			Farmers	Miners	Rural people	short term	medium term	long term	environmental corporations	Communities	Government	Universities	Local service providers	NGOs	Local authorities
Managing water quality *Vision*: All Antioquia rural people has access to water of appropriate water quality	Ob2)Reduce the negative effects of productive water use on environment and Antioquia rural communities Ob2.1)Reduce the water pollution in rivers and guarantee the aquifers protection Ob2.2) Protect the environment	IMPROVE THE AUTHORITY CONTROL to reduce the informal extraction and runaway use of fertilisers and pesticides.	x	x		x	x		x		x				x
		Support informal miners to promote sustainable and controlled mining, agriculture and breeding activity.	x	x		x			x		x		x	x	
		Water Resources Plan and Environmental Plan Management of Aquifers must be implemented with special emphasis on the proper handling of the effluents, on the conservation of water sources, on the treatment plant installing and modernizing	x	x	x		x	x	x		x	x			x
		ESTABLISH LAW and apply the existence ones to limit mercury use	x					x	x	x	x	x		x	
		PROMOTE RESEARCHES and studies on these topics	x	x	x	x						x	x	x	
		ESTABLISH MECHANISM AND COSTS to rehabilitate affected basins in the near future	x	x	x		x		x		x	x		x	x
		INCREASE THE PRICE OF MERCURY to limit its accessibility	x				x				x				x
		Provide sustainable agriculture technology and free products to improve food production as well as environmental protection		x		x	x		x			x	x	x	
		Adoption of mercury-free techniques and low cost mercury capturing devices that allow a high rate of recycling (e.g. community retort)	x			x			x	x		x	x	x	
		Decontamination of water and soils contaminated by mercury via phytoremediation as a practical and feasible method from environmental, biological, economic and social point of view	x			x	x			x		x	x	x	
		Develop studies and plans to assess the state of watersheds that have been affected by high sedimentation due to mining and evaluate changes in hydro-morphology over years.			x	x	x		x	x		x		x	
		Promote nutrient and micropollutant control, recovery and removal		x	x	x			x			x			x
		Periodical analysis and monitoring of waterbodies			x	x	x		x			x			x
		Promote and finance educational programmes for informal workers	x	x		x			x		x	x	x	x	x
		Start a strong educational intervention in Antioquia showing how “new” cleaner toxic-free techniques can increase the production.	x	x		x				x		x	x	x	x

Appendix 9

Policy	Initiative	Priority Action	Target			Timescale			Who act						
			Farmers	Miners	Rural people	short term	medium term	long term	environmental corporations	Communiti	Governmen	Universitie	Local service providers	NGOs	Local authorities
Disposal of wastewater *Vision* : Protection of community health through appropriate sewerage and sanitation	Ob4) Provide sustainability through appropriate sanitation service in the poorest and most vulnerable areas of rural Antioquia	Promote an integrated WASH approach			X	X				X			X	X	
		Improve sustainable wastewater treatment installing constructed wetlands			X	X	X		X	X		X	X	X	X
		Rudimental sludge treatment and reuse technologies (e.g. bore sewer system and composting toilet			X	X	X		X	X		X	X	X	X
		Implement pilot programmes based on reuse methods for the reduction of pathogens, organic material, nutrients and micro-pollutants in greywater that reach the downstream creeks.			X		X		X	X	X	X	X	X	X
		Provide to rural population, knowledge and skills to manage wastewater at small scale level			X	X				X		X	X	X	
		Engage communities in educational programs regarding health protection			X	X				X		X	X	X	

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