Contribution to Evolution of Water Supply in Rural Areas of Santiago Island, Cape Verde

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Abstract

Given the current situation of water supply in rural areas, particularly in the Africa, it is important and urgent to develop technologies for water supply at low cost. These technologies must have features that suit to local conditions, both in terms of quantity and quality of water available.

This paper focuses mainly on the sector of water supply in rural areas with scarce water resources. Initially, it characterizes the situation of the water sector in Cape Verde and then move on to the island of Santiago. Within the country, the situation, however, varies from island to island, from County to County, and between urban and rural areas. In terms of the island, it was found that there are disparities between Counties.

It is analyzed the water supply in the municipality of São Lourenço dos Organs on the island of Santiago, where there is a great shortage of water supply services. It is one of the critical aspects for the development of the sector in rural County awareness in terms of public health, training in water supply and choice of alternative technologies. In this sense, we propose solutions, which may be used to increase access to drinking water of the rural population of the County.

Key-words: water supply, rural areas, Cape Verde, low-cost technologies.

1. Introduction

Water is an essential good to human life. However, it is a finite resource, so it should be used and managed in a rational and sustainable way. Yet, water is a vehicle of transmission of various diseases, which make it responsible for high infant mortality rates in African regions, and others, where availability is also, as a rule, poor, and this feature is poorly managed. Sill, about 1/6 of the world population (about 884 million) lack access to safe drinking water. It is expected that with the increase in population by 80 million people/year, the demand for water increases by about 64 billion m^3/ per year in 2050. Then, around 90% of the population in developing countries may not have access to safe drinking water or basic sanitation (WHO, UNICEF, 2010), if there is no improvement on these services.

However, this problem that affects the entire world is not restricted to water scarcity, it includes also quality. Although there are places with access to water, it doesn't always have enough quality to be consumed, which causes various health problems. According to the Inter-American Development Bank, which launched in 2004*Las Metas Del Milenio y lasnecessidades de inversiónemAmérica Latina y el Caribe*, 189 nations agreed in 2000 to the Millennium Declaration, that sets out matters relating to peace, security and development, including such areas as the environment, human

rights and governance concerns as being centered in that right. Among the priority goals, there is ensuring environmental sustainability that incorporates the goal of halving, by the year 2015, the proportion of people without access to safe drinking water.

The Government of Cape Verde is currently, committed to accomplish the Millennium Development Goals, in line with the efforts undertaken by the international community to eradicate poverty and improve living conditions in developing countries.

2. Situation of water supply in Cape Verde

2.1 - Geographic Location

Cape Verde is an archipelago of volcanic origin, located west of the African continent, between the parallels 4 ° and 18 ° north latitude and longitudes 22 ° and 26 ° West. The archipelago is divided into two groups, the group of Windward and Leeward group. It consists of ten islands and eight islets, which are about 500 km from the west coast of Africa (Fig. 1). It had 537000 inhabitants in the year 2012.

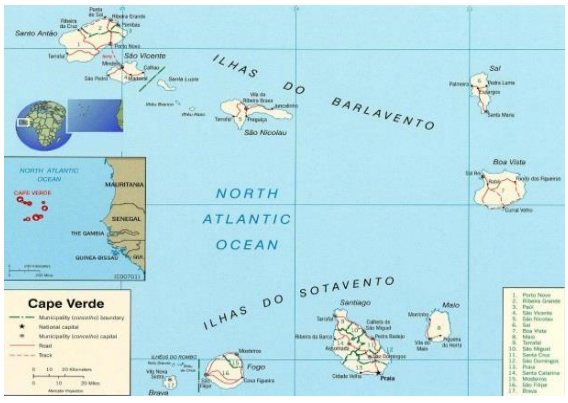

Figure 1: Map of the Cape Verde Archipelago

The climate is dry tropical with two seasons: rainy very short (August to October) and the dry season (December to June), with the months of July and November being the transition ones. The average annual rainfall is 230 mm, with a large annual variability due to strong influences that the archipelago suffers from the Sahara desert. In addition to scarce, rainfall is irregular in time and space and sometimes come in a downpour, which hinders its use. Fresh water is a scarce resource in Cape Verde, which imposes the search for alternatives to conventional water sources. The main sources of supply are: the groundwater, about 70% (holes, drainage galleries, springs and dug wells), desalinated water, about 25%, and 5% other sources.

2.2 - Water supply in Cape Verde

Since the colonization of the archipelago, one of the most serious problems is the drinking water supply, thus conditioning the welfare of the population and also the development of the country. This situation results from the local climate characteristics, in other words, rare and irregular rainfall. The power supplies used in Cape Verde are fountains, galleries, springs, wells, among others, from ancient times. With the increasing of population and growth of urbanization, the problem has worsened. According to INGRH the overall volume of groundwater exploited was estimated at 99 409 m3 / d in 3715 water points in 2008 in Cape Verde.

Access to infrastructure

In Cape Verde it appears, according to the 2010 Census, that nationally, only 51.6% of the population supplies through the public network connection, 5.8% uses public but will search her home neighbor, 23% supplies through fountains, 5.8% by pump trucks and 14.05% in supply wells, driven, among other sources, which can be considered as non-potable sources.

The population devoid of connection to the public network is supplied by fountains, pump trucks or other sources (wells and springs taken). This service is provided by the Municipality or Municipal Corporations and also by private companies that now exist, even in places where the public water supply is the responsibility of ELECTRA.

2.3 - Collection of water in Cape Verde

It is the National Water Council who sets the fee to be charged by INGRH and is the Agency

Economic Regulation who stipulates the selling price of water that the SAAS, the private and the associations are allowed to practice. It is noteworthy that in Cape Verde, the services of the sector water supply are relatively high. Water tariffs for public supply are about 4 euros per cubic meter. They are by far the highest in Africa and should be among the highest in the world. These higher prices reflect the scarcity of water resources, which means that the country depends on desalination. In addition, the cost of the desalination process that consumes a lot of energy is particularly high, due to its dependence on diesel generation on a small scale and expensive imported diesel. The high cost of water in Cape Verde can be changed or minimized by adopting low-cost technologies for power generation.

2.4 – Water supply on the island of Santiago

2.4.1 – Geographic Location

The Santiago Island is located south of the archipelago of Cape Verde, integrated in a group of Leeward Islands, between parallels 15 º 20 'and 14 º 50' north latitude and meridians 23 º 50 'and 23 º 20' West longitude of the meridian of Greenwich. Santiago is the largest island of Cape Verde, occupying an area of 991Km ² emerged. Administratively, the island of Santiago consists of a total population of 271,781 inhabitants (2010 Census) in nine (9) Counties and eleven (11) parishes. The city of Praia is the capital of the country, where much of the population of Cape Verde resides (Fig. 2).

Figure 2: Map of the island of Santiago

As is the case throughout the archipelago, the island of Santiago is framed in the types of arid and semiarid, with two seasons, a drought or "windscreen", which runs from December to June, and the rainy season or "waters ", which runs from August to October. The months of November and July are considered transition months, being able to present characteristics of the dry season or wet, as is lesser or greater the duration of annual precipitation. The warmest of the stations above is the 'waters' that occurs during the rainy season and is characterized by very irregularity. Thermal amplitudes are low, once the temperature is nearly uniform throughout the year, with the annual average of 25 º C.

2.4.2 – Water Supply on Santiago Island

On the island of Santiago is common exploitation of water from the so-called "water points", places where water is available to the surface naturally or due to human intervention. The water explored on the island is mostly from the subsoil, from 2148 water (springs, wells and boreholes), an estimated total of 53 989 m3 / d (INGRH, 2008) with the sources contributing about 44%, with holes 28% and the wells with 28%.

According to INGRH, in urban centers is estimated, on average, uptake systems in public at 50 l / person / day, and 15 l / person / day for users of standpipes. In rural areas, consumption is variable: 25-50 l / inhabitant / day for domestic connections and between 5-15 l / person / day to

other forms of supply, with average per capita consumption below that recommended by the World Health Organization, which is 20 to 40 l / person / day.

Access to infrastructure

On the island of Santiago it appears, according to the 2010 Census, only 43.5% of the population supplies through the public network connection, 6.7% use public but will pick her neighbor's house, 23 1% fuels through fountains, pump trucks by 7.1% and 18.3% in supply wells, taken, springs, among others, which can be considered as non-potable sources.

On the clusters where the population supplies itself through fountains, pump trucks or other sources (wells and springs taken), the water supply service is provided by the Municipality or Municipal Corporations and also by private companies that now exist, even where the responsibility for public supply is the ELECTRA.

2.5 - Challenges and objectives of the sector in Cape Verde

In the water supply sector, the main objectives of the Government are to ensure investment that will improve access to clean water and reduce water losses, through the implementation of projects of water supply in rural and urban areas, with assistance from bi and multilateral (UNDP, EU, UNICEF, Germany, Saudi Arabia, United States and others).The sector must be reformed and restructured so that the management and supervision thereof are improved.

It is envisaged the mobilization of about 75 million m3 of water supply by 2016, aiming to promote the modernization of agriculture. For this, it is necessary to build 17 dams, increasing the irrigated area to 3070 hectares. It is anticipated the construction, strengthening and modernization of water supply infrastructure on the part of various stakeholders and various programs that enable the mobilization of more water (irrigation and connection to the public network) and increased access and sustainable to these services for the populations of the different islands, reducing disparities between municipalities and rural and urban areas.

In July 2004, it was implemented the Second National Action Plan for the Environment (PANA) (Ministry of Environment Agriculture and Fisheries, 2004), whose objectives are to be achieved by 2014. With regard to the sustainable management of water resources, the main objectives are to mobilize resources for the construction of water infrastructure, so that the population has access to potable water, and also the reduction of water losses. They should also protect the water resources against pollution. For these objectives to be achieved, it is intended to extend and make the necessary substitutions in the water distribution network, acquiring pump trucks and accessories, open up more holes and have the necessary equipment, improve management of water resources, build dams and cisterns and use the desalination of sea water.

3. Technology Options of Water Supply - Low Cost Solutions

3.1 – Service levels and operations

According to local conditions and needs, it can be considered various technological options for water supply. In Figure 6, we present general solutions to common water supply in rural areas in Cape Verde. According to *Levels of Service (NS)*, depending on the quality of service, comfort and protection provided, and considering that as you will NS increases, the level of well-being, protection and quality of service provided to the population. Note that the appropriate system does not have to include all these operations and does not obey the order indicated in Figure 3.

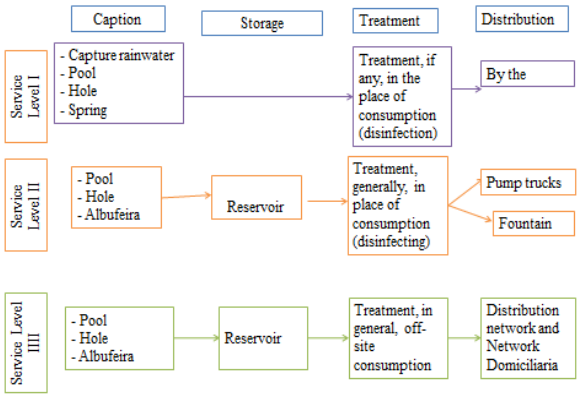

Figure 3: Levels of service system of water supply in rural areas with scarce water resources

3.2 – Eligible Innovative Tecnologies – Tecnologies of water supply

3.2.1- Captation

The most common way to capture water in Cape Verde is the groundwater in wells, springs and boreholes and surface water catchment rainfall ("rain water harvesting"). There are other methods of funding, which are not presented in this work. Figure 4 illustrates some of the most common methods of water harvesting in Cape Verde.

Figura 4: Images of options for water catchment in rural Africa. A-Water catchment rainfall, B-East, C-Hole, D-Pit

Hand pumps

There are many types of hand pumps, operating mainly in the piston, diaphragm or rotary vane principle with a check valve, ports of entry and exit to the camera operating in opposite directions. Most hand pumps are plunger or piston alternative, and are positive displacement.

Table 1 shows the elevation range of different types of pumps.

Table 1: The lifting range of different types of manual pumps

Type	Reach
Suction pumps	0-7 m
Low lift pumps	0-15 m
Pumps direct action	0-15 m
Intermediate lift pumps	0-25 m

There are several types of hand pumps, which are not presented in this work. Pumps that are presented are appropriate for conventional wells (shallow).

Figure 5 and 6 show hand pumps suction and direct action.

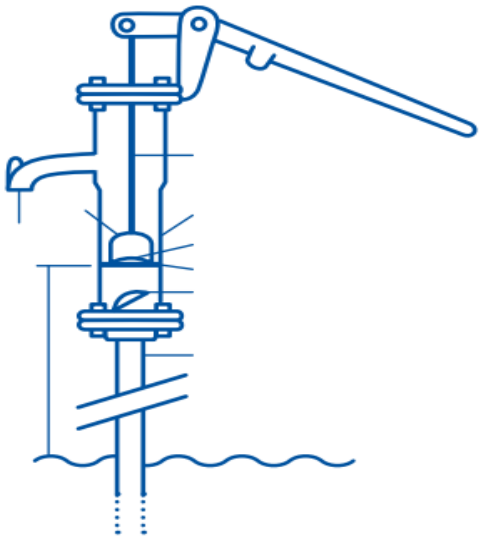

Figure 5: Pump suction

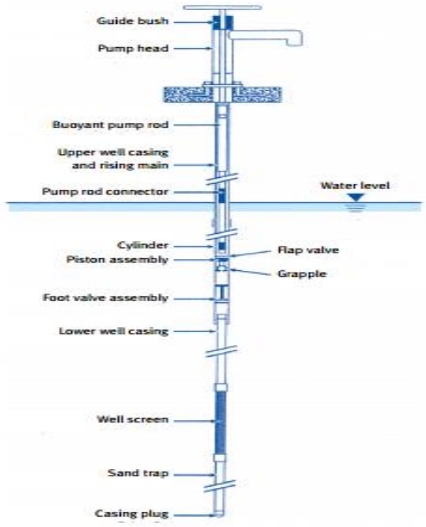

Figure 6: Pump Model Tara direct action

In Africa, many hand pumps installed do not work due to the high cost of spare parts and limited local capacity. Therefore, to solve the problems of maintenance of hand pumps were developed projects of hand pumps type VLOM (Operation and Maintenance at the Community Level).They can be constructed locally, are easy to maintain and operate, and replacement parts are at any local store building materials. The following is two examples of hand pumps (manual pump rope and push-pull), built with material acquisition easy and maintainable.

Pump manual push-pull

It is a pump comprising a circuit with valves, a cylinder-shaped with a syringe plunger to the pump. It is built with materials easily acquired. Usually found in stores of building materials. In Figure 7 there is illustrated a hand pump push-pull with all its basic components.

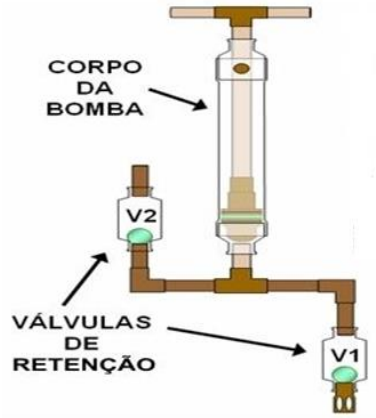

Figure 7: Pump Manual push-pull

The pump is constructed with a rope, PVC pipes, pistons and a bicycle wheel or motorcycle fixed in a holder and connected to a crank. In Figure 8 is illustrated the rope pump with all its basic components.

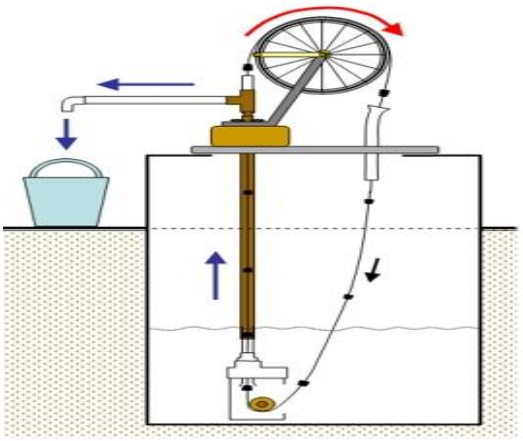

Figure 8: Manual pump rope

3.2.2 – Storage

The intermittent water supply in the public supply system drives the need to have a household reservoir for storing water and use it when the supply is interrupted. Storage in Cape Verde is essential, since the non-domiciliary network does not operate 24h / d. There are reservoirs having a capacity around 3 to 6 m3 in homes and smaller capacity (<1m3) used for storage of water (Fig. 9).

Figure 9: Domestic tanks used for storage of water

3.2.3 – Treatment

The Service Level III is ideal. However, the reality of rural areas in Cape Verde is characterized mainly by the Service Levels I and II without warranty of water quality is necessary to perform the treatment at home (boiling, disinfection with chlorine and iodine or radiation). SODIS (Solar Water Disinfection) uses solar radiation to destroy pathogenic microorganisms, which causes diseases transferred by contaminated water (Fig.10).

Figure 10: Steps of operation of solar SODIS method disinflation

3.2.4 – Distribution

According to Figure 3.1, for each Service Level there are different options for distribution of water. Includs domiciliary network in the NS III, pump trucks, fountain in NS II, and the distribution made by them the NS in I.
Figures 11, 12, 13 and 14 illustrate the distribution potions Cape Verde.

Figure 11: Fountain

Figure 12: Fountain

Figure 13: Autotanque for drinking water supply, in Baia das Gatas, Cape Verde

Figure 14: Distribution of water made by the African

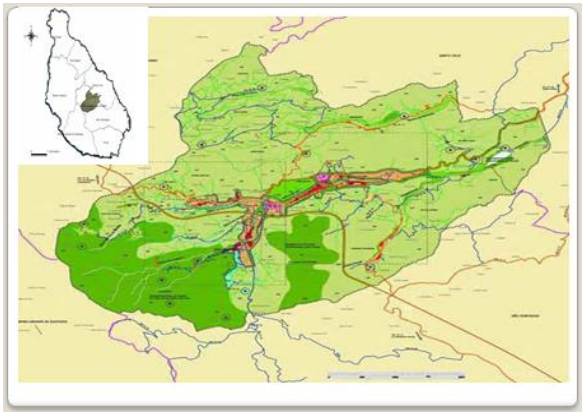

Figure 15: Plan of land of St. Lawrence Bodies

4. Supply to rural areas of the County of São Lourenço dos Órgãos

4.1 - Geographic Location

The County of São Lourenço dos Órgãos is located in the central north of the island of Santiago, confining the borders with the municipalities of São Salvador do Mundo to the north, Santa Cruz to the east, São Domingos to the south and Ribeira Grande de Santiago to the west (Fig. 15). In terms of area, it occupies a surface area of 39.5 km2 (3.950ha) which represents about 4% of the total area of the island of Santiago and 1% of the national territory. According to the 2010 Census, it has 7350 inhabitants, with 48.1% male and 51.9% female. The rural population is about 77% and the urban population is about 23%. São Lourenço dos Órgãos is a County since May 9, 2005, with the approval and publication of Law No. 64/IV/2005 of 9 May. Formerly part of the municipality of Santa Cruz, created in 1972, in full season Colonial São Lourenço dos Órgãos is one of the five most recent Municipalities of Cape Verde.

The Municipality of São Lourenço dos Órgãos is comprised by a single parish with the same name and for fifteen major areas: Achada Costa, Boca Larga, Fundura, João Goto, João Teves, Montanha, Montanhinha, Lage, Levada, Órgãos Pequeno, Mercado, Longueira, Pico de Antónia e São Jorge.

4.2 – Water supply in the County of São Lourenço dos Órgãos

The water is mostly exploited in the County is mostly of underground origin, from 102 water points (boreholes, wells and springs), an estimated total of 720 m3 / d from the wells and 913 m3 / d from the holes according to the Environmental Plan Municipal. Of this total, the holes represent 12.8% of the water used, wells and springs 25.5% 61.7%.

Access to infrastructure for water supply

In the Municipality of São Lourenço dos Órgãos, according to the 2010 Census, 56.4% of the population supplies through the public network connection, 7.8% uses public but will pick her neighbor's house, 13 2% are supplied by fountains, pump trucks by 2.1% and 20.4% in supply wells, taken, springs, among others.

It is noteworthy that there is still a significant part of the population that supplies precariously through sources that are considered as possibly non-potable (wells, taken, springs, etc..).

4.3 – Presentation of solutions for improvement of the water supply in the municipality of São Lourenço dos Órgãos

It is intended at this point to present some possible solutions or feasible, which will increase access to safe water to the rural population of the Municipality of São Lourenço dos Órgãos, aiming to improve the well-being and economic development of the same County. Within this work, solutions or proposed actions with a view to sustainability, divided into three components as shown in Figure 16. The proposals have particular application in the higher areas of the Municipality of São Lourenço dos Órgãos, where most of the population supplies precariously (wells and springs). Being the zones are comprised Boca Larga, Fundura, Montanha, ,Montanhinha and Pico de Antonia, with a total population of about 2016 inhabitants (2010 census), with approximately 66.1% (1333 people) of the population supply so precarious, with an average consumption around 13330 l / day (ie 10 l / person / day).This consumption, which is below the level recommended by the World Health organization (20 to 40 l / person / day), result in this case in 26 660 l / person / day, to a value of 20 l / person / day.

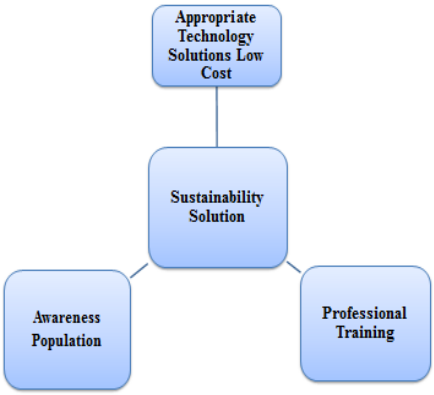

Figure 15: Schematic of the components of the proposed solution

In rural areas of the County of São Lourenço dos Orgãos there is still a good part of the population that supplies precariously, around 20.4% according to the 2010 Census, through springs and shallow wells, which are likely sources of contamination. The majority of this population is not aware of the risk of waterborne diseases.

Appropriate low-cost technological solutions

According to the INGRH average consumption is 10 / person / day. As most of the population consists of families of farmers, capitation value must be at least (40 l / person / day), in total about 53 320 l / person / day to allow also the irrigation of small gardens. The proposal consists of the implementation of hand pumps simple operation and maintenance of existing wells, in other words, the method Volm (Operation and Maintenance at the Community Level). For each zone it is expected the implementation of two hand rope pumps to get the desired consumer. Thus, it will increase the water consumption to about 53320 l / inhabitant / day, improving the welfare of the population in a sustainable and increasing their income generation, providing the County's own economic development.

A pump must operate in each zone each time and keeping the other as a backup pump in case of failure and maintenance. Due to the variability of intake over the day, it is natural to have two pumps operate continuously for prolonged periods in the case of wide mouth

Awerness of the Population

The creation of an environmental education program in schools in the county of São Lourenço dos Orgãos would consist in an asset to promote the awareness of young people and lead to a harmonious coexistence with the environment and other species that inhabit the planet. It would help the student to critically analyze the anthropogenic principle, which has led to reckless destruction of natural resources and various species. The Environmental Education Program should promote water themed activities for students with some maturity. Soon, the water theme can be approached from the 4th grade to 6th grade. To sensitize the population to the House of São Lourenço dos Orgãos must create an information program, door to door, in the case study areas. There are about 423 households (Census, 2010) that fill up

precariously. They should take advantage of technical support, which mobilizes and energizes civil society of the Institute of Agrarian Sciences of the County, and make a selection of about 30 students to participate in the program information door to door, with a duration of a period of 2:30 a.m. about 15 days a year in the holiday period (15 days in February) in order not to harm school performance.

Professional Training (Water Supply)

A professional training course in water supply would be ideal to transmit the knowledge to train competent professionals and able to handle different situations. The proposal is a course of vocational training of short duration (2 months) taught once a year with nightly regime to ensure that it does not affect the life of the target audience. The main target audiences are the householders and applicants aged over 18 years, and they should have at least the 4th grade qualifications. The aim of the course is to impart knowledge on water supply (Collection, Storage and Treatment) and especially knowledge about operation and maintenance of hand pumps, so that in case of malfunctions or maintenance needs of the pumps, it is not necessary to call in outside help, since it can be done by the expert community for this purpose.

5. Conclusions

By analyzing in the situation of water supply in Cape Verde, it was found, that it varies from island to island, county to county, and varies between urban and rural. Is important to note the characteristics of each island, as this information, including climate, hydrology, socio-economic conditions, among others, are essential to decide which ones are the best solutions to implement the level of water supply. According to the analyze of the situation of water supply of the island of Santiago, especially the County of São Lourenço dos Orgãos, there is still a significant part of the population that supplies precariously through sources that are considered as possibly non-potable (wells, springs, taken, etc..).Given the current situation of the island is possible to know what the most appropriate solutions, such as the use of surface resources (by dams), improvements to existing infrastructure, implementing self-sufficient systems, among others. Since the customs and traditions of the communities are also relevant because they influence the choice of the best solution.

Another difficulty faced is the difficulty of access to infrastructure supply to guarantee some drinking water (public fountain and fountain) of the rural population, for reasons of financial hardship or there are no such services in rural areas. As consequence, people resort to non-potable sources such as wells and springs. To fix this problem, solutions have been proposed to improve the water supply in terms of quantity and quality. Taking into consideration the financial condition of the House of the County, a sustainable and cost effective solution was proposed. It consists in the improvement of existing infrastructure (wells and springs family) with appropriate technologies of manual pumping and treatment, considering the needs of each zone.

One of the difficulties faced by the County of São Lourenço dos Orgãos is the lack of awareness of the rural population, given the importance of drinking water on human health. The public awareness on the issue is crucial to the generation of knowledge in the communities and therefore the need was identified to develop this theme. Therefore, we proposed a program of public awareness, through a program of information, door to door, and the creation of an environmental education program to raise awareness among young people in primary and secondary school on this subject. It was also proposed an action training, with the aim of providing theoretical knowledge / practical level of water (collection, storage and processing) and especially knowledge about operation and maintenance of hand pumps, so that in the event of malfunctions or needs maintenance of pumps is not necessary to use external help, since it may be made within the skilled persons in the community for this purpose.

Due to the economic problems of the county and the country, it is concluded that the solutions proposed in this work may prove an asset for increasing access of drinking water in rural areas of the County of São Lourenço dos Organs short / medium term.

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