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IMPACT OF WATER POLLUTION ON PUBLIC HEALTH AND THE ENVIRONMENT IN ORAN

IMPACT DE LA POLLUTION DE L'EAU SUR LA SANTE PUBLIQUE ET L'ENVIRONNEMENT A ORAN

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ABSTRACT

The water scarcity in Algeria is a major problem difficult to solve; in addition to a changeable Mediterranean climate, low rainfall and water pollution emphasizes this problem. Oran (west of Algeria) has suffered a long period of lack of water, due to its topography, climatology and insufficient water resources. This lack has exposed the population to waterborne diseases, and the environment to a deteriorating of its "green heritage" due to the progressive degradation of fauna and flora.

This study focuses on epidemiological field surveys by integrating several parameters, as water pollution at the source by the proximity of discharges, or the infiltration of wastewater into the drinking water network (cross-connection). Finally, an action plan to enhance citizens' quality of life was proposed.

In measures to combat water pollution, one of the most important steps is the prevention. This action requires implication of several sectors as health, hydraulics and information. Thus, the implementation of the "Information-Education-Communication" (I.E.C) plan has proved its performance in practice by convincing results, concretized by the reduction of water-borne diseases from epidemic episodes to sporadic rare case and the protection of aquatic ecosystems on both coasts and great Sebkha of Oran.

Keywords: waterborne diseases, water pollution, sanitation, I.E.C plan, littoral of Oran, great Sebkha.

RESUME

En Algérie, la pénurie d'eau est un problème majeur difficile à résoudre. En plus d'un climat méditerranéen changeant, les faibles précipitations et la pollution de l'eau accentuent ce problème. Oran (ouest de l'Algérie) a souffert d'une longue période de manque d'eau, en raison de sa topographie, de sa climatologie et de ses ressources en eau insuffisantes. Ce manque a exposé la population aux maladies d'origine hydrique et l'environnement à une dégradation de son « vert patrimoine » en raison de la dégradation progressive de la faune et de la flore.

Cette étude est basée sur les enquêtes épidémiologiques de terrain intégrant plusieurs paramètres, tels que la pollution de l'eau à la source due à la proximité des rejets, ou l'infiltration des eaux usées dans le réseau d'eau potable (interconnexion). A la fin, un plan d'action pour améliorer la qualité de vie des citoyens a été proposé.

Parmi les mesures de lutte contre la pollution de l'eau l'une des étapes les plus importantes est la prévention. Cette action nécessite l'implication de plusieurs secteurs tels que la santé, l'hydraulique et l'information. Ainsi, la mise en place du plan « Information-Education-Communication » (I.E.C) a prouvé son efficacité dans la pratique par des résultats probants, concrétisés par la réduction des maladies d'origine hydrique, d'épisodes épidémiques à quelques rares sporadiques et la protection des écosystèmes aquatiques sur les deux côtes et la grande Sebkha d'Oran.

Mots clés : Maladies à transmission hydriques, pollution de l'eau, Programme I.E.C, littorale d'Oran, Grande Sebkha.

INTRODUCTION

Population growth and economic development exercise an unprecedented pressure on renewable but limited water resources, mostly in arid regions. It is estimated that on the horizon 2025, 1.8 billion people will live in countries or regions with less than 500 m^3 of renewable water per year per capita (FAO, 2007). Although alternative solutions are proposed such as the desalination of seawater or construction of dams, the most effective guarantee implicates the protection of existing resources through the control of, firstly the water pollution and secondly improving water supply.

In this context, the 2030 Agenda for sustainable development, a wide range of initiatives was taken for effective management of freshwater resources in order to protect public health and the ecosystem (United Nations General Assembly, 2015). Water pollution is inextricably linked to the degradation of its vital qualities i.e. deterioration or suppression of water potential functions. Adequate knowledge about the pollution status of all the

water sources is thus crucial for ensuring safe and hygiene potable water (Khalid Hassan et al., 2019).The waters divide into two groups, terrestrial water and groundwater, The last group improves water supply for drinking water, however, this resource is today threatened by pollution such as inadequate supply of drinking water services, inaccessibility and / or dilapidated sanitation facilities and excessive use fertilizers, and industrial wastewater and solid waste pesticides (Boubacar, 2010) and the rapid urbanization in great cities (Foster, 2001). Freshwater represents just 2.5% of Earth's water and is increasingly threatened by human (economic) activity and climate change (Distefanoa and Kelly, 2017). The consumption of water contaminated by intestinal pathogenic organisms, whether bacterial, viral or parasitic, results from human or animal carriers and can induce the appearance of microbial diseases (typhoid fevers, bacillary dysenteries, diarrhea and gastro-enteritis. The consequence of drinking water contamination on health is the spread of waterborne diseases, leaks in the water supply networks have contributed to this decrease in drinking water. In addition to public health impact, waterborne diseases can have a significant impact on the economy of endemic countries and globally (Ngowi, 2020). In Algeria, the rate of loss of water in drinking water systems is estimated at more than 40% (Adjim, 2004). Researchers have reported connections between water pollution and acute water-borne diseases which include hepatitis, cholera, dysentery, cryptosporidiosis, giardiasis, diarrhea and typhoid (WB-SCEA, 2006; Cutler and Miller, 2005; Jalan and Ravallion, 2003; Roushdy et al., 2012). Human beings are constantly in contact with water, whether for drinking, bathing, swimming ... which makes it a privileged link. However, for various reasons, this water may be contaminated, thus creating a harmful effect on public health and environment. The relationship among ecosystems, urban settlements and human health is complex and multifaceted (La Greca et al, 2011).

In Algeria, the water demand for the purposes of human consumption (drinking water supply the agricultural sector or the industry continues to develop (Achour et al, 2020). Water quality monitoring and cooperation between three important sectors: health, water, and information, have significantly improved the quality of life of citizens while preserving public health and the environment. For these purposes, this study also explores issues related to protection of aquatic ecosystems on both coasts and great Sebkha of Oran. As well, it is important to keep in mind that in the context of the water pollution control, one of the most important steps is the prevention. Thus, the implementation of the "Information-Education-Communication" (I.E.C) plan has proved its performance in practice by convincing results, concretized by the reduction of water-borne diseases from epidemic episodes to sporadic rare cases. The creation of sewage lifting station and wastewater treatment allows the depollution of the coastline and the great Sebkha of Oran.

This paper focused on epidemiological field surveys, based on technical and human participation between decision-makers and technicians within the health and water sectors. The goal of this study is to promote public health and prevent waterborne diseases through action on health determinants and preserving the environment across all concerned sectors: health, water, and information. This study uses local data which may

be extended to other areas with the same problem, based on a lack of water combined with pollution, to establish a specific program according to the characteristics of the area

DESCRIPTION OF THE STUDY AREA

This study was conducted in Oran; it is a coastal city in the Mediterranean, located 432 km west of the capital Algiers (Figure 1).

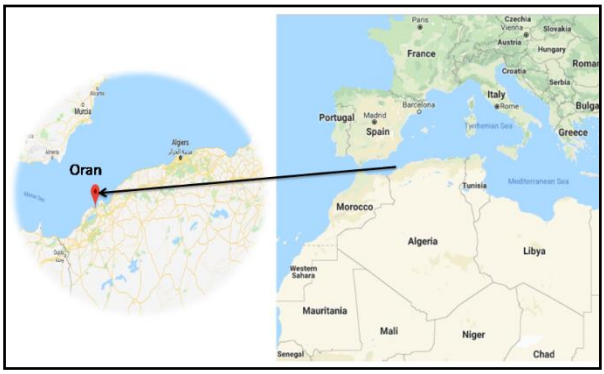

Figure 1: Location of Oran (Maps.google.com)

The water resources

Although the situation of water supply has improved considerably in recent years, the irregularity of the climate and low rainfall condition the dam fill rates and recharging groundwater in the region. Algeria, due to its climate, is a country with limited water availability and increasing water scarcity, the annual water availability per capita estimated at about 500m^3/inhabitant (CEDARE, 2014). Due to its climate, topography and low rainfall, Oran suffered from a clear water shortage previous to the completion of the hydraulic projects. Significant progress in this context has been evident for the improvement of the drinking water supply inter alia: The upgrading of Oran's drinking water supply by seawater desalination, Kahrama plant since 2006; "Kahrama "is a mixture between two Arabic words which results from "Kah" for "Kahraba which means electricity and "Ma" for water. The desalination plant of Kahrama (located 42 km east of Oran) is a combined factory which produces and supplies 344 MW of electricity and 88888 m^3 / d of drinking water intended exclusively for the human consumption (Manuel opératoire, 2005). MAO project, which consists of strengthening the drinking water supply of three areas Mostaganem-Arzew-Oran (MAO) corridor of 560,000 m^3/d or the realization of desalinization plant of seawater of 500 000 m^3/d.

The "health"systems: drinking water and sanitation networks (DWSN)

The sanitation drinking water systems have an important impact on the health of citizens. While these two networks perform their functions optimally and correctly, they act favorably on the daily lives of citizens by maintaining a high quality of life and preserving public health and the environment particularly for children. As claimed by (Santiago et al, 2016), lack of water impairs children's academic performance by reducing their cognitive capacities. So, the close link between drinking water systems / Sanitation - public health – environment is well established. However, there are many factors that disturb the normal functioning of the both systems, thus threaten the life of consumers. In Oran, the parallelism between drinking water and sanitation systems assumes that at any time, these networks may come into contact due to any malfunction, the interaction between DWSN cause the cross connection which is the infiltration of wastewater from the sanitation system into the drinking water supply network. This problem is well known to health services in general and epidemiologists and hygiene services in particular. The cross connection appears as a result of trace fault or land subsidence. A field diagnosis was made to detect the causes of network malfunction and locate black spots.

Public health and the environment

Public health

During the years of high affluence of waterborne diseases, it was noted that in addition to water scarcity, the condition of the networks (obsolete, state of repair, compliance, operability, etc) enabled the development of diseases by cross connection between DWSN called also black-spots. This pollution has contributed to the decrease in household drinking water. Consumption of water contaminated by intestinal pathogens, whether bacterial, viral or parasitic, from human or animal carriers may induce the emergence of microbial diseases (cholera, typhoid fevers, bacillary dysentery, hepatitis A, diarrhea and gastroenteritis), therefore the spread of waterborne diseases. Waterborne diseases are notifiable diseases, as soon as a case is declared or suspected, a field investigation is initiated in order to determine the probable causes of contamination and black-spots. Thus, the recorded cases of waterborne diseases in Oran were reported in figure 2.

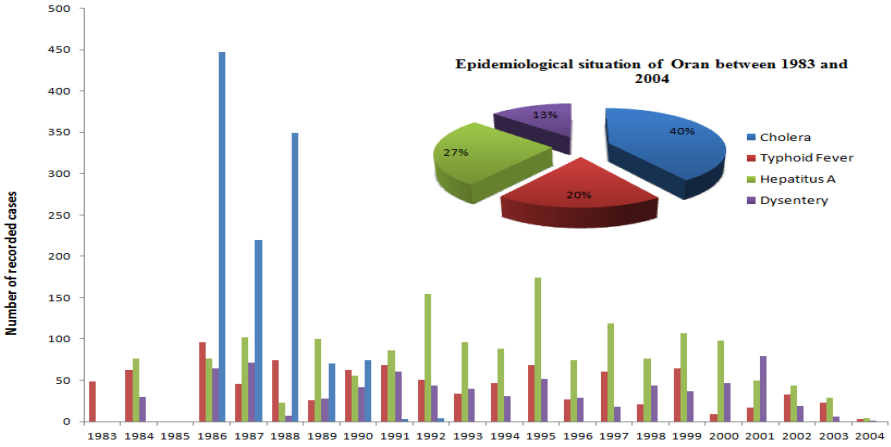

Figure 2: Epidemiological situation of Oran between 1983 and 2004 (INSP, 2017)

The environment

Oran is a coastal city in the Mediterranean and has the second largest port after Algiers in Algeria. The Mediterranean is a complex region with high biological diversity and a long history of human activity (Blondel and Aronson, 2005; Lotze et al., 2011). In addition to maritime traffic, wastewater discharges pollute the coast. Generally, more than 90 million m^3 of unprocessed wastewaters are liquidated annually by the city of Oran (Tayeb et al, 2015). On the other hand, in the south-west part 10 km from Oran; is located the great Sebkha, it is a large salt lake with an average elevation of 80 m. The site was ranked in 2002, as wetlands of international importance by the Ramsar Convention (Benziane, 2013)

The Great Sebkha of Oran was polluted by the discharges of urban and industrial waste effluents from the city of Oran and two neighboring areas which constitute the urban group of Oran. There are several types of pollutants that seem to predominate in groundwater, such as heavy metals, nutrients, pesticides and other organic chemicals and fertilizers (Ohou-Yao et al, 2020). Wastewater treatment plant was built in order to protect the environment and aquatic ecosystems; the site of the wastewater treatment plant of the Urban Group of Oran is located on the North-East edge of the Great Sebkha in a commune called El Kerma hence the name of "El Kerma Wastewater Treatment Plant" as illustrated in figure 3.

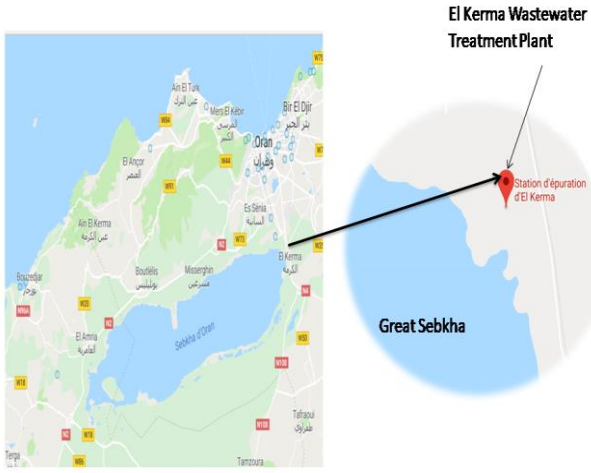

Figure 3: The localization of Great Sebkha and El Kerma Wastewater Treatment Plant (Maps.google.com)

There are also other secondary discharges flowing into the port of Oran. In order to solve this difficulty, the creation of five lifting stations allows the transfer of wastewater from the lower part of Oran to El Kerma station.

The wastewater treatment plant was commissioned in 2009 and has a capacity of 270,000 population equivalent. Part of the wastewater from the city of Oran is discharged into the bay using two main collectors: Collector East "Fort Lamoune" and Collector West "Covalawa", as shown in figure 4 the water in the vicinity of the collectors changes the color highlighting the pollution of the coasts.

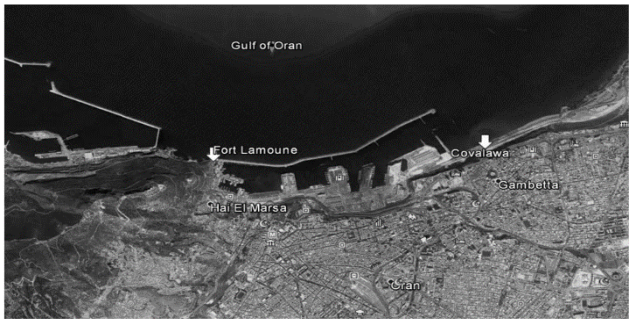

Figure 4: Location of the two collectors (http://www.earth.google.com)

METHODOLOGY AND GENERAL CONSIDERATIONS

The methodology followed in this study highlights three important interrelated aspects: (i) the water resources; (ii) the two precious networks, the "health" systems: drinking water supply and sanitation; (ii) public health and the environment. Initially, some examples of recent water resources in the city of Oran are defined, then a global view on the state of the drinking water supply and sanitation networks are considered. In a second time the interaction between these two networks: cross-connection and finally the effect of pollution on public health and the environment. The consequence of the contamination of drinking waters on health is the propagation of waterborne diseases; this requires the establishment of a process of shared control between different sectors as shown in figure.5.

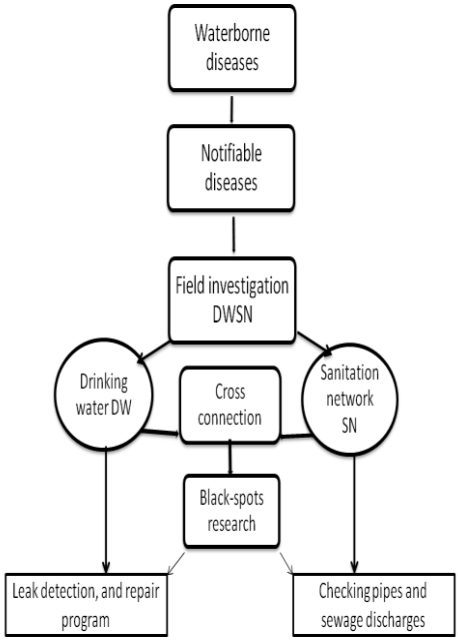

Figure 5: Investigation program on the field

Control water pollution: technical and public health programs.

This section supports a simple process based on the principle of controlling water pollution by introducing a technical and social program, including several entities, all interested parties and stakeholders related to water on the one hand, and the awareness public with regard to the management of the common resources of water and aquatic ecosystems in other hands. The current situation has become increasingly alarming and

critical not only because of water scarcity, but also and above all because of water pollution and lack of awareness of the crucial importance of this resource. Considering the rapid development of water borne diseases, anticipatory and prevention work directed at the concerned sectors (water, health, information) can be effective on the ground, thus avoiding or at least limiting the psychosis related waterborne diseases and their consequences to the population.

The technical program: monitoring of DWSN

The technical program acts on the reasons of the pollution by implementing an action plan on the drinking water and sanitation networks. The water intended for consumption can be contaminated following infiltrations or rejections. The main problem that directly affects public health is the pollution of drinking water and indirectly the environment. Water sources may be contaminated because of poor sanitary protection measures due to inadequate design, sitting, construction or operation and maintenance (Giné Garriga et al, 2015). Water pollution has many origins and may be superficial and/or, underground such as the infiltration of sanitation network into the drinking water network commonly known as "the cross-connection", leaking deficient septic tanks or overloaded sewage treatment plants as shown in figure 6. Certain number of actions whose main objective was saving water and the prevention against pollution.

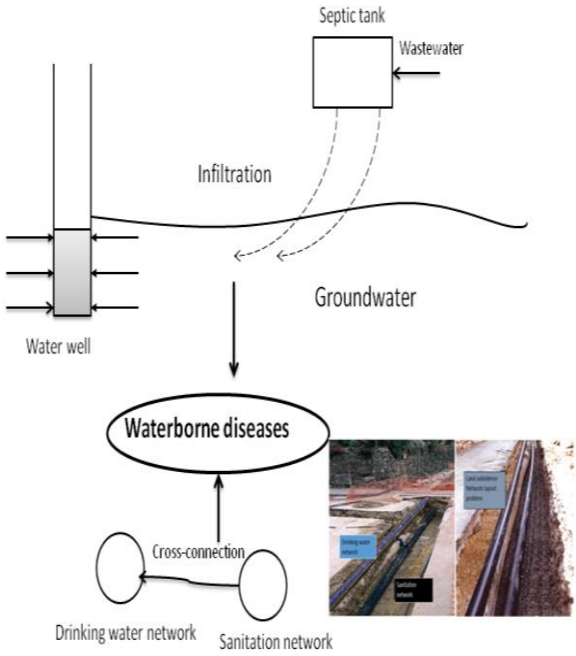

Figure 6: Probable sources of drinking water pollution

Actions by water professionals cover several fields, awareness-raising measures for water users are organized in order to ensure the fight against pollution, waste and tackling leaks. These actions are described briefly below:

- To strengthen the pressure of public opinion against the wasters and the polluters. The polluter is any natural or legal person who, by his act or activity, causes a contamination or a direct or indirect modification of the quality of the water
- Improvement of drinking water supply
- Respect of standards of potability
- Monitoring the water quality by analysis and control of bacteriological quality
- Maintenance of water points, chlorination and automatic bleaching of tanks and liming of the wells.
- Maintenance of drinking water supply networks

Following the diagnostic report on the state of the networks, the renovation and rehabilitation of DWSN were carried out from 2008; the results are reported in figure 7.

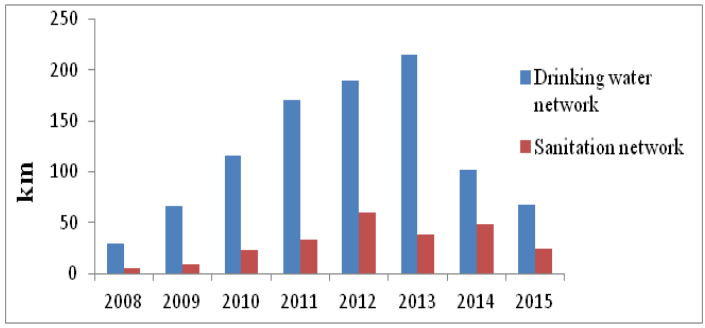

Figure 7: Rehabilitation of drinking water and sanitation networks Years: 2008-2015 (Water society – Oran)

The public health program: The Information-Education-Communication (I.E.C)

This program was instituted by health professional. Certainly, in this type of disease involving a community, human lifestyle and behaviors can have a decisive impact on the decisions to be made. It is clear that human behavior could play an important role in shaping the complex epidemic and endemic pattern of a disease (Bauch and galvani, 2013), (Manfredi and d'Onoftio, 2013), hence the importance of a program relating three important parameters: Information, education and communication. This program consists of awareness sessions in the different structures including the following three phases:

I as information: good information is needed to make consistent decisions, the information should be provided through the media (radio, newspapers…) and meetings in each municipality on pollution events and individual responsibility.

E as education: Educate consumers about the risks of water of unknown origin and increase the pressure of public opinion against wastes and polluters water. The polluter is any natural or legal person who, by his act or activity, causes a direct or indirect contamination or modification of the water quality

C as communication: It is important to listen to the consumer complaints and react favorably to citizens' grievances. Regular and draconian monitoring of water points has been put in place to ensure that conventional indicators of the microbiological quality of drinking water are in the standards

The technical and public health programs have resulted in the eradication or reduction of waterborne diseases, as shown in Figures 8and 9.

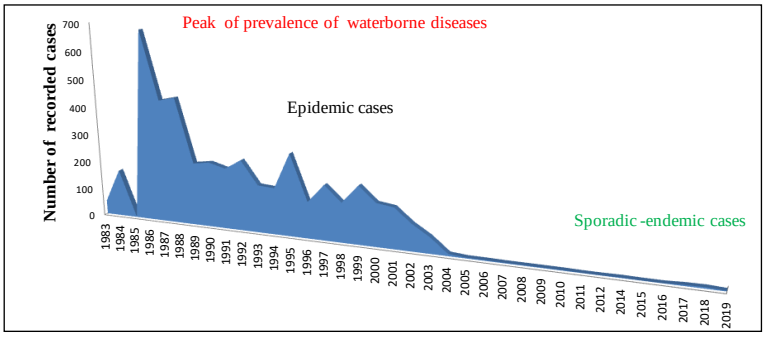

Figure 8: Reduction of waterborne diseases from epidemics to sporadic-endemic cases (INSP, 2019).

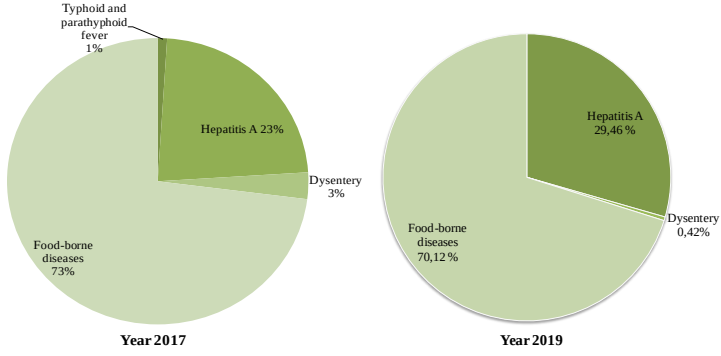

Figure 9: Estimated Incidence of Waterborne Diseases in Oran- Years 2017 and 2019 (INSP 2017, 2019)

RESULTS AND DISCUSSION

The measures taken by the health and water sectors have an evident impact on public health and environment. Epidemiological surveys and field studies carried out in the studied area showed that interventions on the DWSN, the wastewater treatment plants and I.E.C plan had positive impacts on the health and the environment

Census of the Water-related Diseases in Oran

Figure 2 illustrates the epidemiological situation of Oran between 1983 and 2004 , during this period, Oran was subjected to quasi-permanent water scarcity and lengthy stoppages in water supplies; this has resulted in the spread of waterborne diseases: cholera, dysentery, typhoid and hepatitis A. Peak of waterborne diseases with epidemic episodes was observed during the year 1986, 447 cases of cholera were recorded; 96 cases for typhoid fever, 76 cases for hepatitis A, 64 for dysentery and a total of 683 cases. These diseases result from exposure to pathogenic microorganisms or pollutants in drinking water from different sources. Waterborne disease can be transmitted through contaminated environmental water sources such as lake, river as weholell as through contaminated household water sources like pond, private water reservoir, etc. (Huq et al., 2005). On the other hand, it is difficult to conclusively situate the origin of microbial outbreaks responsible for waterborne diseases, as there are so many possibilities for contagion. Waterborne diseases are difficult to control as they have multiple transmission pathways (Tien and Earn, 2010).

Waterborne diseases are diseases subject to obligatory reporting, so as soon as a case is reported by hospital health services, a rigorous investigation program is followed to detect the factors responsible for triggering these diseases. Their list needs to be updated regularly and take into account isolated cases, and it is necessary to take care of the diffusion of statistics in conformity with the field reality. These measures have allowed the transition of diseases from epidemic cases to sporadic-endemic cases and the eradication of cholera. This period corresponds to the improvement of water reserves, interventions carried out on drinking water supply and sanitation networks and citizens' awareness.

Health public and sanitation system

The program set out working at the upstream by improving the drinking water in Oran at first and intervening on networks in a second time.

The rehabilitation works carried out on the DWSN were important and extended over a period from 2008 to 2015. As shown in figure 7, the rehabilitation was done on a total of 955 km for the drinking water network (33%); and 242 km for the sanitation network (11%). Sections requiring renovation were replaced with polyethylene pipes for the water

supply network while the other defective pipes were repaired after a leak detection companion was launched on the ground

After the improvement of the water resource, the rehabilitation and renovation of the water supply and sanitation networks, the results of field surveys are illustrated in figure 7. The most conclusive consequences substantiated by the statistics are the reduction of waterborne diseases (all diseases combined) from epidemic episodes to a few rare sporadic cases. The measures taken have led to the eradication of cholera as shown in figure 9, where only the typhoid and paratyphoid fever are present with 1% of cases; however, the emergence of food-borne disease with 73% is due the use of water of poor bacteriological quality when preparing food for year 2017. Whereas for the year 2019, no cases of thyphoid and parathyphoid fever have been reported.

There is an indisputable relationship between the sanitation system and public health in the occurrence of environmentally related diseases. Although the causes of environmental enteric dysfunction are difficult to describe precisely, it is assumed to be caused by exposure to bacteria from faecal contamination due to inadequate sanitation behaviours and unsafe sanitation systems (Harper at al., 2018); hence the necessity to challenge the conscience of citizens by involving each person.

A project for the rehabilitation of drinking water and sanitation systems has a significant impact on health since the black-spots dots were eliminated. In reality, the leaks in the water supply network are an "open door" to all the germs that come from the sanitation network. Water sector proceeded of the renewal of the defective drinking water pipes which caused leaks, 15% of losses between the production systems and the storage structures, reached a rate of 55% (MEAT, 1995). The material used for the pipes is HDPE (High Density Polyethylene), which is chemically inert and not subject to rot in water, so leakage and cross connection problems appear to be solved, but it takes several years before definitive conclusion are reached. The lack of insight into the human health relevance of many chemicals appearing in the water cycle is a growing concern for drinking water utilities (Baken et al, 2018). However, a significant number of water contaminants have been identified, demonstrating the difficulty of working downstream and the significance of educating households about this vital and yet so vulnerable resource. As argued by (Schwarzman and Wilson, 2009), there are nearly 10 0,0 0 0 registered water contaminants present in the water of daily use. After detecting and identifying the main sources of water pollution, the next step is to determine whether monitoring systems and the actions of key stakeholders are able to rapidly detect changes in epidemiological trends and emerging risks, and enable appropriate interventions to fight against disease threats in a short time. To address this complex and multidimensional problem, the most important is to protect existing reserves against pollution. The water sector contributes in the following way:

is to protect existing reserves against pollution. The water sector contributes in the following way:

- Monitoring of the water quality, protection of the superficial reserves by controlling the rejections and establishment of a periodic report on the state of the DWSN. An annual review of monitoring and management details should be added as implementation progresses. One of the important constraints and shortcomings in water sector in Algeria is that data and information systems and analytical tools on water resources have to be implemented, maintained and regularly updated (CEDARE, 2014).
- Maintenance and management of the drinking water network with regular control for the detection of leaks and check the bacteriological quality of the water, because all water exits are an entry for the polluting substances. Delivering safely managed drinking water services requires joint progress on adequate, safe, reliable, accessible and affordable water for everyone, every day (Koehlera et al, 2018).

Health public and environment

In the near-Sebkha region, during wet periods, the rise of the water table destabilizes the discharge pipe transferring wastewater from the lifting station to the El kerma wastewater treatment plant, often causing the joints to rupture. As reported by (Mahaut and Andrieu, 2019) the depth of the sewer network below the ground in relation to the level of the groundwater table has an important impact on the behavior of sewage overflows. By extending, to the different areas, this pollution affects water supply, agricultural lands and public health by causing the waterborne diseases with serious consequences on the health of children in particular and a psychosis within the population. Water-borne and water-related diseases continue to be one of the leading causes of morbidity and mortality, especially child and infant mortality, in the world (Galvão Junior, 2009).

The epidemics are caused by a quantitative insufficiency of the water resources, an insufficiency of maintenance DWSN and a lack in the management and the monitoring of the groundwater resources. However, the spread of waterborne diseases is exacerbated by social conditions such as poverty and illiteracy. The mechanisms of disease transmission and spread are usually complex and possibly involve social, economic and psychological factors in addition to the intrinsic disease biology and ecology (Wang et al, 2015).

El-Kerma treatment plant is located in the upper part of Oran, to collect wastewater from the lower part, the five lifting stations will allow the discharge of wastewater to the station, achieving the following goals:

- Coastal protection and remediation lead to the reduction of marine pollution that caused dermal and conjunctival diseases as a result of bathing summer visitors in reactive waters, close to the waste collectors
- The decrease in return and stagnation of wastewater, source of pollution and nuisance.
- The reuse of treated water in the framework of agricultural irrigation project

This program allowed the preservation of the great Sebkha therefore the environment and public health, the pollution of this wetland was causing nuisance to local residents, increasing the risk of vector-borne disease. Infectious diseases, frequently associated with wetland use include diarrhoeal diseases and typhoid fever (faecal-oral route), malaria (mosquitoes as disease vectors) and schistosomiasis (trematode hosting snails as disease vectors) (Anthonjetal.,2017). The return of migratory birds such as flamingos and waders has been noticed in the Sebkha, this restores the hope of reconstituting a healthy and sustainable environment

In the health sector, specific preventive measures have been taken with regard to the following:

- The spread of waterborne diseases can be reduced by adequate supplies of safe drinking water; suitable disposal of sewage within communities; and personal hygiene practices such as regular hand washing with safe water. A study conducted by (Giné Garriga et al, 2018), shows the importance of sanitary measures as hand washing with soap at appropriate time, in any program to preserve the health of the citizen.
- Permanent monitoring and epidemiologic investigation by ensuring coordination between the various medical sectors allow the realization of an epidemiologic investigation in the direct surrounding of the patient to detect the potential disease carriers. For example, telephone triage was useful in early detection of outbreaks in Sweden (Andersson et al., 2014). If the disease is already well developed, diagnosis, confirmation of the disease and treatment of the patient are required with all costs incurred
- The information has proven its efficiency on land in all areas and particularly for health field. Nowadays, the fast growth of information technology allows prompt and up-to-date reports on the details of disease out breaks from internet (especially those popular social networking sites), newspaper, television and radio stations, and government announcements. Consequently, these media coverage and health education will, to a large extent, affect human behavior which can lead to a significant reduction in outbreak morbidity and mortality (Wang et al, 2015)
- Awareness-raising campaigns for the population and health education are essential to overcoming waterborne diseases the coming years. Deliveries in health facilities should occur in an enabling environment ensuring adequate hygiene (WHO, 2012; WHO, 2009)

In order to reach the sustainable development goals for the coming decades, sanitation programs will have to leverage the investment of individual households, at least in the low income countries (Cairncross, 2018); especially since drought and water pollution are aggravating factors of the situation in Algeria, particularly in the western part known for its low rainfall. However, Algeria must take up the short-term and long-term challenge since it is classified among the countries which are threatened by water shortages due to climate change (Remini, 2020). In the coming years, water pollution will be a major

problem, due to two major causes; increasing urbanization has rendered cities major contributors to river pollution (most rivers are of seasonal flow and dry during the summer) (CEDARE, 2014). Although the actions taken by the health and water sectors have conclusive results for public health, the preservation of the marine coast and the great Sebkha of Oran, there is still a lot of work to be done in the future in terms of monitoring and control of DWSN, the supply of pure water free from any pollutant taking into account the several constraints (climatic, pollution, scarcity…) of the region and elsewhere. The scarcity of safe drinking water is a major problem at the present time (Sharma and 2019).

This approach is not easy as it involves variable parameters based on climatic factors, community habits and health education. Nevertheless, the hope of an immediate and definitive eradication of the waterborne diseases or at least their decrease became possible thanks to the improvement of the water supply of the city of Oran and the implication of the different public sectors and the population on the one hand, and the preservation of aquatic ecosystems on the other.

CONCLUSION

The fight against water pollution requires permanent efforts on behalf of the various institutions such as health and hydraulics. The studies carried out in Oran show that it is possible to reduce these diseases, by the settlement of a wide and continuous campaign against water related diseases throughout the year.

This study stressed the indisputable link between drinking water, sanitation network, public health and the aquatic environment. Efforts still need to be made to establish a culture of water, correlated with that of protecting and safeguarding the environment.

The health and water sectors provided an appreciable effort to protect the citizen against the consumption of polluted water, then the reduction of waterborne disease prevalence given the importance of the social impact with psychosis and death.

Wastewater lifting units allow the sewage to be conveyed to El Kerma wastewater treatment plant for purification, thus promoting the restoration of a healthy and viable environment by the cleanup of coastline and the great Sebkha of Oran.

The hope of an imminent and definitive eradication of waterborne diseases appeared during the control of water pollution and the awareness of people. However, these achievements can only be sustained in the context of a constant effort of field investigation and listening to the citizens in collaboration with the water and health sectors.

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