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Population growth and its environmental impact in Syria: A case study of Lattakia region

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This paper investigates and monitors the impact of population growth on the standard of living in the Lattakia region of Syria Arab Republic. It focuses on the effect of pollution on population growth in the region and how this affects the surface and groundwater resource. There has been symmetrical expansion of the agricultural and urban sectors in Lattakia as its population increased and this has caused negative effect on the water quality resource available in the region. For the purpose of this research, the region of Lattakia has been divided into four study areas; Firstly, Alsin River area, which is the main source of drinking water in the region, is designated as area (A1). While the east of Gable town is designated as area (A2), and area (A3) includes the main city of Lattakia and its countryside, and area (A4) is made up of the largest rivers in the costal basin. Chemical, biochemical and bacterial tests were carried out, and the results obtained shows the existence of chemical and bacterial contaminants and it was also observed that the surface and ground water in area (A1), which is the main source of drinking water in the region is polluted with bacteria *Escherichia coli*. Laboratory tests investigations carried out proved the existence of germs type *E. coli* in excessive concentration of bacteria from sewage, and high value of nitrate and nitrite ions in area A2 which are predominantly used for agricultural activities. The results from area (A3) and (A4) shows the existence of chemical and bacterial contaminations and the increase in the rates of pollution in area P1 (springs great north River Area) to the estuary area P2 (the estuary point the great north river in the sea) and the presence of a strong correlation between the number of inhabitants in the area of the river and increase in the rates and various types of pollution. This research was carried out just before the commencement of the crisis in The Syrian Arab Republic.

Key words: Lattakia, pollution, rain fall, great north river, nitrate, *Escherichia coli*, nitrite, biological oxygen demand (BOD).

INTRODUCTION

Population growth and rising demand for improve standard of living in terms of agricultural, industrial and housing activities by human being has led to many global environmental problems (McMichael, 2000). Water

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pollution is one of the most significant problem caused by anthropogenic activities by man, due to his neglect of environmental rules (wastewater, spraying pesticide, used fertilizers in agriculture, remnants of the olive oil industry, and salinity of sea water intrusion (Owens et al., 2005).

In the region of Lattakia, in Syria, wastewater (domestic, industrial and run off) is dispose off by combined sewage collection system which is discharged at several coastal sites to the north and south borders of the city. Lattakia city lacks waste water treatment facility, and all the waste water produced in the city is discharged directly to the coastal zone near tourist attraction centres and this usually causes harm and endangers the safety and health of inhabitants living in these places and negatively impact both tourist and aquatic activities (Sabouh and Chahin, 1997).

The situation in the countryside and in smaller towns in the region is much worse, sewage network covers only 30% of households and ends in the next valley, home cesspools are built without compliance with prescribed standards and becomes a source of pollution of the surrounding waters. The geological formations in the study area, such as rains, flood issue and soil erosion has a great effect on the determination of the concentration of chemical electrolytes in water and fill dams. The presence of ammonium ions is linked to a large degree of sewage leakage. And the art of drilling in areas that are not connected to sewage networks (http://www.damasuniv.edu.sy/mag/farm/old/agri_pdf/2002/18-1/kbeebo.pdf)

Microbial and biochemical tests carried out showed presence of intestinal bacteria, especially fecal coliforms (FC) at different levels of water bodies in many parts of Lattakia region, especially in the north great river estuary. This further increase the rate of pollution and contamination of water bodies in Lattakia, especially in areas prone to sewers and the rivers estuary. A good correlation was demonstrated between intestinal floras total coliforms (TC), *Escherichia coli* with FC In most areas (Salman and Mualla, 2003; http://www.arabscientist.org/english/page/369/).
Significant increase in cases of diarrhea and intestinal infections was registered in specific seasons and changes in the taste and smell of the water bodies were observed (Directorate of Environment, 2008).

With the cooperation of the Directorate of Environment, Directorate of Agriculture and the Department of Water Resources, the study and test plans were designed to specify the types and sources of pollution and their specifications in order to find cheap and adequate solutions to these issues, especially bacterial and microbial pollution(its gross) and chemical fertility. At first, water samples from four different locations were taken, these covered the region from south to north. And next samples were taken from four other points located from east to west of the north river.

STUDY AREA

Demography and human activities

Lattakia region forms the North West part of the Syrian Arab republic with an area of 2302 km^2, and the population is over 1.200 thousand people before 2010. The total land mass of Lattakia is 1.24% of the total territory of Syria, and her population is 6% of the total population of Syria, and with a population density of 520 (minimum 21, maximum 9000 inhabitants/km^2) (Directorate of Environment, 2008). The population growth rate in Lattakia declined from 3.3% in the eighties of the last century to a current figure of about 2.2% (3 Winckler, Onn (ed.), 1998) (Figures 1 and 2). The region is divided into three zones: The first is the coastal plain with a width of 3-15 km and an altitude of 0-100 m, with very good fertile soil, living here is 60% of the total number of inhabitants of the area. The second zone is the plateau area with 100 to 400 m above sea level, this area is fertile and suitable for planting trees, such as citrus and olive trees, living here is 25% of the total number of inhabitants of the area .The third zone is the mountains and highlands, which is 400 to 1600 m, it has a milder fallout to the sea and forms a natural barrier against rainy clouds in the interior of state, living here is 15% of the total number of residents of the area (Directorate of Environment, 2008). There are intensive agricultural activities in the coastal areas, including 70,000 plastic greenhouses that led to excessive and uncontrolled use of fertilizers and pesticides. The most important agricultural crops in Lattakia come from olives and citrus (1.2 mil tons/year from citrus and 160 thousand tons olives oil from 87 million trees). The cultivation of large expanse of land of citrus plantations brings about the use of pesticide, which is used to prevent pest from the large agricultural investment (Directorate of Agriculture, 2006).

The number of dams on the rivers streams is 20, the storage capacity of the dams is about 600 million cubic meters, and this is mainly dedicated to the irrigation dams and Troy 56000 ha, these are mostly located in heights above 500 m (Directorate of Agriculture, 2006). 797 facilities is registered in Lattakia region and their distribution are as follows: 309 food establishments, chemical small factories, 292 Engineering Industries and 75 Textile Industries (Directorate of Environment, 2008).

Hydrology and human demand of water

Lattakia"s water supply comes from three main sources, these are: rainfall, groundwater and surface water (Directorate of Environment, 2008). The annual amount of rainfall on the coastal basin is about 4880 million cubic meters, of which the annual average surface runoff is 1464 million cubic meters. The average runoff available

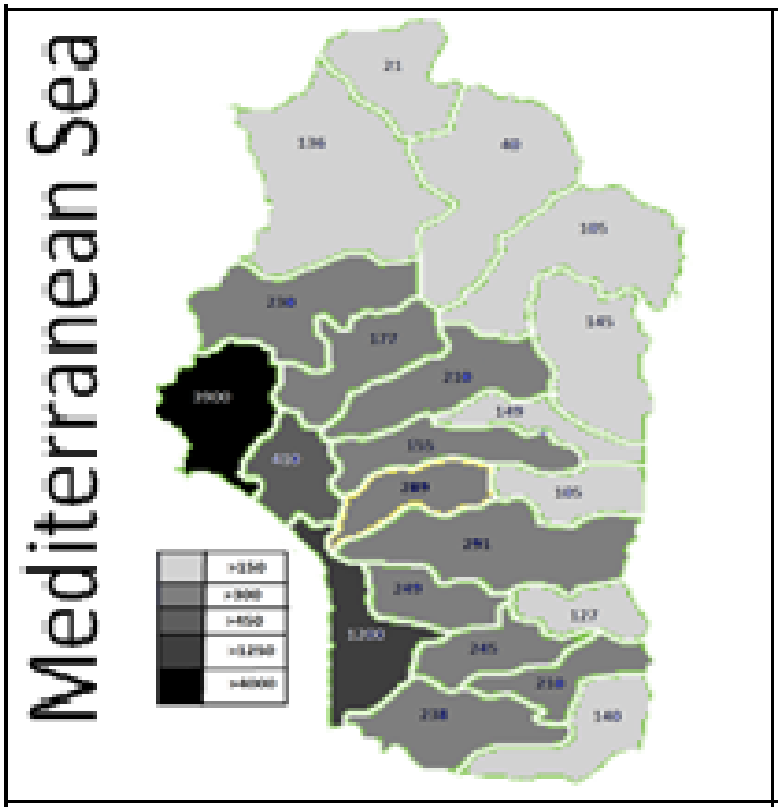

Figure 1. Population density in Lattakia (http://www.geographic.org/maps/new2/syria_maps.html).

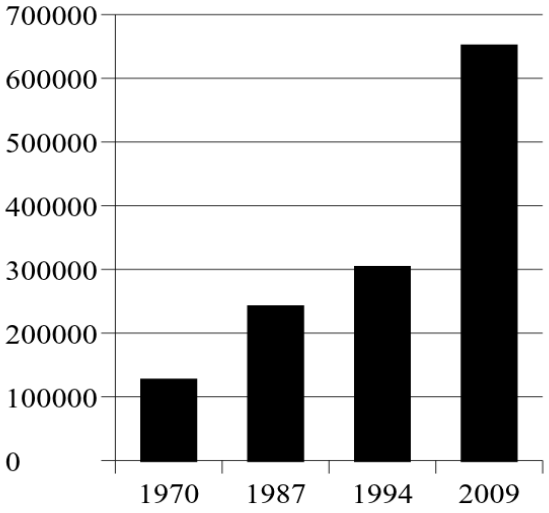

Figure 2. Population growth in Lattakia (Syrian Central Bureau of Statistics, 2010).

for use is 1414 million cubic meters of which about 560 million cubic meters is being currently used. The usage is captured as follows; drinking water is 35 million cubic meters, irrigation is 525 million meters in Mkaab.aa and the net surplus surface water is equal to 854 million cubic meters. The average annual runoff of underground water is 2830 million cubic meters, of which 1786 million cubic meters is not available due to its existence at a depth greater than 600 m. Only an average of 1044 million cubic meters runoff groundwater is available for use, of which only 478 million cubic meters is currently being used, 145 million cubic meters is used for drinking purpose, 273 million cubic meters is used for irrigation, and 60 million cubic meters is used for industrial purposes. Hence, there is a surplus of 566 million cubic meters groundwater in Mkaab.aa, from the foregoing, this area losses 586 million cubic meters by evaporation annually (Directorate of Agriculture, 2006). From the above, we find that the total available water resource, on average, each year is 2458 million cubic meters. Therefore, total runoff is 560 million cubic meters, of which groundwater flow is 478 million cubic meters. This gives a total surplus equal to 1420 million cubic meters in the basin (Figures 3 and 4).

Agriculture is the largest water-consuming sector in Lattakia accounting for about 88% of water use. The domestic and industrial water use stand at about 9 and 3% respectively (Bou-Zeid and Mutasem, 2002). The most important agricultural crops in Lattakia is olives and citrus, 1.2 Mil tons / year of citrus and 160000 tonnes of

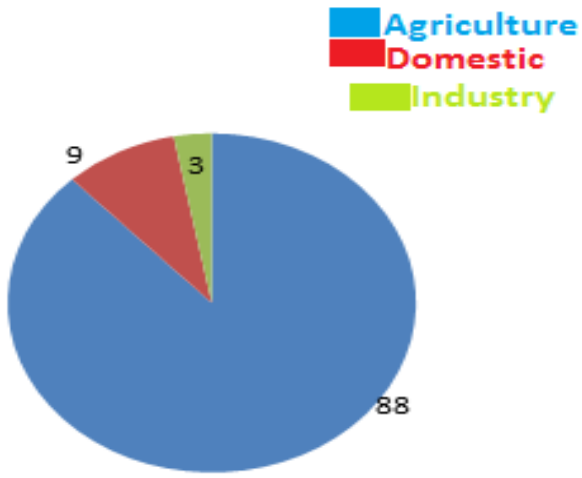

Figure 3. Water consumption in Lattakia (Syrian Central Bureau of Statistics, 2010).

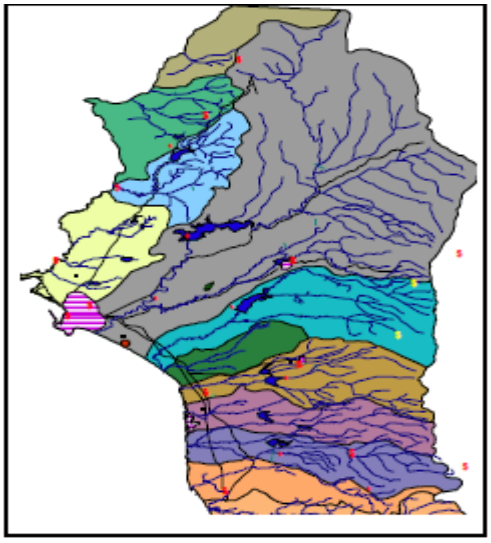

Figure 4. Water Map of Lattakia region (http://www.geographic.org/maps/new2/syria_maps.html).

olive oil of 87 million trees, the increase in the planting of these fruit trees brings about more use of pesticides (Directorate of Agriculture, 2006).

Waste water production and requirements for cleaning units

Lattakia region decided sometime ago to build a 51 wastewater plant as a response to the increase of water pollution in the region, This was actualized as five plants were built, the largest one, is located 20 km east of Lattakia with a population of about 10,000. The other end of the sewerage network is linked directly to the estuary (with 16 outlets in coastal areas) (Directorate of Environment, 2008). Currently, Lattakia city lacks waste water treatment facilities, and all the waste water produced discharge directly to the coastal area near tourist attractions which do harm and endanger the safety and health of inhabitants (Sabouh and Chahin, 1997). The countryside, where 70% of the population resides, houses are mostly equipped with cesspools, which do not correspond to basic sanitary conditions, which also has fatal consequences to the environment (Tameem, 2007) Sewage network covers 47% of total area at the countryside, In 2003, out of the 57 sewer line decided, only 27 was realized (Directorate of Environment, 2008).

METHODOLOGY

Four sections were chosen in Lattakia region namely; A1, A2, A3 and A4. The Alsen Basin area was designated as (A1). In this area contaminations in the water bodies were monitored and its relationship to the amount of rainfall values was investigated. In the Jableh area (A2). Values of bacterial and chemical pollutants in wells were compared before and after the establishment of the sewage site monitored. The main part of the experimental research was conducted in A3 and A4 (the north river basin) at four points, the first point (P1) was chosen directly upstream, the second point (P2) is located downstream, while (P3) and (P4) are located at the point of outflow of water from the Dam. Samples from area A2 and A3 and A4 were taken 6 times per year (6x/year) during the months of January, March, May, July, September, and November (1, 3, 5, 7, 9, 11) in the year 2009, 2010, and 2011. This was just before the commencement of the crises in Syria. Seasonal harvest of citrus and olive trees and rainy season were taken into consideration. The effects of rainfall on water pollution on the sites were also determined.

Measurements in area A4 (great north River) were taken to determine the kinds, level, and sources of pollution in the lake and river Basin (GNR), the relationships between human activities and high rates of pollution in the water from upstream to downstream were also determined, also the slope of the terrain corresponding with the flow of the river from the north-east to south-west was also taken into account (Figures 5 and 6).

The following pollution indicators in the four areas were observed throughout each season: (Water temperature, ph, Total hardness, Dissolved oxygen, microbiological, and nitrate and nitrite indicators). Some of these indicators were measured in the laboratory. And other measured on-site sampling, due to the fact that the sites were easily accessible and on-site inflow and outflow of water in lakes were observed, these qualities makes this points better locations for collecting samples for the research.

A digital thermometer was used to measure the water temperature, pH meter (GLI P53 analyzer) for pH measurement, (GLI D53 5600-DOS) and Winkler method was used for determining the values of oxygen demand. Also, samples to detect total fecal coliform and bacteria *E. coli* were obtained and taken to the laboratory; the chemical oxygen demand (COD) level was detected by using the measuring device Laviband ET108. The measuring Device to detect nitrate used was Nitrate sensor for lab IT-1201. The values of nitrite and nitrate were monitored. During the next bacteria measurement we concentrated on the presence *of E. coli*, Entero-Staphylo-Bactria Bacilli in water due to the increase in the value reached during the first measurement.

Bacteriological analyses were performed upon arrival of samples to the laboratory, which included counting the number of intestinal bacteria census and (FC). Water samples were collected for bacteriological and chemical analysis. Bacteriological analysis was

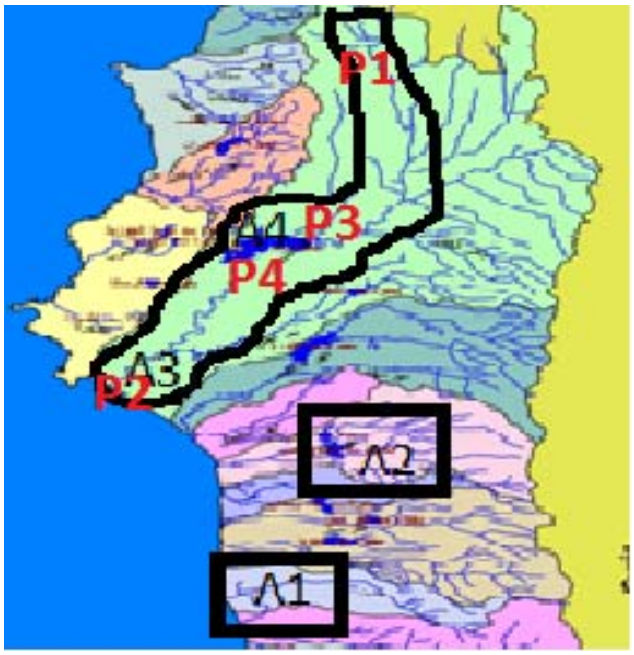

Figure 5. Studing points in region Lattakia (http://www.geographic.org/maps/new2/syria_maps.html).

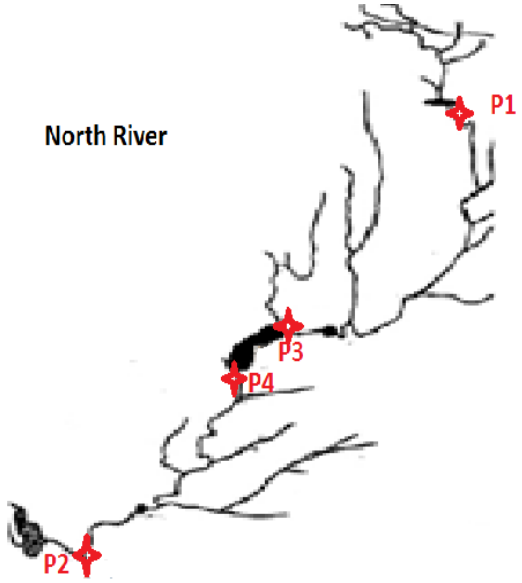

Figure 6. Great north river scheme (Directorate of Agriculture, 2006).

performed in the laboratory of Tishreen University in Lattakia, which included counting the number of (FC). For qualitative and quantitative results, the following methods were used to detect bacteria, these include: multiplier tubes, membrane filtration, brushes on the casting dish, and the dish.

A thermometer of mercury was used to measure the temperature. Further a pH meter was used to determine the degree of acidity. These methods were adopted to measure the nitrite anion to interact with stray Asalafanil acid amide in the middle of phthylamineAitelin de and Secretes composite Aso pink-N were also measured, and finally results in the diazo salt that reacts with N vaveth at wavelength 490 microns mg, and the ANOVA study was conducted using the statistical analysis of variance.

RESULTS AND DISCUSSION

Area A2

In area A2 Temperature affects the density and viscosity of water and the rate of dissolution of gases and the speed of chemical and biological reactions and thus affects the self-purification process of water. Temperature of water in the well remained within normal limits, ranging from 12.1 to 14.3 in the study period, increase in the rates of nitrates was observed in some months, this increase coincided with rainfall and agricultural activity season and close values of datas were observed in the study of the well as shown in Figure 7. Bacterial contamination values fell in the second and third year of the study, the reason is due to the completion of the drainage network building as shown in Figure 8.

Area A3, A4

In area A3 and A4 the temperature of water in the river remained within normal limits, ranging from 11.8 in January to 29.3 August. The Dam water temperature remained at a depth of 30 cm from 11.4 to 13.5 in the winter and a significant difference in the water temperature was observed at the irrigation canal, that is 13°C in the winter and the surface dam recorded 30°C in the summer (Figures 9 and 10).

BOD values slowly rose between point P1 and point P4, and there was a large difference between points P1 and point P2 located at the mouth of the river leading to the sea, this is because the impact of the increase of human activities in lattakia city and water quality in river. The BOD value remained at acceptable limits in the Dam, although the downstream water recorded the highest concentration when the annual average was 8.56 mg/L while at the Dam and at the lake it has a recording of 4.85 and 2.1 mg/L in the river, which is the lowest value as shown in Figure 9. Minimum values of *E. coli* in the water were registered in the spring and, the maximum values exceeded the permitted standards in the downstream, this is as a result of rainfall and seasonal climatic conditions and human seasonal agriculture activities as shown in Figure 10. The values of *E. coli* in A2 during realization sewers and after was noted, it was observed to have reduced from a maximum value of 245 bacterial to a minimum of around 5 bacterial. Hence, the water was then safe for drinking, all round the whole year, as it is free from bacterial as shown in Figure 8.

The pH value remained between the acceptable limits in the research sites during the study period. The

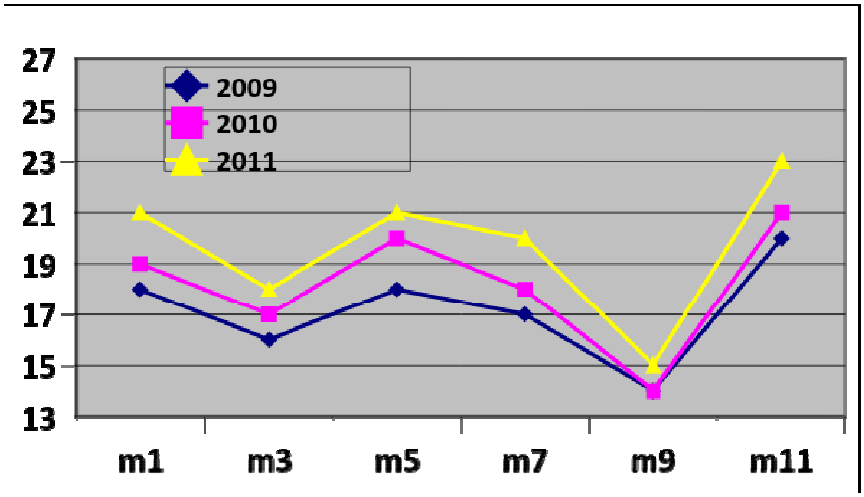

Figure 7. NO_3 value in wells area (A2).

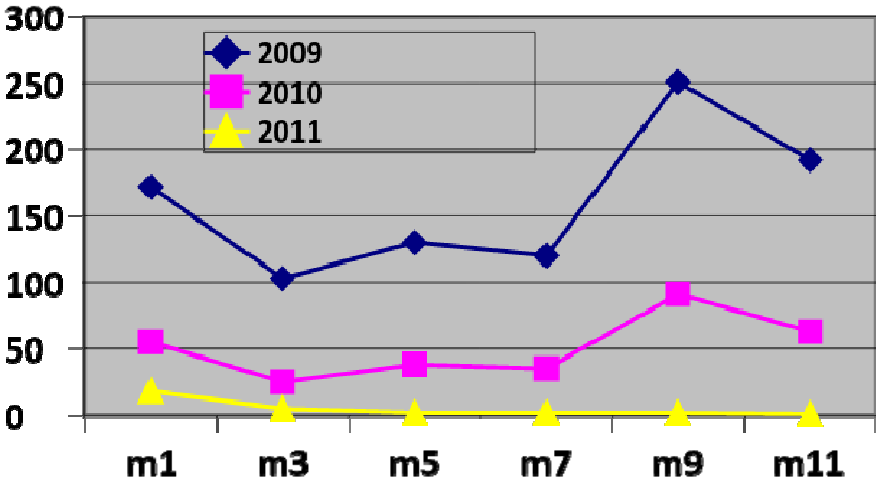

Figure 8. *E. coli* value in wells area (A2).

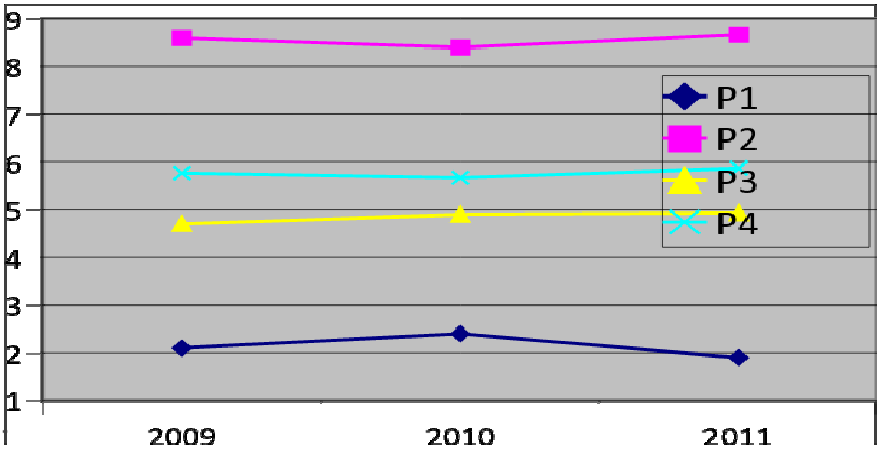

Figure 9. BOD levels in area (A3, A4).

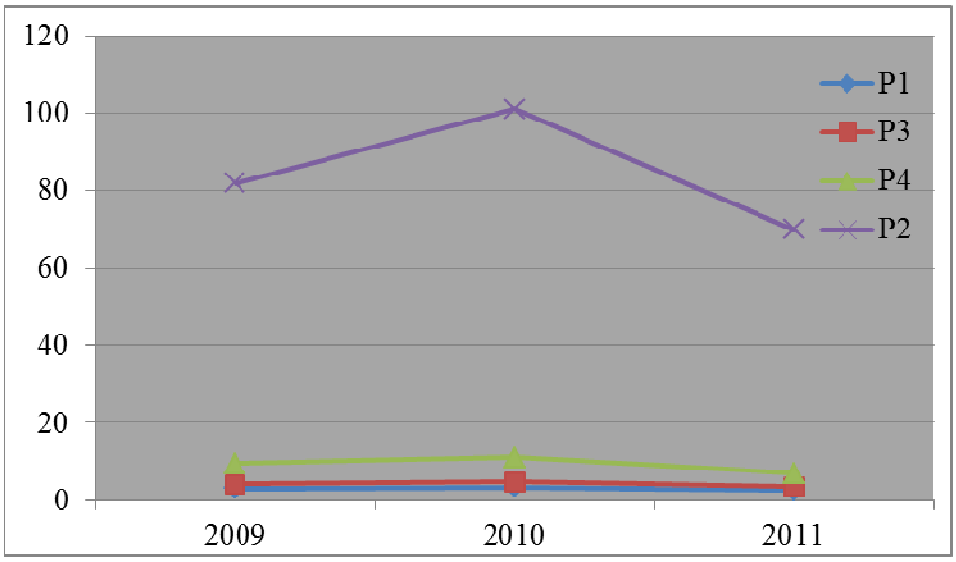

Figure 10. *E. coli* levels (A3, A4).

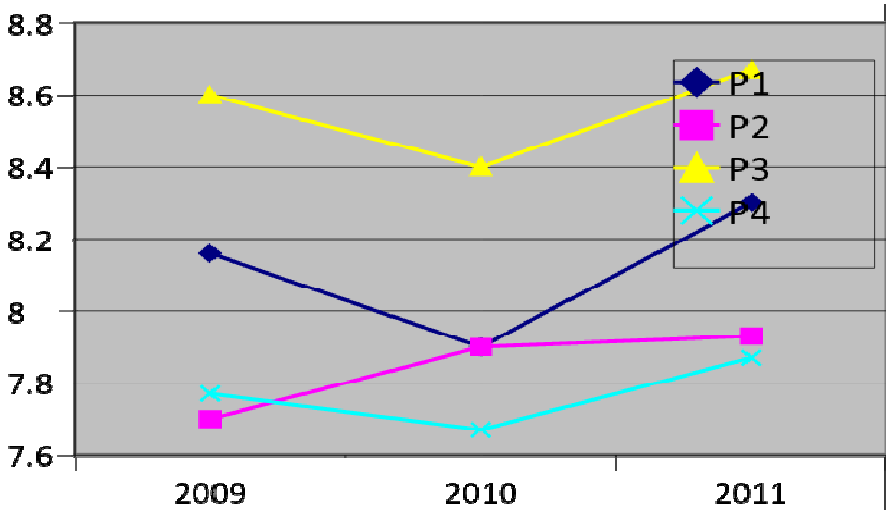

Figure 11. The pH levels in (A3, A4).

following annual average values were recorded; 8.4 in the dam lake, 8.2 in the river, and 8 in the irrigation canal. The high value of pH in both the lake and the river is due to photosynthesis of water plants that consumes a large share of CO_2 dissolved in water as shown in Figure 11, minimum values of nitrates were registered in the irrigation canal and maximum values exceeded the permitted standards in the downstream, this is as a result of changes in climatic conditions and human seasonal agricultural activities as shown in Figure 12.

Figure 13 describes the results of laboratory tests to show the validity of water usage for human, values obtained proved the existence of germs of type *E.coli* and excessive concentration of bacteria from sewage in P2.

The results show that the pollution is due to a very large extent on human activities and the results also show that the water is safe for drinking in terms of chemical contaminants and not safe for drinking in terms of bacterial in area higher than 800 m. Results obtained down the river show that, the water is not safe for drinking in every right, in areas lower than 800 m.

Conclusion

The study confirmed that, in coastal areas where there are intensive agricultural activities, water bodies are not safe for drinking as a result of contamination due to

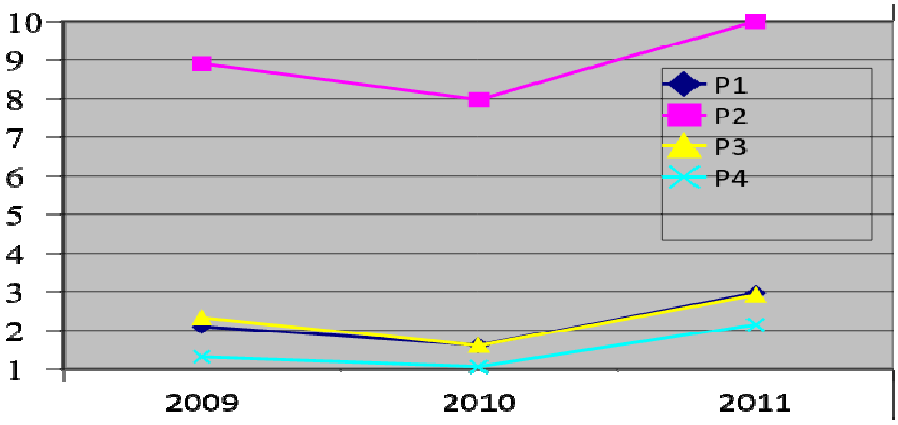

Figure 12. NO_3 levels in (A3, A4).

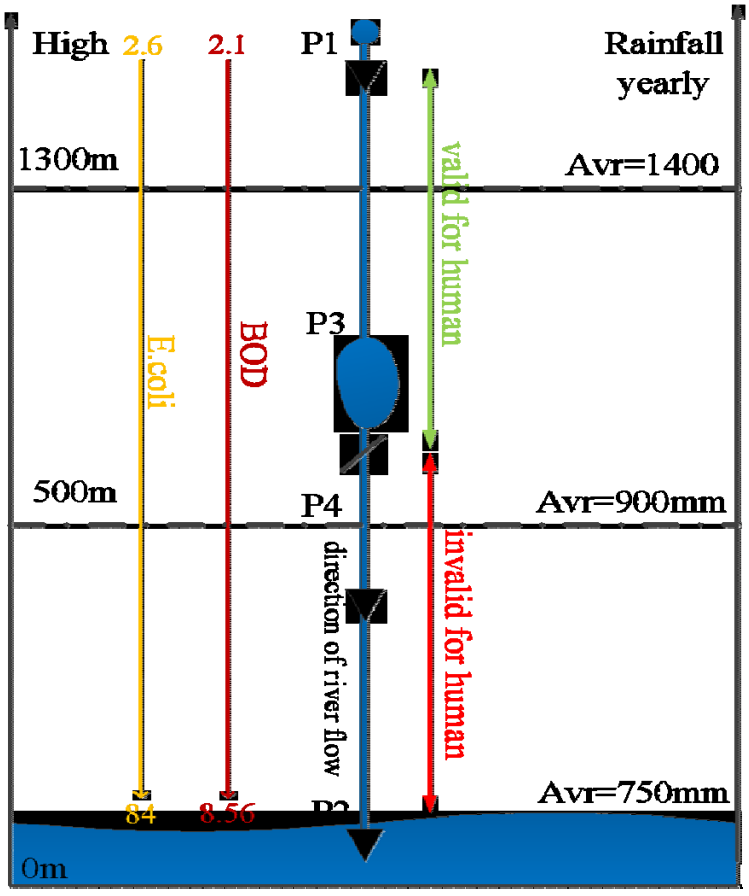

Figure 13. validity of water usage for human.

organic and chemical fertilizers. Water pollution in Lattakia as a result of the consequence of waste water constitutes more than 70% of the total pollution issues; also there is more presence of bacterial in water bodies, in the results for 2010 than in 2009, which arises as a result of the new network of wastewater treatment plants constructed. The experience in area A2 has shown that, the construction of sewage networks and treatment plants reduced the pollution of surface; ground and sea water by 75%. And it was observed that one of the chemical forms of water pollution in this area is due to pollution by nitrates and nitrites resulting from solid waste

landfills and agriculture activates.

Generally, the studies observed that the impact of pollutants increases with increasing of human activity, also rainfall was impact factor to spread of pollutants, it was not mentioned that the existence of the pollution was from nature sources. Through co-operation with competent authorities, it was identified that most kinds of pollutions in the region, is as a result of the absence of basic environmental requirements (such as; infrastructure, culture, care, and proper planning). Hence, it was very important in this study to monitor these environmental requirements, measures them and obtains results. The monitoring of the impact of the construction of wastewater treatment plants in area A3.

RECOMMENDATIONS

(1) Emphasis should be on sewage treatment outcomes and address the situation of landfills located within the protection ranges from secondary and tertiary pollutants in the study area.

(2) There should be reduction in the use of chemical fertilizers and pesticides on lands within the scope of agriculture area, and of the various classes of danger that is poses on groundwater protection and rationalization.

(3) Rainwater should be harvested through the implementation of new rainwater harvesting techniques to be used for agriculture or groundwater recharge purposes. This would give an increase in available water resources, which means an additional increase in the amount of water available.

(4) Proper water management and development practices should be adhere to, most especially in sanitation and irrigation techniques. Implementing modern irrigation techniques and treated wastewater facilities means abundance of stable water supplies to the entire citizenry of Syria.

(5) There should be improved public awareness and participation in water projects at local, regional, and international levels, as this will eventually be a lasting solution to better sustainability and effective water conservation measures in the country. Also, renewable water resource management and utilization should be introduced in the school curriculum at primary, secondary and tertiary Education levels.

(6) Human resource development, critical knowledge and know-how transfer should always be in focus for renewable water projects development, project management, monitoring, evaluation, implementation and actualization in the country.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

McMichael AJ (2000). The urban environment and health in a world of increasing globalization: issues for developing countries. Bull. World Health Organ. 78(9):1117-1126. PMid:11019460 PMCid:PMC2560839

Owens PN (2005). Fine-grained sediment in river systems: environmental significance and management issues." River Research and Applications 21:693-717. http://dx.doi.org/10.1002/rra.878

Sabouh H, Chahin H (1997). Environmental Engineering (2), Tishreen University publication, Lattakia, Syria. http://www.damasuniv.edu.sy/mag/farm/old/agri_pdf/2002/18-1/kbeebo.pdf

Salman M, Mualla W (2003). The utilization of water resources for agriculture in Syria: Analysis of current situation and future challenges." Erice International Seminars on Planetary Emergencies. PMCid:PMC1494836 http://www.arabscientist.org/english/page/369/

Directorate of Environment (2008). Water supply and sanitation in Lattakia. 3 Winckler, Onn (ed.). Demographic developments and population policies in Ba'athist Syria. ISBS, 1998. http://www.geographic.org/maps/new2/syria_maps.html.

Syrian Central Bureau of Statistics 2010, The Statistical Abstract for 2010 shows, (statistical population), Statistical Indicators and National Accounts Statistics

Directorate of Agriculture (2006). Development of citrus cultivation in the Syrian Coast.

Bou-Zeid El, Mutasem El-F (2002). Climate change and water resources in Lebanon and the Middle East. J. Water. Resour. Plan. Manage. 128(5):343-355. http://dx.doi.org/10.1061/(ASCE)0733-9496(2002)128:5(343)

Tameem A (2007). Establishment and Modernization of Sewerage Networks in the Region of Lattakia Aziz Saker and EbtisamMarouf: Sources of groundwater contamination in the Syrian Coast 2004-2006.