SURVEY OF POTABLE WATER QUALITY PROBLEMS IN EGYPT

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ABSTRACT

Of all the environmental concerns that developing countries face, the lack of adequate water of good quality is probably the most serious. Safe potable water is very vital for life. The objective of this study is to survey and evaluate the variation in the potable water quality in some selected Egyptian governorates. The regions without safe drinking water were delineated; the regions without enough drinking water supply and the regions with problems in potable water networks had been identified. Finally many solutions of these problems have been recommended in order to help the decision makers to improve the potable water quality in Egypt.

INTRODUCTION

Water is essential to sustain life, and availability of safe drinking water is very important. To ensure this, reliance has to be placed on regular bacteriological analyses to assess potability and to determine the best course of action for protecting the population against waterborne diseases. Drinking water should be clear, cool, free from objectionable tastes and odors and from harmful chemicals and microorganisms. Of these desired sanitary qualities, freedom from harmful micorganisms is most difficult to achieve. It is not impossible, but it demands constant vigilance and repeated testing. The problem is made more acute because water sources are subjected to contamination by human and animal wastes which most probably contains a variety of bacteria, viruses and other microbial pathogens. Water containing only a very few pathogens in each liter may by sufficiently polluted to cause the spread of infectious diseases such as cholera, typhoid, dysentery, hepatitis,... etc. Purification of water to be used for drinking is therefore necessary and must be controlled by constant testing.

In Egypt, a plan for big water treatment plants has been prepared since the last two decades to provide safe potable water, for rural areas and secondary cities. This plan was in need of time for design and construction of these plants. So a decision for using the water treatment compact units was taken as a temporary solution till the finish of the big projects. Now and after about 22 years of their application, with the funding from NOPWASD (1985), about 560 of these Compact units have been constructed in Egypt, and the compact units become one of the options for production of potable water as a permanent solution in rural areas of Egypt for both villages and towns (El-Nadi and Refaat, 1995). In the conventional systems raw water is flocculated and

coagulated with alum, pre-chlorinated, filtered through 14 sand and carbon flters, post-chlorinated .and pumped from tanks through the distribution systems. In the compact units water is treated in the same manner as in conventional systems, but in the compact systems filters are reduced to three sand filters. The methods used for the sanitary water analysis were those recommended by the American Public Health Association (APHA, 1995).

Considering the drinking water resources, the individual's expenditure in Egypt was around 1000 m^3/yr at a population size of 58 million. By the year 2000 it decreased to 957 m^3/yr which can be divided as 7% and 93% for the domestic use and the industrial and agricultural uses, respectively, (El-Kassas, 1998). Compared to the minimum demand required per individual (1300 m^3) it can be seen that Egypt is far below that level. It is worth mentioning that the per capita water income in the USA, India, China, and the international level are 10.000, 2.430, 2.520, and 2.500 m^3, respectively. Thus, it can be concluded that the Egyptian water expenditure is about 38% of the international level.

The Egyptian government, presented by the Implementing agency: NOPWASD, the National Organization for Potable Water & Sanitary Drainage realized the importance of providing potable water and sanitation services to all citizens, reducing losses in potable water from deteriorated networks, increasing productivity and extended availability of water and sanitation to Egyptian villages planned to be completed by year 2003.

Egypt has 217 cities that are 100% covered by potable water network, while the sanitation network covers only 38%.

- There are also 4617 villages, 43% of which are covered by potable water network while sanitation network is extended to only 4%.
- The government's plan up till the year 2012 regarding potable water and sanitation is:
    - Management of existing assets & facilities.
    - Replacement of depreciated plants & networks.
    - Establishment of new projects for the new communities.
- The plan includes LE 18 billion out of which LE 9 billion is allocated for potable water projects while LE 9 billion will go for sewage treatment.

The government invites the participation of the private sector in the operation, maintenance, replacement of plants and networks in different provinces, and connecting houses with networks. The government's plan is to enhance the role of the private sector in developing this field.

In Egypt, the River Nile is the main source of drinking water and other purposes; every effort should be made to achieve drinking water quality as high as practicable, otherwise people life are extremely subjected to hazardous effects. Proper selection and protection of water sources to be used for supplying water treatment systems are of prime importance in the provision of safe drinking water.

In the present research paper, the problems of potable water in Egypt were delineated. The Sharkia Governorate was taken as a case study. Four water treatment plants were subjected to bacteriological and physico-chemical analysis following the APHA (1995) standard procedures in order to determine the sanitary quality of the produced water and its suitability for human consumption. The investigated water treatment systems were selected to represent the different running water treatment systems in Sharkia Governorate.

2. Problem definition

The water treatment plants have got to face the following problems that largely affect the quality of water produced (Abdel-Dayem, 1994).

(a) The relatively high levels of alum dose and the relevant problems in terms of aluminum residues in water and the duly high expenses of water produced.

(b) The relatively high levels of added chlorine to raw water (prechlorination) to reduce total counts of bacteria and fungi and similarly the added chlorine to the filtered water (postchlorination). The high level of bacteria is ascribed to the drained sewage, which leads also to growth of fungi and to increased amounts of nitrogenous and phosphorous salts. As the dose of chlorine increases, it leads to increased concentration of organochlorinated compounds that are known as carcinogenic and mutagenic. Therefore, the well-known trend to replace chlorination by ozonation for disinfection is actively suggested.

(c) The currently implemented processes of water treatment are inefficient in removing residues of pesticides and organochlorinated pollutants. Furthermore, they are also insufficient in removing parasites, viruses, and other non-parasitic microorganisms. As a result, these residues of chemical and biological pollutants may persistently remain in drinking water.

(d) The growing levels of biological and chemical pollutants in raw water impose heavy burden on the efficiency of sand filters leading to blockages and development of microbial colonies, such as Nematode larvae which may eventually be present in drinking water.

Other difficulties are related to the drinking water distribution system, such as the ageing of some networks, leakage to groundwater and sewer systems, deterioration of municipal and buildings' water reservoirs, and the chlorinated compounds.

SURVEY OF POTABLE WATER STATUS

The following section include a survey of the main problems of water supply is illustrated including the deterioration of drinking water quality and the problem in distribution networks

1. Regions with problem in network distribution

The survey deducted that the Behira (Damanhour, Edkou, Abis, Gharb Nobaria), Kafr el Sheigh (Metoubas), Kalioubia (Khanka, Shobra el Kheima, Shebin el Kanater), Sharkia (Belbis, Zakaziq), Aswan (Abou Ris), Beni Sweif (Samasta) and Elminia (Deir Mouas) has the following problems in network distribution:

- Aging of pipes that results in cracking and explosion in pipes
- the low water pressure in some regions due to informal pipes connections
- The increase in abstraction of water on the design rates due population increase.
- The loss in produced water due to the aging of networks and the non maintenance of the public valves.
- No existence of cleaning valves in the end of pipes that results in the increase of precipitation and reduction in the amount of water to consumers and the increase in the probability of pollution
- No residual in chlorine in the end of pipes due to the increase in pollution due to precipitation in pipes and the big length of pipes

2. Regions with problems in the use of compact water purifications plants

The following regions: Dakahlia (Gamalia, Msanblawin, Belkas, Talkha, Gamalia), Bheira (Domiat, Kafr Batikh, Kafr el Shenawy), Kafr Elsheikh (Metoubas), fayoum (Kom Ashim, Kahk, roashdia,), Ismailia (Salam, Abtal, Takadom), Kalioubia (Shobra el Kheima, Bigam, Kawasim), Sharkia (Roda1, Roda2) have the following problems:

- The intakes of these regions exist on end of canals and the low water level is affected by the winter closure period.
- The high pollution of the river intakes due to the misuse of inhabitants such as the cleaning of dishes, of animals and clothes).
- The operation and maintenance is done by unqualified trainees.

3. Regions with problems in water bacteriological pollution

There is bacteriological pollution in the groundwater in the following regions:

- Wells of Giza Governorate especially in Badrashin and Hawamdia regions.
- Wells of Sharkia Governorate especially in Zakaziq, Aboumetna and Fakous regions.
- Wells of Kalioubia Governorate especially in Toukh, Kalioub, Kafr Shebibn and Kafr Ragab regions.

4. Regions with problems in water chemical pollution

Potable water is not compatible to the healthy water regulations in some locations as follows:

- Water is polluted in some regions with manganese as in Giza Governorate (Bortos region, Osim district) and in Ebn Kared and Elhekma and Kafr Esam, Gharbia Governorate. Also high concentration of manganese is observed in Assiut Governorate (Kousia, Sadfa, Abou tig, Badari and Fath regions).

- Water is polluted in some regions due to the increase of iron and manganese concentrations as in Tala, Ashmoun and Shebin Elkom regions in Minoufia Governorate.

EL SHARKIA GOVERNERATE WATER TREATMENT PLANTS CASE STUDY

El Sharkia Governorate is chosen as case study and includes many of the above problems especially in Hosainia water treatment plant (34 thousands m^3/day for 327 thousands capita) whose intake exits at the end of Salhia Canal. A detailed survey of this plant is conducted for 15 months and the analysis of water quality parameters (Residual chlorine, total dissolved solids, chlorides, turbidity, calcium, sulfate, Ammonia, Nitrate, Nitrite) are illustrated in graphs (1, ,2, 3, 4, 5, 6, ,7, 8, 9) and the results are compared with other water treatment plants in the same region such as Abou Kebir, Fakous (51 thousands m^3/day) and Kafr Sakr (102 thousands m^3/day) water treatment plants.

The results of the physico-chemical analysis of the potable water produced by the different water treatment systems under investigation clearly establish the fact that all values of the various parameter tested with respect to the treated water are compatible with the recommended standards by the Egyptian regulation (1985) and WHO (1995) guidelines.

The only exception is that the values of residual chlorine in the treated water produced ARE above the standard. Also, the dissolved solids are very high at Elhosainia water treatment plant due to the high drainage effluents from Elsalhia el Gedida area.

The results of the microbiological investigations revealed that the potable Water produced by all of the 4 conventional water treatment plants were compatible with the recommended standard by the Egyptian regulations. However, these water treatment plants exhibited different efficacies for turbidity and bacterial removal.

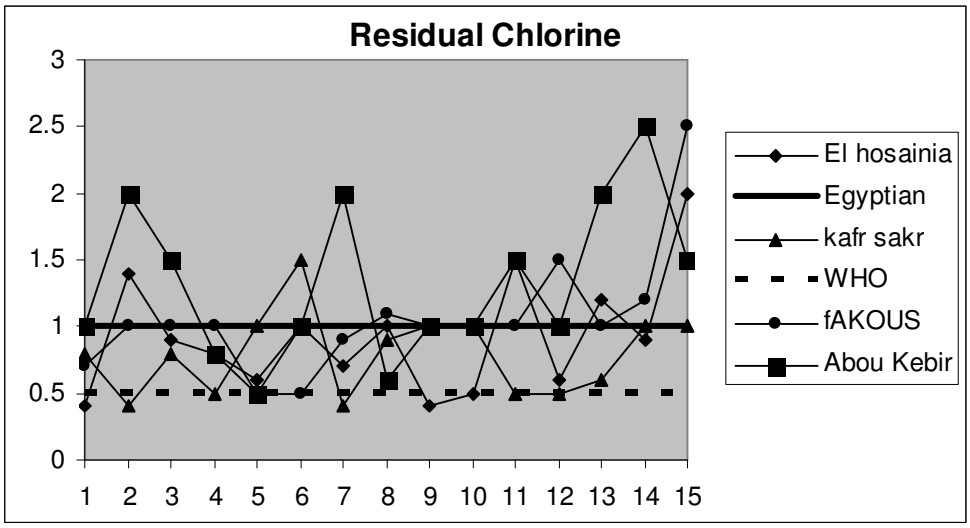

Fig. 1 Residual Chlorine at the water treatment plants in Sharkia Governorate

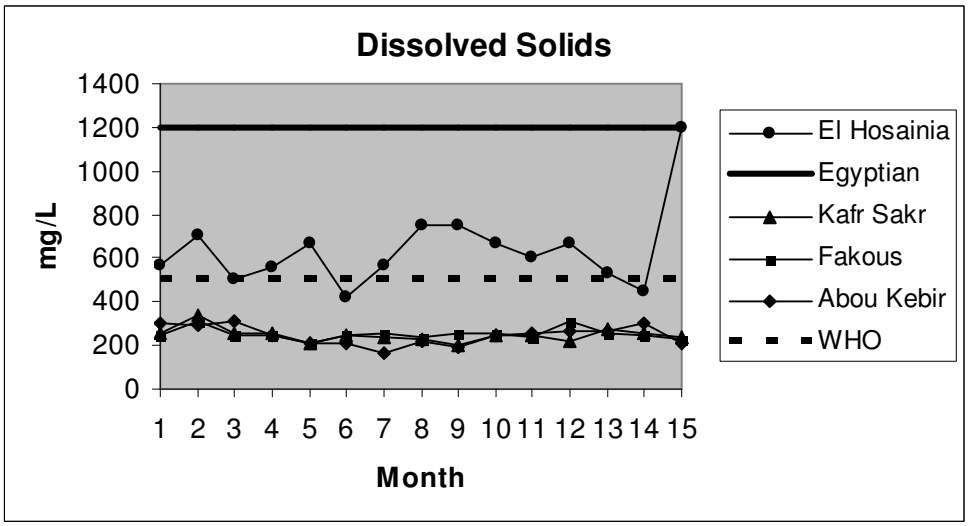

Fig. 2 Dissolved Solids at the water treatment plants in Sharkia Governorate

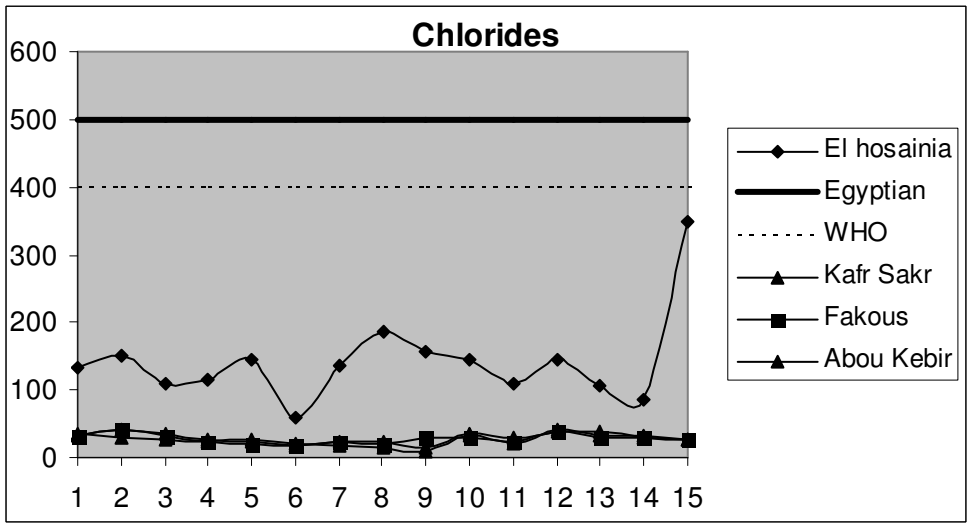

Fig. 3 Chlorides at the water treatment plants in Sharkia Governorate

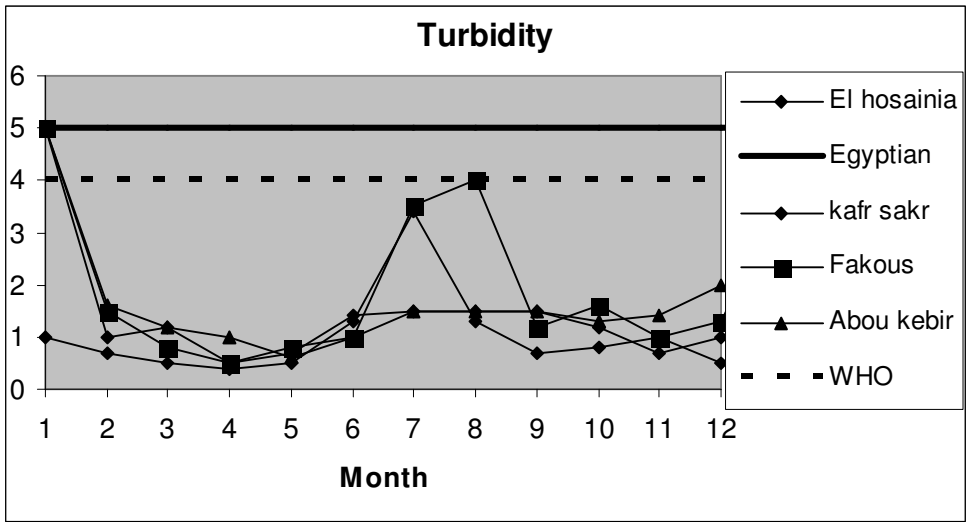

Fig. 4 Turbidity at the water treatment plants in Sharkia Governorate

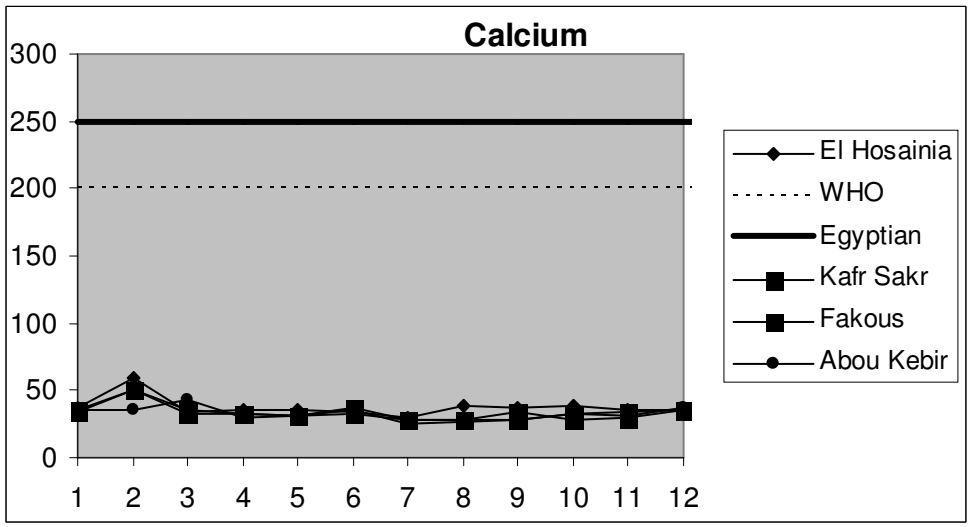

Fig. 5 Calcium at the water treatment plants in Sharkia Governorate

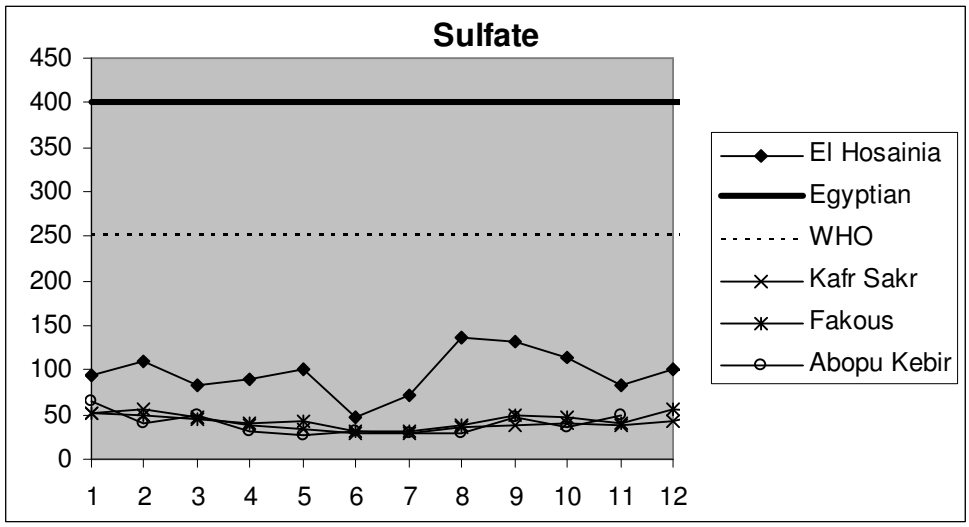

Fig. 6 Sulfate at the water treatment plants in Sharkia Governorate

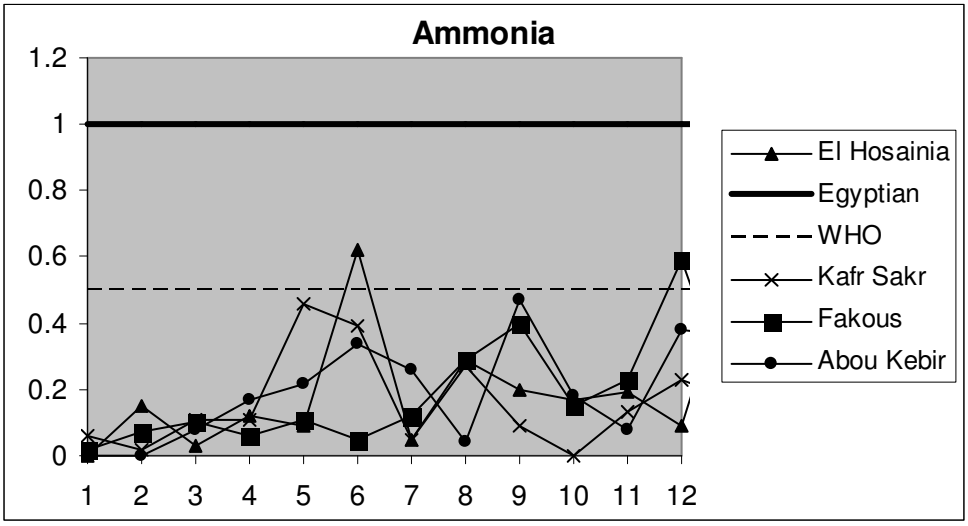

Fig. 7 Ammonia at the water treatment plants in Sharkia Governorate

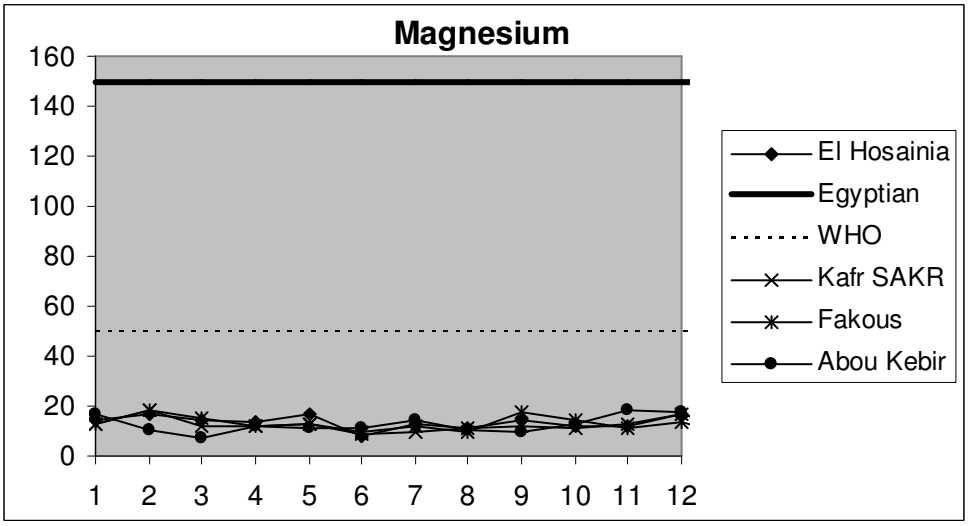

Fig. 8 Magnesium at the water treatment plants in Sharkia Governorate

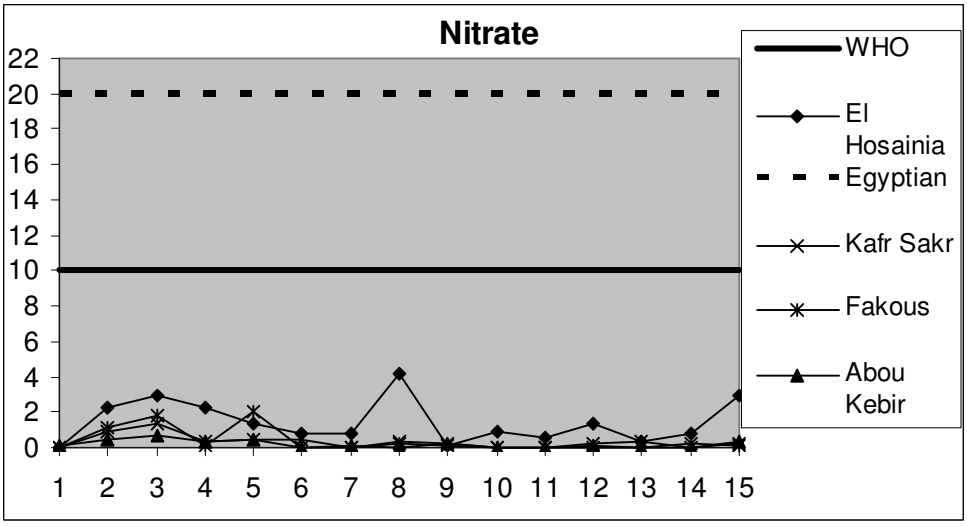

Fig. 9 Nitrate at the water treatment plants in Sharkia Governorate

RECOMMENDATIONS

The main problem of potable water in Egypt can be summarized in:

1- The deterioration of operation efficiency of water treatment plants.
2- The ageing of water supply networks which affects the water quality and results in increasing the loss in produced water with percentage 20-50% according to formal statistics.
3- The weakness of technical experience required for operation and maintenance of water treatment plants.
4- The increase of organic and chemical pollution of surface water and groundwater.
5- The use of one fixed system for the water treatment plants all over the country and this is not compatible with the types of pollution in different places.
6- The actual price of water is not compatible with the real production cost.

Therefore the following items are recommended:

1- With respect to the water treatment systems:
The analysis and monitoring of water must be conducted to define the water characteristics and identification of the biological and chemical pollutants through the establishment of a database for the water type that must be purified and treated for the production of healthy water and therefore identification of the optimum treatment technique that realizes the following:

- The ability of the system to remove all the pathogens in the treatment process,
- There is no effects on the human health due to the use of disinfectant such as chlorine that forms carcinogenic compounds after reaction with dissolved organic matter in the main water source,
- The system must guarantee the healthy potable water arriving to the consumer through the water distribution network,
- The system must be economic and easy to maintain and operate,
- With respect to the production of water and distribution networks.

The production operation of water and distribution must have the following components of any industrial production operation:

- The raw material: the abstracted water,
- The product: the pure drinking water,
- The tools of production: the purification units,
- The tools of product transportation: the distribution networks and the connections to housing,
- The market: the water consumers.

Therefore the following requirements must be fulfilled:

- The management capable of developing the performance and realizing the objectives and have the authorities to fulfill the responsibilities,
- The trainee personals on all levels from the technical employees and management,
- The cost benefit analysis that realizes the self funding that guarantee the coverage of operation cost, the maintenance and the expansion.

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