SUMMARY AND CONCLUSIONS

The present thesis deals with the study of the possibility of using synthetic photocatalytic membranes in the treatment of polluted water resources in Fakous– El Hussania area, located in East Nile Delta region between longitudes 31° 45\ , 32° 10\ E and latitudes 30° 34\ , 30° 55\ N. It covers an area of about 1760 Km^2 and it is considered climatically dry.

Also, this study is concerned with the evaluation of the hydrochemical setting of water resources (surface water and groundwater) to assess the hydrochemical processes affecting water quality (leaching, dissolution, cation exchange,….etc). In addition, genesis, mineralization, geochemical evolution and evaluation of groundwater for different uses have also been discussed.

The main results of the present study can be summarized as following:

Chapter I: Introduction.

This chapter includes the previous works, climatic conditions, geomorphology, geology, and definition of the existing aquifer. In addition, the different techniques, methods and instruments and synthesis of membrane used in analysis for the collected surface water and groundwater samples are discussed.

-Aquifer system:

This aquifer is classified into three geomorphic units have been distinguished in the study area; these are El Salhiya Plain, Northern Low Lands and Eastern Nile Delta Flood Plain.

-The study area is covered mainly by Pleistocene deposits. The Pleistocene deposits are composed of sand and gravel which constitute the main water bearing formation in the area.

-Water resources; emphasis was given to the surface water system and groundwater system. The former is represented by the irrigation water of Ismailia canal and its branches, the mixed water of irrigation and drainage water, the drainage water of Bahr El Baqar and Bahr El Batekh drains, and finally the water of waste water ponds. On the other hand, the groundwater system is represented by the main aquifer present in the study area namely the Pleistocene aquifer.

Chapter II: Review of literatures.

This chapter includes the previous hydrochemical studies which have been carried out by the different authors in addition also to the previous researches in synthesis of SA membrane, nanocomposite of SA/TiO_2, nanocomposite of SA/ZnO and their role in the treatment of organic water pollution.

Chapter III: Water Chemistry.

In this chapter, the chemistry of surface water and groundwater and water pollution are discussed on the basis of the analytical results of 180 water samples collected from two water systems during September, 2007. The analytical data includes EC, pH, TDS, major cations and anions Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, CO_3^{2-}, HCO_3^{-}, SO_4^{2-} and Cl^{-}, some minor and trace elements including PO_4^{3-}, NO_3^{-}, NO_2^{-}, NH_4^{+}, B^{3+}, S^{2-}, Cd^{2+}, Co^{2+}, Cr^{2+}, Cu^{2+}, Fe^{2+}, Mn^{2+}, Pb^{2+}, Zn^{2+}, COD, BOD and TOC in order to study water pollution.

III.1. General chemical characteristics of surface water;

- The total dissolved solids:

The determine salinity of the branches of Ismailia canal ranges from 198 to 972 mg/l with a mean value of 445 mg/l, Mixed drainage water with irrigation water it ranges from 257 to 5731 mg/l with a mean value of 1369 mg/l, Bahr El Baqar drain and Bahr El Batekh drain ranges from 297 to 2871 mg/l with a mean value of 956 mg/l and Waste water ponds range from 3414 to 15109 mg/l with a mean value of 8863 mg/l. These variations can be attributed to different degrees of dissolution and leaching, evaporation, ion exchange and mixing and.

- The branches of Ismailia canal have mean value of total, permanent and temporary hardness 177, 18 and 159 mg/l respectively, while in the mixed drainage water with irrigation water total, permanent and temporary hardness reached 428, 199 and 229 mg/l respectively, and in the Bahr El Baqar drain and Bahr El Batekh drain the determined mean values of total, permanent and temporary hardness reached 359, 137 and 222 mg/l respectively, but in the waste water ponds the determined mean values of total, permanent and temporary hardness reached 106, 25 and 81 mg/l respectively.

- The results of the different hydrochemical coefficients and hypothetical salt assemblages in the study area reveal that:

The majority of surface water samples are characterized by the hydrochemical coefficients and assemblages of hypothetical salts that reflect the effect of leaching and dissolution processes of terrestrial salts. However, the dominant salt reveal that 100% of the branches of Ismailia belong to terrestrial salts (Assemblage I, II), while 58% and 42% of Mixed drainage water with irrigation water belong to terrestrial salts (Assemblage I, II, III) and marine salts (Assemblage IV, V) respectively, 91% and 9% of the Bahr El Baqar drain and Bahr El Batekh drain belong to terrestrial salts (Assemblage I, II, III) and marine salts (Assemblage IV) respectively, but 100% of Waste water ponds belong to terrestrial salts (Assemblage I).

III.2. General chemical characteristics of groundwater;

-The total dissolved solids:

The fresh and brackish waters represent 62% and 38% of the total groundwater samples respectively, where the TDS ranges from 271 and 4622 mg/l with a mean value of 1546 mg/l. A gradual increase in water salinity is recorded in two directions, i.e. from southwest to northeast and from West to East. These trends agree with the regional movement direction of groundwater.

-The total and permanent hardness increase with increasing water salinity. While, the temporary hardness decreases with increasing water salinity.

-The saturation indices (by WATEQ F programs) reveal that, most groundwater is supersaturated with carbonate minerals (aragonite, calcite, dolomite, huntite, magnesite) and silicate minerals. This supersaturation indicates the groundwater in the study area is affected by the terrestrial salts.

- Cation exchange process plays a considerable role in water chemistry leading to a decrease in the temporary and permanent hardness while leads to a considerable increase in water salinity with respect to continental facies groundwater types. Moreover, leaching and dissolution processes lead to a considerable increase in water salinity and permanent hardness more than cation exchange process and other processes affecting groundwater quality.

-The variations in the distribution patterns of different ions for groundwater are due to the variations in the hydrochemical processes affecting water quality i.e. leaching, dissolution, ion exchange, concentration, oxidation-reduction……etc. Show that, the effective anions that cause an increase of water salinity in the Pleistocene aquifer are shown to be; $Cl^->SO_4^{2-}>HCO_3^-$ that represents 48% of the total samples.

The effective cations that cause an increase of water salinity in the Pleistocene aquifer is shown to be $Na^+>Mg^{2+}>Ca^{2+}$ or $Na^+>Ca^{2+}>Mg^{2+}$, that represent 95% of the total samples. This reflects the effect of leaching and dissolution of terrestrial and marine salts.

- Moreover, the distribution of Na^+, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+} and HCO_3^- concentrations displays very irregular patterns that follow, more or less, the pattern of water salinity distribution, i.e., the ions concentration and water salinity increase from southwest to northeast direction and from West to East. The changes in water salinity and ions distribution from southwest to northeast direction and from West to East suggested that the groundwater flow is still in movement state, i.e., in agreement with the general groundwater flow direction. In turn, HCO_3^- concentration in the groundwater of the studied aquifer shows a reverse trend since its concentration increases from northeast to southwest and from east to west direction in an opposite direction to the general groundwater flow direction.

-The results of the different hydrochemical coefficients and hypothetical salt assemblages in the study area reveal that:

Most groundwater samples of the Pleistocene aquifer are characterized by the hydrochemical coefficients and assemblages of hypothetical salts that reflect the effect of leaching and dissolution processes of terrestrial salts (group I, II, III). However, some groundwaters are characterized by the hydrochemical coefficients and assemblages that reflect the presence of marine salts (group IV, V) caused by leaching of Fluviomarine facies.

In conclusion, the chemical characteristics of surface water system could be more or less correlated with those of groundwater which indicate the close relation between both water systems.

III.3. Genesis and classification of groundwater;

Applying the methods proposed by different authors for the genesis and classification of groundwater the following could be mentioned:-

III.3.1. Geochemical classification based on ion dominance:

Based on ions relationship of the groundwater of there are six main hydrochemical facies are distinguished, namely; $HCO_3^->SO_4^{2-}>Cl^-$ and $HCO_3^->Cl^->SO_4^{2-}$ (early stage of hydrochemical evolution), $SO_4^{2-}>HCO_3^->Cl^-$ and $SO_4^{2-}>Cl^->HCO_3^-$ (less advanced stage of hydrochemical evolution), and $Cl^->HCO_3^->SO_4^{2-}$ and $Cl^->SO_4^{2-}>HCO_3^-$ (more advanced stage of hydrochemical evolution) regardless of their magnitude.

III.3.2. Geochemical classification according to genesis:

-The Trilinear diagram of (Piper's, 1953):

79%, 15% and 6% of the groundwater belong to group I, II and III related to sub-area 7, 9 and 5 respectively.

-Sulin's diagram (1948):

95% of the groundwater samples located at the lower Quadrant in the fields of (SO_4-Na) and (HCO_3-Na), and about 5% of the samples located at the upper quadrant in the fields of (Cl-Mg) and (Cl-Ca) types.

-Modified Durov's diagram (1948):

56% and 22% of groundwater samples show intermediate stage and advanced stage of mineralization due to the presence of groundwater in the sub-square Glauberite and Halite sub-square respectively.

III.3.3. Geochemical evolution of groundwater (Burdon's, 1958);

The geochemical evolution of groundwater as outlined by Burdon's system, indicated that the groundwater belongs to the more advanced grade of metasomatic sequence $Cl^->SO_4^{2-}>HCO_3^-$ and $Cl^->HCO_3^->SO_4^{2-}$ 48% and 15% respectively, where the dominant anion is Cl^-, which reflects the effect of leaching and dissolution of Fluviomarine facies. Some of the groundwater samples 12% and 18% belong to early stage of mineralization $HCO_3^->Cl^->SO_4^{2-}$ and $HCO_3^->SO_4^{2-}>Cl^-$ respectively, where HCO_3^- is the dominant anion. This indicates the effect of fresh water of irrigation on the studied aquifer. About 3% to 4% of samples are located in the intermediate stage of mineralization where the ion dominance has the trend $SO_4^{2-}>HCO_3^->Cl^-$ and $SO_4^{2-}>Cl^->HCO_3^-$ respectively.

Chapter IV: Evaluation of groundwater for different purposes.

The use of groundwater for drinking, domestic and agricultural purposes is as follows:

IV.1. Evaluation of groundwater for drinking and domestic uses:

In general; most of the groundwater samples 72% of the Pleistocene aquifer in the study area are unsuitable for drinking because they have concentrations of water salinity greater than that of the permissible limits while the rest of samples 28% is suitable for drinking. According to the values of total hardness, the majority of the groundwater samples in the study area (94% of total samples) is unsuitable for laundry use because they are ranging from hard to very hard waters. The rest of groundwater samples 6% is suitable for laundry use, since they are ranging from slightly hard to moderately hard.