سامية محمد مصطفى

شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

سامية محمد مصطفى

شبكة المعلومات الجامعية

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التوثيق الالكتروني والميكروفيلم

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سامية محمد مصطفى

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

سامية محمد مصطفى

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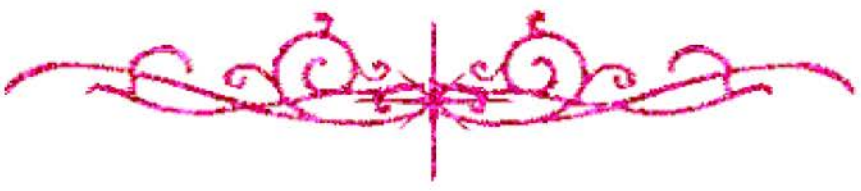

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شبكة المعلومات الجامعية

بالرسالة صفحات لم ترد بالأصل

Cairo University

Faculty of Economics and Political Science

Department of Statistics

Spatial Analysis of Water Pollutants: A Case Study on the Nile River in Egypt

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A Thesis Submitted to the Department of Statistics, Faculty of Economics and Political Science in Partial Fulfillment of the Requirements for the M.Sc. Degree in Statistics

2011

Abstract

This study aims to assess and evaluate the water quality along the main stream of the Nile River in Egypt through analyzing and modeling the spatial distributions of the factors that influence the water quality, using spatial statistical analysis with the aid of the software "Geographic Information Systems".

The sample frame of the study consists of 78 sampling points located on the main waterway of the Nile River and its two branches Rosetta and Damietta. Values of five variables -Dissolved Oxygen, Acidity, Biological Oxygen Demand, Chemical Oxygen Demand and Total Dissolved Solids - are official measures for each sampling point taken for the period of "February 2008". Additionally, three water quality indices have been constructed as general indicators of the overall water quality of the Nile River, with special emphasis on the drinking water quality.

Exploratory Spatial Data Analysis was carried out on the water quality variables and indices to check the normality assumption and to identify global and local outliers, data trending and spatial autocorrelation. Then, experimental semi-variograms have been plotted and modeled, using theoretical semi-variograms, and spatial interpolation has been performed, using kriging technique. Cross validation was carried out to determine the best fit models. Generated surfaces maps illustrate the spatial distribution of each water quality variable and index along the Nile River. Finally, the resulted levels of each water quality variable have been compared with national and international acceptable limits, concluding the status of the water quality of the Nile River in Egypt.

The generated surfaces maps show that the levels of the five water quality variables are generally within their accepted limits, except some polluted areas spotted on the maps. The maps of the three water quality indices show that the quality of water is acceptable along the Nile River except the Rosetta Branch. They also indicate that Upper Egypt has excellent water quality in general, while unfit water for drinking is dominant at Middle and Lower Egypt due to accumulated industrial and agricultural discharges into the river. In fact, intensive physical and chemical treatments with disinfection are becoming pressing options to improve the quality of drinking water.

Key Words:

Water Pollution, Water Quality, Spatial Analysis, Geographic Information Systems, Exploratory Spatial Data Analysis, Semi-variogram, Kriging

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Title of the thesis:

Spatial Analysis of Water pollutants: A Case Study on the Nile River in Egypt.

Summary of the thesis:

The Nile River pollution turns out to be a pressing national issue in Egypt. This is mainly due to the accelerated growth of population and economic activities, which impose a heavy burden on the viability of quality water along the Nile River. Accordingly, this study was proposed to assess the water quality of the Nile River in Egypt at "February 2008", using spatial statistical analysis with the aid of the software tool "Geographic Information Systems (GIS)".

The thesis tried to balance between the theoretical knowledge and the empirical work related to the concept of spatial statistical analysis. This objective has been accomplished through organizing the thesis in seven intersected chapters: the introduction, literature review, water quality, the methodology, the scope of the study, results and conclusion and recommendation.

The sample frame of the study consists of 78 water quality monitoring points located on the main waterway of the Nile River. The data are the measured values of five variables (Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Total Dissolved Solids and Acidity) at each sampling point.

After data collection and validation, three water quality indices have been constructed as general indicators of the overall water quality of the Nile River, with special

emphasis on the drinking water quality. They are the Average Water Quality Index (AWQI), the Weighted Water Quality Index (WWQI) and the Drinking Water Quality Index (DWQI).

Then, Exploratory Spatial Data Analysis (ESDA) was carried out on the water quality variables and indices. Its results indicate that the DO and the BOD are normally distributed and either log transformations or Box-Cox transformations have been applied to the other variables and indices. Semi-variogram clouds spotted global and local outliers. Also, they confirm the presence of positive spatial autocorrelation between the sampling points. Trend analysis indicated that DO and pH may exhibit a second order polynomial trend, and the order of trends concerning BOD and COD are not clear enough, while TDS and the WQIs may have linear trends. However, it is difficult to obtain a definite conclusion about stationarity from the trend analysis.

Therefore, ordinary kriging assuming constant trend had been performed in the first place, then ordinary kriging after detrending (using either first or second order polynomial trend based on the trend analysis results) has been carried out to determine the best kriging method that interpolates the water quality along the Nile River.

According to the cross validation statistics and the stationarity test results, ordinary kriging assuming constant trend has been used in the spatial interpolation, except for the DO and the TDS variables where ordinary kriging after detrending were applied, using second order polynomial trend and linear trend, respectively. Kriging involves the fitting of experimental semi-variogram with theoretical semi-variogram models. The cross validation statistics showed that the best fitted models are the spherical semi-variogram model for the DO and the TDS, the Gaussian model for the pH and the WQIs and the exponential model for the BOD and the COD.

Interesting results of this study can be read from the generated surfaces' maps of each water quality indicator. Generally, the levels of DO are within its national tolerance limit but exceed its permissible level at some segments on the Rosetta Branch. Similarly, the pH map shows that the acidity is generally within its acceptable level along the Nile River but relatively high in Greater Cairo compared to Upper and Lower Egypt. The BOD is generally within its standard limit along the Nile River but approaching the maximum limit at Kafr El-Zayat on the Rosetta Branch and surpasses the limit at the south part of Upper Egypt. The COD levels are noticeably high in all the governorates along the Nile River, except Asuit and El-Minya, and exceeding its

permitted limit at Cairo, Beni-Suef and Kafr El-Zayat. The TDS exhibit a general increase along the Nile River as flows from south to north.

In fact, Kafr el Zayat located on Rosetta Branch appeared to be the highly polluted site with respect to all the studied variables due to the industrial discharges originated from Kafr El-Zayat Complex. In addition, levels of COD and TDS at Beni-Suef surpassed their standard limits due to the discharges of agricultural drainages in the Nile River. Greater Cairo exceeded the standard limit of the COD and the pH due to the domestic and industrial discharges. Moreover, some segments in Upper Egypt showed high levels of DO, BOD and COD due to the poor municipal sewage networks and the effluents of the floating hotels. El-Sarw drainage, which is one of the major sources of pollution due to the industrial and agricultural discharges, is the main responsible of the exhibited high levels of pollution at some segments located on Damietta Branch.

The AWQI indicated that the quality of water is acceptable along the Nile River except at the Rosetta Branch. However, the spatial distribution of the WWQI showed that Upper Egypt only (except Asuit) has excellent water quality. It also revealed that water varies between poor and good quality in Middle Egypt and along Damietta Branch and very poor water quality along the Rosetta Branch. Due to accumulated industrial and agricultural discharges into the river, the DWQI indicated that unfit water for drinking is dominant at Middle and Lower Egypt. Therefore, intensive physical and chemical treatments with disinfection are the most suitable options to improve the quality of drinking water. However, good water suitable for drinking after simple physical treatments with disinfection is located at Upper Egypt except at Asuit.

It is noticed that the prediction standard errors are smaller in areas with a quite reasonable number of sampling points compared to areas with few number of sampling points such as Luxor, Qena and Rosetta Branch. Thus, it is recommended to increase the number of water quality monitoring points at these areas, if possible, in future studies.