Water Quality Management Upstream Cairo Drinking Water Plants along the Nile River

A Thesis Submitted in Partial Fulfillment for the Requirements
of the Ph.D. Degree of Science in Civil Engineering
(Irrigation and Hydraulics)
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Statement

This thesis is submitted to the Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Civil Engineering.

The work included in this thesis was carried out by the author in the Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University from 2013 to 2016.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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Mohamed A. Reda.

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List of Abbreviations

Abbreviations	Referent
AD	Advection-dispersion
BOD	Biological Oxygen Demand
CCME	Canadian Council of Ministers of the Environment
CDWP	Cairo Drinking Water Plant
CT	Disinfection Contact Time
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DHI	Danish Hydraulic Institute
DRI	Drainage Research Institute
DSS	Decision Support System
DWP	Drinking Water Plant
EC	Electrical Conductivity
EEAA	Egyptian Environmental Affairs Agency
EPA	Environmental Protection Agency
FC	Fecal Coliform
GIS	Geographic Information System
GDWP	Giza Drinking Water Plant
HAD	High Aswan Dam
HD	Hydrodynamic
HSPF	Hydrological Simulation Program {FORTRAN}
NEQS	National Environmental Quality
MCA	Multi Criteria Analysis
MHUNC	Ministry of Housing, Utilities and New Communities
MWRI	Ministry of Irrigation and Water Resources
NBOD	Nitrogenous Biochemical Oxygen Demand
NWRC	National Water Research Center
SOD	Sediment Oxygen Demand
TC	Total Coliform
TDS	Total Dissolved Solids
TMDLs	Total Maximum Daily Loads
USEPA	US Environmental Protection Agency
VBA	Visual Basic for Application
WASP	Water Quality Analysis Simulation Program
WHO	World Health Organization
WQ	Water Quality
WQI	Water Quality Index
WQD	Water Quality Data
WQMIS	Water Quality Management Information System
WQP	Water Quality Parameters

List of Symbols

pH	A measure of the activity of the hydrogen ion
CO3-2	Carbonates
HCO3-	Bicarbonates
CaCO3	Calcium Carbonate
NH3	Ammonia
Ca2+	Calcium
Mg2+	Magnesium
Na+	Sodium
0C	Degrees Centigrade
Cl-	Chloride
NO2-	Nitrite
NO3-	Nitrate
PO4-3	Phosphate
NH4–N	Ammonium Nitrogen
SO4-2	Sulfate
Mn	Manganese
Zn	Zinc
Cu	Copper
Al	Aluminum
Cd	Cadmium
Cr	Chromium
Fe	Iron
Hg	Mercury
Ni	Nickel
µS/cm	Micro Siemens per centimeter

ABSTRACT

Cairo, sits on the River Nile south of the Mediterranean Sea, has an average reach length along the river about 50 km (from Km 900 to km 950 referenced to Aswan High Dam). This area is a particular importance in the study of surface water quality because of industrial, municipal and agricultural wastes were mixing with river flow and surrounding water body thereby deteriorating the water quality. However, Cairo Drinking Water Plants (CDWPs) that takes their raw water source from Nile river need a particular attention and continuous control for their water source quality to prevent health hazards.

This study mainly aims to develop Water Quality Management Information System (WQMIS) capable of proposing the required management scenarios to improve water quality upstream CDWPs and control the pollution sources. The work tasks can be divided into three phases. In the first phase water quality index (WQI) was calculated using Canadian Water Quality Index (CWQI) in order to evaluate the water quality upstream Cairo drinking water plants. In the second phase, the mathematical model (MIKE11) was formulated to simulate various water quality parameters. In the second phase, different scenarios were proposed to predict water quality improvement. An integrated evaluation framework is developed using analytical hierarchy process of Multi Criteria Analysis (MCA) that takes four indicators into account; technical, environmental, economical and socio-community for evaluation and ranking various water quality management scenarios. MCA for different scenarios showed that the water quality management scenario focusing on treatment of CDWPs sludge instead of discharging it to Nile River is the most convenient scenario. In the third phase, WQMIS was constructed by using Microsoft Visual C programming applications to store required data for assessing and predicting the situation of the water quality status under current and future conditions.

Based on the results of this study, the developed WQMIS can be used as an effective tool to facilitate assessing, predicting water pollution and can provide easier decision making process for achieving designated water quality objectives.

Keywords

Surface Water, Drinking Water Plants, CWQI, MIKE11, MCA, WQMIS.