Ain Shams University
Faculty of Engineering
Irrigation and Hydraulics department

GROUNDWATER POLLUTION RISK ASSESSMENT IN SEMI – ARID REGIONS (CASE STUDY: SADAT CITY)

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Approval sheet

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Statement

This dissertation is submitted to the Faculty of Engineering-Ain Shams University for the degree of Master of Science (M.Sc.) in Civil Engineering (Irrigation and Hydraulics).
The work included in this thesis was carried out by the author in the department of Irrigation and Hydraulics, Faculty of Engineering-Ain Shams University.
No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

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List of abbreviation

BCM	Billion Cubic meter
d	Average diameter of particles
EC	Electrical conductivity
FAO	Food and Agriculture Organization of the United Nations
Fe	Iron
GIS	Geographic Information System
Mn	Manganese
n	porosity
NO_3	Nitrate
OC	Organic chlorine
OP	Organ phosphorus
PSQCA	Pakistan Standards and Quality control Authority
Q	The pumped flow Rate
Q_B	Subsurface flow over boundary
Q_L	Leakage component leaving adjacent aquifers
Q_N	Natural groundwater recharge or discharge
Q_R	Exchange with surface water
Q_W	Local discharge or recharge such as wells
r	radius
RIGW	Research institute of Groundwater.
R_n	Reynolds number
SAR	Sodium Adsorption Ratio.
SO_4	Sulfate
t	Time
TDS	Total dissolved Solids.
UNEP	United Nations Environment Programme
v	Critical seepage velocity
vi	Average discharge in the i direction
VMF	Visual Modflow
WHO	World Health Organization
Δ Qs	Change in storage Qs
Δ t	Time increment
υ	Kinematic viscosity of water

Abstract

Inarid and semi-arid regions, such as in Egypt, groundwater is considered one of the main sources of water where there is a lack of surface water, like in the western and eastern deserts. Groundwater is usually used in various purposes such as domestic, industrial and agriculture. Due to the rapid expansion and uncontrolled plans of the reclamation lands(national projects and private farms) and new communities, especially in the Delta fringes. Accordingly, groundwater in such new cities should be wisely used, monitored and protected from pollution sources. Pollution sources in these cities come from industrial, agricultural seepage, leakage from wastewater treatment plants and sewer systems.

The area of interest in this study is El Sadat city, which is one of the largest and relatively new industrial cities in Egypt. It has been constructed more than 3 decades ago. Itis locatedin theWesternNileDeltafringes,onthe Cairo-AlexandriaDesertRoad between km93 and km 103 fromCairo.El Sadat city and its surroundings mainly depend on groundwater for domestic, agricultural and industrial purposes. The industrialareais locatedin theeasternportion ofthecityand consistsof more than450factories.

Sadat city is located where the two-aquifer systems overlap (the Nile Delta aquifer and Moghra aquifer). The two aquifers are separated by a semi-pervious clay layer ranging in thickness from 5 to 10 m. Due to the difference in hydraulic heads, groundwater recharge occurs from the Quaternary aquifer to the Moghraaquifer. The regional direction of groundwater flow is northeast southwest.

Sadat cityis considered a vital area in the western Nile Delta fringes due its various industrial and agricultural activities; therefore, it is needed preventive and protective measures. To maintain groundwater potential in terms of quantity and quality in order to sustain the development plans of this city at present and future as well.

This research study is dealing with a critical problem as Sadat Industrial City suffers of leakage from industrial zone, which is very close to the wells field. This means that undesirable heavy elements still exist and may pollute the groundwater on the future and cause health problems.

ArcGIS and Visual MODFLOW have been used to simulate the groundwater flow movement for the area of interest. The final result of the calibration has been used

to simulate the industrial pollutant transport rates and directions by transport MODFLOW model.

The conceptual model showed that the pollution moves from the industrial areas towards the main city drinking wells, which located near the industrial zone. However, the rate of pollutant transport is too slow, which can give a chance to be controlled before reaching the wells field. Another output was concluded from the model calibration and the model water budget that there are many unregistered wells withdrawing which can be misleading to the actual situation in the city and can rapid the pollutants transport.

The model main governing parametersand studies made can be summarized in the following points:
1- The water bearing formation in the study area is made of one unconfined quaternary aquifer system.
2- Hydraulic parameters of the aquifers (e.g.:K_h, K_v, S_y, S_s, n).
3- The flow system of the groundwater in the Quaternary aquifer in the study area is governed by a surface water network from El-Nubariya Canal at the North and Nile River branch at the East.
4- Discharge of groundwater in the quaternary aquifer takes place through: production well fields and withdraw which have been represented as negative recharging areas.
5- Several maps like digital elevation map (DEM), Piezometric map, satellite maps and wells data have beenusedin the model calibration and to study the hydrodynamics of the groundwater movement.
6- Particlespathlines (forward and backward) were assigned to study the pollution movement and speed from the industrial area and the wells field capture zone.
7- Several scenarioshave been suggested and simulated to reduce or eliminate the pollutant movement towards the supplying wells. These scenarios are:

- Using a long diaphragm wall.
- Long diaphragm wall and preventing pollution from closed area.
- Shorter length of diaphragm wall and preventing pollution from close area.
- Using artificial recharge basin before capture zone.

After a detailed study for each scenario, conclusions and recommendations were drawn out.

- Keywords:
Arid and semi arid areas, Pollutant transport, groundwater, El-Sadat City, ArcGIS, Modeling.