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Potential Hydrogen (PH) Evaluation of ground water from Karbala landfill in Iraq

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ملخص :

الرقم الهيدروجيني للماء له تأثير كبير على صحة البشر والنباتات ، قيمة الرقم الهيدروجيني للماء 7.0 لذلك إذا كانت قيمة الرقم الهيدروجيني أقل ، يصبح المحلول حامضيًا ، وكلما زادت حمضية المحلول يعني انخفاض قيمة الأكسجين التي يمكن احتوائها في الدم ، بالنسبة للنباتات ، انخفاض قيمة الرقم الهيدروجيني للماء يؤدي إلى تغير في نسب الأيونات التي يحتاجها النبات للنمو ، وبالتالي تنخفض معدلات نمو بعض النباتات.

من خلال تحليل عينة من المخلفات السائلة المتولدة من المكب وجد أن قيمة الرقم الهيدروجيني كانت 5.3 ، مما يعني أن المحلول حمضي والذي تم تناوله في هذه الدراسة لمعرفة مدى انتشار الأس الهيدروجيني الناتج عن مكب النفايات في محافظة كربلاء بالعراق من خلال المياه الجوفية ، و تم تطبيق نظام نمذجة المياه الجوفية (GMS) في منطقة الدراسة لإعداد محاكاة لانتشار الأس الهيدروجيني حول موقع المكب والتنبؤ بتركيزات الأس الهيدروجيني في الأراضي الزراعية المحيطة أظهرت النتائج خلال السنوات التالية زيادة في انتشار الأس الهيدروجيني عبر المياه الجوفية إلى الأراضي الزراعية المحيطة ، حيث وصل تأثير الانخفاض في قيمة الرقم الهيدروجيني 5.3 إلى مسافة 7700 متر باتجاه الشرق.

Abstract:

The pH of the water has a great impact on the health of humans and plants, the pH value of water is 7.0, so if the pH value is lower, the solution becomes acidic, the more acidic the solution mean lower oxygen value that the blood can contain, as for plants, the decrease in the pH value of the water leads to a change in the ratios of ions that the plant needs for growth, and thus the growth rates of some plants decrease.

By analyzing a sample of liquid waste generated from the landfill, it was found that the pH value was 5.3, which means that the solution is acidic, which was dealt with in this study to find out the extent of the spread of the pH resulting from the landfill in the district of Karbala, Iraq through the groundwater, , Groundwater Modelling System (GMS) was applied in the study area to prepare a simulation for the PH spread around the landfill site and to predict the PH

concentrations in the surrounding agricultural lands for the next years, the results showed an increase in the spread of the pH through the groundwater to the surrounding agricultural lands, as the effect of the decrease in the pH value of 5.3 reached a distance of 7700 meters towards the east of the landfill.

Keywords: groundwater flow, groundwater simulation, pollution transport, Groundwater Modelling System.

1. Introduction: The waste represent a serious threat to the environment, where comes from many sources which take different forms whether liquid, solid, leachate or gases and constitutes the greatest harm when stored, transported, processed, or make any changes, including what accumulates over the water then seepage into groundwater aquifers and reaches to organisms through drinking, the pH value is greatly affected due to the waste discarded in the landfill, in this study the focus will be on the impact of the influence PH from landfill to the groundwater and reveal its concentrations, the rate of domestic waste generation in the study area (the city of Karbala) Approximately 0.44 kg/day and have a household waste (food scraps, paper, plastics, glass, metal, wood) different rates change depending on the level of living and food waste is the highest percentage, up to 65% of household waste, density of waste 469 kg/m, and moisture content represent 48% and the rate of waste generation 396 Tons/day (Mona. Faiq. Ali 2007).

the amount of waste generated is estimated at more than 260 thousand tons per year annually are transferred to the landfill site which it's an exhausted quarries used to dump the waste and its located about 11 km south west of the city center and the site surrounding by a number of agricultural lands .

Numerous studies have dealt with the spread of pollutants in groundwater using simulation models prepared with specialized programs such as Groundwater Modelling System (GMS) or Visual MODFLOW, (Seyed Reza Saghravani) used Visual MODFLOW program to create groundwater flow simulation for Phosphorus that is derived from fertilizers which have adverse effect on surface and subsurface water, study area was the campus of University Putra Malaysia, results of contamination transport modeling revealed the different rates of phosphorus transport in layers at the end of simulation period.

2. Methodology: The study area is located between the center of Karbala City in Iraq from the Northeast and Al-Razaza Lake in the Northwest and along Karbala- Najaf road as shown in Figure (1), between latitudes (32˚ 41' 18"N - 32˚23'40" N), and longitudes (44˚10' 05"E - 43˚ 53'41"E)rising above sea level about 32 meters and is located 88 km southwest of Baghdad, and it's near the west bank of the Euphrates River.

Dibdibba aquifer represents the main aquifer in the studied area, the formation is well exposed along both ridges of Tar Al-Najaf and Tar Al-Sayed, occupying the top most part of the exposed sequence, hence making up the bed rock of the desert plain between Karbala and Najaf, This formation is outcrop in the area between Al-Razaza Lake and Karbala City from the Northern West (Sumayah A. Al-din Majeed 2012).

In Dibdibba basin rain water is the only recharge source due to the lack of river branches in the region, the relatively high permeability nature of sandy sediment surface and the absence of surface water runoff that allows rain water to penetrate and filtrate (Al-Aani, 2004).

The ground layers depth of the study area was divided by relying on field visits to the site, the information available from specialized institutions and related studies, which were divided into two layers, first layer represent the unconfined aquifer with 50 meter thickness and consists of sand, the horizontal conductivity value equal to 140 m/d and the vertical conductivity value is 14 m/d, second layer represent the separating layer between the confined and unconfined aquifer with 10 meter thickness and consists of clay, the horizontal conductivity value equal to 0.14 m/d and the vertical conductivity value is 0.014 m/d.

Figure (1) geographical location of Karbala governorate – Iraq

To find out the PH value of the waste that dumped in the landfill, a sample was taken from the leaky liquid waste from the waste and a laboratory test was performed on it, and the results

showed that the sample is an acidic solution because the PH of the sample was (5.3), were the permitted pH value in the irrigation water ranges from 6.4 to 8 according to the Iraqi environmental determinants.
The numerical model of ground- water has been created by the (GMS) program based on the available data to simulate the characteristics of groundwater movement such as flow direction, dynamics and transport of pollutants in groundwater.

Model boundaries are determined as follows:-

i) Northwestern borders represented by Al-Razazah Lake, in addition to the changing area of the underground water level, which was recorded at the lake 35 meters to a minimum, which represented the northern and northeastern borders, which recorded 20 meters above sea level.

ii) Limits of no flow, which represented in the southeastern borders, which ranged from the level of 20 meters to 35 meters above sea level.

iii) Southwestern border, which recorded a level of 35 meters above sea level, which is equal to the level of the water level of the lake.

The study area was modelled using 120 columns and 80 rows in the software package and each column and row of the model represents 300 m wide strip of the aquifer within the study area, the cells outside the study area were neglected due to their effect on the model from the mathematical point of view**,** the model was calibrated by running the program from 2012 to 2019 and comparing the groundwater levels with the values of the levels resulting from (Sumayah A. Al-din Majeed 2012) study "Simulating the Impacts of Groundwater Pumping on Dibdibba Aquifer in Karbala Province"**.**

3. Analysis and Result

3.1. Simulation of Groundwater Flow and pollutants spread:

The study area was considered as a heterogeneous land in view of the disparity in the level of the surface of the earth, the unconfined aquifer represented by the first layer with a depth of 50 meters, Groundwater Modeling System used to predict the spread of pollutants, simulations were performed for five periods of (10, 20, 30, 40and 50) years the result of the simulations is as follows:-

3.1.1. Case 1: The Ten-Year Simulation Period: First case represented by the spread of PH for a period of 10 years.

It is worth noting that the migration of pH in the first ten years is not as large as shown in figure (2), and the pollutants need a longer period of time for the pollutants to migrate to other places, it was observed that the pH concentration in the first layer was 5.3, as the distance of the pollutants spread reached 2226 meters to the east.

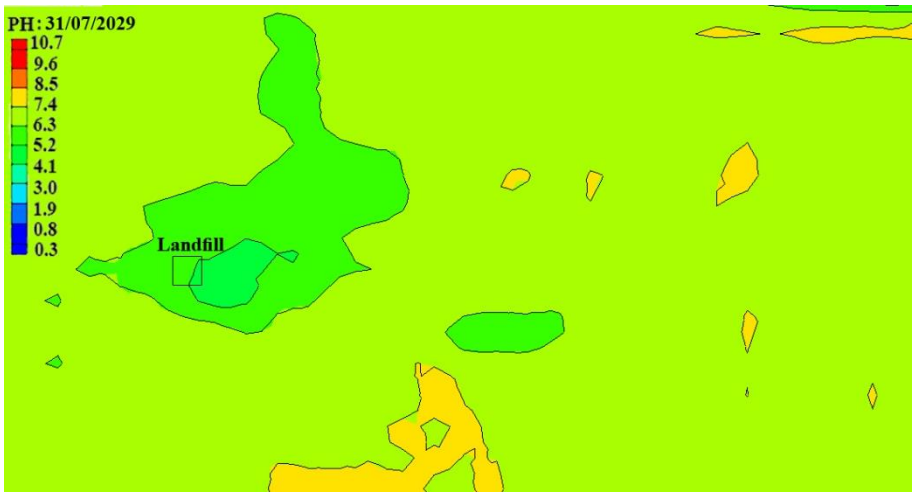

Figure (2) Spread Plume of PH for 10 years period

3.1.2. Case 2: The Twenty-Year Simulation Period:

Second case represented by the spread of PH for a period of 20 years.

In the second stage of the simulations, the pH concentration of 6.3 migrated to a greater distance as illustrate in figure (3), and it reached a distance of 3370 meter and it's below the permissible limit.

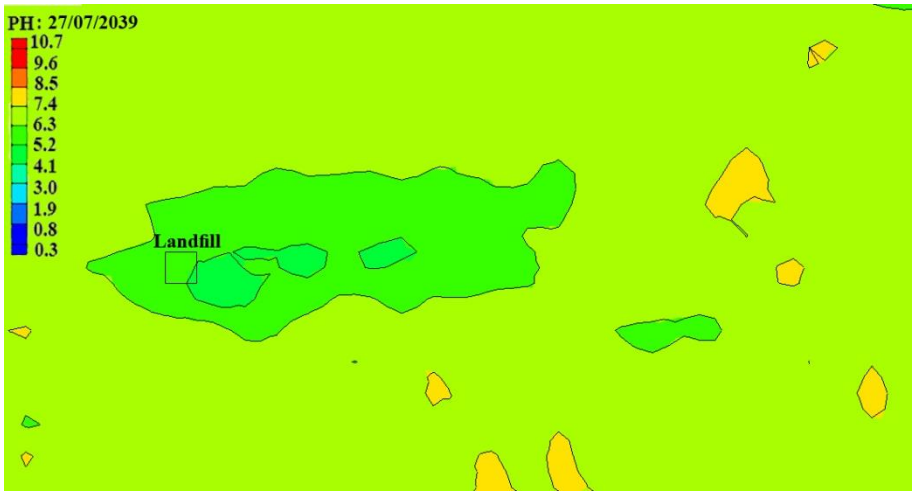

Figure (3) Spread Plume of PH for 20 years period

3.1.3. Case 3: The Thirty-Year Simulation Period:

Third case represented by the spread of PH for a period of 20 years.

In the Third stage of the simulations, the pH concentration of 6.3 migrated to a greater distance as illustrate in figure (4), and it reached a distance of 5140 meter and it's below the permissible limit.

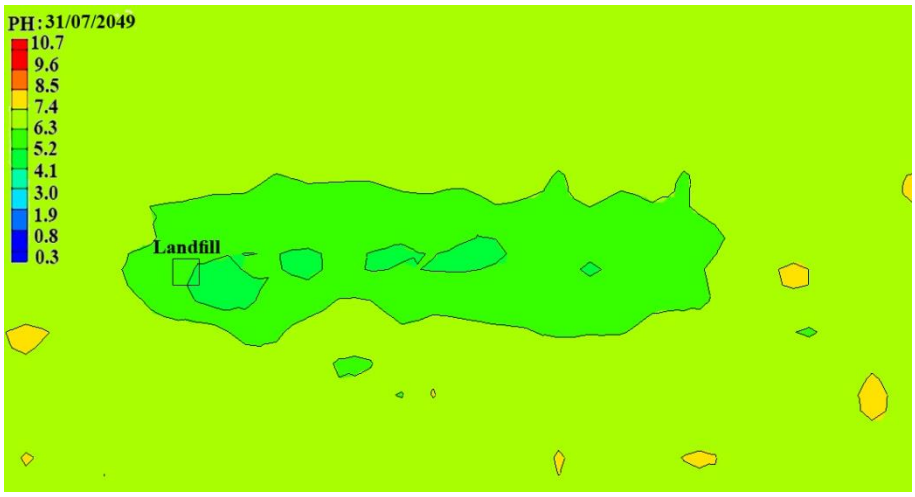

Figure (4) Spread Plume of PH for 30 years period

3.1.4. Case 4: The Forty-Year Simulation Period:

Fourth case represented by the spread of PH for a period of 20 years.

In the fourth stage of the simulations, the pH concentration of 6.3 migrated to a greater distance as illustrate in figure (5), and it reached a distance of 6625 meter and it's below the permissible limit.

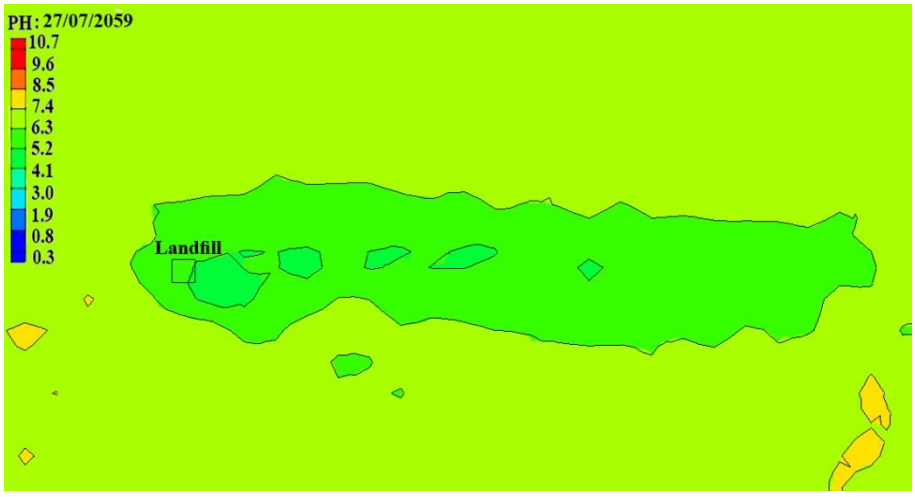

Figure (5) Spread Plume of PH for 40 years period

3.1.5. Case 5: The Fifty-Year Simulation Period:

Fifth case represented by the spread of PH for a period of 20 years.

In the fifth stage of the simulations, the pH concentration of 6.3 migrated to a greater distance as illustrate in figure (6), and it reached a distance of 7950 meter and it's below the permissible limit.

Figure (6) Spread Plume of PH for 50 years period

4. Conclusion: The research focused on the future of groundwater by pH in the area surrounding the landfill in Karbala Governorate, Iraq. The study contained a digital simulation of groundwater runoff and pH spread throughout the region using a groundwater modeling system in five stages (10, 20, 30, 40 and 50) years, determination of pollution by pH in different parts of groundwater in the unconfined layer was the key point to the study, the spread of pollutants in the unconfined layer occurred rapidly, reaching a distance of 7950 meters east of the landfill site.

REFERENCE

1- Mona.Faiq.Ali. A study of solid waste collection for Karbala city2007.Baghdad University. Faculty of Engineering. Department of Environmental Engineering. https://uomustansiriyah.edu.iq/libdata/mqlat.php?page=775

2- Seyed Reza Saghravani, Phosphorus migration in an unconfined aquifer using MODFLOW and MT3DMS, Putra Malaysia, December 2011 https://www.researchgate.net/publication/235423733_Phosphorus_migration_in_an_unconfined_aquifer_using_MODFLOW_and_MT3DMS

3- Sumayah A. Al-din Majeed 2012 (Simulating the Impacts of Groundwater Pumping on Dibdibba Aquifer in Karbala Province) College of Engineering University of Karbala . https://www.researchgate.net/publication/326723393_Simulating_the_Impacts_of_Groundwater_Pumping_on_Dibdibba_Aquifer_in_Kerbala_Province

4- Al-Aani, A. (2004): "Choosing the Best Method to Assess Groundwater Recharge / Case Study Reservoir Dibdibba in the Area Between Karbala and Najaf ", Ph.D. Thesis, College of Science, University of Baghdad, Iraq (In Arabic).

5- Harbaugh, A. W., MODFLOW-2005, the U.S. Geological Survey Modular Ground-Water Model—the Ground-Water Flow Process: U.S. Geological Survey Techniques and Methods 6-A16, Reston, Virginia, 2005, p. 253.

6- Zheng, C. (Ed.). 2006. MT3DMS: A modular three-dimensional multi-species transport model for simulation of advection, dispersion and chemical reactions of contaminants in groundwater systems. Department of Geological Sciences, University of Alabama.
7- Hai V. Pham, Groundwater Modeling, November 2016
https://www.researchgate.net/profile/Hai_Pham5/publication/312538784_Groundwater_Modeling/links/5b64a8fa0f7e9bd7ae92e8b0/Groundwater-Modeling.pdf
8- Bear, J., *Dynamics of Fluids in Porous Media*, Courier Corporation, New York, NY, 1972.
9- Freeze, R. A. and J. A. Cherry, *Groundwater*, Prentice-Hall, Englewood Cliffs, NJ, 1979.
10- Bear, J. and A.H-D. Cheng, *Modeling Groundwater Flow and* Contaminant Transport, Springer Science & Business Media, the Netherlands, 2010.
11- 39- Voss, C. I. and A. M. Provost, SUTRA: a model for saturated-unsaturated, variable-density ground-water flow with solute or energy transport, US Geological Survey Water Resources Investigation Reports 02-4231, Reston,VA, 2010, p. 300.
12- Diersch, H. J. G., FEFLOW Reference Manual, DHI-WASY, Berlin, Germany, 2002, p. 116.
13- Haitjema, H. M., Analytic Element Modeling of Groundwater Flow, Academic Press, London, UK, 1995.
14- Servan-Camas, B. and FT-C. Tsai, "Two-relaxation-time lattice Boltzmann method for the anisotropic dispersive Henry problem," Water Resources Research, 46: W02515, 2010, doi: 10.1029/2009WR007837.
15- Aquaveo, Groundwater Modeling System (GMS), Aquaveo, LLC, Provo, UT, 2014.
16- Waterloo, Visual MODFLOW v. 4. User's Manual, Waterloo Hydrogeologic, Ontario, Canada, 2005, p. 654.
17- Rumbaugh, O. J. and O. D. Rumbaugh, Groundwater Vistas User's Manual, Environmental Simulations, Reinholds, PA, 2001, p. 258.
18- Liskov, B., M. Day, M. Herlihy, P. Johnson, G. Leavens, R. Scheifler, and W.Weihl, Argus Reference Manual, MIT Laboratory for Computer Science, Arlington, VA, 1987, p. 165.
19- Winston, R. B., ModelMuse—a graphical user interface for MODFLOW–2005 and PHAST, Techniques and Methods 6–A29, U.S. Geological Survey, Reston, VA, 2009, p. 52.