Groundwater aquifers susceptibility index of Waterborne Diseases Outbreaks (ASIWD) in Nile Delta, Egypt

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Overview

- Introduction
- Objectives
- Study Area
- Methodology
- Results
- Conclusion and Recommendations

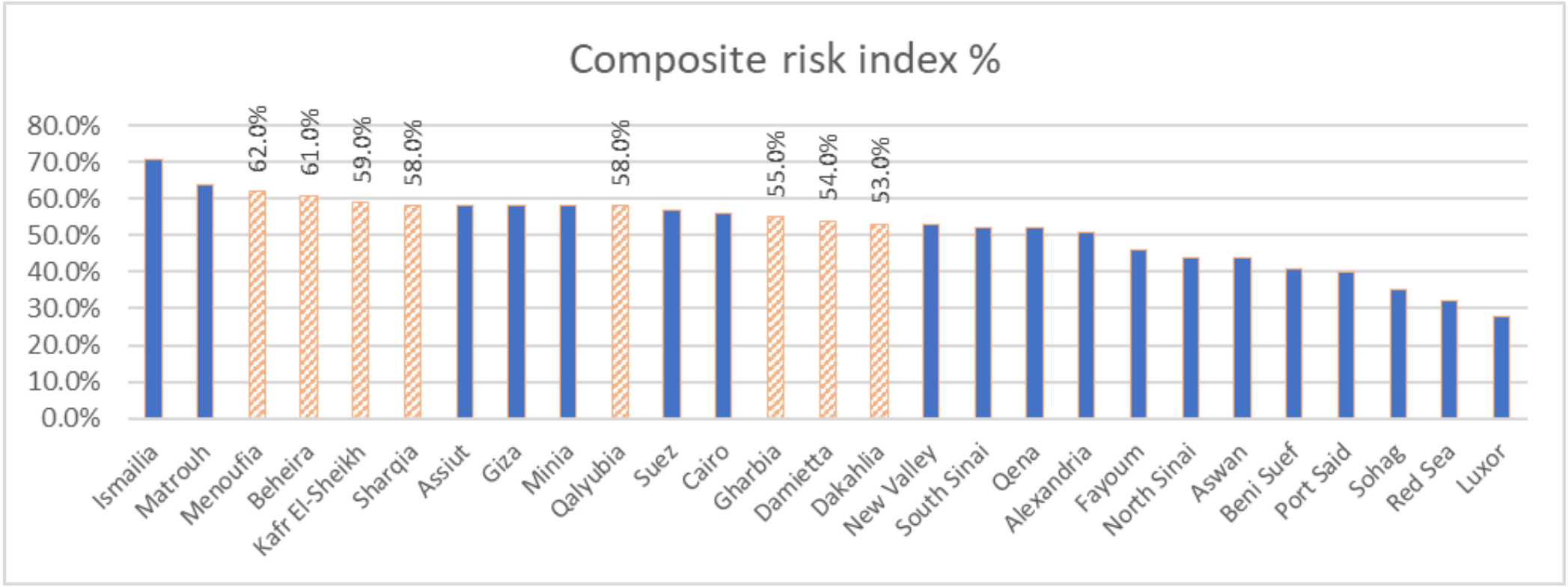
Introduction

- Sewage water is the primary source of microbiological contamination in groundwater.
- Sewage water contains a group of pathogens such as bacteria, viruses, and protozoa.
- Poor sanitation conditions of urban areas and settlements might lead to major waterborne diseases hotspots such as COVID-19 (Barbosa et al, 2022).
- Wasterwater surveillance could be an efficient tool in tracing different waterborne such as SARS-COV-2 (Róka et al, 2022), Daleiden et al. (2022).
- Tools might be developed to detect the areas vulnerable to waterborne diseases through groundwater.

- **Previous Studies around the globe**

Study	Author
Evaluation of groundwater quality and health water brone diseases at **Dass town, Bauchi state, Nigeria**	Jacob K. and Nyanganji. (2011)
Assessment of Groundwater quality and health risk at **Setabganj sugar mills limited, Dinajpur, Bangladesh)**	Syed Md. et al. (2020)
Detection of the origin of the groundwater pollution at **Bouira, the North center of Algeria**	Rizka et al. (2018)
Studied impacts of anthropogenic activities on groundwater quality at **Mostored area, Abu Zabel, East Nile Delta, Egypt**	Hegazy D; al et. (2018)

Food and Waterbrone Diseases in Egypt. Data source: (Madiha, et al. 2017).



Objectives

Main Objective

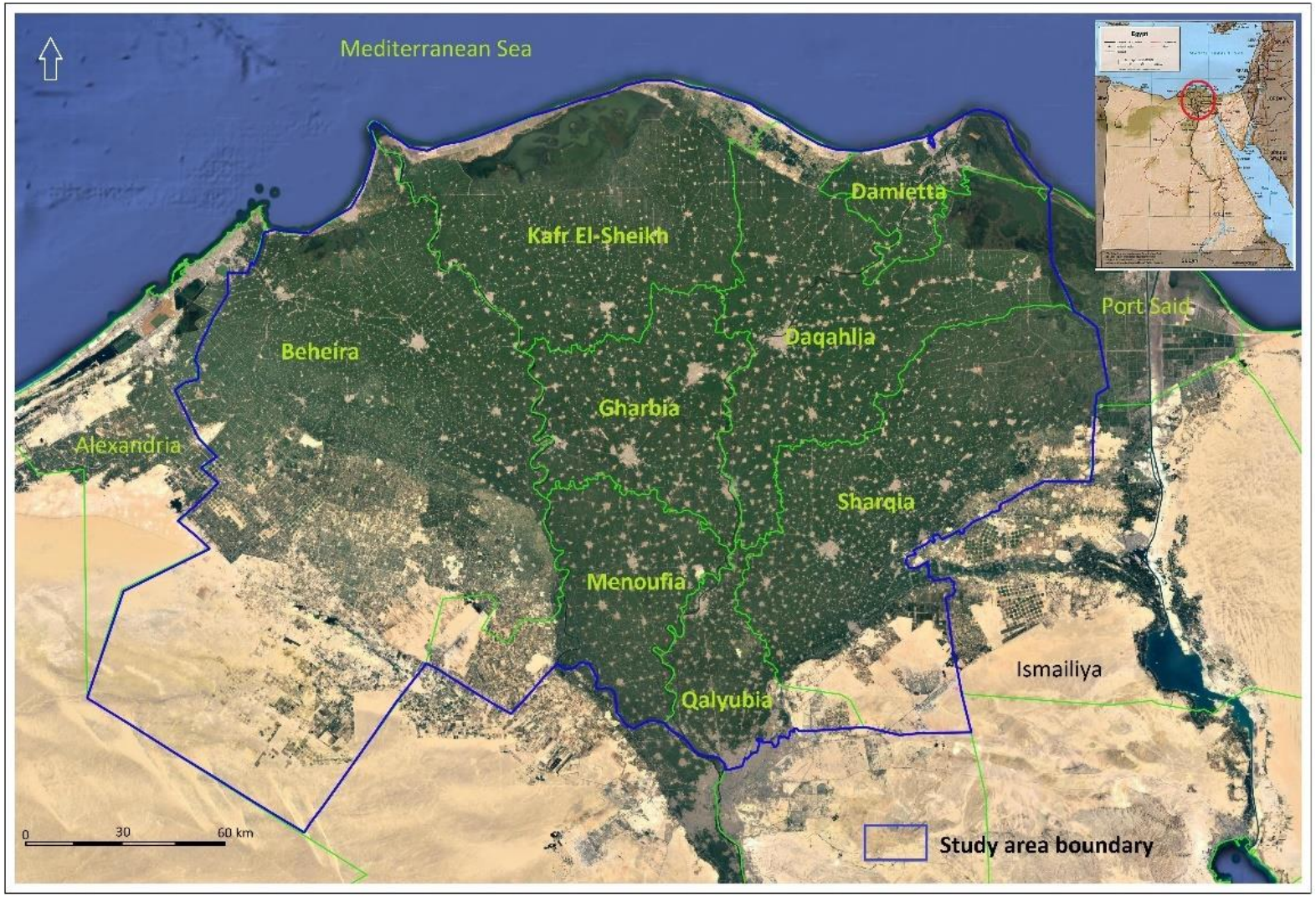
- Index for evaluating groundwater aqufiers' susceptibility water brone diseases

Goals

- Develop Aquifer susceptibility index to Waterbrone Diseases (ASIWD) considering urbanization, population density, water drains density, and sewage treatment sysetms
- Apply the method on Nile Delta Governorates
- Validate the ASIWD parameters
- Classify the study area according to the sensitivity of waterborne diseases transmission

Study Area

- **Study area covers the following governorates:**
- Menofia
- Gharbia
- Beheira
- Kafr El Sheikh
- Sharqia
- Daqahlia
- Qalyuibia
- Damietta

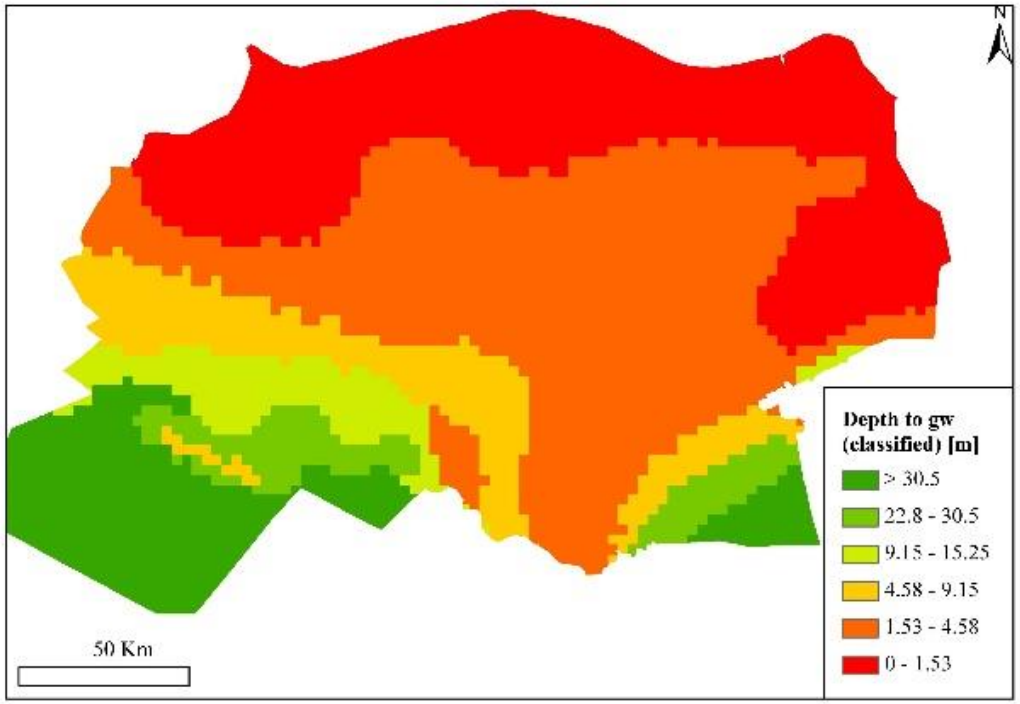


Methodology

- Processing parameter thematic layers(groundwater hydrogeological parameters, anthropogenic parameters)
- Parameters weighting (DRASTIC weighting for hydrogeological parameters, ASIWD weighting for anthropogenic parameters)
- Parameters ranging and rating
- ASWID index calculation (Weighed Linear Combination (WLC))
- Sensitivity analysis (map removal sensitivity analysis, single parameter sensitivity analysis)

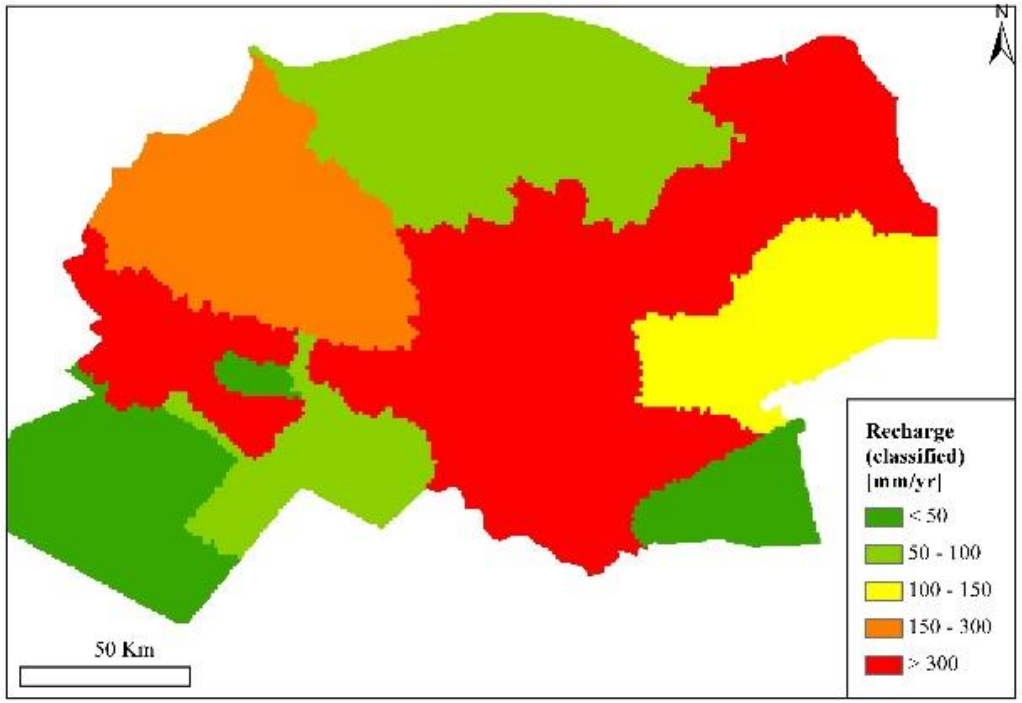
Results

- **Thematic parameter layers processing**



Depth to Groundwater

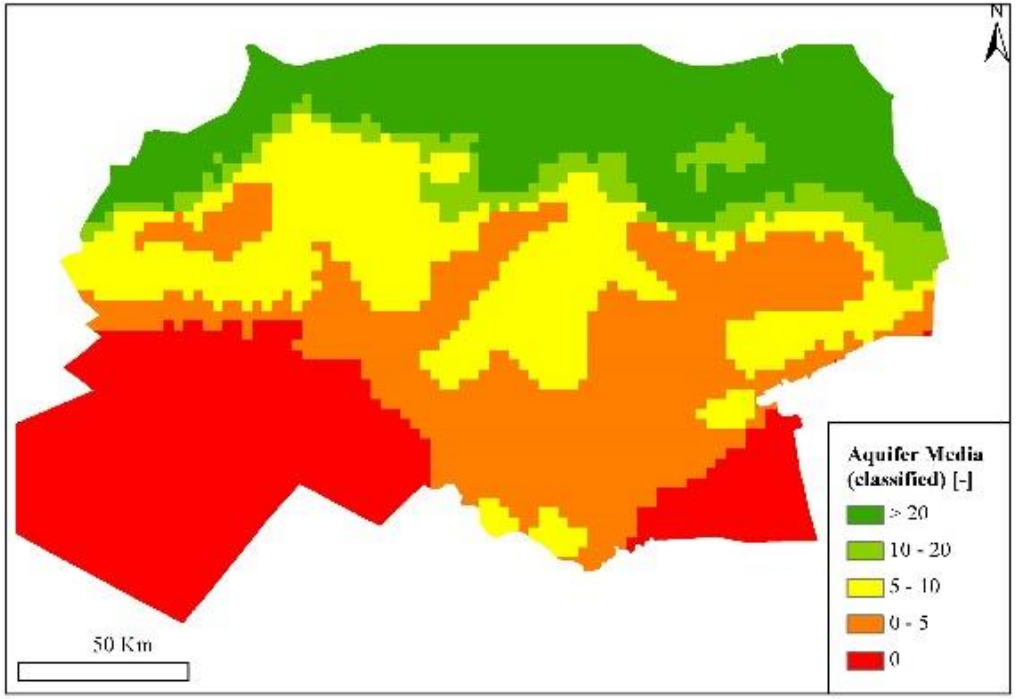
Data source: Mursy (2009), Dahab, K (1993), and Armanuos et al. (2016)



Net recharge rate

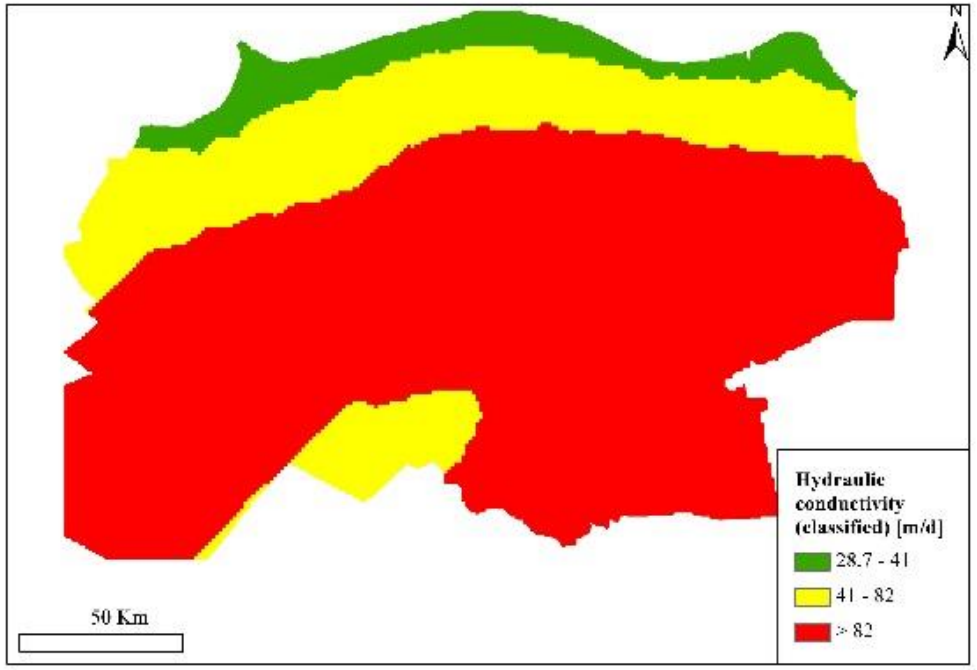
Data source: Farid, M (1985), RIGW (1992a), Masterson et al. (2007), and Armanuos et al (2016)

Thematic parameter layers processing



Aquifer media

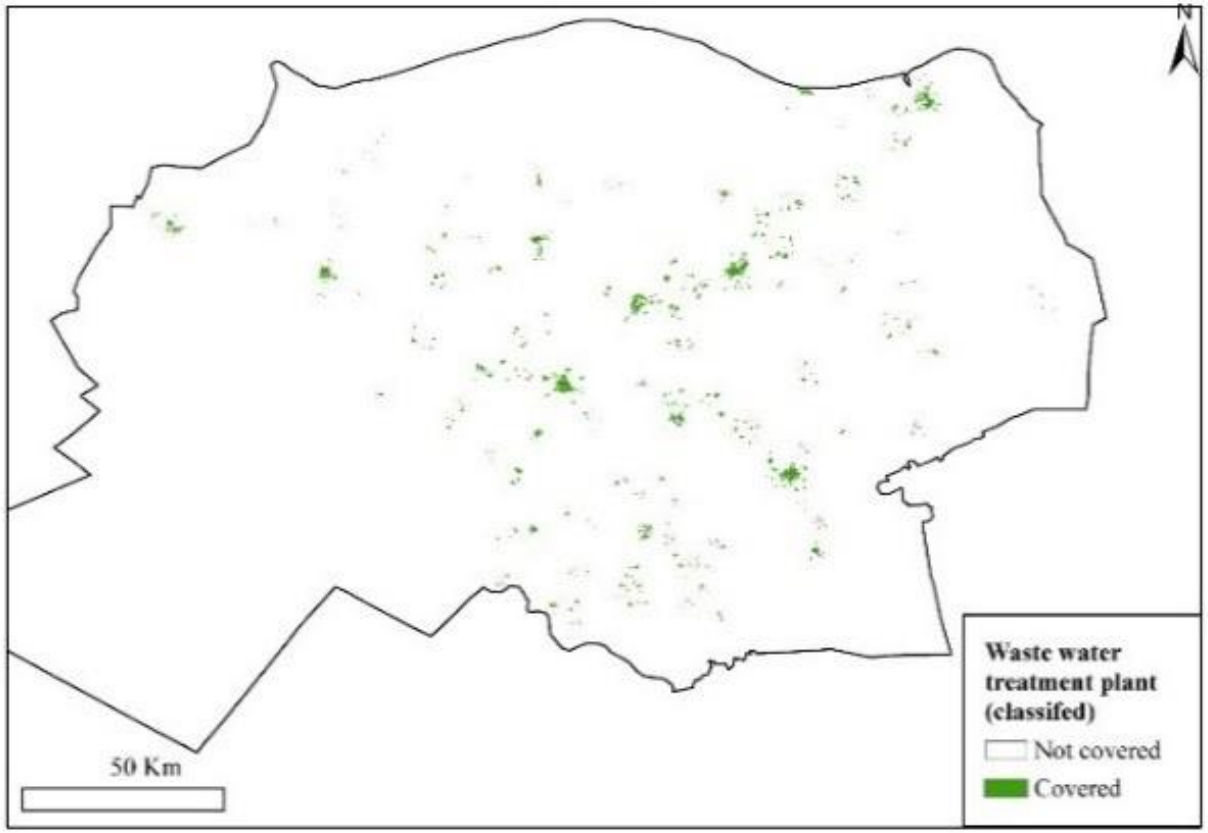
Data source: Elewa and Nahry (2009), CONOCO, Co. (1987) Diab, M et al (1997), Dahab, K (1993), and Armanuos et al (2016)



Hydraulic conductivity

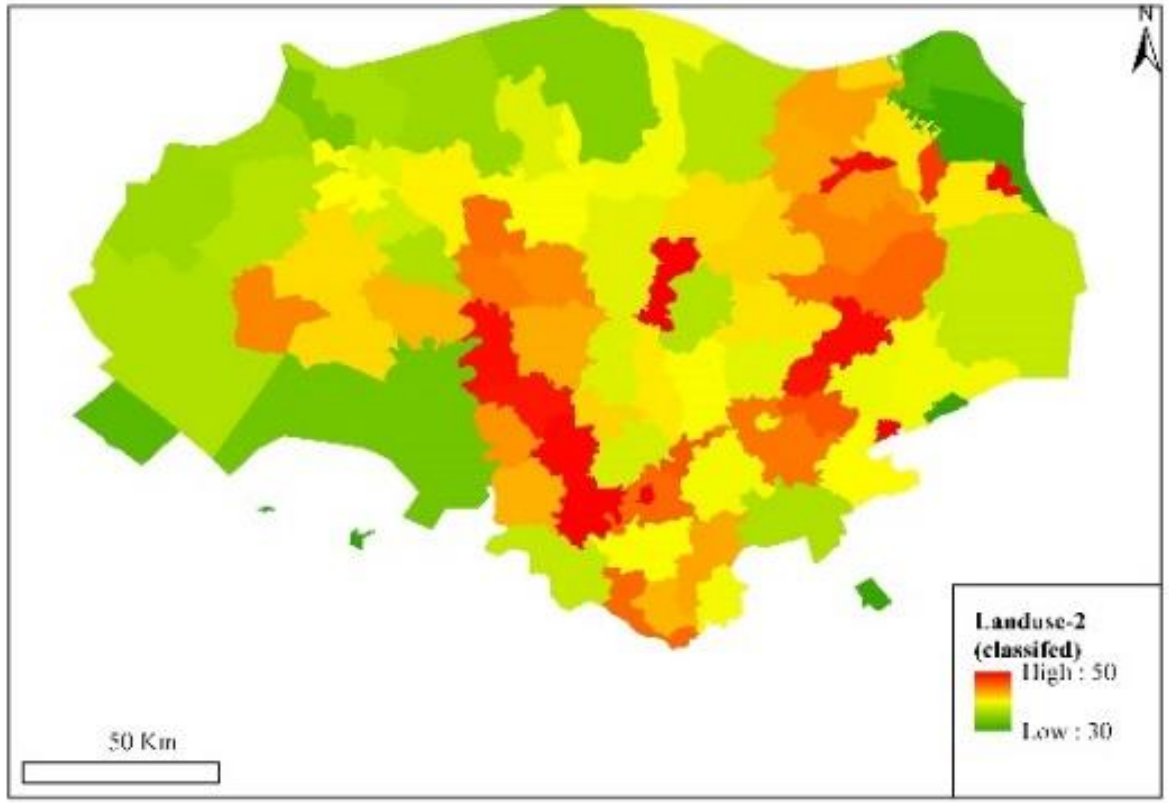
Data source: Wolf, P (1987), Arlt, H (1995), Sherif et al. (2012), Mursy (2009), and Armanuos et al. (2016)

➢ Thematic parameter layers processing



Sewage treatment system

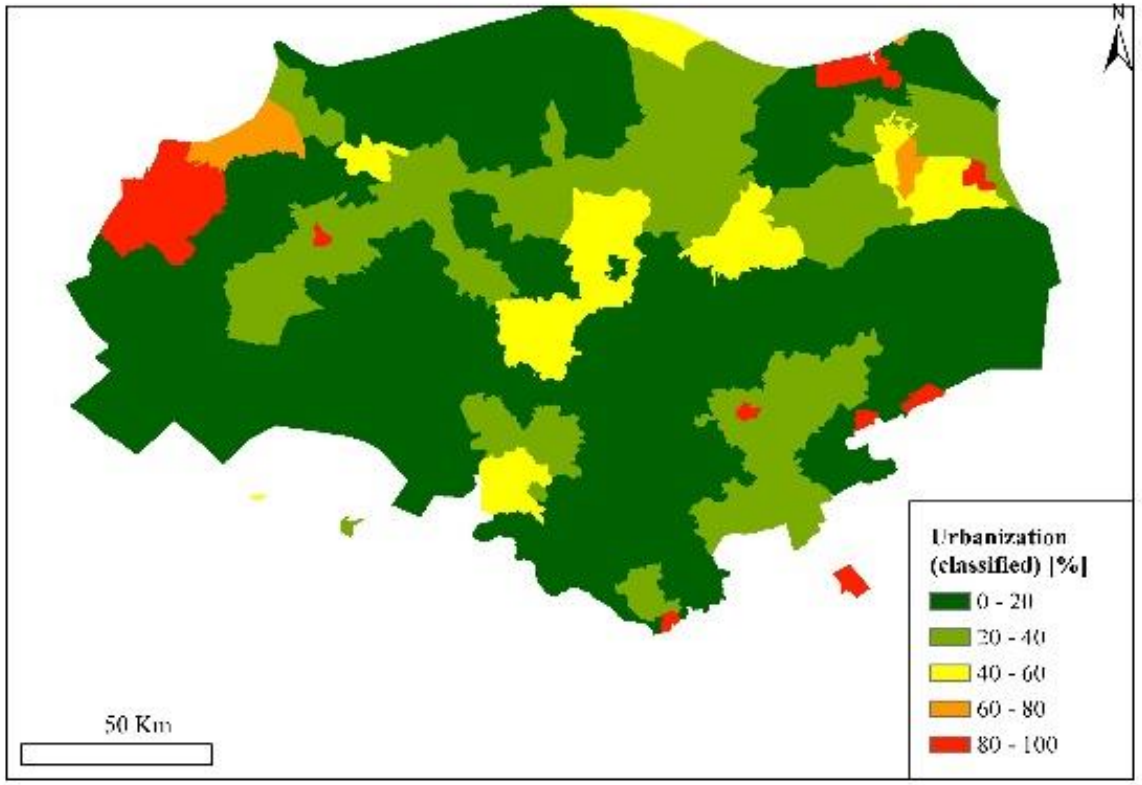
Data source: Capmas2021



Drains density

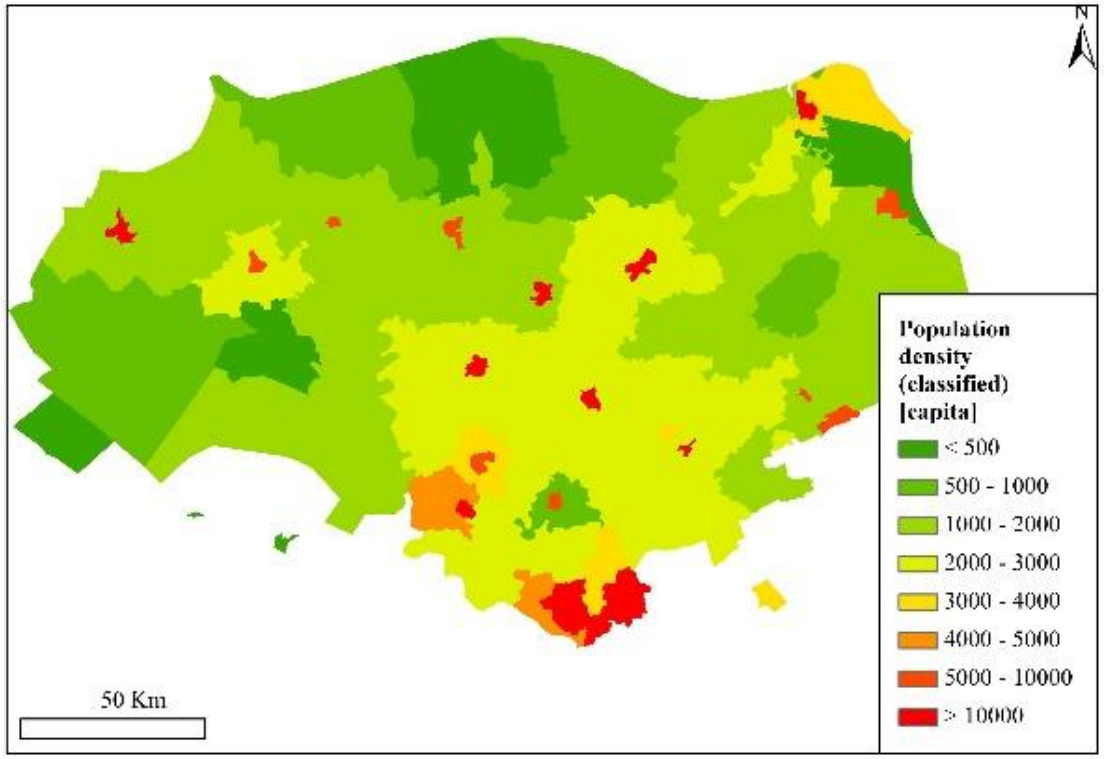
Data source: Capmas2021

Thematic parameter layers processing



Urbanization factor

Data source: Capmas2021

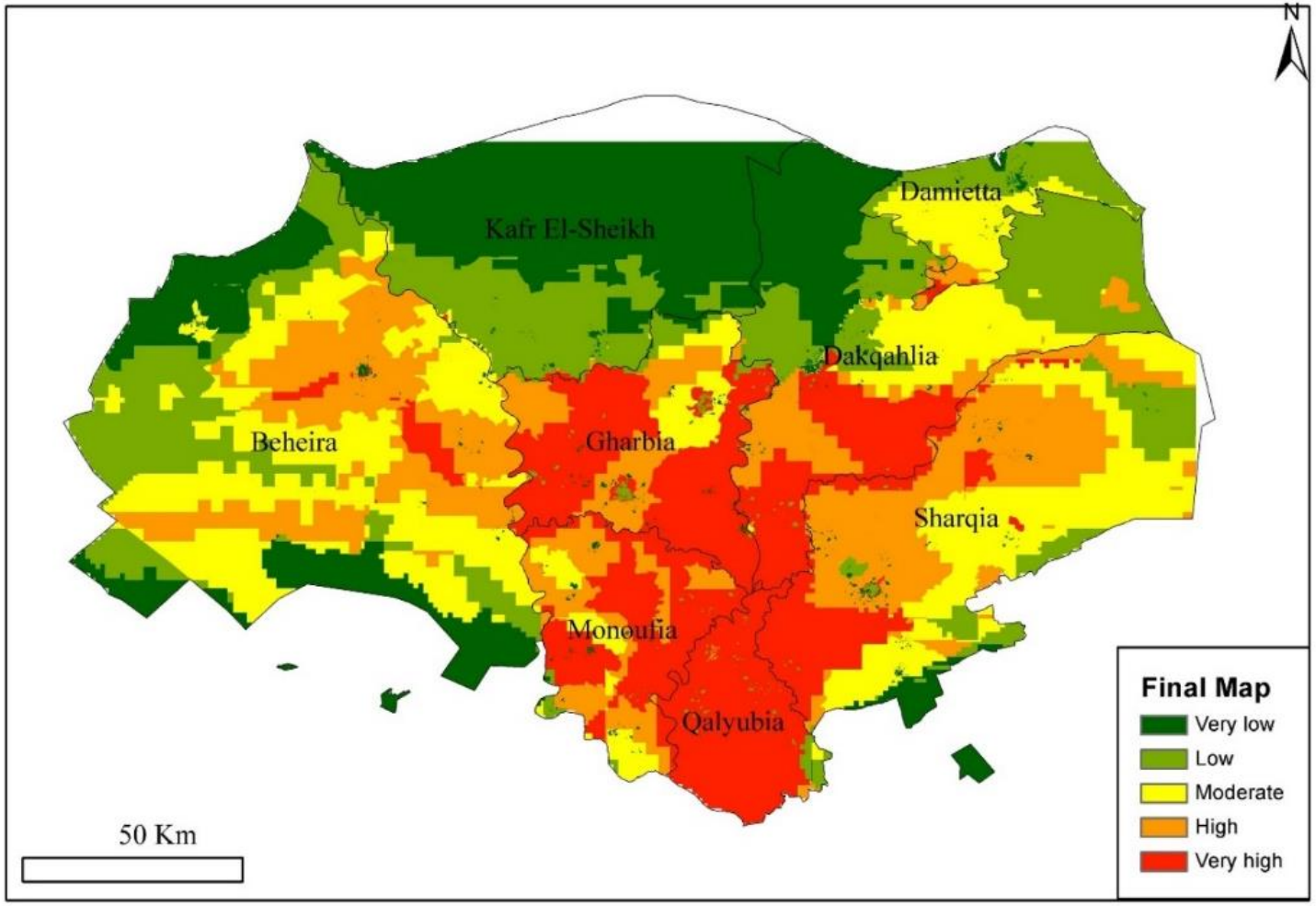


Population density

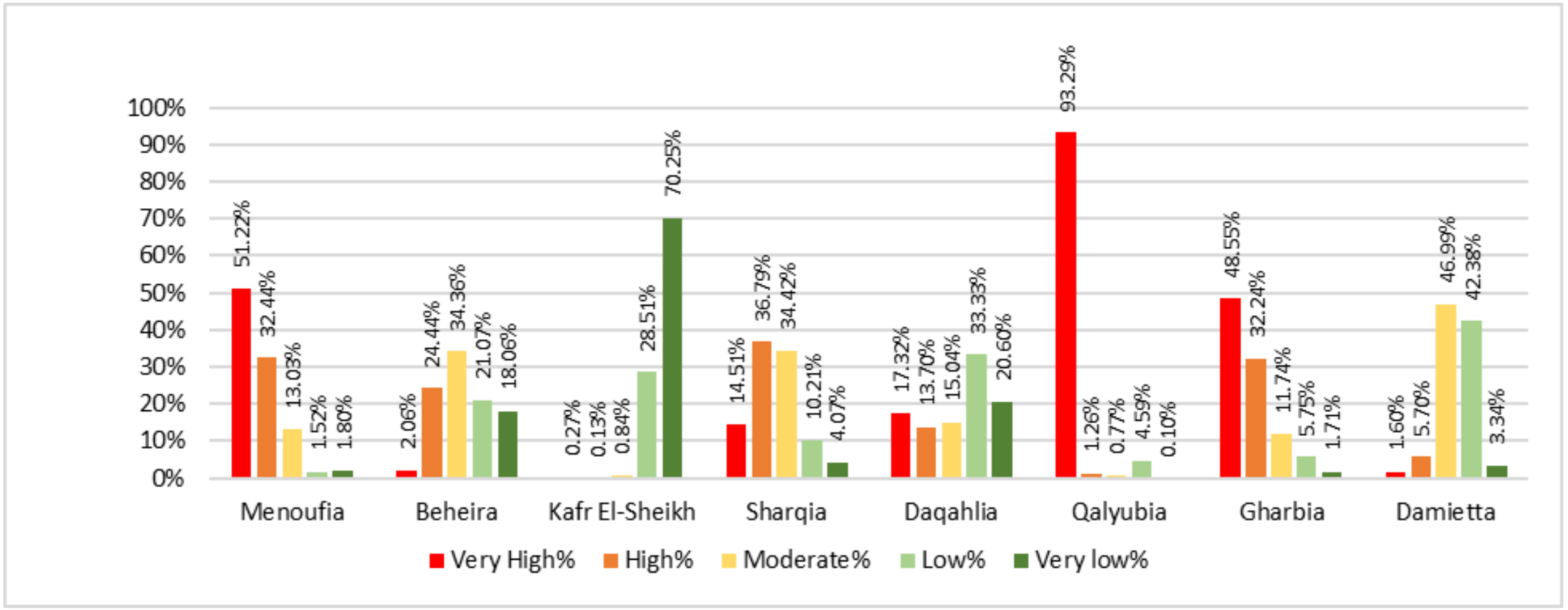
Data source: Capmas2021

ASIWD Index of the Study Area

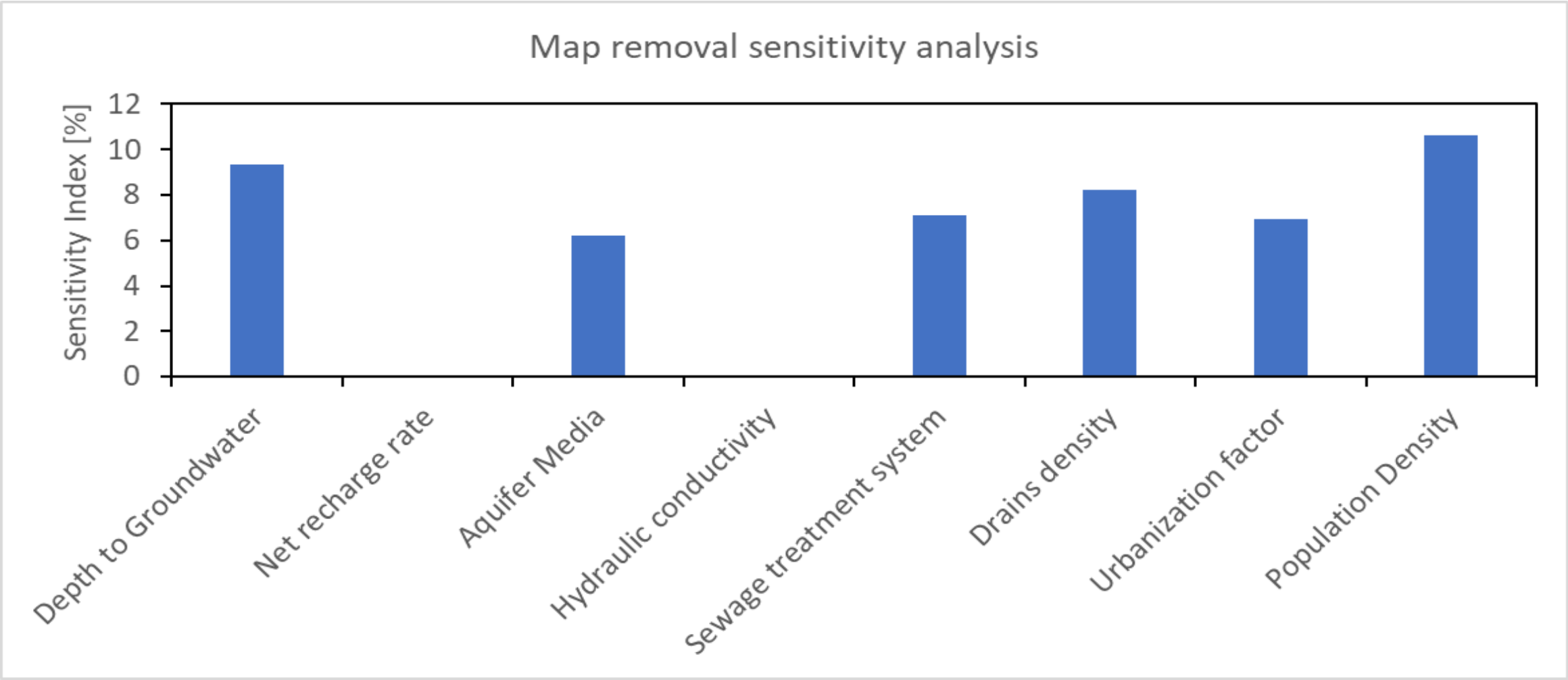
ASIWD index	Area [%]
Very low	19.8
Low	19.9
Moderate	21.7
High	19.5
Very High	19.1



ASIWD Index classification of each governorate



Results Sensitivity Analysis



Conclusion and Recommendations

- ASIWD has approved the importance of including the anthropogenic parameters of groundwater aquifer susceptibility to waterborne diseases outbreak in the Nile Delta, Egypt
- The frame work could be applied in other region taking into account the adjustment of the weighting factos and rates based on site conditions.
- It is recommended to improve the irrigation system and prevent the continuous drainage of sewage and wastewater to the canals and the drainage system.
- Sewage treatment services must be developed and concentrated in high-risk governorates such as Qalyuibia, Gharbia and Menofia (South Delta)
- Public Awareness should be conducted especially at the vulnerable areas.

References

- Jacob K. Nyanganji; John Abdullahi; Ibrahim Umaru Sarkin Noma; 2011 Groundwater quality and related waterborne diseases in Dass town, Bauchi state, Nigeria.Journal of Environmental Issues and Agriculture in Developing Countries, Vol. 3, No. 2 August 2011, (133-148).
- Syed Md. Sazzad Hossain a, Md. Emdadul Haque a, Md. Abdul Hadi Pramanik a , Md. Jalal Uddin b and Md. Abdullah Yousuf Al Harunc; 2020, Assessing the groundwater quality and health risk: A case study on Setabganj sugar mills limited, Dinajpur, Bangladesh, WATER SCIENCE 2020, VOL. 34, NO. 1, 110–123, https://doi.org/10.1080/11104929.2020.1790184
- Rizka Maria. 2018. Comparative studies of groundwater vulnerability assessment, IOP Conf. Ser.: Global Colloquium on Geosciences and Engineering 2017, IOP Conf. Series: Earth Environ. Sci. 118 012018, doi:10.1088/1755-1315/118/1/012018
- Hegazy1 D, El-Bastaweesy M, Garamoon H, Ahmed Melegy A, Mohamed Ali Elsaid M. A. 2018 “The impacts of human and agriculture activities on the groundwater quality in Motorod, Abu Zabal, East Nile Delta, Egypt, Al Azhar Bulletin of Science Vol. 29, No. 2 (December), 2018, pp. 59-71.
- Barbosa, M. R. F., Garcia, S. C., Bruni, A. D. C., Machado, F. S., de Oliveira, R. X., Dropa, M., da Costa, A. C., Leal, E., Brandão, C. J., da Silva, R. L. O. & Iko, B. Y. 2022 One-year surveillance of SARS-CoV-2 in wastewater from vulnerable urban communities in metropolitan São Paulo, Brazil. Journal of Water and Health 20 (2), 471–490.
- Elewa HH, El Nahry AH (2009) Hydro-environmental status and soil management of the River Nile Delta, Egypt. Environ Geol (2009) 57:759–774, DOI 10.1007/s00254-008-1354-5
- CONOCO, Co. (1987) The geological map of Egypt. Scale 1:500.000. General Petrol. Co., Cairo
- Diab, M. S., Dahab, K., and El Fakharany, M., Impacts of the paleohydrological conditions on the groundwater quality in the northern part of ND, The geological society of Egypt, Geol. J. 4112B, 779–795, 1997.
- Sherif, M. M., Sefelnasr, A., and Javad, A. 2012. Incorporating the concept of equivalent freshwater head in successive horizontal simulations of seawater intrusion in the NDA, Egypt, Hydrol. J. 464-465,186-198, 2012.
- Capmas. 2021. The Central Agency for Mobilization and Statistics reports for the year 2021

- Róka, E., Déri, D., Khayer, B., Kis, Z., Schuler, E., Magyar, N., Pályi, B., Pándics, T. & Vargha, M. 2022 SARS-CoV-2 variant detection from wastewater: rapid spread of B. 1.1. 7 lineages in Hungary. Journal of Water and Health 20 (2), 277–286.
- Daleiden, B., Niederstätter, H., Steinlechner, M., Wildt, S., Kaiser, M., Lass-Flörl, C., Posch, W., Fuchs, S., Pfeifer, B., Huber, A. & Oberacher, H. 2022 Wastewater surveillance of SARS-CoV-2 in Austria: development, implementation, and operation of the Tyrolean wastewater monitoring program. Journal of Water and Health 20 (2), 314–328.
- Madiha S.M. Abdel-Razik;, Hoda I.I. Rizk; and Mahmoud H.M. Hassan 2017, Surveillance of communicable diseases for decision making in Egypt: 2006–2013, Eastern Mediterranean Health Journal EMHJ, Vol. 23 No. 6, 2017; 395-403.
- Morsy WS (2009). "Environmental Management to Groundwater Resources for Nile Delta Region‖, PhD thesis, Faculty of Engineering, Cairo University, Egypt
- Farid, M. S.1985: Management of groundwater system in the ND, Ph.D. thesis, Fac. of Eng., Cairo Univ, Egypt, 1985.
- RIGW, 1992a, Hydrogeo. map of ND, Scale 1: 500,000, 1st Edn., ND, 1992a. Research Institute for Groundwater, Egypt
- Masterson, J. P. and Garabedian, S. P., Effects of sea-level rise on groundwater flow in a coastal aquifer system, Groundwater J. 45, 209–217, 2007.
- Armanuos AM, Negm A, Yoshimura C, Valeriano OCS. 2016. Application of WetSpass model to estimate groundwater recharge variability in the Nile Delta aquifer. Arab J Geosci 9:553. https://doi.org/10.1007/s12517-016-2580-x
- Dahab, K., Hydrogeological evaluation of the ND after High Dam construction, Ph.D. thesis, Fac. of Sci., Menoufia Univ, Egypt, 1993.
- Wolf, P.1990, The problem of drainage and its solution in the Nile Valley and ND, Natural Res. Develop. J. 25, 62–73, 1987. 40 RIGW/IWACO, hydrological inventory, and groundwater development plan western ND region, TN77. 01300-9-02 Research Inst. for Groundwater, Kanater El-Khairia, Egypt, 1990.
- Arlt, H. D., A 1995. hydrogeological study of the NDA with emphasis on SWI in the northern Area, Mitteilung/Institut fur Wasserbau und Wasserwirtschaft, Technische Universit at Berlin, Nr. 130, OCLC No. 636899992, 291–302, 1995.