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Assessing the Hazards of Groundwater Logging in Tourism Aswan City, Egypt

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Abstract: This paper studies the groundwater logging problem in the Quaternary aquifer in Aswan city, Upper Egypt. Groundwater levels are already very high in Aswan city, but this has not been exploited, and it causes damage to the environment and infrastructure for roads, building, and templets. Rising groundwater leads to the deterioration and poor quality of agricultural lands. The main objective of this study is to assess and investigate the main reasons for the groundwater logging in the tourist city of Aswan using field investigation during different periods and gain a better understanding of the water dynamics in the study area. This study investigated the surface water levels in the High Dam Lake (HDL), the Kima Lake water levels, the recharge in the fish hatchery, the abstraction well rates in Kima and El-Shalal, and the leakage from the drinking water and wastewater network in Aswan city within the study area using field investigation. The results of this study show that the HDL is one of the most important sources feeding the aquifer in the study area, and it affects the rise and fall of the groundwater levels, but it is not the only factor that affects this problem. Moreover, the rise in the groundwater levels was due to the infiltration from the unlinking fish hatchery, the reduction in abstraction well rates from Kima Lake, the lack of abstraction from El shallal region, the increase in the leakage from drinking water pipelines, sewage networks and septic underground wastewater tanks; these factors are affecting groundwater logging in Aswan city. Potential groundwater level maps for the study area were generated using field data and ArcGIS technique for the years 2010, 2012, 2014, 2017, 2018, and 2020. Based on the results of the potential groundwater maps, the maximum and minimum difference for the groundwater levels in the study area between 2017 and 2012 reached 12.56 m and 0.83 m, respectively; also, between 2018 and 2017, the levels were 4.34 m and 0.25 m, respectively. Moreover, between 2020 and 2018, they were 8 m and 0.38 m, respectively.

Keywords: groundwater; logging; Aswan; HDL; leakage; withdrawal

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1. Introduction

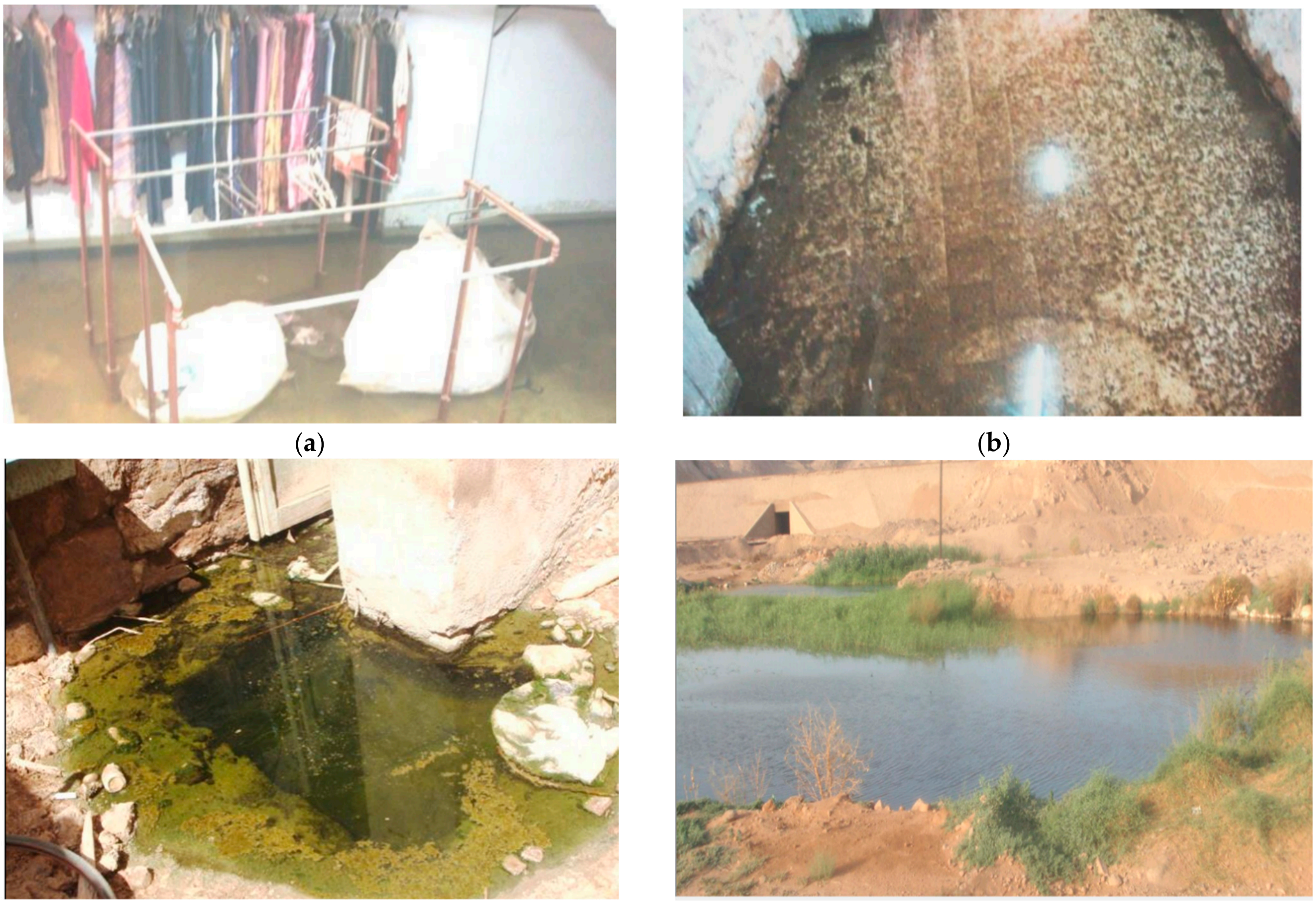
Hydrologists' studies of interactions between groundwater and surface water are a topic of interest, leading to better combined use of water from two different sources, surface water and groundwater, for demands purposes. Correct shared use can alleviate water shortages in irrigated agriculture, increase water use efficiency, and improve regional environmental conditions in irrigated areas. Overpopulation and climate change increase water demands and lead to the over-pumping of the aquifers. Furthermore, groundwater provides about 31% of the world's drinking water [1,2]. A lot of researchers have studied groundwater flow and the factors affecting its quantity and quality in arid and semi-arid regions. Xiao et al. [3,4] investigated the sources of driving forces and potential health hazards of nitrate and fluoride in typical alluvial plains fan groundwater for groundwater logging using hydrogeochemical investigation in an intensively human-impacted in semi-arid piedmont in North China. Youssef et al. [5] used a MODFLOW simulation to plan and manage the groundwater problems in Wadi El-Farigh in Western Desert, Egypt. El-Rawy et al. [6] investigated the potential impacts of the Grand Ethiopian Renaissance Dam (GERD) on the groundwater levels (GWL) in the Nile Valley aquifer in El-Minia Governorate. Negm et al. [7] gave an overview of the groundwater resources in the Nile Delta aquifer, Egypt. Abd-Elhamid et al. [8] examined the potential negative impact on the Nile Delta aquifer as a result of the possible decrease in flow in the Nile, due to the construction of the GERD in Egypt.

The phenomenon of groundwater logging is a major problem that worries researchers, as if it is not exploited and managed well, it can cause great destruction to the areas that suffer from this phenomenon. Therefore, it has become necessary to study the problem in order to know its source and develop scenarios to control it and improve the utilization of the water. Awad et al. [9] used field measurements to assess the surface water and groundwater interaction for the area around the project of New Dairut Group Regulators (NDGRs), Assuit, Egypt. Noureldeen et al. [10] developed an Artificial Neural Network (ANN) model for monitoring the changes in groundwater levels due to the construction of the Naga-Hammadi barrage. Hatton et al. [11] studied water logging and groundwater recharge in southwestern Australia. Bob et al. [12] attempted to gain insight into the shallow groundwater table rise problem that has recently been observed in this important location. AL-Sefry and Sen [13] followed a quantitative method to assess the risk of groundwater levels rising in Jeddah, Kingdom of Saudi Arabia. Ray [14] proposed an interdisciplinary planning strategy to deal with the issue of rising groundwater levels.

A Number of researchers used different methods to study groundwater flow. Abd-Elaty et al. [15] developed a numerical study for studying the problem of rising sea levels in three climate zones in humid and wet zones, hyper-arid and arid zones, and semi-arid and semi-humid zones. El-Rawy et al. [16] assessed the groundwater quality using factor statistical analysis, GIS, and hydro-geochemistry in Qena governorate, Egypt. Abd-Elaty et al. [17,18] applied MODFLOW to assess the effect of open drain systems on groundwater quantity in the Eastern Nile Delta, Egypt and the integration between the two water supply systems of surface water and ground water.

ArcGIS software was used to assess and study changes in groundwater potential, which is considered one of the most important applications used to study the problems of water logging. There are many researchers who used ArcGIS software in similar fields. Jhariya et al. [19] used the combined applications of advanced techniques and tools such as electrical resistivity, remote sensing, the geographic information system (GIS), and MCDA to assess the potential areas of groundwater occurrence in Raipur city, Chhattisgarh, India. Celik [20] utilized the ArcGIS, MCDM, and AHP as a spatial prediction tool in exploring the groundwater potential for the drainage area in the Tigris River, Batman-Hasankeyf Sub-Basin, Turkey. Aryanto et al. [21] used a GIS to assess the potential area of groundwater recharge in Purworejo District, Central Java Province, Indonesia. Thapa et al. [22] used multi-influencing factor (MIF) and GIS to assess groundwater potential zones in Birbhum district, West Bengal. Nagarajan et al. [23] used the GIS technique to assess groundwater potential zones in the Kattankulathur block, Tamil Nadu, India. Nithya et al. [24] applied the GIS-based AHP technique to assess groundwater potential zones in Chittar basin, Southern India. Abd-Elaty and Zelenakova [25] studied water management in shallow and deep coastal aquifers for high aridity regions. The study explored two extensive and important regional aquifers: the first is the shallow Gaza coastal aquifer (GCA), Palestine, and the second is the deep aquifer of the Nile Delta (NDA), Egypt. The two sites suffer from high water stress and contamination by saltwater intrusion (SWI). El Shinawi et al. [1] studied land subsidence and environmental threats in coastal aquifers under sea level rise and over-pumping stress in the coastal aquifer of Nile delta, Egypt.

These conditions were applied to the current study area (Aswan City, Egypt), where surface water is available and represented by the Nile River and groundwater rising in the aquifer. The rising in groundwater represents a threat to buildings, infrastructures, and the surrounding environment because of the formation of ponds, as shown in Figure 1. The problem of groundwater logging in Aswan city was studied by Meneisy et al. [26], who clarified the effects of surface and underground structures on the direction of groundwater flow, and the discovery of the thickness (of the groundwater aquifer in Wadi Al-Amal, Aswan, Egypt.



(**a**) (**b**) (**c**) (**d**)

Figure 1. The bad effects of groundwater on the study area: (**a**,**b**) the effect of groundwater on buildings; (**c**) the effect of groundwater on foundations; and (**d**) formation of surface ponds.

Mohamed et al. [27] used the Gravity Recovery and Climate Experiment (GRACE) data with other datasets for a gravity-based assessment of spatiotemporal changes in mass for groundwater resources in the Eastern Desert, Egypt. Gaber et al. [28] used ALOS/PALSAR polarimetric information to assess the potential of the groundwater resources west of Aswan, Egypt. Selim et al. [29] examined the rising of groundwater levels in Aswan city as an environmental problem, its causes, and solutions. Farrag et al. [30] used chemical analysis, remote sensing data, and ArcGIS software to assess environmental impacts on rising groundwater around Kima Company, Aswan, Egypt. Abdalazem et al. [31] assessed the quality of groundwater for irrigation in West Edfu District, Aswan, Egypt. Abdelrady et al. [32] performed a three-discipline study to evaluate the feasibility of the application of this technique in Aswan City (Egypt). Meneisy [33] applied an integrated approach to acquire geologic structures and groundwater potentiality at a highly deformed area. As a case study, remote sensing (RS), aeromagnetic, and geoelectrical data were collected to delineate the subsurface structures and hydrogeological regime in Aswan City. Hikmat et al. [34] developed numerical simulation to identify the groundwater logging in Aswan and showed that the recharge boundaries and conditions effect on the water logging in the city. Hamdan and Rady [35] studied the vulnerability of the groundwater in the quaternary aquifer at El Shalal-Kema area, Aswan, Egypt. Figure 2 shows Aswan city.

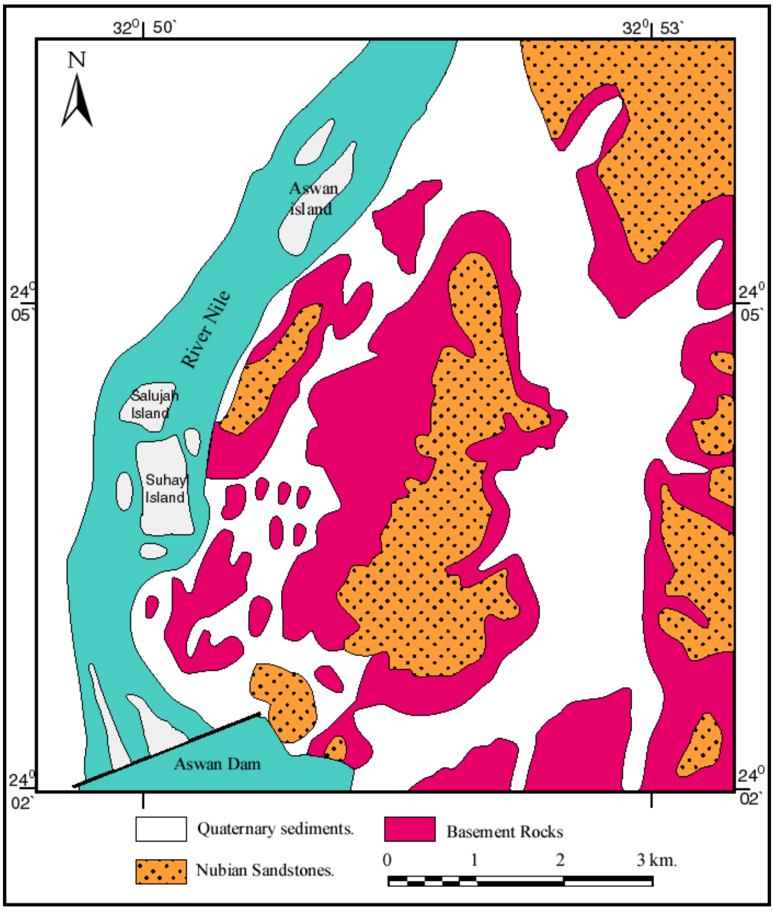


Figure 2. Geological map of Aswan area (modified after Hamdan and Rady [35]).

The main objective of this research was to assess and investigate the main reasons for the problem of groundwater logging in the tourist city of Aswan, follow it up, and identify the reasons for the rise of groundwater levels in the study area to help formulate solutions. Moreover, the groundwater level maps for different yeas were developed to show the spatial distribution and hazards of water logging in Aswan city.

2. Material and Methods

2.1. Methodology

The field data were collected from the study area by conducting field visits to measure the groundwater levels in the observation wells, which are distributed throughout the study area, using a manual device. This was also done using the records from the Aswan Drinking Water and Sanitation Company and the Kima company, from the published material about the history of water levels and quantities for water storage. The surface water levels in Kima Lake were calculated by means of surveying equipment. The surface water levels in the Nile River and the HDL were collected and monitored by the Ministry of Water Resources and Irrigation using the scales spread and distributed over the HDL and the Nile River. The data of groundwater levels were used to generate groundwater distribution maps, with the help of interpolation techniques in the ArcGIS software. Charts were made using the Excel tool for spatial distribution of groundwater levels in the study area, as well as the water levels in Kima Lake and HDL, in order to carry out an accurate investigation and assessement of the groundwater logging problem in the study area. The whole technical flow chart of the methodology adopted in this study is given in Figure 3.

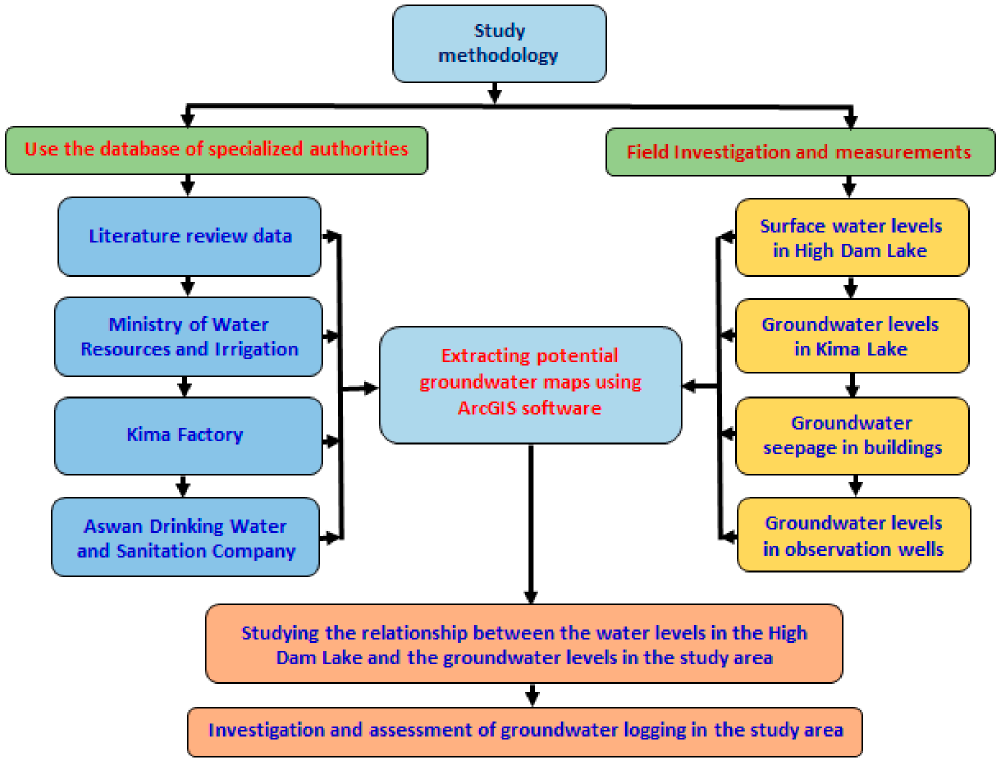


Figure 3. Methodology adopted in the present study.

2.2. *Aswan City as Case Study*

The study area was located along the Nile Valley in the southern part of Egypt at the eastern bank of the Nile River, restricted by latitudes 24°01′30″ and 24°06′30″ N and longitudes 32°52′ and 32°56′ E, as shown in Figure 4. Over the last few years, an increase in groundwater levels has been observed in several parts of Aswan city (the study area), the rising of groundwater levels can flood underground infrastructure, flood basements of buildings, submerge sewage pipes and utility lines that provide water and electricity, and form ponds and swamps in areas where a land depression intersects with the groundwater table. The scale of humans' influence on their environment makes them the main geological factor on the planet's surface. The phenomenon of rising groundwater that occurred in 2009 is directly related to the cessation of groundwater pumping from the wells of El-Shallal area and the reduction in pumping from the wells of the Kima factory. Generally, the rates of rising groundwater are much higher in the western side of the city and in the Kima factory area, as they have low terrains and are densely populated. The most disturbed groundwater levels are likely to develop under urban areas in low-lying areas with a relatively highly permeable aquifer that is not exploited for water supply. This problem will become more widespread if the groundwater logging remains out of control. The study area was bounded in the east and the west by the basement rocks and Nile River, respectively. The study area was about 19.43 km^2, and its maximum width was 4.5 km. Aswan city has a dry climate, with no rain, except for one event every 10 to 15 years. The land levels in the study area ranges from 88 to 211 m above mean sea level at an average of 112 m. The study area included three geological components (base rocks, Nubian sandstones, and quaternary sediments). The quaternary sediments consist of sand, gravel, clay from the Pleistocene age, mud, and Aeolian sediments. In the southern side of

Aswan city, the aquifer is mainly composed of fine-to-medium sand intersected by thin clay intersections. These insides usually thicken from the south to the north. The study area was delineated from the western and eastern boundaries by complex pre-Cambrian igneous and metamorphic rocks, particularly granite and schist. Layers of Nubian sandstone covered the base rocks with thickness ranging from 20 to 85 m.

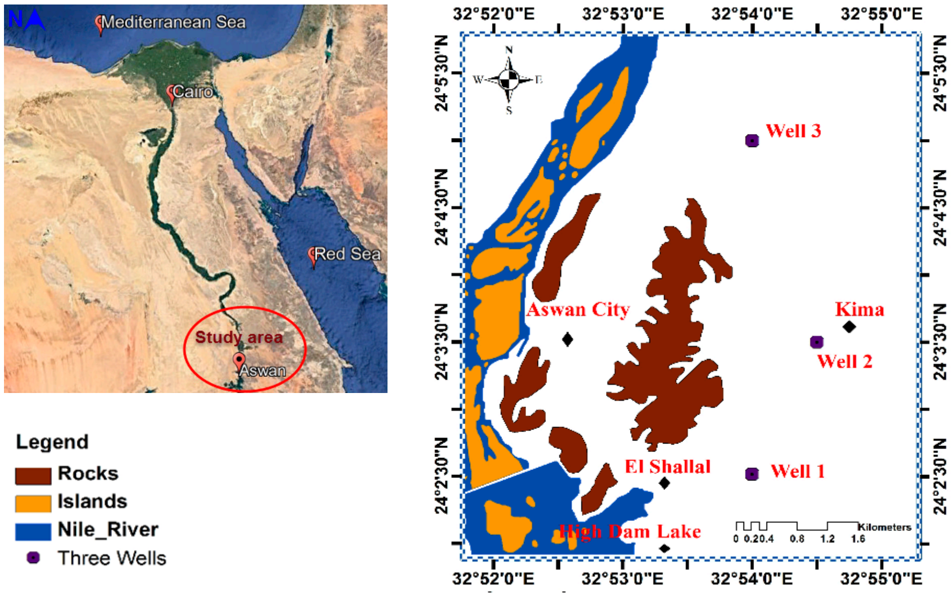


Figure 4. The study area location map.

2.3. Field Investigation

The field data for the groundwater levels in the study area and the surface water level in the HDL were collected through field visits to these sites and taking the measurements of groundwater levels from observation wells distributed over the study area using a water level meter (it is a cable connected at the head with two follower poles that touch once they reach the surface of the water and give a signal to a bell and lamp at the top), and Kima Lake surface water levels were measured by a surveying device, as shown in Figure 5, using the database of authorities specialized in collecting this data, such as the Ministry of Water Resources and Irrigation, Kima factory administration, and Aswan Drinking Water and Sanitation Company. Sufficient data were collected to feed the ArcGIS technique to make an appropriate assessment and investigation of the Aswan groundwater levels, in order to make appropriate scenarios for the management of the groundwater logging problem in Aswan city and the reduction of the damage caused by it, and to increase its exploitation.

2.4. ArcGIS Tools

ArcGIS is an excellent assessment technique that analyzes multiple criteria methodologies. The spatial analyzer extension for Arc GIS software is well suited to execute this form. The analysis process was performed with the Spatial Analysis and Overlay tools, considering the relative values and grading and interpolating the final potential groundwater maps.

Figure 5. Field data collection and measurements: (**a**) El-Shallal wells; (**b**) Kima wells water levels measurement; (**c**) Kima Lake after 2009; (**d**) Kima Lake 2020; (**e**,**f**) Kima Lake measurement.

3. Results and Discussion

3.1. Investigation of Surface Water Levels in High Dam Lake

The relationship between the surface water levels in the HDL between various years from 2010 to 2020 was found to explain the rising and falling rates of those groundwater levels during those years (see Figure 6). A decrease in the HDL water levels was observed in 2012 compared to 2010, and the HDL water level rose again in 2014 compared to 2012, which was then followed by a decrease in the HDL water level in 2017 compared to 2014, and another increase in 2018 compared to 2017; it then continued to rise in 2020 compared to 2018. The rise and fall of the surface water levels of the HDL depend on the quantities of water entering the HDL and the quantities of water discharged from the High Dam. The amount of water entering the HDL increases in the rainy seasons and decreases in the dry seasons, based on the River Nile hydrograph.

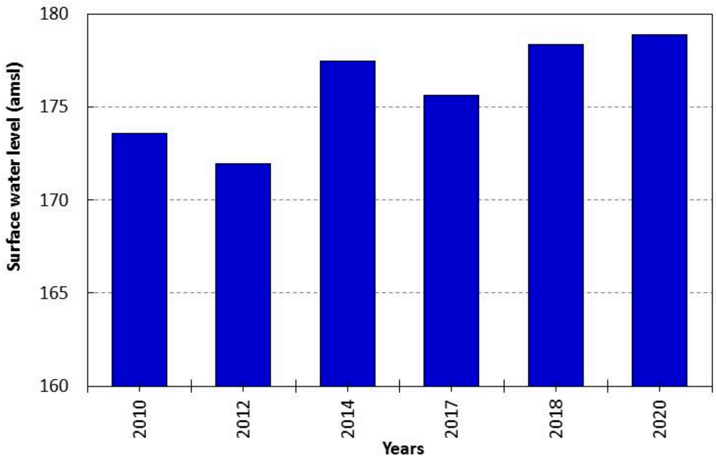


Figure 6. The relation between years and High dam lake water levels.

3.2. Investigation of Groundwater Levels in Kima Lake

Kima Lake is a pond that formed as a result of the intersection of lowland with the groundwater table. The relationship between the groundwater levels in Kima Lake throughout various years were found to explain the rise and fall rates of those levels during those years (see Figure 7). A decrease in the groundwater levels of Kima Lake was observed in 2018 compared to 2017, and the water level of Kima Lake rose again in 2020 compared to 2018. It is clear from Figures 7–9 that there is a consensus in the rates of rising and falling water levels in Kima Lake, and the rates of rising and falling groundwater levels in the observation wells distributed in the study area. Moreover, there was a decrease in these levels in 2018 compared to 2017, and the levels rose again in 2020 compared to 2018. The drop in the groundwater levels in 2018, despite the rise in surface water levels in the HDL, is due to the fact that some government agencies are digging pumping wells to extract the groundwater that flooded the basements of the facilities and pumping it into the sewage networks in order to reduce groundwater levels. This is as a temporary solution to reduce the damage caused by rising groundwater levels. However, these wells were stopped due to the inability of the sewage networks to bear the large quantities of water.

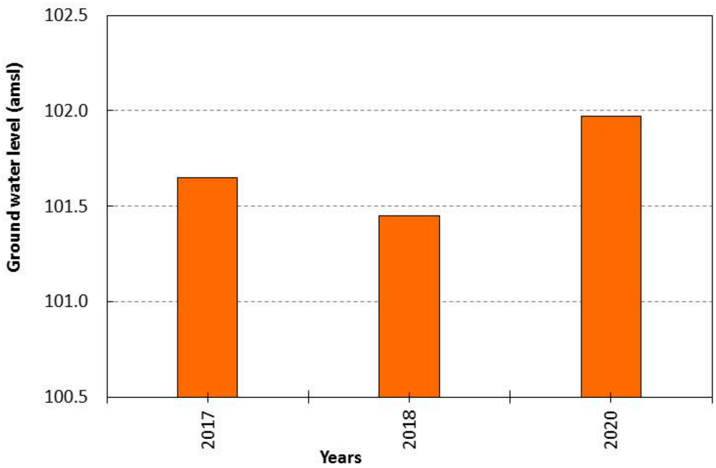


Figure 7. The relation between years and Kima Lake water levels.

3.3. Investigation of Recharge in Fish Hatchery

The fish hatchery in El Shallal area, Aswan city, which is affiliated with the Ministry of Agriculture and Land Reclamation and fisheries authority, is one of three hatcheries in the Aswan governorate; the other two hatcheries are in Toshka and Garf Hussein, but they have not been operated so far. The purpose of fish hatcheries is to produce large quantities of El Mabrouka fish, which works to eliminate water weeds. The fish breeding ponds in the fish hatchery project are located in the El Shallal area beside El hebs region, and the water is raised from El hebs. These ponds are dug with sediments of the fourth age and are unlined, which leads to the infiltration of water towards Aswan city and causes the problem of groundwater logging. The water level in these ponds reaches 118 m above mean sea level, and about 12,960 m^3 per day of water has been pumped into the project (4.66 Million Cubic Meter in year (MCM/year)) since 2010 to now. The water storage in the project from 2010 to now has contributed to the groundwater logging phenomenon in the city.

3.4. Investigation of the Withdrawal Rates in Aswan Aquifer

The groundwater project was implemented by Aswan Drinking Water and Wastewater Company, where there is a continuous withdrawal due to industrial and domestic use, especially in the Kima and El-Shalal areas, reaching 13.277 and 12.44 MCM/year respectively. After 2009, the El Shallal pumping wells stopped completely, and the production of Kima pumping wells decreased to 9.12 MCM/year. The last period saw part of the El Shallal wells beginning to operate, with a production capacity of 0.13 MCM/year and the continuation of Kima wells, with a production capacity of 9.12 MCM in year. Table 1 shows the quantities of withdrawal from Aswan aquifer [34]. The reduction in withdrawal rates and the termination of withdrawal are the main reason for the problem of groundwater logging in Aswan city, because this great and sudden rise appeared as soon as the closure of the El Shallal pumping wells and the reduction in withdrawal from Kima wells occurred.

Table 1. Groundwater withdrawal rates from the areas of Kima and El-Shallal.

Year	Unit	2009	2010	2020
Kima	(MCM/year)	13.277	9.12	9.12
El-shallal	(MCM/year)	12.44	0	0.13

3.5. Investigation of Drinking Water and Wastewater Leakage in Aswan City

Table 2 shows the quantities of water produced, pumped, and drained into the networks for consumption purposes to Aswan city and the quantities of sanitation water that are collected from the city through lift sanitation stations and raised to the treatment plants, whether dual treatment through the Arbaeen station or triple treatment through the Kima station. Based on the difference between the quantities of water pumped into the drinking water networks and the quantities of sewage water collected in the treatment plants, the quantities of leakage from the sewage networks and the drinking water networks were calculated, as shown in Table 2, to reach 4.27, 4.15, 9.72, 9.93 and 10.01 MCM/year for year 2017, 2018, 2019, 2020, and 2021, respectively. This indicates that the leakage water quantities of drinking and wastewater increased each year by large amounts and led to increased groundwater logging in Aswan city. It is also due to the deterioration of the networks over time, poor implementation from the beginning, failure to follow the necessary precautions during implementation, and the use of shoddy materials.

Table 2. Quantities of drinking water, sewage water and leakage water for different years.

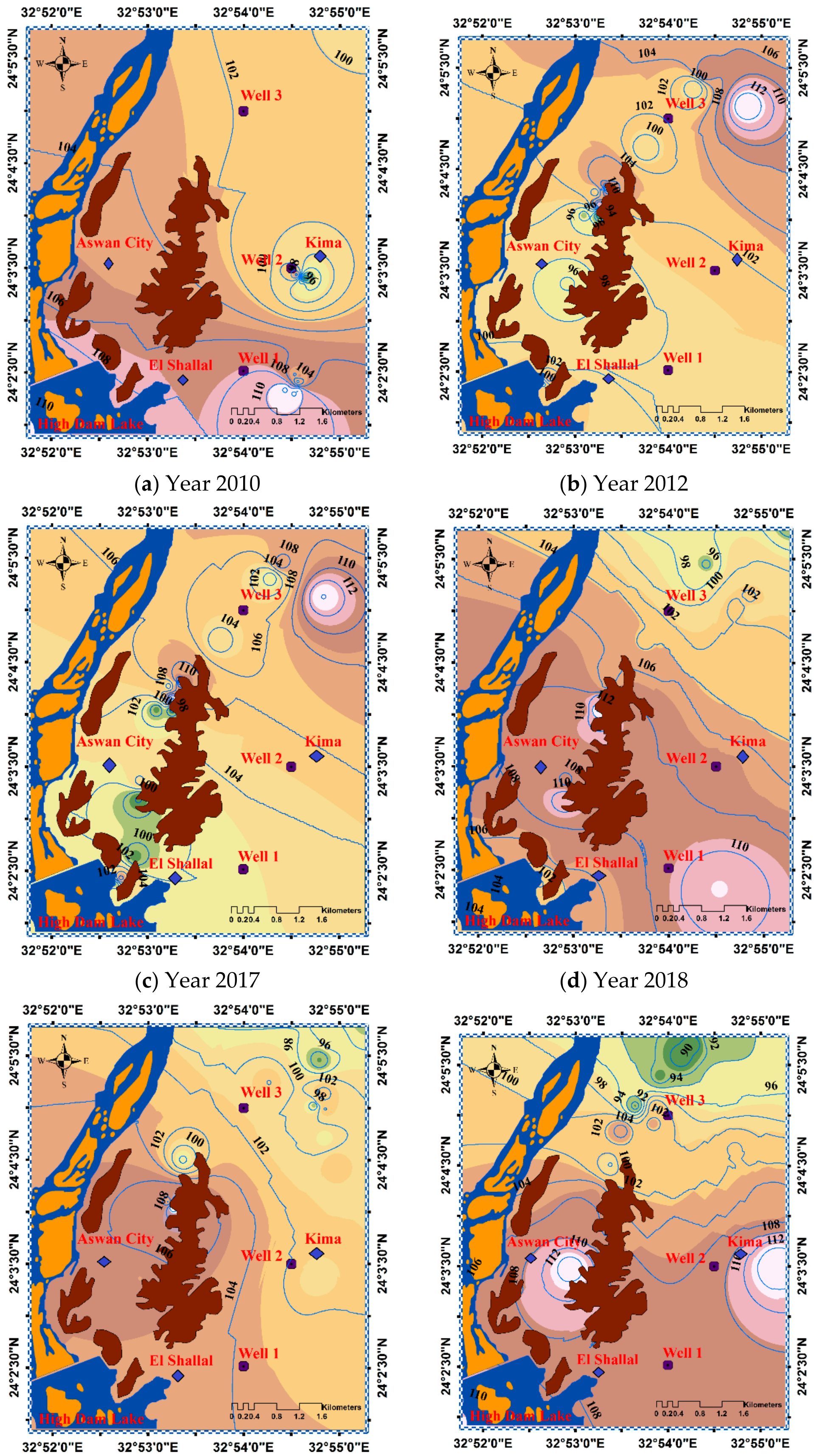
Year	Unit	2017	2018	2019	2020	2021
Drinking water	(MCM/year)	37.92	38.48	48.61	49.67	50.07
Wastewater	(MCM/year)	33.65	34.33	38.89	39.74	40.06
Water leakage	(MCM/year)	4.27	4.15	9.72	9.93	10.01

The potential of groundwater level maps for the study area were established using ArcGIS techniques for the following years: 2010, 2012, 2014, 2017, 2018, and 2020, as shown in Figure 8. These maps show the spatial distribution of the groundwater levels in the study area and were constructed by interpolation using the GIS technique. These maps show the contour lines that express the groundwater levels of the study area for the different years, as well as the location of three wells. These wells express the groundwater levels in three areas within the study area, where well #1 expresses El Shallal area, well #2 expresses the Kima area, and well #3 reflects the area north of Aswan city. By comparing the produced maps, the following rise in groundwater was found where the maximum and minimum difference in the groundwater levels throughout the study area between 2017 and 2012 was by 12.56 m and 0.83 m, respectively. Moreover, between 2018 and 2017, levels were 4.34 m and 0.25 m, respectively, whereas between 2020 and 2018, they were 8 m and 0.38 m, respectively. These maps show the high rates in the rise of groundwater levels within the study area in the period from 2010 to 2020, which is due to several reasons, the most important of which is the reduction of withdrawals from wells in the Kima area and El Shallal area to about a third of the quantity, to 9.12 MCM/year. This is in addition to the increase in the quantities of leakage from drinking water and sewage networks, leaching from the fish hatchery and leaching from sewage tanks in areas not attached to sewage networks, and the last increase in leaching quantities as a result of the expansion of the agricultural land.

Three observation wells were selected in three different areas to evaluate and follow up the groundwater levels and their distribution in the study area, also these wells can give a good understanding for the problem of water logging in the study. The first well is located in El-Shallal area at the south of the study area, the second well is in the Kima area at the central of the current study, and the third well is located at the north of Aswan city, in the north (See Figure 4). Table 3 shows the values groundwater levels of the three wells which reached 107.87, 100.17, 102.77, 109.17, 103.79 and 107.10m above mean sea level in well #1, also it reached 101.52, 101.65, 104.98, 106.80, 101.78 and 106.66m in well #2 while in well #3 the groundwater levels reached 101.89, 101.95, 105.14, 101.80, 100.88 and 100.40 m for years 2010, 2012, 2014, 2017, 2018 and 2020 respectively.

Table 3. Groundwater levels for three selected observation wells for different years in study area.

Years	Groundwater Levels		
	Well (1)	**Well (2)**	**Well (3)**
2010	107.87	101.52	101.89
2012	100.17	101.65	101.95
2014	102.77	104.98	105.14
2017	109.17	106.80	101.80
2018	103.79	101.78	100.88
2020	107.10	106.66	100.40



(**a**) Year 2010 (**b**) Year 2012

(**c**) Year 2017 (**d**) Year 2018

(**e**) Year 2018 (**f**) Year 2020

Figure 8. Groundwater distribution maps in the study area of Aswan city for different years.

In 2009, about 40 producing wells were closed in the Al-Shallal area at a production rate of 12.44 MCM/year due to the deterioration of the water quality. Moreover, groundwater abstraction from Kima has been reduced from 13.23 MCM/year to 9.12 MCM/year. From the above data, it is clear that the phenomenon of groundwater logging that occurred in 2009 in Aswan can be directly linked to the termination of pumping groundwater from El-Shallal pumping wells and the reduced pumping from the Kima pumping wells. This study also look to assess and follow the groundwater levels through the three wells, which reflect the groundwater levels in these areas, and identify the reasons for the rising and falling of the groundwater levels in those areas after 2009, which was linked to the water levels in the HDL, because it is one of the most important sources that feed Aswan aquifer. In 2012, there was a decrease in water levels in the HDL compared to 2010. For wells, there was a decrease in GWL in well #1 and a rise in well #2 and well #3 in 2014, there was a rise in surface water levels in the HDL compared to 2012. There was a rise in GWL in the three wells, and in 2017, there was a decrease in the surface water levels in the HDL compared to the year 2014. There was a rise in GWL in well #1 and well #2, and a decrease occurred in GWL in well #3, also in 2018, there was a rise in the surface water levels in the HDL compared to 2017, and for wells, there was a decrease in GWL in the three wells. In 2020, there was a rise in water levels in the HDL compared to 2018, and for wells, there was a rise in GWL in well #1 and well #2 and there was a decrease in GWL in well #3. From the above, we conclude that the surface water levels in the HDL are not the only factor affecting the rise or fall of groundwater levels in the study area. It is not certain whether if the surface water level in the HDL rises, the groundwater levels in the study area rise, and vice versa. Therefore, the rise in groundwater levels in some areas, with a decrease in water levels in the HDL, is due to several reasons, including the leakage from drinking water and sewage networks and the presence of surface drainage from other sources such as a fish hatchery. The phenomenon of low groundwater levels in some areas (well #3) from 2014 to 2020 within the study area with a high-water level in the HDL is due to unproven water withdrawals in these areas for the purposes of agriculture. The drop in groundwater levels in 2018, despite the rise in water levels in the HDL, is due to the fact that some government agencies are digging wells to extract the groundwater that flooded the basements of facilities and pumping it using pumps on the sewage networks in order to decrease groundwater levels as a temporary solution to reduce the damage caused by rising groundwater levels. However, these wells were stopped due to the inability of the sewage networks to bear the large quantities of water. The relation between years and groundwater levels in the three wells are shown in Figure 9. The results that have been reached in this research are in agreement with the findings of many researchers such as Selim et al. [29] and Farrag et al. [30].

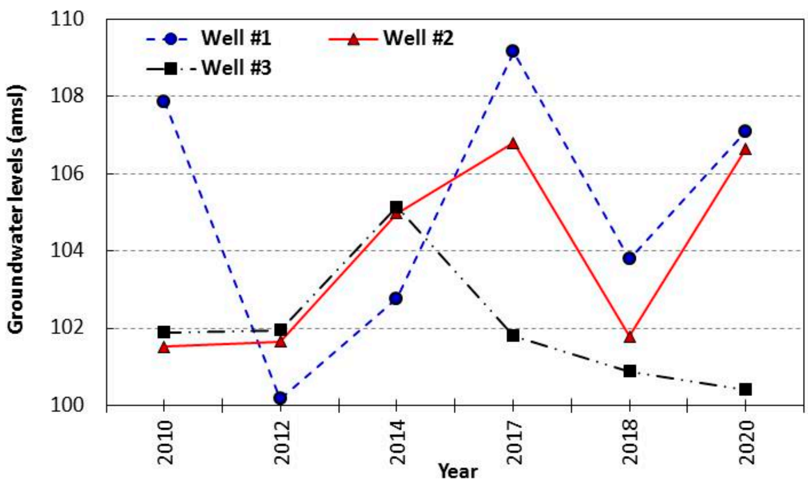


Figure 9. The relation between the groundwater levels in the three wells and different years.

The zone flow water budget of Aswan aquifer in 2020 is presented in Figure 10. The total inflow reached 63,979 m^3 day^{-1} with constant heads reaching 35,327 m^3/day and the flow to the aquifer 28,652 m^3 day^{-1}. The zone budget for outflow coming from abstraction production wells were 24,986 m^3 day^{-1} with river leakage reaching 38,993 m^3 day^{-1}; the total outflow reached 63,979 m^3 day^{-1}.

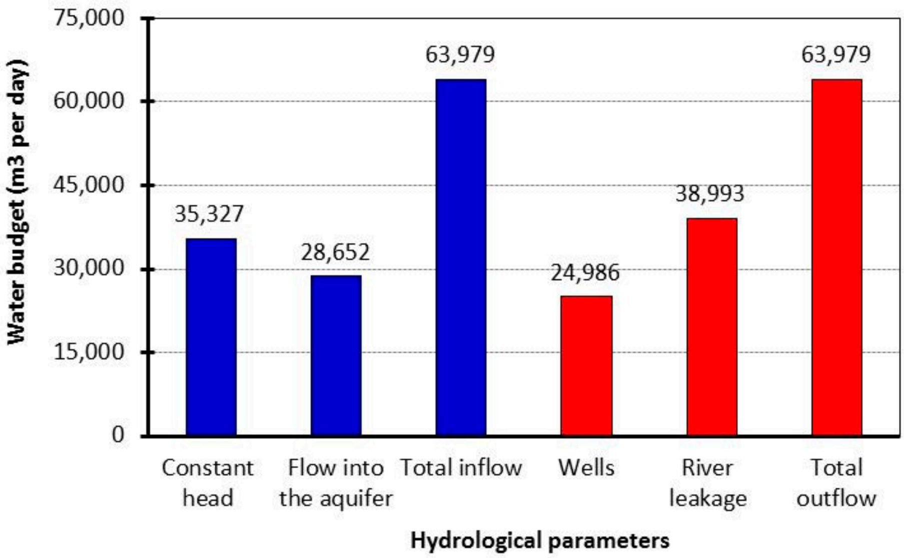


Figure 10. The total inflow and the total outflow in the study area of Aswan city.

4. Conclusions

In this study, the potential of groundwater levels in Aswan city was explored using the field data and ArcGIS techniques. The current study examined the extent of the correlation between the surface water level in the High Dam Lake (HDL) and the groundwater levels in the study area. The groundwater logging in Aswan city is an environmental problem which affects human lives given the rising groundwater levels (GWL) in buildings and streets; also, the templets in the city are impacted by this problem. The results of the current study show that the HDL is one of the most important feeding sources for the aquifer in the study area. Furthermore, the surface water levels (SWL) in the HDL are not the only factor that affects the rise or fall of the GWL in the study area. Moreover, the rise in GWL is due to several reasons, including the reduction of abstraction rates in Kima and El-shallal, which decreased from 13.27 and 12.44 Million Cubic Meter per year (MCM/year) in 2009, to 9.12 and 0.13 MCM/year in 2020, as well as the infiltration from the unlinking fish hatchery project located in the El Shallal area in the south, with recharge reaching 4.66 MCM/year from 2010 to now. Additionally, there is the leakage from the drinking pipelines, sewage networks, and septic underground tanks, which reached 4.27, 4.15, 9.72, 9.93, and 10.01 MCM/year for year 2017, 2018, 2019, 2020, and 2021, respectively. The phenomenon of decreased GWL in some areas within the study area with a high-water level in the HDL is due to unproven water withdrawals in these areas for the purposes of agriculture and industry. The drop in GWL in some places within the study area in 2018 is a general result of wells being drilled to withdraw groundwater from facilities and it being pumped into the sewage networks. The results of this study will be useful as first-hand information to planners and local authorities for assessment, planning, management, administration, sustainable utilization, and artificial recharging in the near future.

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