Egyptian Journal of Geology

https://egjg.journals.ekb.eg

Engineering-Geological Hazards Assessment for Sustainable Development of New Rashid City, Egypt

Abd Allah Fares Mahmoud[1], **Samir Abdeltawab Mohamed**[1], **Waleed Abdulmoghny Ogila**[1], **Osama Abd Alal Deraz**[2] and **Mahmoud Salah El Hadidy**[3]

[1] *Geology Department, Faculty of Sciences, Ain Shams University, Egypt*
[2] *Geology Department, Nuclear Material Authority, Egypt*
[3] *Seismology Department, National Research Institute of Astronomy and Geophysics, Egypt*

NEW RASHID City is located the northwestern of Nile Delta, Egypt. As many coastal cities around the world, it has susceptible to liquefaction and radiation hazards. These hazards affect the environment, the humans, the economy, and sustainability. Eighty-one boreholes, two hundred and four samples, three hundred seismic refraction profiles, and radiometric measurements were carried out to evaluate and analyze these hazards and build a geo-hazard map for the study area. The obtained results, that should be the soil profile, are divided into two main types: loose to medium dense, poorly graded, fine- to medium-grained sand, followed by high plasticity silt with sand. The main geotechnical hazard in New Rashid is soil aggression from the intrusion of seawater; hence, should be the average GWL (Ground water level) is 0.6 m. The effective dose rate of New Rashid was between 29.8 μSv y^{-1} and 135.4 μSv $y^{-1,}$ with an average value 72.5 μSv y^{-1} (< 1 μSv y^{-1}), so it is safe for radioactivity. Still, the potassium concentration only was average 430 Bq/kg, more than the International Atomic Energy Agency limit (370 Bq/kg). This is because of saturated soil by seawater, which increases potassium concentration between soil particles during wetting and drying cycles. Seismically, New Rashid has low dynamic and low damping properties and has a moderate liquefaction potential index (LPI) 5 > LPI > 15%. New Rashid does not have collapsibility or swelling potential hazards, with an average of the collapsibility index = 1.50 and an average of swelling pressure = 100 kPa. New Rashid achieves sustainability by mitigating liquefaction potential by the stone column technique and amendments of potassium radionuclides through stabilization by aluminum silicates as primarily clay minerals.

Key words: Geo-hazards; Radiometric; Geotechnical; New Rashid, Earthquakes, collapsibility.

1- Introduction

New Rashid City is located northwest of the Nile Delta to the west of Rashid Promontory, Al-Buhayrah Governorate. New Rashid is an extension of the current old Rashid City, along the coastal plain of the Mediterranean Sea. It is between longitudes 30˚ 20' and 30˚ 22' E and latitudes 31˚ 22' and 31˚ 28' N. It extends from south to north about 10 km and is more than 1.0 km in width (**Figure 1**).

This study aims to identify and assess geoengineering hazards such as soil swelling pressure, soil aggression, and soil collapsibility. As well as the seismic and radiometric hazard of the coastal and Aeolian deposits at Rashid New City. Integration of field and laboratory tests and radiometric measurements, to mitigate the influence of environmental hazards on human health and economic loss.

Ozcelik (2021) studied the Liquefaction Susceptibility at the Antalya Urban Area, Turkey. He used standard penetration tests and simulated earthquake scenarios Mw = 6.0, 7.0, and 7.4, and Peak ground acceleration (PGA) 0.28, 0.30, and 0.32 g. He concluded that when PGA is 0.28, there is no liquefaction. When PGA is

*Corresponding author e-mail: faresabdullah035@gmail.com
Received: 03/05/2025; Accepted: 10/07/2025
DOI: 10.21608/egjg.2025.381083.1112

0.30g, there is a tendency to liquefaction. When PGA is more than 0.32 g, liquefaction occurs.

Moubarak et al. (2021) assessed the geo-environmental and geotechnical risk of the east Port Said region, Egypt. They used boreholes and GIS to map the geo-hazard of the study area. They concluded that the northern zones of East Port Said have a soil layer 13 m thick overlying the basal sticky clay layer of almost 40 m thick, and it is safe to build the constructions of shallow foundations. The layer becomes thinner southwestern ward <2.5 m, and there are mak engineering problems for foundations.

Abbasi and Mirekhtiary (2020) studied heavy metals and natural radioactivity concentration in sediments of the Mediterranean Sea coast, North Cyprus. They conclude that average activity concentrations ^{226}Ra are 20.1 Bq kg^{-1}, ^{232}Th is 18.4 Bq kg^{-1}, and ^{40}K is 467.3 Bq kg^{-1}. The average activity concentrations of ^{226}Ra and ^{232}Th in the sediment samples were less than the acceptable limits.

Oladotun et al. (2019) studied dynamic geotechnical parameters in near-surface coastal environments in Nigeria. They used P-wave and S-wave to detect the dynamic properties of soil. They concluded that the result of the liquefaction potentials of the study area was between 0.533 and 0.649 in the first layer and between 0.669 and 1.237 in the second layer. This result revealed that the first layer has a higher liquefaction potential than the second. The bulk density of the first layer was 1708.8 kg/m^3 and 1745.7 kg/m^3. The bulk density of the second layer varied between 1752.7 kg/m^3 and 2043.3 kg/m^3. The most competent layer ranged between 7 m and 15.7 m.

Abdel-Halim and Saleh (2015) studied the radiological characterization of beach sediments along the Alexandria–Rosetta coasts, Egypt. He concluded that levels of ^{226}Ra and ^{228}Ra appeared in sands at the sites west of the Rosetta Nile promontory were 499.184 Bq/kg and 386.2 Bq/kg, respectively.

2- Geologic Setting

Rashid region is divided into six geomorphological areas: Rashid promontory, beach, backshore sand flat, backshore depression, coastal dune, lagoon, and Abu Qir ridge (**Stanley et al., 1992**). The width of the coastal area ranges from 0.5 km near Abu Qir to 10 km immediately west of the Rashid branch. The coastline between Rashid promontory and Abu Qir ridge to the west is concave. The new Rashid area is characterized by a low relief, mainly 0-1m above sea level (**Frihy and El-Sayed, 2013**). It slopes gently from north to south. It is saturated with seawater, and the groundwater table ranges from zero to 2.00m.

The sediments of the new Rashid area are related to the late Quaternary. Seawater and wind transported large volumes of eroded sediments to each side of the Rashid promontory. This results in a rapid increase in the accretion and propagation of adjacent beach sand, backshore flats (**Stanley et al., 1992**). The geology of the beach sands along the Mediterranean coast is directly related to the development of the Nile Delta and its past branches. The geological units of Rashid New City are divided into the following:

2.1 Near-shore Marine to Beach Sands

Near-shore and beach deposits in the study area are represented by fine to medium-grained sand. This sand has a relatively low proportion of quartz and a high proportion of heavy minerals, including magnetite, zircon, rutile, and monazite. These facies have 5 to 63 m in thickness (**Stanley et al., 1992**).

2.2 Backshore Sand Flat and Dune Sands

Coastal dune sand is derived primarily from near-shore sand and represented by greyish orange to yellowish brown very fine-to-fine well-sorted sand (**Figure 2**). Quartz is the dominant mineral constituent with mica, gypsum, and lithic, and some shell fragments, heavy minerals are accessory components. These facies have a thickness between 5 and 9 m (**Stanley et al., 1992**).

2.3 Delta Front Muds, Silts, and Sands

Light olive grey to yellowish grey to dark grey interbedded mud, silts, and sands occur in the vicinity of Rashid Promontory. These facies are about 6.5m thick (Ctellier and Stanley, 1987).

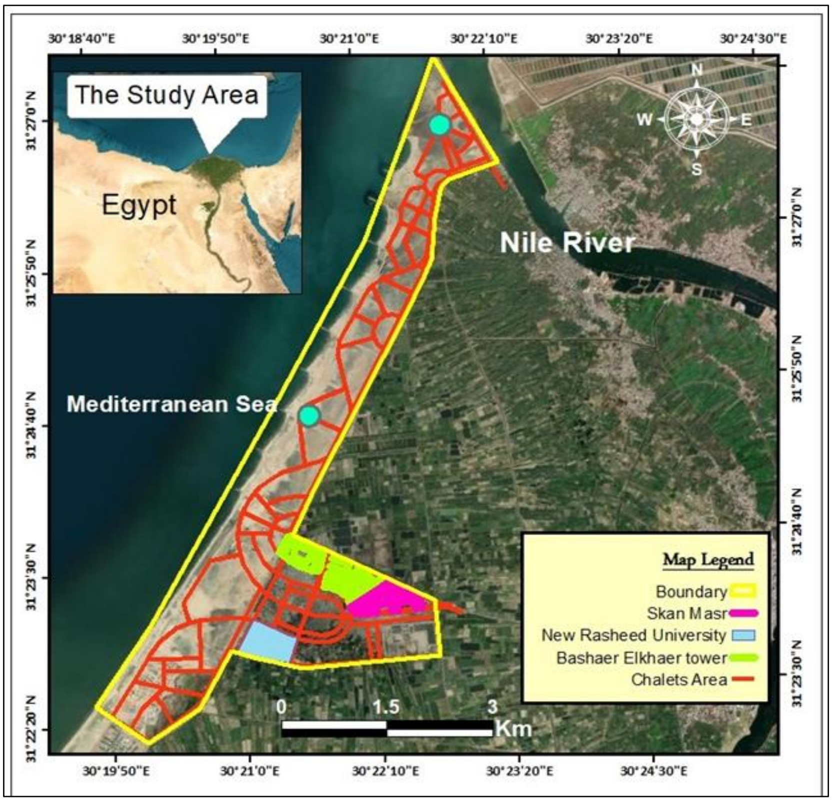

Fig. 1. Location map of the study area.

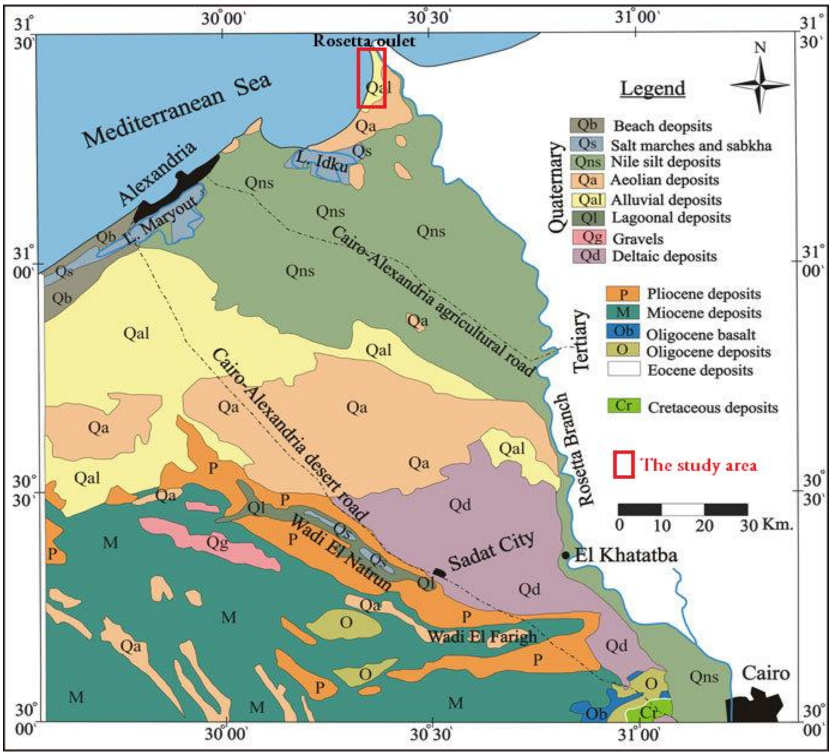

Fig. 2. Geological map of the study area (Modified after CONOCO, 1987).

2. Methodology

The Data of the study were derived from eighty-one drilled boreholes (**Figure 3**) and five hundred seventy standard penetration test (SPT) **ASTM D1586-18**, three hundred shallow seismic refraction profiles (**ASTM D5777-18**) as part of the row data for the new Rashid project of the Egyptian Nuclear Material Authority. The seismic profile, which was carried out at New Rashid City, used a 24-channel "Smart Series"

Seismograph system (**Figure 5**). The total length profile was **160** meters and is covered by **24** geophones. One hundred two soil samples were selected from different depths for geotechnical testing. Onehundred two samples were selected at 1.0 and 2.0 m depth for radiometric measurements, see (**Figure 5**).

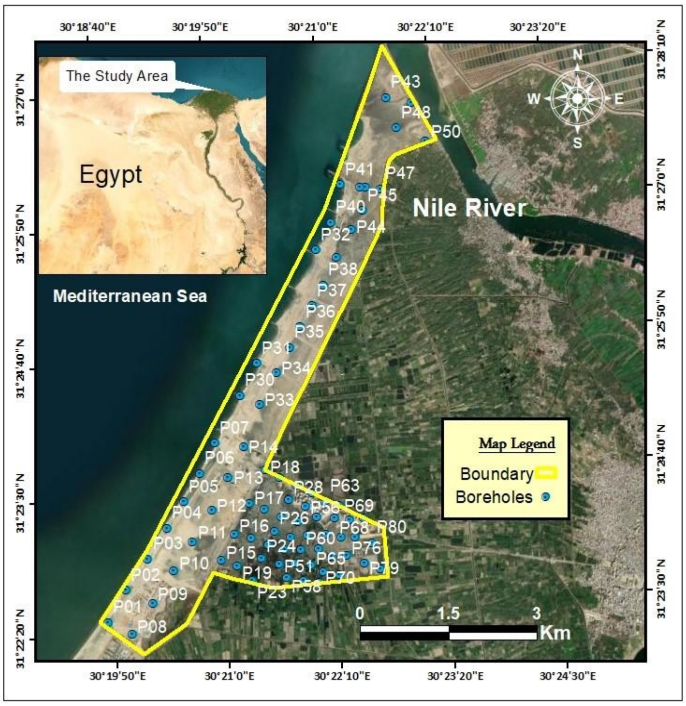

Fig. 3. Borehole locations in the study area.

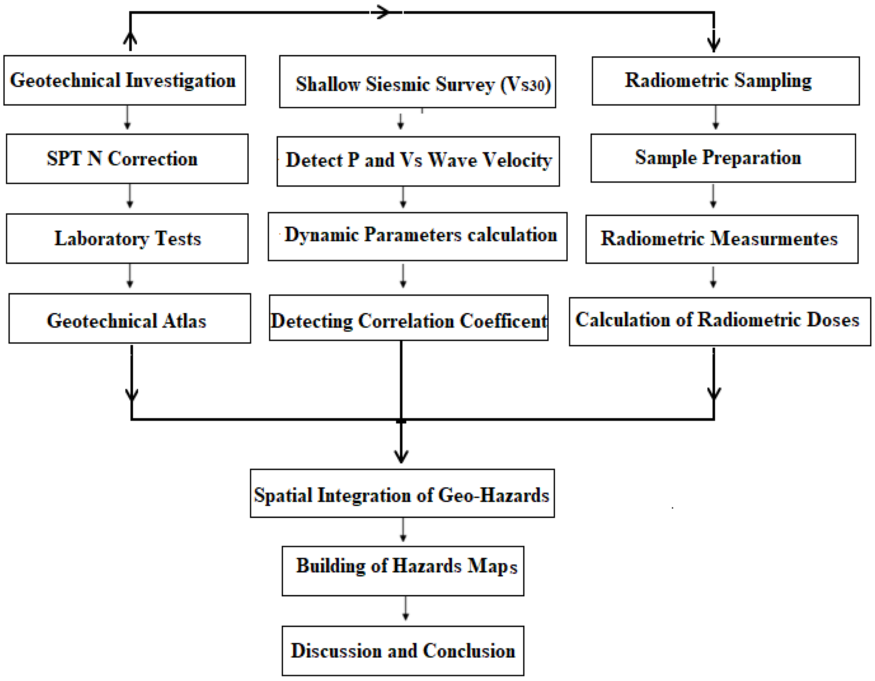

Fig. 4. Flowchart for the methodology of the study.

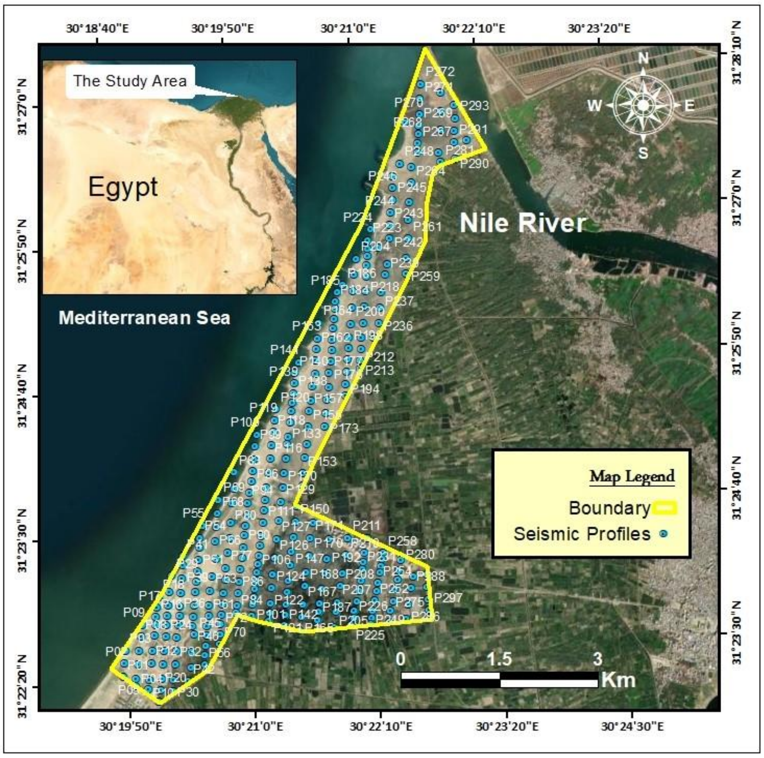

Fig. 5. seismic profiles at the study area.

2.1 Laboratory Testing

The laboratory tests were conducted on selected samples to detect geotechnical parameters, which are used in geotechnical hazard calculations. Physical and mechanical tests include moisture content (**ASTM D2216-19**), sieve analysis (**ASTM D6913M-17**), specific gravity (**ASTM D854-14**), relative density (**ASTMD4254-16**), shear box (**ASTM D3080-11**), permeability (**ASTM D2434-19**); chemical test (**BS-1377**), including total dissolved salt (TDS), pH, chloride content (Cl^-), sulfate content (So_3^{++}) and $CaCo_3$ content (**ASTM D3042-17**).

2.2 Shallow Seismic Investigation

The shallow geo-physical methods are used to give a better understanding of the engineering condition of the subsurface rocks in the study area. In this paper, both P- and S-wave velocities, as well as density values, are used to find different geotechnical parameters, which allows classifying the area of study into different zones depending on the quality of the subsurface soils and rocks. These include Young modulus (E), shear modulus (G'), concentration index (C_i), material index (M_i), N-value, Poisson's ratio (υ), the stress ratio (S_i), foundation material-bearing capacity (q), and subgrade reaction (K_s). Earthquake hazard and soil response are more affected by shear modulus G', which is an important parameter because it controls undrained deformations (Anne, 1997). The shear modulus can be addressed in terms of shear wave velocities (V_S) (**Bowles, 1996 and Othman, 2005**) as: $G' = \rho\, V_s^2$ ………… (1)

Table 1. Geotechnical properties of the New Rashid sand layer.

Item	Unit	Min.	Max.	Average.
Water content	%	2.6	22.1	13.8
Specific gravity	--	2.461	2.688	2.662
Unit weight	kN/m^2	16.01	18.87	17.2
Relative density	%	22.03	55.8	37.3
CaCo3	%	2.0	10	4.8
Cl	PPM	11428	4300	9970
SO_3^{--}	PPM	2069	7753	6027
Conductivity	(Ω/m)	211	389.2	277.5
Cohesion	kN/m^2	3	20	11
Fraction Angel	o	26 o	34 o	30.9
Void Ratio	%	53.2	84.9	76.2
Collapsibility Index	--	1.447	1.668	1.505

2.3 Radiometric Measurements

Radioactivity hazard was evaluated by detecting soil samples using a γ-ray spectrometer, High Purity Germanium (HPGe) Detector **(Figure 6)** to estimate the activity concentration of radionuclides (A) for ^{238}U (^{226}Ra), ^{232}Th, and ^{40}K. Radium equivalent activity (Ra_{eq}), effective dose rate (D_{eff}), and external hazard index (H_{ex}) are derived to detect human safety according to the International Atomic Energy Agency (IAEA) limits protocols. Where C is the concentration of radionuclides and D is the dose rate, h is hours, and μ Sv Gy-1 conversion coefficient for dose rate radiation. The final step is making a geo-hazard zoning map of the study area as an urban area to use in planning and land use for sustainable development.

$Ra_{eq} = C_{Ra} + 1.43C_{Th} + 0.077C_k$ ... (2)

$D_{eff} = D \times 8760h \times 0.2 \times 0.7\mu\ Sv\ Gy^{-1} \times 10^{-3}$ … (3)

$H_{ex} = A_{Ra}/370 + A_{Th}/259 + A_K/4810 \le 1$ ... (4)

Fig. 6. High Purity Germanium (HPGe) Detector.

3. Results

3.1 Geotechnical Laboratory Results

Soil profile at New Rashid City can be classified into loose to medium dense, poorly graded fine to medium grained sand with a thickness 12 m followed by high plasticity silt with sand with thickness 3.0 m except in north of the study area at section C-C' where change to silty clayey sand (**Figure 7**). The results of the geotechnical parameters of New Rashid City soil layers are given in (**Table 1**) and (**Table 2**).

Table 2. Geotechnical properties of the New Rashid Silt layer.

Item	LL (%)	PL (%)	PI (%)	Wc (%)	CI (%)	Ps** (kPa)
Min.	59.5	31.2	26.0	19.2	1.2	61.9
Max.	78.2	40.1	42.1	25.0	1.6	125.0
Average	71.4	35.6	35.8	21.7	1.4	100.9

** Where LL = Liquid Limit, PL= Plastic Limit, PI = Plasticity index, Wc = Water content, Ci= Consistency index, Ps = Swelling Pressure.

Collapsible probability of sand soil at New Rashid City according to an equation of (Das, 2011); Eq. (5) gives a range between 1.4٥ and 1.6٧ with an average of 1.51. The results revealed that the New Rashid City sand soils could be classified as non-collapsible soils.

$\gamma_d \le \frac{G_S\gamma_w}{1+e_o} = \frac{G_S\gamma_w}{1+(LL\%\ xG_S)}$ KN…. (5)

Where e_o Void ratio, G_s specific gravity, LL liquid limit, γ_d dry density and γ_w water specific gravity

Swelling potential values of New Rashid according to an equation of **Aniculaesi (2019)**, Eq. (6), range between 61.9 kPa and 124.9 kPa with an average of 100.6 kPa. According to Gelany et al. 2019 classification, the New Rashid City silt soils are classified as low swelling potential soil.

Ps = (3.71 * LL - 125)/CI kPa …. (6)

Where Ps is swelling pressure, CI is consistency index, and LL is liquid limit.

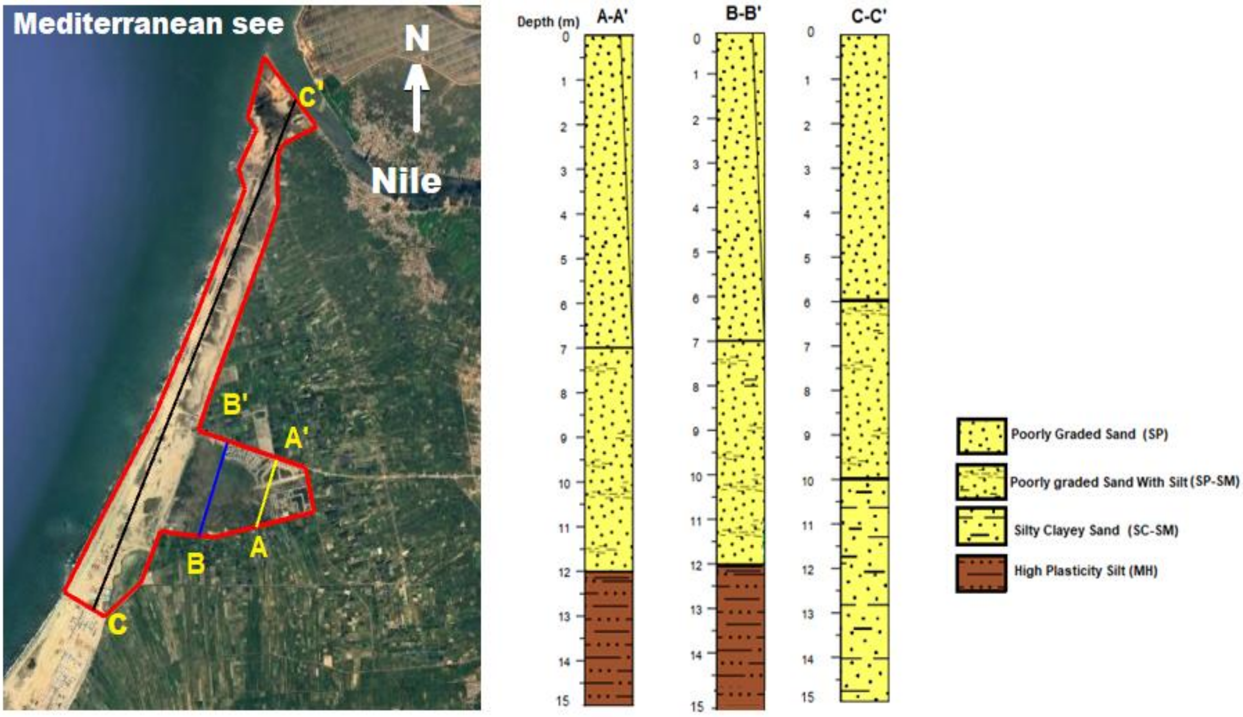

Fig. 7. Correlation of the New Rashid soil profile.

Relative density of the sand layer ranged from 22.03%, which is classified as loose sand, to 55.8%, which is classified as medium dense sand, with an average 36.7 % classified as loose sand (Das, 2010). Results of sieve analysis and grain size distribution indicate that the upper ten meters of New Rashid have a high liquefaction possibility according to the Ministry of Transportation Japanese code (1999), because it is poorly graded fine sand with low non-plastic fine content >10%. The pore water pressure built up faster than drainage under earthquake load, leading to loss of effective strength of soil and liquefaction.

3.2 Geotechnical Shallow Seismic Results

Geotechnical seismic results were used to determine the subsurface material quality and locate zones that should be avoided during construction. All geotechnical seismic parameters increase at the center of the eastern part and south of the study area, and the smallest values are present at the northeastern and southwestern parts of the area. Table (3) shows a brief of geotechnical parameters from the shallow seismic survey.

3.3 Radiometric Measurement Results

The average of activity concentrations of ^{238}U, ^{232}Th for all samples at depths of 1.0m and 2.0m (**Figure 8**) is in the expectable limit, which is (370 Bq/Kg) or one disintegration per second/Kg as recommended by the International Atomic Energy Agency (IAEA, 1989), except for potassium, which was 430.2 Bq/kg, see (**Table 4**).

The Radon equivalent, Ra_{eq} for soil samples has an average value of 176.46 Bq/ kg, which is lessthan the allowable limit (370 Bq/kg) as recommended by **IAEA (1989)**. The average value of annual effective dose, D_{eff} with an average value 72.5 μSv/y^{-1}, which is less than the average allowable public exposure limit (1mSv/y) recommended by **IAEA (2004).** The average value of the external hazard index was less than unity **(Table 5)**, which is recommended by the **IAEA (1989).** The corresponding gamma radiation hazard indices were below the acceptable limits,and there is no radioactive hazard to human lives.

Table 3. Results of geotechnical properties of New Rashid from shallow seismic survey.

Parameter	Primary wave velocity	Shear wave velocity	Soil Density	Shear Modulus	Young modulus	Poisson Ratio	Lams constant	Bulk modulus	Stress ratio	Material index	Concentration index	Density Gradient	SPT N-Value	Bearing Capacity	Elastic Settlement	Reaction Modulus
Unit	(m/s)	(m/s)	g/cm^3	MPa	MPa	UL	MPa	MPa	UL	UL	UL	UL	…	Kg/m^2	cm	MPa
Max.	940	432	2.0	377	1030	0.45	1031	1408	0.8	-0.5	3.7	-0.4	99.5	2.9	11.2	111
Min.	300	104	1.4	15	43.1	0.37	95	110.2	0.6	-0.8	3.2	-0.5	1.5	0.5	2.8	2.0
Average	400	150`	1.5	42	117.8	0.42	195	236.4	0.7	-0.7	3.4	-0.4	6.7	0.8	8.6	8.2

Table 4. Radionuclide concentration results of ^{238}U, ^{232}Th, ^{226}Ra, ^{40}K at the study area.

Depth (m)	^{238}U Concentration (Bq/kg)			^{232}ThConcentration (Bq/kg)			^{226}Ra Concentration (Bq/kg)			^{40}K Concentration (Bq/kg)		
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
1	24.7	347.6	69.5	16.2	117.7	46.3	12.4	148.2	42.4	187.8	597.8	430.2
2	24.7	247.0	80.3	16.2	65.0	33.8	12.4	111.2	56.0	172.8	523.3	359.4

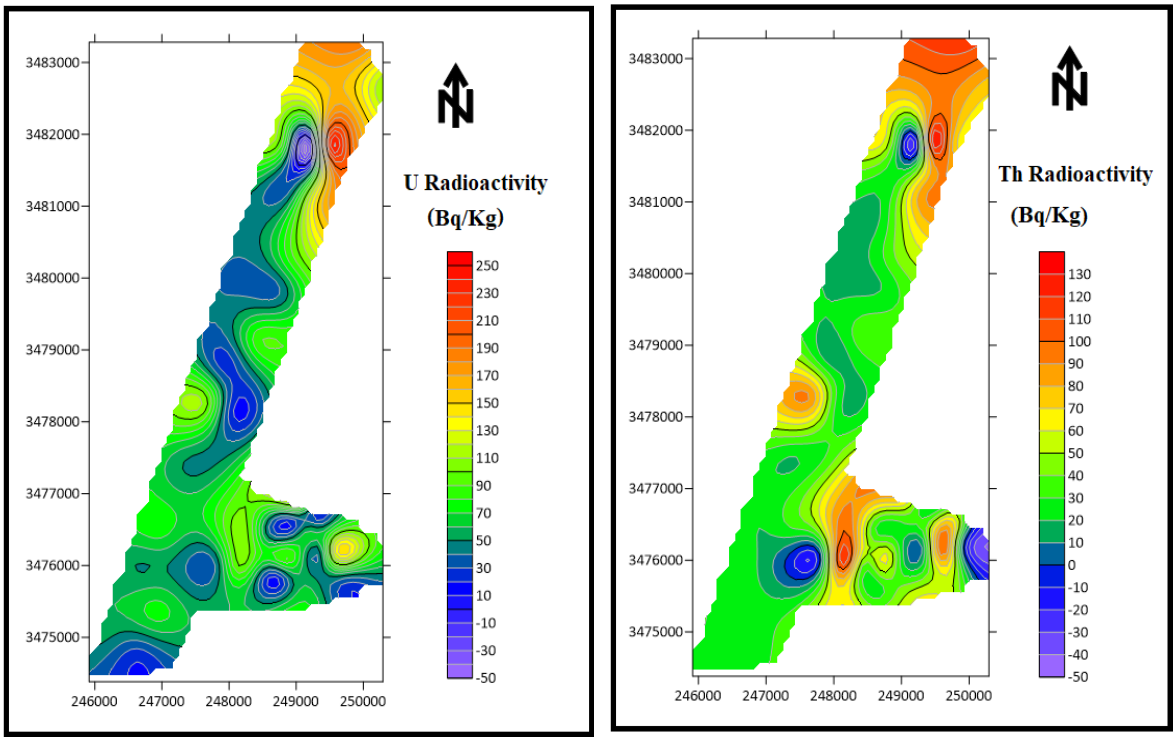

Fig. 8. ^{238}U and ^{232}Th radionuclides concentration map of New Rosetta.

Table 5. Results of radioactive doses and external hazard at the study area.

Parameter	**Radium Equivalent (Ra_{eq})**			**Effective dose rate (D_{eff}) Index**			**External hazard (H_{ex})**		
Unit	**($Bqkg^{-}1$)**			**($\mu Sv\ y^{-1}$)**			**($Bqkg^{-1}$)**		
Depth (m)	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
1	53.2	347.6	146.9	29.9	195.7	83.0	0.14	0.94	0.4
2	37.1	238.7	125.5	29.9	135.4	72.9	0.16	0.64	0.36

4. Discussion

The main geotechnical hazard in New Rosetta is soil aggressiveness from the intrusion of seawater and the rising level of the groundwater surface. The soil aggressiveness was increased in the sea direction and decreased outward and Nile direction (**Figure 9**). According to the grain size distribution, Rashid has a high liquefaction possibility because of loose to medium dense fine sand with non-plastic fine content. The liquefaction potential of Rashid is aggressive.

Radioactively, the New Rashid City is safe from radioactivity hazards, except from potassium activity that was more than the IAEA limit. This potassium activity hazard may be due to saturation of soil by seawater, which increases in Potassium concentration in soil particles during wettingand drying cycles. Generally, there is an increase in radioactive concentration in the central eastern part and the Nile border as in (**Figure 10**).

The dynamic properties for Rashid City mainly are low; the shear modulus (G_o), indicate that Rashid has low earthquakes damping properties, stress ratio (Si) classified as soft to very soft material, material index (Mi) as slightly competent, and the density gradient (Di) classified as high porous material. Statistically, when comparing SPT, which is derived from a seismic survey with field SPT (**Figure 11**), it can be concluded that it usually has low values, because shear wave SPT-derived values are calculated as corrected SPT values.

5. Conclusion

The main hazards of New Rashid were liquefaction and radiation. It has a liquefaction potential index (LPI) under an earthquake load equal to 15% (medium potential); the radiological risk of New Rashid can be negligible except for potassium radionuclides, which are more than IAEA limit of 430 Bq/kg. Rashid soil has aggressive behavior due to the intrusion of seawater and the rise in the level of the groundwater surface.

Rashid soil does not have a collapsibility or swelling potential hazard. Rashid soil can achieve the principle of sustainability for roads using filter material and increase road levels, and for foundation chemical resistance, it should use sulfate-resistant cement and concrete additives such as silica fume or meta-kaolin, and use bitumen isolation. Liquefaction mitigation should be using soil improvement as a stone column, which is suitable for the Rashid case; hence, it is classified seismically as type-D, and low permeable. For heavy and urgent building using piling foundations. As well, for potassium, radionuclides should be using leaching fromthe soil matrix and soil amendments through stabilization by aluminum silicates as primarily clay minerals and zeolites.

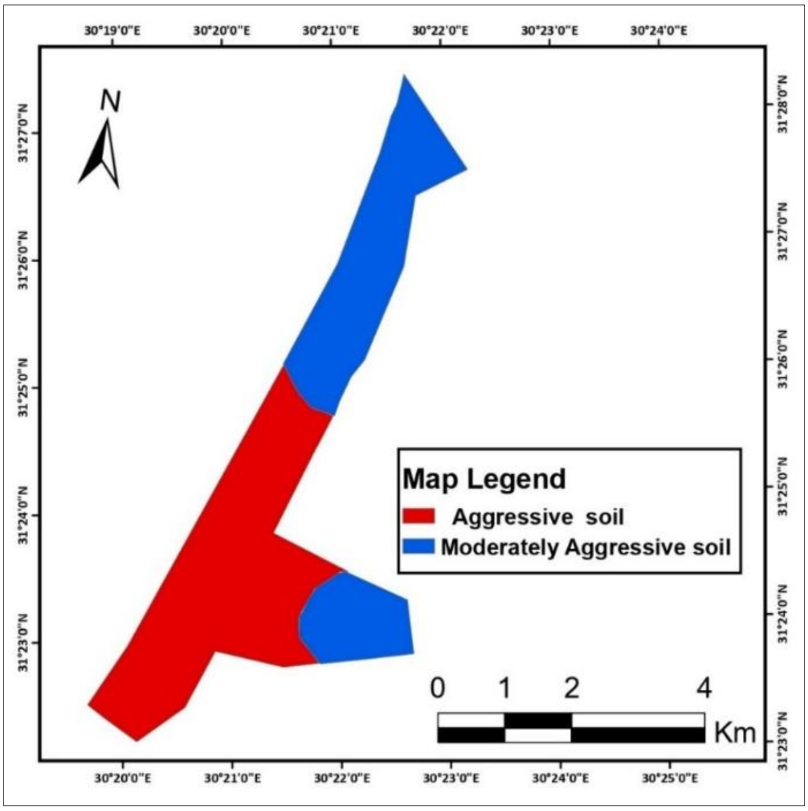

Fig. 9. Shows zonation maps of New Rosetta soil.

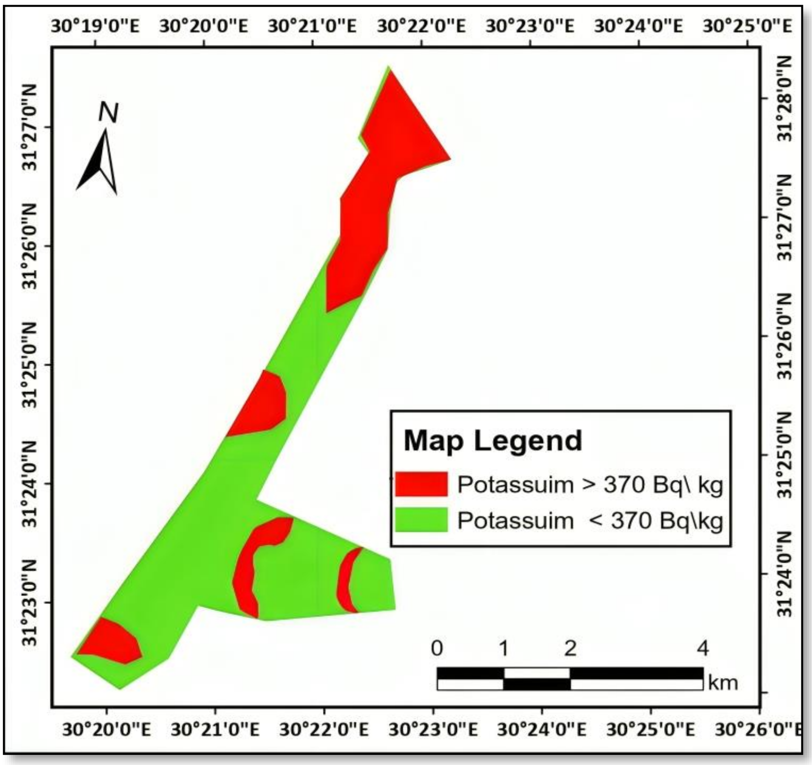

Fig. 10. shows hazard map of New Rosetta Potassium radionuclides concentration.

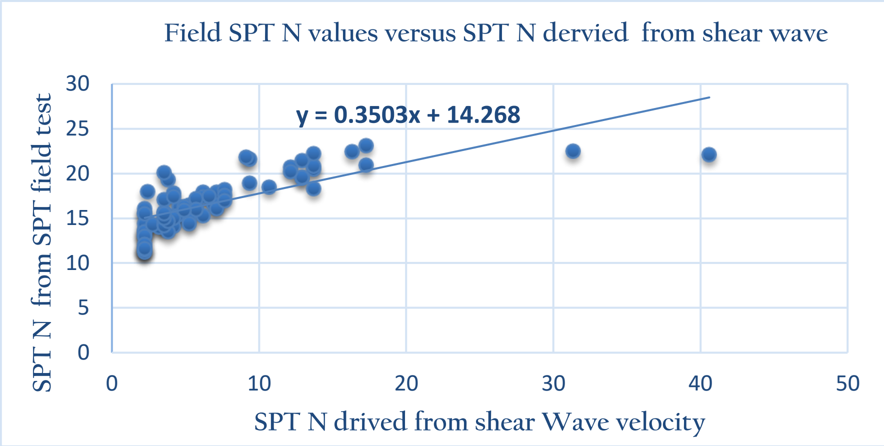

Fig. 11. Field SPT N values versus SPT N derived from shear wave.

6. Acknowledgment

I extend my deepest gratitude to the Egyptian Nuclear Material Authority to support me by some borehole soil samples and to Ain Shams University to carrying out some laboratory tests, also my supervisors for her unwavering support and insightful critiques throughout my research journey and for their constructive feedback and essential suggestions that enhanced the quality of my work.

References

Abbasi, A., & Mirekhtiary, F. (2020). Heavy metals and natural radioactivity concentration in sediments of the Mediterranean Sea coast. Marine Pollution Bulletin, 154, 111041.

Abdel-Halim, A.; Saleh, I. H., (2016). Radiological characterization of beach sediments along the Alexandria–Rosetta coasts of Egypt. Journal of Taibah University for Science, Vol. 10(2), pp. 212-220.

Aniculaesi, M.; Lungu, I. (2019). Evaluation of the swelling pressure for expansive soils. In IOP Conference Series, Materials Science and Engineering, Vol. 586 (1), pp. 0-12.

ASTM D1586-18. Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

ASTM D5777-18. Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation

BS 1377-3 (2018). Methods of test for soils for civil engineering purposes - Chemical and electro-chemical testing

ASTM D2216-19. Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D6913-17. Standard Test Methods for Particle-Size Distribution of Soils Using Sieve Analysis.

ASTM D3080-11. Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D4254-16. Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

ASTM D 854–02. Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer.

ASTM D2434–19. Standard Test Method for Permeability of Granular Soils (Constant Head)

ASTM D3042-17. Standard Test Method for Insoluble Residue in Carbonate Aggregates

Bowles, J. E., 1996. Foundation analysis and design, McGraw-Hill, 1241 p.

CONCO (1987). Geologic Map of Egypt. Egyptian General Authority for Petroleum (UNESCO Joint Map Project), 20 Sheets, Scale 1:500 000. Cairo.

Coutellier, V.; Stanley, D. J., (1987). Quaternary stratigraphy and paleogeography of the eastern Nile Delta, Egypt, Marine geology, Vol. 77(3-4), pp. 257-275.

Das, B. M., 2010. Principle of Geotechnical Engineering, Cengage Learning, Seventh Edition, 683 P.

Das, B. M. 2011. Principles of Foundation Engineering, Global Engineering: Christopher M. Shortt, Seventh Edition, 815 P.

El-Sayed, A.; Vaccari, F.; Panza, G.F., 2001. Deterministic seismic hazard in Egypt. Geophysics Journal, Vol. 144, pp. 555–567.

Frihy, O. E. and El-Sayed, M. K. 2013 Vulnerability risk assessment and adaptation to climate change induced sea level rise along the Mediterranean coast of Egypt Mitigation adaptation strategies for global change, Vol. 18 (8), pp. 1215-1237.

Gelany, A. F. Y.; Zeid, M. A.; Abd El-Sadek, M. S. ; Mansour, A. M., (2019). Evaluation of the Expansive Esna Shale and Its Role in the Deterioration of Heritage Buildings at West Bank of Luxor. Journal of Geoscience and Environment Protection, Vol. 7(8), pp. 24-37.

Egyptian Geological Survey and Mining

Authority (1981). Geologic map of Egypt 1:2000000. EGSMA, Cairo.

IAEA. 1989. International Atomic Energy Agency, measurement of radionuclides in food and the environment. A Guidebook on Technical Report Series No. 295 IAEA, Vienna.

Fergany, E.; Omar, K., (2017). Liquefaction potential of Nile delta, Egypt. NRIAG Journal of Astronomy and Geophysics, Vol. 6 (1), pp. 60-67.

Hussien, H.; Rabie, M., (2012). Assessment of liquefaction potential in Sinai, Egypt. In The International Conference on Civil and Architecture Engineering, Vol. 9, pp. 1-19.

IAEA. (2004). Radiation People and the Environment, Report No. IAEA/PI/A.75/04-00391, Austria.

Ministry of Transport Japan, (1999). Design standard for port and harbor facilities and commentaries, Japan Port and Harbor Association, 438p.

Mubarak, A. H., Arnos, M. O., & El-Rays, A. E. 2021 Integrated geo-environmental and geotechnical risk assessment of east Port Said region, Egypt for regional development. Geotechnical and Geological Engineering, 39, 1497-1520.

Muhammad, A. and Aly, A., (2013). Environmental Assessment of Rosetta Area. Mediterranean Sea Coast, Egypt. M. Sc. thesis, Zigzag University, Egypt. 130P.

Oladotun, A. O., Oluwagbemi, J. E., Lola, A. M., Maxwell, O., & Sayo, A. (2019). Predicting dynamic geotechnical parameters in near-surface coastal environment. Cogent Engineering, 6(1), 1588081.

Ozcelik, M. (2021). Assessment of liquefaction susceptibility in sedimentary deposits on the western side of the Antalya urban area (Turkey). Pure and Applied Geophysics, 178(5), 1859-1869.

Salama, A. (2017). Active tectonics and paleo-tsunami record of the Northern coast of Egypt. Ph.D., University de Strasbourg., French. 464P.

Sonmez, H.; Gokceoglu, C., (2005). A liquefaction severity index is suggested for engineering practice. Environmental Geology, Vol. 48, pp. 81-91.

Stanley, D. J.; Chen, Z.; Warne, A. G., (1992). Late Quaternary evolution of the northwestern Nile Delta between the Rashid promontory and Alexandria, Egypt. Journal of coastal Research, Vol. 8 (3), pp. 527-561.

Othman, A. A., (2005). Construed geotechnical characteristics of foundation beds by seismic measurements, Journal of Geophysics Engineering, 2(2), pp. 126-138.

Gordon, M.A., (1997), Application of field seismic geophysics to the measurement of geotechnical stiffness parameters. PhD thesis, Univ. of Surrey, UK.

تقييم المخاطر الجيوهندسية للتنمية المستدامة لمدينة رشيد الجديدة، مصر

عبد الله فارس*، وسمير عبدالتواب*، ووليد عجيله*، وأسامة دراز، ومحمود الحديدي*****

* قسم الجيولوجيا، كلية العلوم، جامعة عين شمس، مصر
** قسم الجيولوجيا التحت سطحية، هيئة المواد النووية، مصر
*** قسم الزلازل، المعهد القومي للبحوث الفلكية والجيوفيزيقية، مصر

تقع مدينة رشيد الجديدة في شمال غرب دلتا النيل، مصر، وكالعديد من العديد من المدن الساحلية حول العالم، لديها قابلية للتسييل والمخاطر الإشعاعية. هذه المخاطر تؤثر على البيئة والبشر والاقتصاد والاستدامة. واحد وثمانون بئراً، مئتان وأربع عينة، ثلاثمائة قطاع انكسار زلزالي وقياسات إشعاعية تم تنفيذها لتقييم وتحليل هذه المخاطر وبناء خريطة المخاطر الجيولوجية في منطقة الدراسة. من النتائج التي تم الحصول عليها، ينقسم قطاع التربة إلى: رمل فقير التدرج ناعم الي متوسط الخشونة، سائب إلى متوسط الكثافة، يليه طمي عالي اللدونة مع الرمل ثم طين منخفض اللدونة ثم رمل كثيف. ويتمثل الخطر الجيوتقني الرئيسي في مدينة رشيد الجديدة في عدوانية التربة الناتجة عن تسرب مياه البحر؛ حيث كان متوسط عمق المياه الجوفية هو ٠,٦ متر. لم تشير نتائج الدراسة الي احتواء رشيد الجديدة على مخاطر الإنهارية او الانتفاش، حيث كان متوسط مؤشر الانهيار (C_i) = ١,٥٠ ومتوسط جهد الانتفاش (P)= ١٠٠ كيلو باسكال. زلزاليا، تتمتع رشيد الجديدة بخصائص ديناميكية منخفضة مثل معامل التركيز، معامل المادة، معدل تدرج الكثافة ونسبة التضاغط وكذلك خصائص تخميد منخفضة ولديها مؤشر متوسط للتسييل (LPI) يتراوح بين ٥٪ الي ١٥%. كما تعد مدينة رشيد الجديدة آمنة من حيث النشاط الإشعاعي، لكن تركيز البوتاسيوم (A_k) كان أعلى من الحد المسموح به من قبل الوكالة الدولية للطاقة الذرية (بمعدل ٤٣٠ بيكريل/ كجم) ويرجع ذلك الي ارتفاع تركيز البوتاسيوم في جزيئات التربة مع دورات الرطوبة والجفاف. ولكي تحقق منطقة رشيد الجديدة الاستدامة يجب تعليه مستوي الطرق وعزل أساسات المنشآت والتخفيف من احتمالية التميع باستخدام تقنية الأعمدة الصخرية، وكذلك تخميد نظائر البوتاسيوم المشعة من خلال حقن وخلط التربة بالمثبتات ومعدلات التربة وأهمها السيليكات الألومينية كالمعادن الطينية والزيوليت.

الكلمات المفتاحية: المخاطر الجيولوجية؛ القياس الإشعاعي؛ الجيوتقنية؛ رشيد الجديدة؛ الزلازل؛ القابلية للانهيار.