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Land Productivity and Fertility Nexus Study in Dakahlia Governorate Using Gis and Remote Sensing

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ABSTRACT

Degradation of crop productivity and soil fertility and fails to meet the demands of it is growing population in the study area. The image was enhanced using ENVI 5.1 software from Landsat ETM+ soil fertility and productivity assessment using remote sensing and GIS. Soil productivity and fertility assessment are important for to a sustainable ecosystem. Soil fertility and productivity indicators according to Riquier *et al.*, (1970).The landscape area includes High river terrace (HRT), low river terraces (LRT), Overflow basin (OB), Overflow mantle (OM), Decantation basin (DB), Sand sheet (SS), Hammock area (H), Costal sand bar (CSB) ,Relatively low clay flats (RLC) Wet Sabkha (WS), Gypsiferous flats (GF), Swamps (S) and Water bodies (WB). About 63.68% of the area is highly fertile, (class I), Soils in this area have been categorized into five mapping units: HRT, LRT, OB, OM and RLC. Approximately 6.86% of the area, is of Good fertility (class II), the soils of SS mapping unit, Class III, VI, and V soils not available. The Land Productivity index classification, outcome, about 29.13% of the total area are classified as excellent productivity class (I). It is made up of units LRT and RLC. Approximately 12.53% of the total area, falls under the good productivity category class (II). It consists of unit HRT. Approximately 22.02% of the total area fall under average class (III), it consists of units OB and OM. Approximately 6.86% of the area, classified as Low Productivity class (IV), it consists of unit SS.

Keywords: Soil Fertility Index (SFI), Land Productivity Index (LPI) and Dakahlia Governorate

INTRODUCTION

The land stands as our most fundamental source of natural wealth, nourishing the lives of millions. It is abundantly clear just how vital it is to nurture. This precious resource and, continues to grow day by day (Dumanski *et al.*, 2010; Mohana *et al.*, 2009). Soil plays a crucial role in ecosystems as it hosts numerous pivotal ecological processes (Liang *et al.*, 2022). Human population expansion, farm division, and improper farm service management in developing countries lower agricultural yields. Soil productivity is the capacity of soil to support plant growth under specific environmental and management conditions. Soil productivity analysis has been a significant area of study in soil science (Agber and Ali, 2012). In Egypt, agriculture transcends the simple notion of a job it is a vital force, nourishing the existence of roughly 26% of population (IFAD, 2021). This lively sector is stitched into the Egypt economic tapestry, teeming with a dynamism which is hard to miss. Its significance echoes throughout the nation, pivotal in driving the hopes and dreams for what lies ahead. Indeed, agriculture takes center stage in the grand narrative of Vision 2030 plan, serving as a crucial pillar in the quest for enhanced food security (Kassim *et al.*, 2018).

Human activity can either enhance Soil's ability to produce crops is based on factors like fertility, allowing it to efficiently use production inputs effectively and sustainably and the ability to yield crops is based on its physical, chemical, and biological make-up (Mueller, *et al.*, 2010; Sokolowski, *et al.* 2020 and Abd El-Kawy *et al.* 2024). Human actions can either enhance or depress soil productivity (Rashed *et al.* 2021). Decision-making relies heavily on a precise assessment tool

that uses detailed quantitative analysis to examine soil composition and properties (Samaei *et al.*, 2022).

Capacity for productivity relies heavily on key factors such as soil texture and its water-holding ability, alongside varying local climates. This makes direct soil or land comparison challenging due to its diverse nature and land productivity capacity is a complex yet precise concept which equates to lands ability to carry out specific functions (Devi and Kumar, 2008). Determining soil productivity is crucial for effectively managing land, increasing crop yields, and safeguarding long-term natural resource availability in high-risk areas (Yu *et al.*, 2018 and Maleki *et al.*, 2021).

A site's potential for agricultural production is measured by its ability to support crop growth or other vegetation under optimal conditions. Land productivity, however, is ultimately influenced by factors such as climate, parent material topography, and various soil characteristics. Evaluating land productivity can inform enhanced agricultural practices to maintain soil fertility and accommodate diversified crop yields (Field, 2017). Soil fertility and ability to provide plants with the right amount of necessary nutrients for healthy growth (Jin *et al.*, 2011).

Soil fertility is characterized by the soil's capacity to supply necessary plant nutrients which significantly impacts plant development and yields (Zhang and Xu, 2005 and Jin *et al.*, 2011 and FAO, 2019). Soil fertility and nutrient management play a significant role in contemporary agriculture, reflected in fertilizer use and crop productivity (Bagherzadeh *et al.*, 2018). Assessing soil fertility is crucial for making informed decisions and developing effective strategies to promote more environmentally friendly agricultural

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practices (El-Seedy 2015). Most soil fertility assessments are conducted through soil analysis and serve as a key tool for devising effective soil management strategies (Nafiu *et al.*, 2012 and Nariyanti *et al.*, 2022). Soil fertility is often defined as a balance between organic matter, nutrient ions, and moisture levels in the soil. The properties and composition of the soil's mineral components also influence its overall fertility (Sushanth *et al.*, 2019). Soil fertility is an all-encompassing concept that can't be directly measured by certain soil characteristics like macronutrient levels (Du and Zhou, 2009).

Using soil fertility assessments provides a scientific basis for managing soil effectively to achieve high crop yields while minimizing environmental harm (Andrews *et al.*, 2004 and Munaf and Mouazen, 2021). Egypt's Nile Delta region and newly reclaimed areas are facing a critical issue due to the decline in soil fertility, primarily caused by increased high-yield farming and decreased Nile sediment deposits since the construction of the high dam (Elnaggar *et al.* 2017).

Research in soil fertility index has increased significantly worldwide (Nariyanti *et al.* 2022). Few recent studies in Egypt have focused on soil fertility index research (Mohamed *et al.*, 2019; Elseedy, 2019; El-Seedy and Saeed, 2019). Agriculture is the dominant economic activity in the Nile Delta, producing field crops for the population. However, soil quality issues including fertility and degradation severely impact agricultural productivity. To optimize plant growth and improve productivity, it is essential to assess the land's state and constantly monitor its changing properties (Aboelsoud *et al.*, 2022 and AbdelRahman *et al.*, 2022).

GIS technology has experienced rapid growth, leading to its widespread use in various research applications, particularly in assessment, mapping ecological capabilities, and land management plans (Maleknia *et al.*, 2017).

Geographical data can be enhanced by incorporating expert opinions. Researchers have applied an integrated approach in various studies involving geographical data to make multi-criteria judgments (Guarini *et al.*, 2018). Land evaluation methods are being refined to combine soil data and site characteristics with geographical information for better soil agricultural planning and management (FAO, 1991 and FAO, 2007). Researchers use geographic information to analyze land productivity and soil fertility, combining soil and climate factors which boost agricultural yields. GIS and remote sensing technology enable data collection across multiple platforms and linking it through a shared spatial connection (Eswaran, *et al.* 2003)

The purpose of the current research was to locate and assess land resources within Dakahlia Governorate, Create and generate soil productivity and fertility maps by analyzing physical and chemical properties using the Riquier Land Productivity Index (RLPI), evaluating soil potential productivity considering its physical and chemical properties, and evaluate how soil properties influence soil productivity by analyzing remote sensing data and utilizing geographic information systems (GIS).

MATERIALS AND METHODS

Location of the study area

The Dakahlia Governorate is situated in the northeastern corner of the Nile Delta near the Damietta branch. The governorate is bordered by Sharqia to the east and

Gharbia to the west, bounded to the north by the Mediterranean Sea, and to the northeast by the Damietta Governorate, located to the northwest by Kafr El-Sheikh Governorate and to the south by Qalyubia Governorate. It covers a section of the Earth between the latitudes of 30° to 31.5° N and the longitudes of 31.25° to 32° E (Figure 1), the area to be studied covers 3843.9944 km², equivalent to (384399.44 ha).



Fig. 1. Location of the study area

Climate conditions:

Climate data from Dakahlia Governorate's climate station indicate relevant information for this study. The study area experiences extremely hot summers and cold winters with moderate rainfall, the area features a spring with sand storm waves, Figure 2 shows that data accompanied by a temperature range of 14 to 29 degrees Celsius. Temperature varies in July with highs of 36°C and January with lows of 8.6°C. The months with the most rainfall are January and February. Relative humidity averages peak in winter months between 59% and trough in May at 47%. average period from 2017 to 2023.

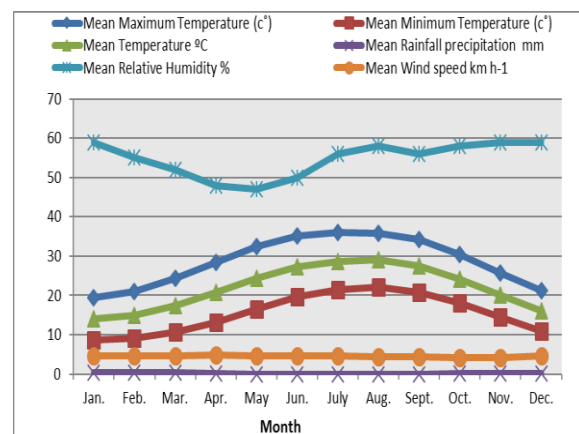


Fig. 2. Climate of Dakahlia Governorate.

Digital image processing and physiographic mapping

The image was enhanced using ENVI 5.1 software from Landsat ETM+ data (path 176, rows 38 and 39), enhance the contrast and sharpen the edges as described by (Lillesand and Kiefer 2007). Noise was reduced and image distortion was corrected using radiometric and geometric adjustments. A digital elevation model (DEM) of the study area was obtained from large-scale topographic maps scale 1:25000. Combining a digital elevation model with land sat image ETM+ enhances the landscape's three-dimensional representation. It can be used to provide various forms of data that aid in mapping landforms and soil types. Data generated from a digital elevation model provide elevation details, Satellite images can enhance the capabilities for soil mapping when utilized with them (Lee *et al.*, 1988). Physiographic units were identified and a soil database was created using ENVI 5.1 software with Landsat ETM+ data and a digital elevation model (Dobos *et al.*, 2002).

Field work and Laboratory analysis:

Soil profile sampling areas were selected to pass through distinct mapping units based on a pedagogical classification (Zink, 1997). Nineteen soil profiles were dug for detailed study. They were described morphologically and analyzed according to (FAO, 1990 and FAO, 2006). Previous studies on soil classification were referenced to conduct a semi-detailed assessment of soil patterns (Schoeneberger *et al.*, 2002; FAO, 2006 and USDA, 2014). Laboratory analysis was conducted on samples taken from the different soil layers, research was conducted on-site using a map of the land's physical features, a hand GPS device was used to pinpoint exact locations in the field.

Soil samples were analyzed for physical and chemical properties. Particle size distribution was determined using the international pipette method. Chemical properties such as soil pH, organic matter content and cation exchange capacity (CEC), electric conductivity (EC) of soil paste extract, soluble cations and anions, were under taken according to the USDA guidelines according to (USDA, 2004).

Method of Land Evaluation:-

Soil fertility and productivity index assessment:-

Soil fertility and productivity indicators were assessed based on the work by Sanchez *et al.*, (1982), and quantified using an equation adapted from Riquier *et al.*, (1970), and further revised by Raji, (2000). according to Table 1

Table 1. Land productivity and fertility and classes and rating defined by Riquier *et al.*, (1970) and Sanchez *et al.*, (1982), modified by Raji (2000)

Productivity Class	Fertility Class	Fertility and Land Productivity Index %
Excellent PI	Excellent FI	65-100
Good PII	Good FII	35-64
Average PIII	Average FIII	20-34
Low PIV	Low FIV	8-19
Extremely low PV	Extremely low FV	0-7

Fertility Index (FI):

The Fertility Index is calculated using a specified mathematical formula:

$$FI = N/100 \times O/100 \times C/100 \times M/100 \times A/100 \dots \times 100 \text{ Eq. (1)}$$

N = soil reaction (pH), O = organic matter, C = nature of clay taken as CEC/cmole/ kg, M = mineral reserve and A = soil salinity in EC as dS m⁻¹. Each factor is assigned a score ranging from zero to one hundred.

Productivity Index (PI):-

The Productivity Index formula is based on an equation that calculates productivity:

$$PI = H/100 \times D/100 \times P/100 \times T/100 \times FI/100 \dots \times 100 \text{ Eq. (2)}$$

Where, H signifies available moisture, D represents drainage, P stands for effective depth, T is for texture/structure, and FI denotes fertility index. Each factor receives a score from 0 to 100. The overall result is an index of productivity, scored from 0 to 100.

RESULTS AND DISCUSSION

Geomorphologic features

The most prominent landscape types in the study region are characterized by floodplains, lacustrine deposit, and Aeolian deposit deposits according to Table 2 and Figure 3. The landscape area includes High river terrace (HRT), landform covering 12.53% of its total 48198.41 hectares area, Area of low river terraces covers almost (LRT) 45336.23 ha 11.79%, of the landscape, Overflow basin (OB) 56239.38 ha 14.63%, Overflow mantle (OM) 28433.12 ha 7.39%, Decantation basin (DB) 61560.17 ha 16.01%, Sand sheet (SS) 26385.26 ha 6.86%, Hammock area (H) 3966.31 ha 1.03%, Costal sand bar (CSB) 12.26 ha 0.07%, Relatively low clay flats (RLC) 66671.12 ha 17.34%, Wet sabkha (WS) 5602.51 ha 1.45%, Gypsiferous flats (GF) 1060.73 ha 0.27%, Swamps (S) 16642.31 ha 4.32% and Water bodies (WB) 23016.13 ha 5.98% of the total area of all geomorphological units.

Table 2. Geomorph units and landforms of the study areas

	Geomorph unit	Landform	Mapping unit	Area (ha)	of total area(%)
Flood plain	River terrace (RT)	High river terrace	HRT	48198.41	12.53
	Overflow basin (OB)	Low river terrace	LRT	45336.23	11.79
	Overflow mantle (OM)	Overflow basin	OB	56239.38	14.63
	Decantation basin (DB)	Overflow mantle	OM	28433.1207	7.39
		Decantation basin	DB	61560.17	16.01
Aeolian deposit	Sand sheet (SS)	Sand sheet	SS	26385.26	6.86
	Hammock area (H)	Hammocks area	H	3966.31	1.03
	Costal sand bar (CSB)	Costal sand bar	CSB	12.26	0.07
	Relatively low clay flats (RLC)	Relatively low clay flats	RLC	66671.12	17.34
Lacustrine deposit	Wet sabkha (WS)	Wet sabkha	WS	5602.51	1.45
	Gypsiferous flats (GF)	Gypsiferous flat	GF	1060.73	0.27
	Swamps (S)	Swamps	S	16642.31	4.32
Others	Water bodies (WB)	Water bodies	WB	23016.13	5.98
	Fish Ponds (FP)	Fish Ponds	FP	1275.49	0.33
Total area				384399.44	100

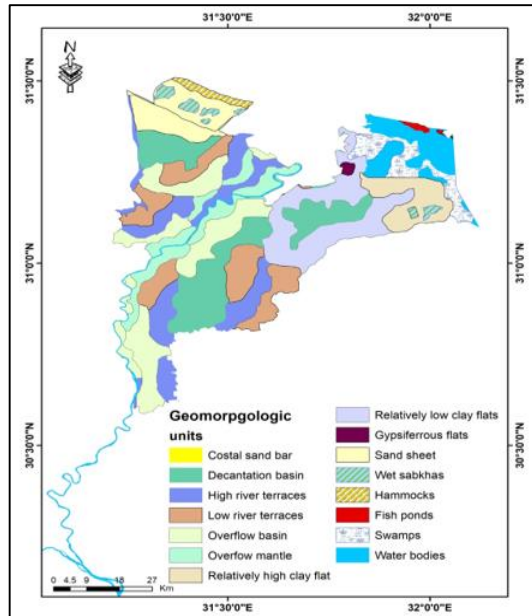


Fig. 3. Physiographic units of the study area

Fertility and productivity Index Model and rating

The soil fertility and productivity index model was developed based on Requier *et al.*, 1970's design according to Figure 4. It considers several key factors for soil fertility, including pH for acidity levels, organic matter content, clay composition, mineral reserves, and salinity levels. For soil productivity, key determinants include available moisture,

drainage, effective depth, texture and structure, and fertility index.

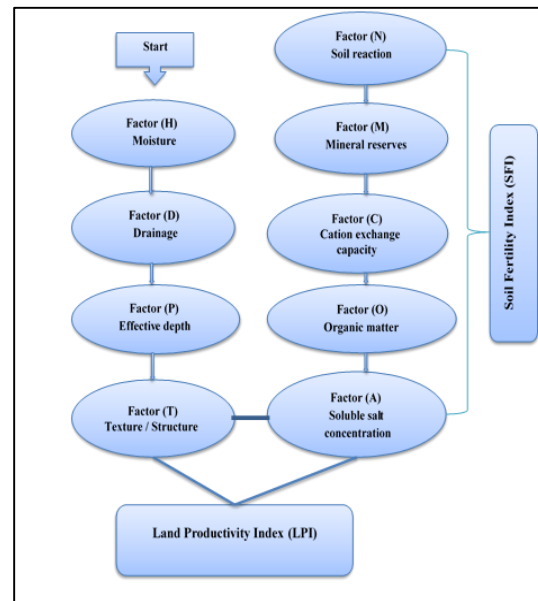


Figure 4. Flow chart Requier of the soil fertility and Productivity Index

Soil Fertility index of the study area:-

The Riquier fertility index evaluation is presented in Tables 3 through 6, with its corresponding map visualized using GIS as shown in Figure 5.

Table 3.Values of the factors of soil fertility of the studied soils of the investigated area

Mapping unit	Soil pH (N)	Organic Matter (O)(gkg ⁻¹)	Cation Exchange Capacity (C)(cmolc kg ⁻¹)	Mineral reserve in B horizon (M)	Salinity " as EC (A)(dS m ⁻¹)
HRT	7.44	17.55	36.70	Minerals derived from basic or calcareous rocks	1.72
LRT	6.79	26.20	42.51	Minerals derived from basic or calcareous rocks	0.97
OB	7.29	15.35	27.22	Basic or calcareous rocks	1.86
OM	7.33	23.90	41.30	Minerals derived from basic or calcareous rocks	2.67
SS	6.86	4.55	9.36	Minerals derived from sands, sandy materials or ironstones	1.24
RLC	6.73	27.70	43.50	Basic or calcareous rocks	3.07

Table 4. Soil characteristics of the investigated area.

Mapping unit	Soil pH (N)	Organic Matter (O) (gkg ⁻¹)	Cation Exchange Capacity (C) (cmolc kg ⁻¹)	Mineral reserve in B horizon (M)	Salinity " as EC (A) (dS m ⁻¹)
HRT	N5	O2	C2	M2c	A1
LRT	N4	O3	C3	M2c	A1
OB	N5	O2	C2	M3c	A1
OM	N5	O3	C3	M2c	A1
SS	N4	O1	C1	M2a	A1
RLC	N4	O3	C3	M3c	A1

Table 5 .Score assessment of soil fertility index of the study area

Mapping unit	Soil pH (N)	Organic matter content (O) (gkg ⁻¹)	Cation exchange capacity (C) (cmolc kg ⁻¹)	Mineral reserve in B horizon (M)	Salinity " as EC (A)(dS m ⁻¹)	Require Fertility Index (RFI)	Grade
HRT	100	90	95	95	100	81.22	I
LRT	90	100	100	95	100	85.50	I
OB	100	90	95	100	100	85.50	I
OM	100	100	100	95	100	95.00	I
SS	90	85	90	85	100	58.52	II
RLC	90	100	100	100	100	90.00	I

Table 6. Soil Fertility Index of the study area

Requier Fertility Index RFI (%)	Grade	Class	Mapping unit	Area (ha)	Area %
65-100	I	Excellent	HRT, LRT, OB, OM and RLC	244878.2607	63.68
35-64	II	Good	SS	26385.26	6.86
20-34	III	Average	—	—	—
8-19	IV	Low	—	—	—
0-7	V	Extremely Low	—	—	—

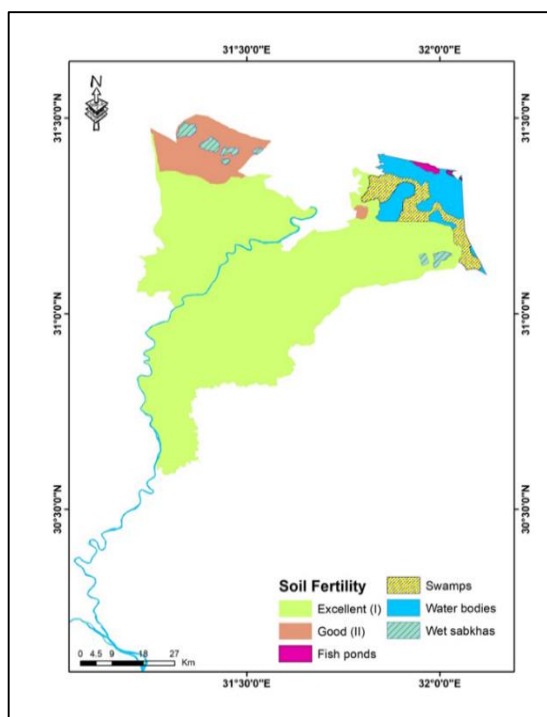


Fig. 5. Soil Fertility index map of Dakahlia Governorate

About 63.68% of the area is highly fertile, (class I), totaling approximately 244878.2607 ha, the soils in this area have been categorized into five mapping units: HRT, LRT, OB, OM, and RLC. Approximately 6.86% of the area, which is 26385.26 hectares, is of Good fertility (class II), the soil are of SS mapping unit, Class III, VI, and V soils not available. Fertility index was fit into 2 classes, which are Good and Fair according to Thomas *et al.* (2006).

Land Productivity index of the study area:-

The results of the Land Productivity index classification according to parametric evaluation system of Requier index are shown in tables 7 to 10 , and their map is shown in Figure 6 using GIS. Results indicate that, the most geomorphologic units of the studied area fall under the highly and moderately classes I & III.

The Land Productivity index classification results, as presented in Table 11 and Figure 6; they indicate a classification outcome, of about 29.13% of the

112007 ha total area units are classified as excellent productivity class (I).

It is made up of units LRT and RLC. Approximately 12.53% of the total area, around 48198.41 ha falls under the good productivity category class (II), it consists of unit HRT. Approximately 22.02% of the total area units fall under average class (III), with 84,672.5 ha, it consists of units OB and OM. Approximately 26385.26 ha account for 6.86% of the area, classified as Low Productivity class (IV), it consists of unit SS. Galbiatti *et al.* (2004) concluded that yield of corn and its attributes were gradually increased as a result of increasing in the availability of soil moisture content.

Comparison between Requier fertility and productivity index:

Variations in the Requier index (RI) and soil productivity are shown in Table 11 and Figure 7. Requier index (RI) for Land Productivity Index (LPI) and soil fertility Index (SFI) varied by LRT and RLC mapping units, showing differences in (class I) fertility and productivity. The HRT and SS mapping units exhibited varied levels of productivity and fertility. Soil fertility index ranked high in unit HRT the mapping unit within class I fertility. The soil productivity index was below average for the OB and OM mapping units ranked (class III) in terms of productivity, and These units exhibited soil fertility with a (class I) rating, this SS mapping unit had the lowest productivity ranking within for (class IV), soil fertility in this unit measured at a moderate level (class II) in fertility. The decline is attributed to reduced soil fertility caused by decreased effective depth, drainage and soil texture most influential respectively in OM mapping unit. Decrease in soil productivity in this mapping unit OB is primarily linked to effective depth and soil texture. Decreased moisture availability and soil texture primarily cause a decrease in soil productivity in this mapping unit SS. The study shows that the Requier Index is significantly influenced by soil depth, moisture levels, drainage quality, and soil texture. These changes adversely affect root respiration and nutrient uptake, thus reducing crop yield potential (Rashed 2015, Minhas *et al.*, 2020, Zein *et al.*, 2020 and Dhaouadi *et al.*, 2021).

Table 7. Values of the factors of land productivity index of the studied soils of the investigated area

Mapping unit	Moisture availability	Drainage	Effective depth(cm)	Texture / structure
HRT	Rooting zone below wilting point for 3 months of the year	Good drained	110	Clay
LRT	Rooting zone below wilting point for 3 months of the year	Well drained	130	Clay
OB	Rooting zone below wilting point for 3 months of the year	Moderate drained	110	Clay
OM	Rooting zone below wilting point for 3 months of the year	Moderate drained	90	Clay loam
SS	Rooting zone below wilting point for 9 months of the year	Well drained	150	Sand
RLC	Rooting zone above wilting point and below field capacity for most of the year	Well drained	130	Clay loam

Table 8. Soil characteristics of the investigated area

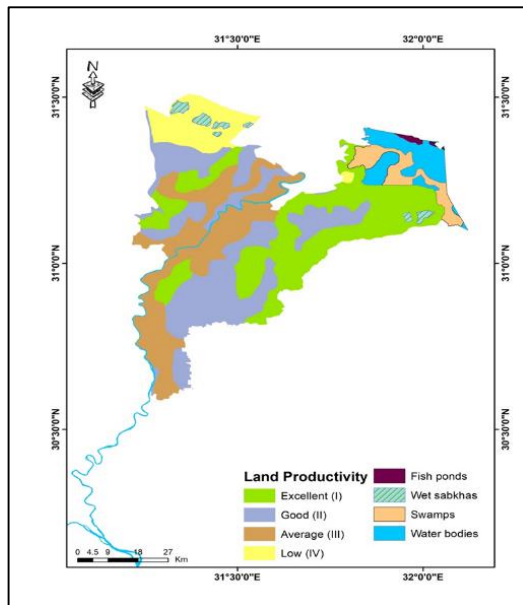
Mapping unit	Moisture availability (H)	Drainage (D)	Effective depth (P)	Texture / structure (T)
HRT	H4c	D3	P5	T5b
LRT	H4c	D4	P6	T5b
OB	H4c	D2	P5	T5b
OM	H4c	D2	P4	T5b
SS	H2c	D4	P6	T4b
RLC	H5	D4	P6	T5b

Table 9. Score assessment of Requier productivity index of the investigated area

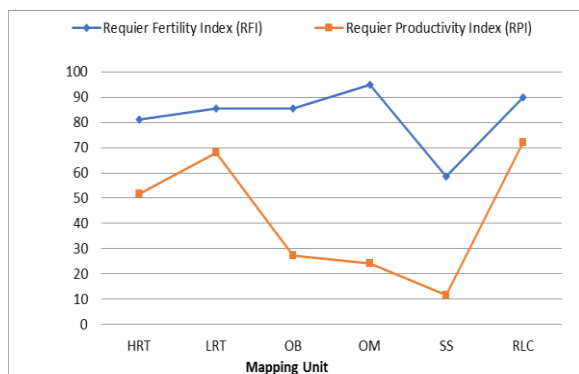
Mapping unit	Moisture availability (H)	Drainage (D)	Effective depth (P)	Texture / structure (T)	Fertility Index (PI)	Grade	Productivity Index (PI)	Grade
HRT	100	80	100	80	81.22	I	51.84	II
LRT	100	100	100	80	85.50	I	68.00	I
OB	100	40	100	80	85.50	I	27.20	III
OM	100	40	80	80	95.00	I	24.32	III
SS	40	100	100	50	58.52	II	11.60	IV
RLC	100	100	100	80	90.00	I	72.00	I

Table 10. Land Productivity Index of the study area

Requier Land Productivity Index RLPI (%)	Grade	Class	Mapping unit	Area (ha)	Area %
65 -100	I	Excellent	LRT and RLC	112007	29.13
35 – 64	II	Good	HRT	48198.41	12.53
20 – 34	III	Average	OB and OM	84672.50	22.02
8-19	IV	Low	SS	26385.26	6.86
0-7	V	Extremely Low	—	—	—

**Fig. 6. Productivity Index map of Dakahlia Governorate****Table 11. Change in the value Requier Index, of land productivity index and Soil fertility index**

Mapping unit	Requier Fertility Index (RFI)	Requier Productivity Index (RPI)	Changes
HRT	81.22	51.84	±29.38
LRT	85.50	68.00	±17.50
OB	85.50	27.20	±58.30
OM	95.00	24.32	±70.68
SS	58.52	11.60	±46.92
RLC	90.00	72.00	±18.00

**Fig. 7. Requier Fertility and Productivity index in the study area.**

CONCLUSION

Soil in (class I) with high fertility scores highly within mapping unit HRT, the soil productivity index was below average for the OB and OM mapping units ranked (class III) in terms of productivity, and these units exhibited soil fertility with a (class I) rating, this SS mapping unit had the lowest productivity ranking within for (class IV), soil fertility in this unit measured at a moderate level (class II) in fertility. The decline is attributed to reduced soil fertility caused by decreased effective depth, drainage and soil texture most influential respectively in OM mapping unit. Decrease in soil productivity in this mapping unit OB is primarily linked to effective depth and soil texture. Decreased moisture availability and soil texture primarily cause a decrease in soil productivity in this mapping unit SS. The study shows that the Requier Index in the study area is significantly influenced by soil depth, moisture levels, drainage quality and soil texture.

REFERENCES

- Abd El-Kawy, W.A., Abd El-Aziz, B. A., Abd El-Hady, A.A. and Ali, R.R. 2024. Monitoring soil productivity using Remote sensing and GIS techniques in El- Qaliobia Governorate, Egypt. *Egypt. J. Soil Sci.* Vol. 64, No. 3 pp: 715 – 730.
- AbdelRahman, M.A.E., Afifi, A.A. and Scopa, A. A. 2022. Time Series Investigation to Assess Climate Change and Anthropogenic Impacts on Quantitative Land Degradation in the North Delta, Egypt. *ISPRS Int. J. Geo-Inf.*, 11, 30.
- Aboelsoud, H.M., AbdelRahman, M.A.E., Kheir, A.M.S., Eid, M.S.M., Ammar, K.A., Khalifa, T.H. and Scopa, A. 2022. Quantitative Estimation of Saline-Soil Amelioration Using Remote-Sensing Indices in Arid Land for Better Management. *Land*, 11, 1041.
- Agber, P.I. and Ali, A. 2012. Evaluation of the productivity of soils in Makurdi, Southern Guinea Savanna, Nigeria, using riquier index. *Journal of Environmental Science and Water Resources*, 1(5), 100 – 104.
- Andrews, S.S., Karlen, D.L. and Cambardella, C.A. 2004. The soil management assessment framework: A quantitative evaluation using case studies, *Soil Sci. Soc. Am. J.*, vol. 68, no. 6, pp. 1945–1962.
- Bagherzadeh, A., Gholizadeh, A. and Keshavarzi, A. 2018. Assessment of soil fertility index for potato production using integrated Fuzzy and AHP approaches, Northeast of Iran. *Eurasian J Soil Sci.*, 7 (3) 203 – 212.

- Devi, G.M.G. and Kumar, K.S.A. 2008. Remote sensing and GIS application for land quality assessment for coffee growing areas of Karnataka. *Journal of the Indian Society of Remote Sensing*, 36, 89-97.
- Dhaouadi, L., Besser, H., Wassar, F. and Alomrane, A. R. 2021. Assessment of natural resources in tunisian Oases: degradation of irrigation water quality and continued overexploitation of groundwater. *Euro-Mediterranean Journal for Environmental Integration*, 6(1), 1-13. [https://doi.org/ 10.1007/s41207-020-00234-3](https://doi.org/10.1007/s41207-020-00234-3).
- Dobos, E., Norman, B., Bruee, W., Luca, M., Chris, J. and Erika, M. 2002 . The Use of DEM and Satellite Images for Regional Scale Soil Database. 17th World Congress of Soil Science (WCSS), 14-21 August, Bangkok, Thailand.
- Du, C and. Zhou, J. 2009. Evaluation of soil fertility using infrared spectroscopy: a review, *Environ. Chem. Lett.*, vol. 7, pp. 97–113.
- Dumanski, J., Bindraban, P. S., Pettapiece, W. W., Bullock, P., Jones, R. J. A. and Thomasson, A. 2010. Land classification, sustainable land management, and ecosystem health. *Interdisciplinary and Sustainability Issues in Food and Agriculture*, 3: 244-266.
- Elnaggar, A. A., El-Hamdi, K.H. H and Daibes T. Y. 2017. Fertility Evaluation of Some Soils in Damietta Governorate, Egypt Using GIS. *J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8(2): 85 – 92*.
- Elseedy, M. E. 2019. Soil fertility evaluation using ASLE, nutrient index models and GIS techniques: A case study on some soils of Dakahlia Governorate, Egypt. *Egyptian Journal of Soil Science*, 59(4), 403-415.
- El-Seedy, M.E and Saeed, M.A. 2019. Tracking changes in soil fertility at North Nile Delta, Egypt using GIS techniques, *J. Soil Sci. Agric. Eng.*, vol. 10, no. 10, pp. 627–635.
- Eswaran, J., Hughes, C and Koronakis, V. 2003 . Locking TolC entrance helices to prevent protein translocation by the bacterial type I export apparatus. *Journal of molecular biology* 327(2): 309-315.
- FAO. 1990. Guidelines for soil profile description. 3rd Ed. (revised), soil resources, management and conservation service, land and water development division. Food and Agriculture Organization Food and Agriculture Organization (FAO), Rome, Italy
- FAO. 1991. Land use planning applications. *Bulletin* no. (68) FAO, Rome.
- FAO. 2006. Guidelines for soil description, 4th edn. FAO, Rome. ISBN 92-5-105521-1.
- FAO. 2007. Land Evaluation, towards a revised framework. FAO, Rome, Italy.
- FAO. 2019. The international Code of Conduct for the Sustainable Use and Management of Fertilizers, Rome, Italy, FAO. 56 pp. <https://doi.org/10.4060/CA5253EN>.
- Field, D. J. 2017. Soil Security: Dimensions. In *Global Soil Security* (15-23). Springer, Cham
- Galbiatti, J. A., Borges, M. J., Bueno, L. F., Garcia, A. and Vieira, R. D. 2004. Effect of different irrigation periods in the development, yield and seedling quality in the maize (*Zea mays* L.) crop. *Engenharia Agrícola* 24, 301–308 (In Portuguese, with English abstract).
- Guarini, M.R., Battisti, F. and Chiovitti, A. A. 2018. Methodology for the Selection of Multi-Criteria Decision Analysis Methods in Real Estate and Land Management Processes. *Sustainability*, 10, 507.
- Jin, J., Xu, Y., Ye, H., Shen, C. and Huang, Y. 2011. Effect of land use and soil management practices on soil fertility quality in north china cities' urban fringe. *African Journal of Agricultural Research*, 6 (9), 2059-2065.
- Kassim, Y., Mahmoud, M., Kurdi, S. and Breisinger, C. 2018. An agricultural policy review of Egypt: First steps towards a new strategy.
- Lee, K.S., Lee, G.B and Tyler, E.J. 1988. Thematic Mapper and Digital Elevation Modeling of Soil Characteristics in Hilly Terrain. *Soil Sci. Soc. Am. J.*, 52, 1104-1107.
- Liang, X., Yang, T., Niu, J., Zhang, L., Wang, D., Huang, J., Yang, Z and Berndtsson, R. 2022. Quality assessment and rehabilitation of mountain forest in the Chongli Winter Olympic Games Area, China, *Forests*, vol. 13, no. 5, p. 783.
- Lillesand, T.M. and Kiefer, R.W. 2007. Remote sensing and image interpretation, 5th ed. Paper back September John Wiley, New York, pp. 820.
- Maleki, S., Karimi, A., Zeraatpisheh, M., Poozeshi, R. and Feizi, H. 2021. Long-term cultivation effects on soil properties variations in different landforms in an arid region of eastern Iran. *Catena* 206, 105465.
- Maleknia, R., Khezri, E., Zeinivand, H. and Badehian, Z. 2017. Mapping Natural Resources Vulnerability to Droughts Using Multi-Criteria Decision Making and GIS (Case Study: Kashkan Basin Lorestan Province, Iran). *J. Range. Sci.*, 7, 376–386.
- Minhas, P.S., Ramos, T.B., Ben-Gal, A. and Pereira, L.S. 2020. Coping with salinity in irrigated agriculture: Crop evapotranspiration and water management issues. *Agricultural Water Management*, 227, 105832. <https://doi.org/10.1016/j.agwat.2019.105832>.
- Mohamed, M.A., Elgharably, G.A., Rabie, M.H., Mohamed, H.M. and Eissa M.A. 2019. Evaluation of Soil Fertility Status in Toshka, Egypt: Available Micronutrients, *World J. Agric. Sci.*, vol. 15, pp. 1–6.
- Mohana, P., Mariappan, N. V. E. and Manoharan, N. 2009. Land suitability analysis for the part of Parambikulam Aliyar command area, Udumalpet Taluk using remote sensing and GIS techniques. *International Journal on Design and Manufacturing Technologies*, 3 (2): 98–102.
- Mueller, L., Schindler, U., Mirschel, W., Shepherd, T.G., Ball, B.S., Helming, K., Rogasik, J., Eulenstein, F. and Wiggering, H. 2010. Assessing the productivity function of soils. A review. *Agronomy for Sustainable Development*. Volume 30, 601–614.
- Munnaf, M.A. and Mouazen, A.M. 2021. Development of a soil fertility index using on-line Vis-NIR spectroscopy, *Comput. Electron. Agric.*, vol. 188, p. 106341.
- Nafiu, A.K., Abiodun, M.O., Okpara, I. M. and Chude, V.O. 2012. Soil fertility evaluation: a potential tool for predicting fertilizer requirement for crops in Nigeria, *African J. Agric. Res.*, vol. 7, no. 47, pp. 6204–6214.
- Nariyanti, S., Herawati, A., Herdiansyah, G., Irianto, H., Riptanti, E.W. and Qonita, A. 2022. Soil fertility index based on altitude: A comprehensive assessment for the cassava development area in Indonesia, *Ann. Agric. Sci.*, vol. 67, no. 2, pp. 158–165.

- Raji, B.A. 2000. Productivity evaluation of quartzsammments and haplustults derived from contiguous sand dun fields for rain fed agriculture pasture and forestry in Northwest Nigeria. Soil Sci., Soc. Nigeria proc.26th Annual. Conf of Soil Sci., Soc. Nigeria (SSSN), Ibadan, 30 Oct – 3Nov,12-18.
- Rashed, H. S. 2015. Impact of Soil Degradation on Land Productivity of South El-Kalubia Governorate. *Egyptian Journal of Soil Science*, 55(1), 67-80. <https://doi.org/10.21608/ejss.2015.208>.
- Rashed, H. S. A., Hassan, F. O., Faid, A. M. and Abdel Salam, A. A. 2021. Assessment of Groundwater Quality for Different Aquifers in Halaib and Shalaten Area at South Eastern Desert of Egypt. *J. Soil Scien. Agricul. Engin., Mansoura Univ.*, 11 (6):203-214.
- Riquier, J., Bramao, D.L. and Cornet, J.P. 1970. A new system of appraisal in terms of actual and potential productivity. *FAO Soil Resources, Development and Conservation Services, Land and Water Development Division, FAO, Rome*, p 38.
- Samaei, F., Emami, H. and Lakzian, A. 2022. Assessing soil quality of pasture and agriculture land uses in Shandiz county, northwestern Iran. *Ecol. Indicat.* 139,108974.
- Sánchez-Navarro, A., Gil-Vázquez, J.M., Delgado-Iniesta, M.J., Marín-Sanleandro, P., Blanco-Bernardeau, A., Ortiz-Silla, R., 2015. Establishing an index and identification of limiting parameters for characterizing soil quality in Mediterranean ecosystems. *Catena* 131, 35–45.
- Sanchez, P.A., Couto, W. and Buol, S.W. 1982. The fertility capability soil classification system: Interpretation, applicability and modification. *Geoderma* 27(4):283-309.
- Schoeneberger, P.J., Wysocki, D.A., Benham, E.C. and Broderson, W.D. 2002. Field book for describing and sampling soils. Version 2.0. USDA-NRCS, National Soil Survey Center, Lincoln, NE.
- Sokolowski, A.C., McCormick, B.P., Grazia, J., De Wolski, J.E., Hernán, A., Eric, R. P., Rodríguez-Frers, C., María, G. P., Silvina, D.R., Ileana, P and Barrios, M.B. 2020. Tillage and no-tillage effects on physical and chemical properties of an Argiaquoll soil under long-term crop rotation in Buenos Aires, Argentina. *Intern.Soil and Water Conserv. Res.*, 8 (2): 185-194.
- Sushanth, K., Kumar, R. and Bhardwaj, A. 2019. Soil mapping of Patiala-Ki-Rao watershed in Shivalik Foot-Hills using GIS. *International J. of Agri. Sci. Res. (IJASR)* 9 (2) 1-8.
- Thomas, R. J., El-Dessougi, H and Tubeileh, A. 2006. Soil system management under arid and semi-arid conditions. En: UPHOFF, N.; BALL, A.S.; PALM, C.; FERNANDES, E.; PRETTY, J.; HERREN, H.; SANCHEZ, P.; HUSSON, O.; SANGINGA, N.; LAING, M.; THIES, J. (Eds.) *Biological Approaches to Sustainable Soil Systems*. Taylor & Francis, CRC Press, Boca Raton, pp. 41-58.
- USDA. 2004. Soil survey laboratory methods manual. Soil Survey United State Department of Agriculture (USDA).
- USDA. 2014. Keys to soil taxonomy, 12th ed. USDA Natural Resources Conservation Service, United State Department of Agriculture (USDA), Washington, DC. 372 pp.
- Yu, P., Liu, S., Zhang, L., Li, Q. and Zhou, D. 2018. Selecting the minimum data set and quantitative soil quality indexing of alkaline soils under different land uses in northeastern China. *Sci. Total Environ.* 616, 564–571.
- Zein, F. I., Gaiza, E. A., EL-Sanafawy, H. M. and Talha, N. I. 2020. Effect of Specific Ions, Salinity and Alkalinity on Yield and Quality of Some Egyptian Cotton Genotypes. *Egyptian Journal of Soil Science*, 60(2), 183-194. <https://doi.org/10.21608/ejss.2020.21065.1334>.
- Zhang, M.K and Xu, J.M. 2005. Restoration of surface soil fertility of an eroded red soil in southern China, *Soil Tillage Res.*, vol. 80, no. 1–2, pp. 13–21.
- Zink, J. A. 1997. *Physiography and Soils*. ITC Lecture Note, K6 (SOL41).Enschede, the Netherlands.

دراسة العلاقة بين إنتاجية الأرض وخصوبتها في محافظة الدقهلية باستخدام نظم المعلومات الجغرافية والاستشعار عن بعد

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المخلص

تدهور إنتاجية المحاصيل وخصوبة التربة وعدم قدرتها على تلبية متطلبات النمو السكاني في منطقة الدراسة. تم تحسين الصورة باستخدام برنامج ENVI 5.1 من Landsat +ETM. لتقييم خصوبة التربة وإنتاجيتها بالاستشعار عن بعد ونظم المعلومات الجغرافية. إن تقييم إنتاجية التربة وخصوبتها يعد من المؤشرات المهمة التي تؤدي إلى نظام بيئي مستدام، وقد تم تقييم مؤشرات إنتاجية التربة وخصوبتها وفقاً لـ Riquier et al., (1970)، حيث تشير النتائج إلى أن أنواع المناظر الطبيعية في منطقة الدراسة هي السهول الفيضية، والرواسب البحرية، والرواسب الريفية. تشمل منطقة المناظر الطبيعية الشروقات النهرية المرتفعة (HRT)، والشروقات النهرية المنخفضة (LRT)، والأحواض الفيضية (OB)، وعاء الفلض (OM)، أحواض الترسيب (DB)، الفرشات الرملية (SS)، ظهور السلاخ (H)، والشريط الرمي الساحلي (CSB)، والمساحات الطينية المنخفضة نسبياً (RLC)، والسبخة الرطبة (WS)، والتكوينات الجبسية (GF)، والمستنقعات (S) والمساحات المائية (WB)، خصوبة التربة حوالي 63.68% من المساحة شديدة الخصوبة (الفئة الأولى) نتائج تصنيف مؤشر إنتاجية الأراضي، حوالي 29.13% من إجمالي وحدات المساحة مصنفة على أنها فئة إنتاجية ممتازة (I) وهي تتكون من وحدات LRT و RLC حوالي 12.53% من إجمالي المساحة، تندرج تحت فئة الإنتاجية الجيدة (II)، وتتكون من وحدة HRT حوالي 22.02% من إجمالي وحدات المساحة تندرج تحت فئة المتوسط (III)، وتتكون من وحدات OB و OM. تمثل حوالي 6.86% من المساحة، وتصنف على أنها فئة إنتاجية منخفضة (IV)، وتتكون من وحدة SS.