# HUMAN INDUCED SOIL AND LANDFORM DEGRADATION IN MARYUT .BURG EL ARAB REGION, EGYPT

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## ABSTRACT

The area of burg el Arab west of the Nile Delta, Egypt, comprises a Pleistocene coastal plain formed due to regression of shorelines, where parallel bars are characterizing recessive shorelines. These bars are considered to be formed during the glacial periods .They is composed of light white calcareous oolitic sand. The older bars are lithified and locally eroded by descending wadis draining the upper coastal plain and the southern table land. The bars are alternating with fresh lagoons near the present sea while the older lagooonal depressions are filled with fluviomarine sediment.

Expansion of agricultural lands comprises some tracts in the region upon digging of El Hammam canal to bringing Nile water for irrigations. Irrigation practices needed leveling of land. Regardless the environmental consequences, this resulted in distructing wide parts of the wadies.

This study aimed at monitoring degradation of landforms and soil upon violation of environmental stability in the region. Fortunately, old soil and geological maps were available .The soil map of the High Dam project (1963) described the soil conditions and outlined the prominent landforms. Fourteen soil profiles, representing different soil units within the High Dam project, were chosen be reinvestigated. Morphological descriptions and sampling soil horizons were undertaken for physical and chemical analyses.

The field and laboratory investigation revealed that a number of four mapping unit are salt affected and two are water logged, Deformation of soil profile horizon sequences are pointed out in a number of four sites. Moreover, two sites showed disturbance of lithified limestone bars as result of quarrying activates. Awareness of soil degradation consequences before reclamation may have led to better management and to avoid intervening in natural drainage. Conservation of the natural history of the famous Pleistocene bars is equally important.

**Keywords:** Human induced soil and landform degradation, change detection and environmental balance

## INTRODUCTION

The rapid increase in population in Egypt forms an attendant challenge of food security . The expansion of agriculture land irrigated from Nile water is practiced in areas as near as possible from this water resource. The area of Burg EL Arab, west of the Nile delta along the Mediterranean Sea was selected for this purpose. Accordingly, Nile water was transported to the rigon by EL Hammam canal a branch from El Nubarya canal. The digging of the canal and traction and leveling of some tracts of the land resulted in degradation in lands and soil.

This area consists of a very famous emerging coastal plain characterized by parallel marine ridges denoting successive shorelines of a Quaternary retreating sea. The shorelines with its successive have are alternating with fresh lagoons near the present coast while old lagoonal depression for south are filled with flaviomarine deposits. The older ridges though still assuming their parallel characters to the old shorelines, they are severely truncated and eroded. The older ridges are lithified (Hammad and Veenebos 1989). Preserving these features and cultivating the lands in the swales were not considered.it seems also that avoiding this disaster was not available.

Evaluation of this damage and the initiation of serious consequence of environmental intervention is the aim of the study.

## MATERIALS AND METHODS

**Location:**

The studied area is located west of the Nile Delta between latitudes 30° 35´ and 31° 10´ N, and longitudes 28° 50´ and 29° 45´E (Fig 1).Total area is approximately 2489 $km^2$ including Maryut,Burg El Arab and El Alalmein Districts.

**Climate:**

The prevailing climate is extremely arid. However, the northern coast of Egypt has an annual rainfall ranging between 150mm at Sidi Barrani to 200mm at Rafah, at the eastern coast of the Mediterranean Sea. Mean annual temperature is 22°C with difference between mean annual summer temperature and mean annual winter temperature within 5°C .The climate therefore, is considered dry and worm desert (Bwh according to kappen - Geiger classification).Soil temperature regime is Thermic and soil moisture regime is Torric.

**-Geology:**

The studied area is essentially occupied by sedimentary rocks belonging to Quaternary. The following are the differentiated units of the Quaternary (CONOCO 1986).

**- Beach deposits** extending along the present shore line of the Arabs Gulf**.**

**- The oldest Lagoonal deposits.** These are alternating with the foreshore beach ridges .They consist of gleyed muds and sand, locally rich in gypsum intercalates . The lagoonal deposits are detected below the more recent alluvial and fluviomarine deposits.

-**Alluvial deposits.** These deposits are exposed and well represented at Abu Mina depression; a basin just west of the Northern Nile Delta plain. They are composed of deep calcareous sandy loam and sandy clay loam soils brought to their location by several Wadis eroded and dissecting the Pliocene and Miocene limestone tablelands to the south. Tertiary rocks are exposed eastern part of the studied area.

**-Geomorphology:**

The coastal plain of the Arabs Gulf consist of the Pleistocene bars denoting off-shore bars with lagoons characterizing different transgressions

above the present sea level . The younger bars are composed of loose calcareous oolitic sand grains lithified upon aging to the south .These bars are alternating with lagoons. The older ones are lithified, eroded, and dissected and alternating with lagoonal depressions filled with fluviomarine and fluviolacustrine deposits, essentially brought by wadis draining the southern Miocene tableland .(Hammad and Veenebos.1989)

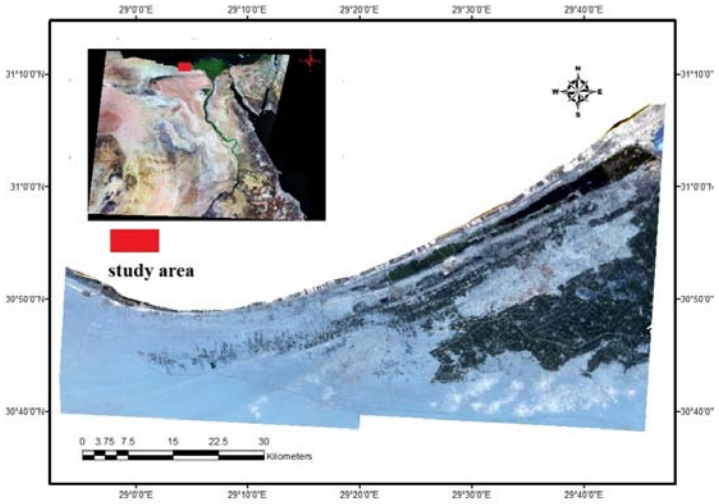


**Fig.1: Location map of the studied area**

**Base maps:**

Base maps including topographic map and geological map were collected for use in the study. Temporal Landsat images were obtained from (NARSS) of Egypt (ETM$^+$ 2000 and 2010)the following are specified detailed .
-Geologicalmap scale 1:150.000 was obtained from the CONOCO (1987).
-Topographic map scale from Egypt survey.
-A previous soil map of the High Dam Project (1963, FAOISF: 16UAR).
-Landsat images processed, corrected geometrically rectified and enhanced.

Digital work including generation of digital elevation model, scanning of geological and soil map and the geometric correction Arc GIS system of ESRI was used to compile layers of the used maps and satellite imageries .

A simplified soil map was made by combing mapping units .defining locations of soil profiles on the simplified map for field work was undertaken by applying the coordinate system.

**Field work:**

Fourteen location were defined for soil profile description site and soil description were made according to the soil survey manual (Soil Survey Staff 2006).soil samples were collected of new differed layers.

**Laboratory analysis:**

The collected soil samples were air dried, ground, and through a 2mm seive and packed in plastic viols. Separated gravels from every sample were evaluated as percentages by volume.

-Soil color by the Munsell soil color charts (1975)

-Particle size analysis was carried out by the hydrometer method according to klute (1986)

-Equivalent calcium carbonate percentages by Collin's calcimeter methods.

-Soil pH in the soil paste using glass electrode meter.

-Electrical conductivity ($EC_e$) in the soil saturation extract by using a standard conductivity at 25°C .

- Soluble cations and anions according to Page et al, (1982).

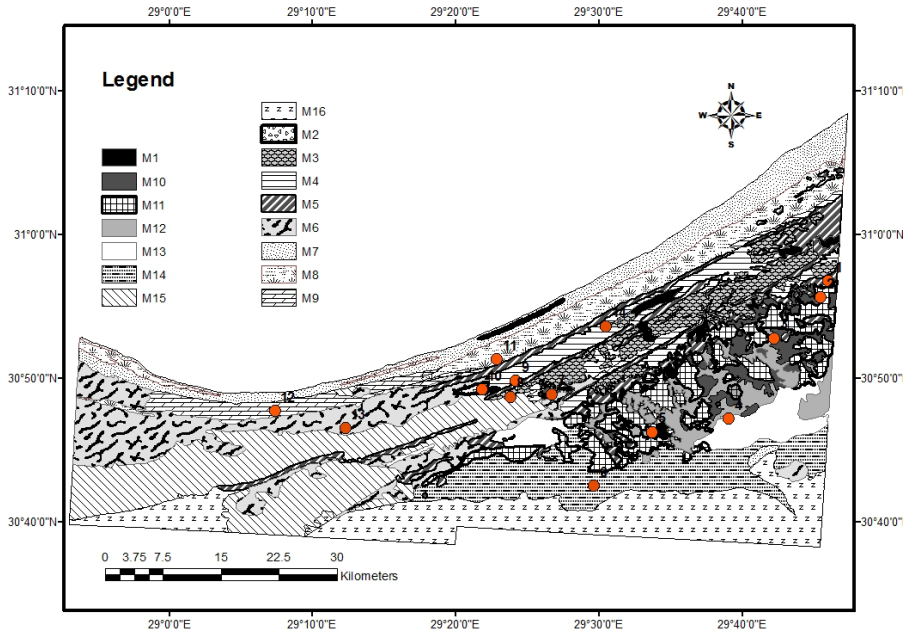


**Fig.2: Soil profile location map projected on the simplified soil map of Maryut –Burg El Arab area.**

**Table 1: The detailed legend**

| Mapping units | **1-Soils derived mainly from oolitic limestone<br>1-1.Older beach ridges, lagoonal saltmarshes and isolated rocky soils** |
|---|---|
| M1 | Shallow silt loam topsoil over clay loam sub soil |
| M2 | Like M1, with thin sheets of wind-blown sand |
| M3 | Like M1, but the silt loam topsoil layer is shallow to moderately deep |
| M4 | Like M3, with rock outcrops |
| M5 | Silty clay loam soils, predominantly shallow over rock, partly exposing remnants of rocky ridge. |
| M6 | Like M5, with wide and thick sheets of wind-blown sand. |
| | **1-2-Younger beach ridge soil with lagoonal depressions** |
| M7 | Shallow Slightly loamy sand soils of second beach ridge. Coarse sand of the coastal ridge Gently sloping, locally rock or in surface. |
| | **1-3-salt marshes of the lagoonal depressions** |
| M8 | Occasionally flooded, saline, sandy clay loam soils. |
| M9 | Not flooded sand soils, locally with loam or clay loam sub soils. |
| | **2-Soils of the plains Fluvio marine and Fluviolacustrine Soils** |
| M10 | Very shallow silt loam soils over clay loam subsoil |
| M11 | Like M10, with shallow-moderately deep silt loam topsoil layer |
| M12 | Very deep silty clay loam soils |
| M13 | Like M12, with thin sheets of wind-blown sand |
| M14 | Like M12, partly shallow over rock or rock in surface |
| | **3-Wind-blown soils** |
| M15 | Loose sand soils of medium and low dunes. |
| | **4-Miscellaneous land types Rock land** |
| M16 | Undissected limestone plateau with rock outcrops . |

**Table 1: Continue**

| Present Mapping Units | Simplified Old Mapping Units | Merged units of the old map | Profile No. |
|---|---|---|---|
| M1 | Lc | Lc | 7 |
| M2 | Lc20 | Lc20 | 10 |
| M3 | Lc13 | Lc13 | 14 |
| M4 | Lc8/13 | Lc8/13+lr/lc+lr/lc13+lr/lc22 | 9 |
| M5 | Lr | Lr | 1 |
| M6 | Lr21 | Lr21+ Lr20+ Lr22 | 13 |
| M8 | Lo | Lo+ Lf+ Lo8+ Lo20 | 11 |
| M9 | Ls | Ls+ Ls8+ Lo8/20 | 12 |
| M10 | Pn | Pn | 3 |
| M11 | Pn13 | Pn13+ Pn20+ Pn4/20+ Pn4/21 | 2 |
| M12 | Pm | Pm | 5 |
| M13 | Pm20 | Pm20 | 4 |
| M14 | Pm4/20 | Pm4/20 | 6 |
| M15 | Du4/18 | Du4/18+ Du+ Du4+ Db4/18+ Ds4/18+ Ds | 8 |

**Table 2: Soil degradation classes and rates.**

| Chemical degradation | Salinization (Cs) increase in (EC) per dS/m/year |
|---|---|
| Non to slight | <0.5 |
| Moderate | 0.5-3 |
| High | 3-5 |
| Very high | >5 |
| **Physical degradation** | **Water logging/increase in water table in cm/year** |
| Non to slight | <1 |
| Moderate | 1-3 |
| High | 3-5 |
| Very high | >5 |

**Adapted FAO (1979)**

**Table 3: Criteria used to determine the degree of the different degradation types.**

| Critical/Hazard type | Indicator | Unit | Hazard class | | | |
|---|---|---|---|---|---|---|
| | | | Low | Moderate | High | Very high |
| **Salinization** | E | dS $m^{-1}$ | 4 | 4-8 | 8-16 | >16 |
| **Water Logging** | Water Table level | Cm | 150 | 150-100 | 100-50 | <50 |

## RESULTS AND DISCUSSION

**1. Morphological and laboratory analysis results.**

The fourteen profiles located in the simplified soil map of the High Dam Project (Fig.2) were described in the field and sampled .Their soil profiles are representing mapping units of the previous map.
The detailed legend is outlined in Table 1.

General description of the morphology of the studied soils and their equivalents in the old High Dam Map are given in Tables 4 and 5.Analysis of the studied soils are given in Table 6. The following is a brief discussion of soil properties and the changes and degradation occurred.

**Soils derived mainly from oolitic limestone**

**-Older beach ridges, lagoonal saltmarshes and isolated rocky soils.**

Previous soils of this group including M1, M2, M3, M4 are shallow to moderately deep and these textures are ranging between silt loam to sandy loam top soil over clay loam subsoil.

Except for M5 which had silt clay loam texture throughout .The material covering the highly dissected remnant of these ridges are brought by running water from weathered materials of the high land south of the region. The soils are usually covered with windblown sand of different thickness. Using these soils in agriculture as indicated from the present work has caused the following changes (Table 9 and Fig 3)

1. Increase in depth (M1, M3, M5, and M6)
2. Salinization (M1, M3)

3. Differences in texture disturbing of natural profile (M1, M3, M4 M5, M6)
4. Water logging (M2).
5. Impeding of natural drainage (M1, M3).
6. Occurrence of calcic horizon (M4, M5)
7. Improving of salinity (M5)

**-Younger beach ridge soil with lagoonal depressions.** This mapping unit is including M**7** of the original simplified soil map which represents the second ridge with slightly loamy sand soil . the unit is also including the coastal ridge which is composed of loose oolitic coarse sand . This ridge is lithified in some parts. Lagoonal depression is included in this unit both in the old and the simplified map present soil map .

**- Salt marshes of the lagoonal depressions.** This mapping unit is including M8 which is permanently submerged and flooded and a saltmarsh of M9 unit occupying the higher flank of the depression. The soil of this mapping unit is sandy over sandy loam subsoil. The present land use did not involve any major change in texture or salinity and the two units were preserved in the final soil map .

**Soils of the lower coastal plain**.

These are composed of fluviomarine sediments. In the old map there are two main units, the first one has a thin silt loam top soil over clay loam subsoil. The other one is presenting a deep silty clay loam to sandy clay loam soil. The present work merged several units of the old map into M10 and M11 which are composed of sandy clay loam throughout the entire depth of the profile. The change in texture upon cultivation is almost nil.The other units in the old map are composed of silt clay loam soil throughout, covered locally with windblown sand of different thickness In the present work they are compiled in M12 and M13. Occasionally, shallow over rock or rock exposures (M14).

In the present work, cultivation resulted in desalinizing of M12 while texture was almost maintained. The unit of M13 in the simplified soil map was drastically changed upon leveling; the soil was covered with loamy sand material. Cultivation induced leaching of salts. The M14 unit of the simplified map is composed of sandy clay loam throughout, locally covered with blown sand.

**Windblown sand**

Unit M15 of the simplified map did not change upon land use and is cultivated by local inhabitants mostly with barley .

**Miscellaneous land types**

These are rock land and rocky ridges

**4**

**4c**

**Table 6:** من الأصل

**6c**

**6c**

**2.Land degradation**

2.1.Quantitative degree of degradation in some properties may require further studies and estimations

-Salinization and Water logging

**Table 7: Land degradation severity level in the studied area:**

| Profile No. | Mapping Unit | Salinization | | Profile No. | Mapping Unit | Water logging | |
|---|---|---|---|---|---|---|---|
| | | Degree | RATE | | | Degree | RATE |
| 2 | M11 | L | L | 10 | M2 | VH | VH |
| 6 | M14 | H | L | 11 | M8 | VH | VH |
| 7 | M1 | H | L | | | | |
| 14 | M3 | V H | L | | | | |

**L= low, H= high, VH= very high**

**-Others degradation features**

**Table 8 : Human based deformation and quarrying of marine ridge.**

| Location | Area 1984(km$^2$) | Area 2004(km$^2$) | total |
|---|---|---|---|
| **Abusir ridge** | 4.7 | 2.6 | 7.3 |
| **Gebel Maryut ridge** | 3.2 | 4.1 | 7.3 |
| **Gebel EL-Carn(Alam-Nayl)** | 0.5 | 17.6 | 18.1 |
| **Total** | 8.4 | 24.3 | 32.7 |

-Human based intervention in local natural drainage upon elevation and ablation of land (Fig .3).

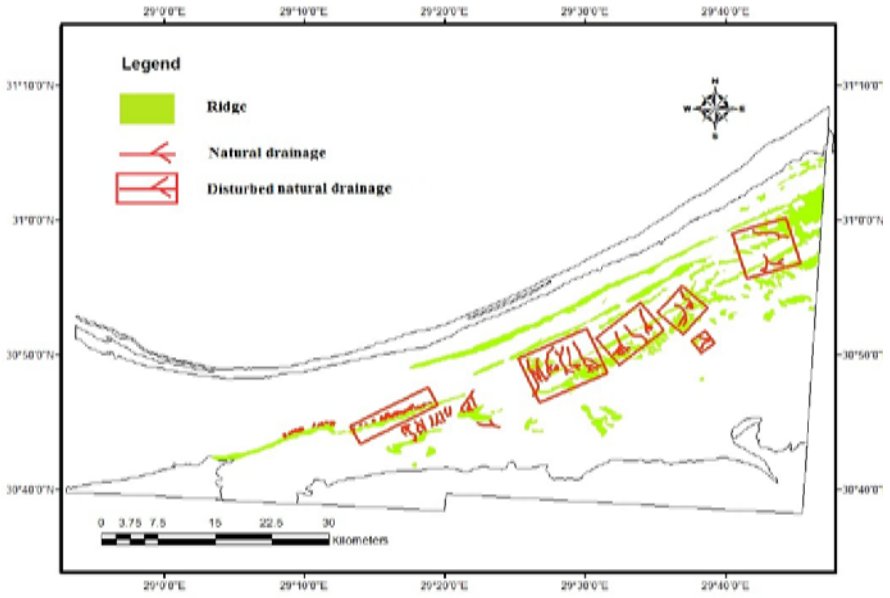


**Fig 3 :Disturbance of nwatural drainage according**

**Table 9: Monitoring of the land degradation in the studied area.**

| Mapping Unit | Old Mapping Unit | Profile No. | Degradation Type | | | | |
|---|---|---|---|---|---|---|---|
| | | | Salinization | Water logging | D.N.D | H.B.D | D.N.S |
| M1 | Lc | 7 | ☻ | ☺ | ☻ | ☺ | ☻ |
| M2 | Lc20 | 10 | ☺ | ☻ | ☺ | ☺ | ☺ |
| M3 | Lc13 | 14 | ☻ | ☺ | ☻ | ☺ | ☻ |
| M4 | Lc8/13 | 9 | ☺ | ☺ | ☻ | ☺ | ☻ |
| M5 | Lr | 1 | ☺ | ☺ | ☻ | ☻ | ☻ |
| M6 | Lr21 | 13 | ☺ | ☺ | ☺ | ☻ | ☺ |
| M8 | Lo | 11 | ☺ | ☻ | ☺ | ☺ | ☺ |
| M9 | Ls | 12 | ☺ | ☺ | ☺ | ☺ | ☻ |
| M10 | Pn | 3 | ☺ | ☺ | ☺ | ☺ | ☻ |
| M11 | Pn13 | 2 | ☻ | ☺ | ☺ | ☺ | ☻ |
| M12 | Pm | 5 | ☺ | ☺ | ☺ | ☺ | ☻ |
| M13 | Pm20 | 4 | ☺ | ☺ | ☻ | ☺ | ☻ |
| M14 | Pm4/20 | 6 | ☻ | ☺ | ☺ | ☺ | ☻ |
| M15 | Du4/18 | 8 | ☺ | ☺ | ☺ | ☺ | ☺ |

**In former Table**

**1.D.N.S = Deformation of natural soil profile**

**2. H.B.D = Human based deformation and quarrying of marine ridge**

**3. D.N.D = Disturbance of natural drainage**

**4.The symbol ☻ indicates degradation while symbol ☺ indicates non apparent degradation**

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## التدخل البشرى وعلاقتة بتدهورالتربة و الأشكال الأرضية بمنطقة مريوط – برج العرب (مصر)

**محمداحمد مصطفى حماد [1] ، صلاح محمد ابوالعنين [1] ، عبدالله جاد عبدالله جاد [2] ، خالد محمد عبدالحليم العشرى[1] و محمد احمد السيد سعيد[1]**

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تعتبر منطقة برج العرب بغرب الدلتا منطقة سهل ساحلى تكونت فى عصر البلايستوسين نتيجة تراجع شاطىء البحر وتتميز هذة المنطقة بتناوب تلال الحجر الجيرى التى من المفترض تكونها بالعصور الجليدية من حبيبات الرمال البيضاء الجيرية ،كما يلاحظ ان المناطق الأقدم فى التكوين تحولت الى صخور متاكلة جزئيا بفعل الوديان المنحدرة من الهضبة الجنوبية ،كما يلاحظ ان التلال الجيرية حديثة التكوين تتناوب مع البحيرات اللاجونية والتى تم تغطيتها بالرواسب البحيرية والمائية القادمة من الجنوب . تم شق ترعة الحمام لتوصيل مياه النيل الى مساحات التوسع الزراعى بالمنطقة مما تطلب بعض اعمال التسوية والتى اثرت هى الأخرى على نظام التصريف الطبيعى والأشكال الأرضية بالمنطقة .

تهدف الدراسة الحالية الى رصد تأثير النشاطات البشرية المختلفة وتاثيرها على تدهور التربة والأشكال الأرضية والتى تؤثر على الإتزان البيئى بالمنطقة . من الأسباب التى سهلت الدراسة توافر معلومات سابقة عن وحدات التربة والملامح الفيزوجرافية حيث تم اختصار وحدات التربة القديمة وعمل اربعة عشر قطاعاارضيا ممثلا للتتناسب مع العمل الحالى، كما تم اخذ عينات تربة ممثلة وذلك لإجراء التحليلات الطبيعية والكيميائية وذلك للوقوف على التدهور الحادث نتيجة هذة النشاطات .

اشارت النتائج المتحصل عليها بوجود زيادة فى الملوحه باربع وحدات كما تاثرت وحدتين بإرتفاع مستوى الماء الأرضى وايضا تم الإخلال بنظام الصرف الطبيعى باربع وحدات اخرى ومن جهة اخرى فقد ظهر تغير فى الترتيب الطبيعى لافاق القطاع الأرضى وذلك فى اربع وحدات مختلفة ،وقد بينت الدراسة عموما مدى التغير فى النظام البيئى الطبيعى وتاثيرة على الوحدات الأرضية المختلفة.

**قام بتحكيم البحث**

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