4. RESULTS AND DISCUSSION

The north Delta area could be divided according to El-Nahal et al (1977) into three geomorphic units, namely, coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits (Map, 3). As the current study aims at evaluating the suitability of different soils forming the studied area for the agricultural puropose, it was important to study the three geomorphic units through describing the most important morphological features characterizing the soils along the five intersects chosen to include the main possible variations between the three geomorphic units. Also, the study involves a detailed quantitative evaluation of the different physical and chemical properties required to attain the purpose of this work.

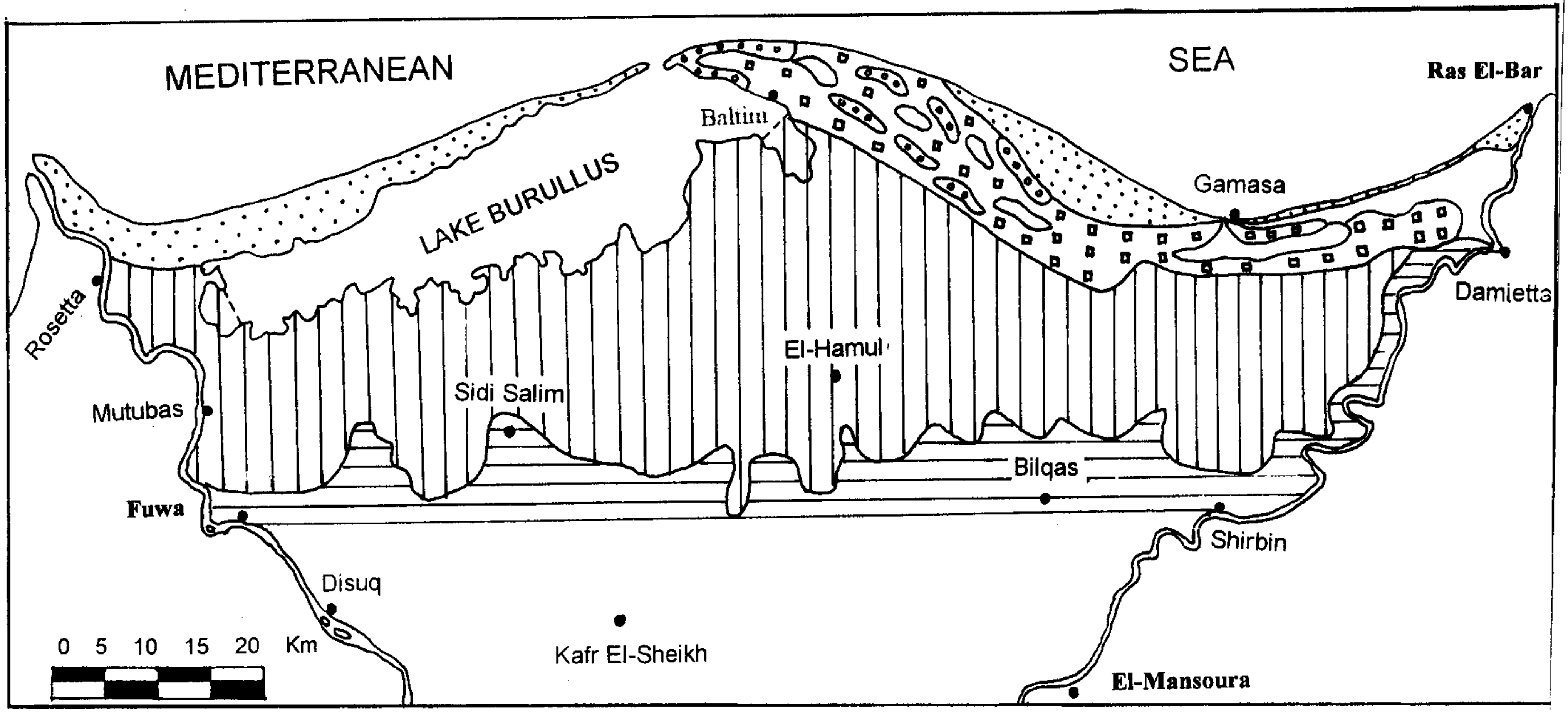
4.1. Morphological characterization of the studied area:

4.1.1. Coastal barrier plains and beaches:

The coastal barrier plains are generally the northern low laying depressions located between Baltim and Ras El-Bar along the coast but further inland. They are bounded to the north by the coastal barrier beaches and extending southwards to the tranzitional zone.

The coastal barrier beaches are running almost parallel to the sea shore line occupying disconnected narrow strip and getting wider in some areas.

The coastal barrier plains as well as the beaches are predominantly sandy



Map (3): Physiographic map of the Northern Delta (After High Dam soil survey, FAO, 1963 with some modifications by El-Nahal et al., 1977).

Legend

Coastal barrier plains and beaches:

- Coastal plains
- Beaches
- High dunes
- Medium and low dunes
- Fluvio marine deposits
- Recent Nile alluvial deposits

and the topography is basically flat except for the coastal dunes which are almost undulating. These sand dunes are rather low and are scattered over the coastal plains. They are mostly of longitudinal shape and bare shifting type, but occassionaly stabilized by natural vegetation cover.

The depth of water table fluctuates between 60 and 80 cm, except for the coastal dunes which have a rather deeper one. In the dry conditions, soil colours vary from brownish yellow (10YR6/6) to very dark grayish brown (10YR3/2) depending on location, and displays an almost unique munsell notation throughout the soil profile. Moist soil colours are changing from yellowish brown (10YR5/4) to very dark brown (10YR2/2). Fine dark gray diffuse mottles appeared in some subsurface layers.

The coastal barrier plains and beaches are commonly sandy with a single grain to massive structure. Soil consistence is usually loose or soft in the dry conditions changing into loose or friable in the moist ones. Under wet conditions, soil consistence is non sticky and non plastic. The soils of this unit are represented by profiles Nos 1, 2, 6, 7, 8, 12, 13, 19 and 25, (Map 2).

The represntative profiles are morphologically described as given hereafter:

Profile No.	:	(1)
Location	:	Kafr El-Batikh, Damietta Governorate
Elevation	:	0.4 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Barren
Water table	:	at 70 cm

Depth (cm)	Description
0 - 25	Yellowish brown (10YR5/6, dry) to dark yellowish brown (10YR3/6, moist); loamy sand; massive; non sticky and non plastic wet; friable moist; soft dry; common coarse to fine random pores; few fine shells; few fine roots; weak effervescence; clear smooth boundary;
25 - 50	Dark yellowish brown (10YR4/6, dry) to very dark brown (10YR2/2, moist); sand; single grain; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence; gradual wavy boundary;
50 - 70	Dark yellowish brown (10YR4/4, dry) to dark brown (10YR3/3, moist); sand; single grain; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence.

Profile No.	:	(2)
Location	:	Kafr El-Batikh, Damiettal Governorate
Elevation	:	1.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with date palme and clover
Water table	:	at 80 cm

Depth (cm)	Description
0 - 30	Dark yellowish brown (10YR3/4, dry) to very dark brown (10YR2/2, moist); loamy sand; massive; non sticky and non plastic wet; friable moist; soft dry; coarse, medium and fine random pores; many fine to coarse roots; weak effervescence; gradual wavy boundary;
30 - 60	Yellowish brown (10YR5/4, dry) to dark yellowish brown (10YR3/4, moist); sand; single grain; non sticky and non plastic wet; loose moist and dry; common coarse to fine random pores; few fine to medium roots; weak effervescence; gradual wavy boundary;
60 - 80	Dark yellowish brown (10YR4/4, dry) to dark yellowish brown (10YR3/4, moist); sand; single grain; non sticky and non plastic wet; loose moist and dry; common medium random pores; very few fine roots; weak effervescence.

Profile No.	:	(6)
Location	:	Abo Madi, Dakahlia Governorate
Elevation	:	0.6 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Barren
Water table	:	at 65 cm

Depth (cm)	Description
0 - 30	Pale brown (10YR6/3, dry) to grayish brown (10YR5/2, moist); sand; massive; non sticky and non plastic wet; very friable moist; soft dry; many coarse to fine random pores; few fine roots; weak effervescence; gradual wavy boundary;
30 - 65	Light yellowish brown (10YR6/4, dry) to yellowish brown (10YR5/4, moist); many fine gray (7.5YR5/0) clear mottles; sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence.

Profile No.	:	(7)
Location	:	Abo Madi, Dakahlia Governorate
Elevation	:	2.5 m.a.s.l.
Topography	:	Undulating
Slope	:	Gently sloping
Land use	:	Under reclamation
Water table	:	at 130 cm

Depth (cm)	Description
0 - 30	Light yellowish brown (10YR6/4, dry0 to dark yellowish brown (10YR4/4, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; common medium and coarse random pores; few fine roots; weak effervescence; gradual smooth boundary;
30 - 60	Pale brown (10YR6/3, dry) to brown (10YR4/3, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence; gradual smooth boundary;
60 - 100	Pale brown (10YR6/3, dry) to brown (10YR4/3, moist); sand; single grains; non sticky and non plastic wet; very friable moist, soft dry; weak effervescence; clear smooth boundary;
100 - 130	Very dark grayish brown (10YR3/2, dry) to very dark brown (10YR2/2, moist); common fine and medium gray (7.5YR5/0) clear mottles; sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence.

Profile No. : (8)

Location : Qalabshu, Dakahlia Governorate

Elevation : 1.1 m.a.s.l.

Topography : Almost flat

Slope : Nearly level

Land use : Cultivated with date palm and tomatoes

Water table : at 100 cm

Depth (cm)	Description
0 - 30	Brown (7.5YR4/4, dry) to dark brown (7.5YR3/4, moist); loamy sand; massive; non sticky and non plastic wet; friable moist, soft dry; common coarse to fine random pores; moderate medium to fine roots; weak effervescence; clear smooth boundary;
30 - 60	Dark yellowish brown (10YR4/4, dry0 to dark yellowish brown (10YR3/4, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; few fine roots; weak effervescence; gradual wavy boundary;
60 - 100	Dark yellowish brown (10YR4/4, dry0 to very dark grayish brown (10YR3/2, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence.

Profile No. : (12)

Location : El-Shahabia, Baltim, Kafr El-Sheikh Governorate

Elevation : 0.7 m.a.s.l.

Topography : Almost flat

Slope : Nearly level

Land use : Barren

Water table : at 70 cm

Depth (cm)	Description
0 - 20	Yellowish brown (10YR5/4, dry) to dark brown (10YR3/3, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; few fine roots; weak effervescence; gradual smooth boundary;
20 - 50	Yellowish brown (10YR5/4, dry) to brown (10YR4/3, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence; gradual smooth boundary;
50 - 70	Pale brown (10YR6/3, dry) to dark yellowish brown (10YR3/4, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence.

Profile No. : (13)

Location : Baltim, Kafr El-Sheikh Governorate

Elevation : 1.0 m.a.s.l.

Topography : Almost flat

Slope : Nearly level

Land use : Cultivated with clover

Water table : at 70 cm

Depth (cm)	Description
0 - 25	Yellowish brown (10YR5/4, dry0 to dark brown (10YR3/3, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fien random pores; many medkium and fine roots; weak effervescence; clear smooth boundary;
25 - 50	Brownish yellow (10YR6/6, dry) to brown (10YR4/3, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; few fine roots; weak effervescence; gradual smooth boundary;
50 - 70	Light yellowish brown (10YR6/4, dry) to dark yellowish brown (10YR3/4, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence.

Profile No. : (19)

Location : about 35 km east of Zaghloul pumps station

Elevation : 0.5 m.a.s.l.

Topography : Almost flat

Slope : Nearly level

Land use : Barren

Water table : at 60 cm

Depth (cm)	Description
0 - 30	Pale brown (10YR6/3, dry) to dark grayish brown (10YR4/2, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; few fine roots; weak effervescence; clear smooth boundary;
30 - 60	Light brownish gray (10YR6/2, dry) to brown (10YR4/3, moist); sand; single grains; non sticky and non plastic wet; loose moist and dry; many coarse to fine random pores; weak effervescence.

state, while in the moist conditions colour is dark yellowish brown (10YR3/4) to a very dark brown (10YR2/2).

The soils of this unit are commonly clayey with a massive to strong fine subangular blocky, being more developed at lower depths. Soil consistence is usually hard or very hard in the dry conditions changing to firm or very firm in the moist ones. Under wet conditions soil consistence is sticky and plastic or very sticky and very plastic.

This unit occupies about half of the studied area, therefor its soils are represented by profile Nos 3, 4, 9, 10, 14, 15, 16, 17, 20, 21, 22, 26, 27 and 28. These representative profiels are morphologically described as given hereafter.

Profile No. : (3)
Location : Al-Mohamadia, Kafr Saad, Damietta Governorate
Elevation : 1.5 m.a.s.l.
Topography : Almost flat
Slope : Nearly level
Land use : Cultivated with clover
Water table : Deeper than 150 cm

Depth (cm)	Description
0 - 25	Dark brown (10YR3/3, dry) to very dark brown (10YR2/3, mosit); clay; massive; very sticky and very plastic wet; friable (moist), hard (dry); many fine and medium roots; moany fine pores; moderate effervescence; diffuse smooth boundary;
25 - 50	Dark yellowish brown (10YR4/4, dry) to very dark brown (10YR2/2, moist); clay; moderate medium subangular blocky; very sticky and very plastic wet; friable (moist); very hard dry; slickensides, wedge shaped aggregates; many fine pores; moderate fine and medium roots; weak effervescence; gradual wavy boundary;
50 - 100	Dark brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist); very hard (dry); slickensides, wedge shaped aggregates; common fine pores; few fine roots; weak effervescence; gradual smooth boundary;
100 - 150	Brown (10YR4/3, dry) to very dark grayish brown (10YR 3/2, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); many fine pores; weak effervescence.

Profile No.	:	(4)
Location	:	Abou-Galal, Shirbin, El-Dakahlia Governorate
Elevation	:	2.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with clover
Water table	:	Deeper than 150 cm

Depth (cm)	Description
0 - 25	Dark brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; massive; very sticky and very plastic wet; friable (moist), hard (dry); many fine and medium roots; many fine pores; moderate effervescence; clear smooth boundary;
25 - 50	Dark grayis brown (10YR4/2, dry) to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); slickensides, wedge-shaped aggregates; moderate fine and medium roots; many fine pores; moderate effervescence; abrupt smooth boundary;
50 - 100	Very dark grayish brown (10YR3/2, dry0 to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); many fine pores; weak effervescence; clear smooth boundary;
100 - 150	Dark brown (10YR4/3, dry) to very dark brown (10YR2/2, moist); clay; strong fine subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); common fine pores; weak effervescence.

Profile No.	:	(9)
Location	:	Al-Satamony, Bilqas. El-Dakahlia Governorate
Elevation	:	1.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with sugar beet
Water table	:	at 100 cm

Depth (cm)	Description
0 - 25	Dark grayish brown (10YR4/2, dry) to dark brown (10YR3/3, moist); clay; massive; very sticky and very plastic wet; friable (moist), very hard (dry); many fine pores; common fine and medium roots; few fine and medium earth worm castings; moderate effervescence; clear somooth boundary;
25 - 50	Dark yellowish brown (10YR4/4, dry) to very dark brown (10YR2/2, moist); clay; moderate medium subangular blocky; sticky and plastic wet; friable (moist), hard (dry); slickensides, wedge-shaped aggregates; many fine pores; few fine roots; moderate effervescence; clear smooth boundary;
50 - 100	Brown (10YR4/3, dry) to dark brown (10YR3/3, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); slickensides, wedge-shaped aggregates; many fine pores; weak effervescence.

Profile No.	:	(10)
Location	:	Al-Shawami, Bilqas, El-Dakahlia Governorate
Elevation	:	1.7 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with clover
Water table	:	Deeper than 150 cm

Depth (cm)	Description
0 - 25	Dark yellowish brown (10YR3/4, dry) to dark brown (10YR3/3, moist); clay; massive; very sticky adn very plastic wet; friable (moist), hard (dry); many fine pores; common fine and medium roots; moderate effervescence; clear smooth boundary;
25 - 50	Brown (10YR4/3, dry0 to dark brown (10YR3/3, moist); clay; moderate medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); slickensides, wedge-shaped aggregates; many fine pores; few fine roots; weak effervescence; clear smooth boundary;
50 - 100	Brown (10YR4/3, dry) to dark brown (10YR3/3, moist); clay; moderate medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); slickensides, wedge-shaped aggregates; many fine pores; wak effervescence; clear smooth boundary;
100 - 150	Dark yellowish brown (10YR4/6, dry) to very dark grayish brown (10YR3/2, moist); clay; weak fine subangular blocky; slightly sticky and slightly plastic wet; friable (moist), slightly hard (dry); many fine to medium pores; weak effervescence.

Profile No.	:	(14)
Location	:	Al-Khashaa, El-Hamoul, Kafr El-Sheikh Governorate
Elevation	:	1.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with sugar beet
Water table	:	at 100 cm

Depth (cm)	Description
0 - 25	Dark brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; massive; very sticky and very plastic; slightly friable, very hard; cracks 1.5 cm wide; many fine pores; common fine and medium roots; strong effervescence; diffuse smooth boundary;
25 - 50	Dark brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic; slightly friable, extremely hard; many fine pores; few fine roots; medium effervescence; diffuse smooth boundary;
50 - 100	Dark yellowish brown (10YR4/4, dry) to very dark grayish brown (10YR3/2, moist); clay; strong medium subangular blocky; very sticky and very plastic; slightly friable, very hard; many fine pores; few fine shells; weak effervescence.

Profile No. : (15)
Location : Ezbet Italia, El-hamoul, Kafr El-Sheikh Governorate
Elevation : 1.2 m.a.s.l.
Topography : Almost flat
Slope : Nearly level
Land use : Cultivated with clover
Water table : at 130 cm

Depth (cm)	Description
0 - 25	Brown (10YR4/3, dry) to dark yellowish brown (10YR3/4, moist); clay; massive; very sticky and very plastic; slightly friable, very hard; cracks 2 cm wide; many fine continous pores; many fine and medium roots; weak effervescence; diffuse smooth boundary;
25 - 50	Brown (10YR4/3, dry0 to very dark grayish brown (10YR3/2, moist); clay; moderate medium subangular blocky; very sticky and very plastic; slightly friable, very hard; slickensides, wedge-shaped aggregates; many fine pores; few fine roots; few fine and medium earth worm castings; weak effervescence; gradual wavy boundary;
50 - 80	Brown (10YR4/3, dry) to very drak grayish brown (10YR3/2, moist); clay; strong medium subangular blocky; very sticky and very plastic; slighatly friable, very hard; slickensides, wedge-shaped aggregates; many fine pores; weak effervescence; clear smooth boundary;
80 - 130	Brown (10YR4/3, dry) to dark brown (10YR3/3, moist); clay; strong medium subangular blocky; very sticky and very plastic; slightly friable, very hard; many fine pores; weak effervescence.

Profile No. : (17)

Location : El-Hamoul, Kafr El-Sheikh Governorate

Elevation : 1.2 m.a.s.l.

Topography : Almost flat

Slope : Nearly level

Land use : Cultivated with clover

Water table : at 100 cm

Depth (cm)	Description
0 - 25	Dark brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; massive; sticky and plastic wet; friable (moist), hard (dry); cracks 3 cm wide; many fine pores; many fine and medium roots; few fine earth worm castings; moderate effervescence; gradual wavy boundary;
25 - 50	Dark yellowish barown (10YR4/4, dry) to very dark grayish brown (10YR3/2, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard 9dry); slickensides, wedge-shaped aggregates; many fine pores; few fine roots; weak effervescence; gradual smooth boundary;
50 - 100	Brown (10YR4/3, dry0 to very dark grayish brown (10YR3/2, moist); clay; moderate medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); slickensides, wedge-shaped aggregates; many fine pores; weak effervescence.

Profile No.	:	(20)
Location	:	Dimro swamps, Sidi Salim, Kafr El-Sheikh Governorate
Elevation	:	0.3 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Fish farms
Water table	:	at 50 cm

Depth (cm)	Description
0 - 25	Yellowish brown (10YR5/4, dry) to dark yellowish brown (10YR3/4, moist); clay; moderate medium subangular blocky; sticky and plastic; slightly friable, hard; many fine and medium pres; moderate fine shells; strong effervescence; gradual wavy boundary;
25 - 50	Dark yellowish brown (10YR4/4, dry) to very dark grayish brown (10YR3/2, moist); clay; moderate medium subangular blocky; sticky and plastic; slightly friable, hard; many fine pores, moderate fine shells; strong effervescence.

Profile No. : (21)

Location : El-Haddadi, Sidi Salim, Kafr El-Sheikh Governorate

Elevation : 0.8 m.a.s.l.

Topography : Almost flat

Slope : Nearly level

Land use : Cultivated with clover

Water table : at 75 cm

Depth (cm)	Description
0 - 30	Brown (10YR5/3, dry) to very dark brown (10YR2/2, moist); clay; weak coarse angular blocky; very sticky and very plastic; friable; very hard; cracks 3 cm wide; many finepores; common fine and medium roots; strong effervescence; gradual wavy boundary;
30 - 75	Dark yellowish brown (10YR3/2, dry) to very dark grayish brown (10YR3/2, moist); clay; moderate medium subangular blocky; very sticky and very plastic; friable, very hard; slickensides wedge-shaped aggregates; many fine pores; few fine roots; strong effervescence.

Profile No.	:	(22)
Location	:	Ezbet Faddan el-Feki, Sidi Salim, Kafr El-Sheikh Governorate
Elevation	:	1.5 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with sugar beet
Water table	:	Deeper than 150 cm

Depth (cm)	Description
0 - 25	Brown (10YR4/3, dry) to very dark brown (10YR2/2, moist); clay; massive; sticky and plastic; friable, hard; many fine pores; common fine and medium roots; moderate effervescence; gradual wavy boundary;
25 - 50	Brown (10YR5/3, dry) to brown (10YR4/3, moist); clay; moderate medium subangular blocky; sticks and plastic; friable, hard; slickensides, wedge-shaped aggregates; many fine pores; few fine roots; few fine and medium earth worm castings; moderate effervescence; clear smooth boundary;
50 - 100	Dark yelloish borwn (10YR4/4, dry) to very dark brown (10YR2/2, moist); clay loam; weak fine subangular blocky; slightly sticky and slightly plastic; friable, slightly hard; many fine to medium pores; weak effervescence; gradual wavy boundary;
100 - 150	Brown (10YR4/3, dry) to very dark grayish brown (10YR3/2, moist); clay loam; weak fine subangular blocky; slightly sticky and slightly plastic; friable, hard; many fine to medium pores; weak effervescence.

Profile No.	:	(26)
Location	:	Koam Dimees, Mutubas, Kafr El-Sheikh Governorate
Elevation	:	1.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly flat
Land use	:	Cultivated with sugar beet
Water table	:	Deeper than 150 cm

Depth (cm)	Description
0 - 25	Dark yellowish brown (10YR4/4, dry) to very dark grayish brown (10YR3/2, moist); clay; massive; very sticky and very plastic; slightly friable, very hard; cracks 2 cm wide; many fine to medium roots; many fine pores; strong effervescence; clear smooth boundary;
25 - 50	Dark brown (10YR3/3, dry0 to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic; slsightly friable, very hard; many fine pores; few fine roots; medium effervescence; gradual wavy boundary;
50 - 100	Dark yellowish brown (10YR4/4, dry) to dark brown (10YR3/3, moist); clay; strong medium subangular blocky; very sticky and very plastic; slightly friable, very hard; many fine pores; strong effervescence; gradual smooth boundary;
100 - 150	Dark yellowish brown (10YR4/4, dry) to dark brown (10YR3/3, moist); few fine dark gray (7.5YR4/0) diffuse mottles; clay; strong medium subangular blocky; very sticky and very plastic; slightly friable, very hard; many fine pores; moderate effervescence.

Profile No. : (27)
Location : Beni Bakkar, Mutubas, Kafr El-Sheikh Governorate
Elevation : 0.8 m.a.s.l.
Topography : Almost flat
Slope : Nearly level
Land use : Cultivated with sugar beet
Water table : at 100 cm

Depth (cm)	Description
0 - 30	Brown (10YR4/3, dry) to dark yellowish brown (10YR3/4, moist); clay; massive; very sticky and very plastic; slightly friable, very hard; many fine pores; many fine and medium roots; moderate effervescence; gradual wavy boundary;
30 - 60	Brown (10YR4/3, dry) to dark yellowish brown (10YR3/4, moist); clay; moderate medium subangular blocky; very sticky and very plastic; friable, very hard; slickensides, wedge-shaped aggregates; many fine pores; few fine roots; moderate effervescence; gradual smooth boundary;
60 - 100	Dark yellowish brown (10YR4/4, dry) to dark brown (10YR3/3, moist); few fine dark gray (7.5YR4/0) diffuse mottles; clayl; moderate medium subangular blocky; very sticky and very plastic; friable, very hard; slickensides, wedge-shaped aggregates; many fine pores; weak effervescence.

Profile No.	:	(28)
Location	:	Abou Ghnima, Sidi Salim, Kafr El-Sheikh Governorate
Elevation	:	1.8 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with clover
Water table	:	Deeper than 150 cm

Depth (cm)	Description
0 - 25	Dark yellowish brown (10YR3/4, dry) to very dark grayish brown (10YR3/2, moist); clay; massive; very sticky and very plastic; slightly friable, very hard; cracks 3 cm wide; many fine pores; many fine to medium roots; moderate effervescence; gradual wavy boundary;
25 - 50	Brown (10YR4/3, dry) to very dark grayish brown (10YR3/2, moist); clay; moderate medium subangular blocky; very sticky and very plastic; slightly friable, very hard; slickensides, wedge-shaped aggregates; many fine pores; few fine roots; moderate effervescence; gradual wavy boundary;
50 - 100	Dark yellowish brown (10YR4/4, dry) to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic; slightly friable, very hard; slickensides, wedge-shaped aggregates; many fine pores; weak effervescence, gradual wavy boundary;
100 - 150	Brown (10YR4/3, dry) to dark grayish brown (10YR4/2, moist); clay; moderate medium subangular blocky; very sticky and very plastic; slightly friable, very hard; many fine pores; weak effervescence.

4.1.3. Recent Nile alluvial deposits:

Recent Nile alluvial deposits occupy the southern parts of the studied area, where deposits were formed since ten thousands years ago during the annual Nile flooding.

Topography of this unit is almost flat. The depth of water table flaculates between 100 and more than 150 cm. In dry conditions, soil colours are yellowish brown (10YR5/6) to very dark grayish brown (10YR3/2), while in the moist ones, they are dark yellowish brown (10YR4/6) to very dark brown (10YR2/2). Soil texture varies from clay or clay loam in the surface to clay loam or sandy clay loam in the deeper layers. Soil structure generally changes from massive to strong medium subangular blocky. Soil consistency is slightly hard to very hard in the dry state; slightly firm to very firm in the moist one; and slightly sticky to very sticky and slightly plstic to very plastic under wet conditions.

The soils of this unit are represented by profiles Nos 5, 11, 18, 23, 24, 29, 30 and 31. These representative profiles are morphologically described as given hereafter:

Profile No.	:	(5)
Location	:	Shirbin, El-Dakahlia Governorate
Elevation	:	2.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with clover
Water table	:	Deeper than 150 cm

Depth (cm)	Description
0 - 25	Very dark grayish brown (10YR3/2, dry) to very dark brown (10YR2/1, moist); clay; massive; very sticky and very plastic wet; friable (moist), hard (dry); many fine and medium roots; many fine pores; moderate effervescence; clear smooth boundary;
25 - 50	Dark brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); slickensides, wedge-shaped aggregates; moderate fine and medium roots; many fine pores; moderate effervescence; clear smooth boundary;
50 - 100	Dark brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; sticky and plastic wet; friable (moist), hard 9dry); slickensides, wedge-shaped aggregates; common fine pores; few fine roots; moderate effervescence; clear smooth boundary;
100 - 150	Very dark grayish brown (10YR3/2, dry) to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); common fine pores; weak effervescence.

Profile No.	:	(11)
Location	:	Bilqas, Dakahlia Governorate
Elevation	:	2.5 m.a.s.l
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with clover
Water table	:	Deeper than 150 cm

Depth (cm)	Description
0 - 25	Brown (10YR4/3, dry) to very dark grayish brown (10YR3/2, moist); clay loam; massive; slightly sticky and slightly plastic wet; firm (moist), slightly hard (dry); many fine to medium continous pores; many fine and medium roots; moderate effervescence; clear smooth boundary;
25 - 50	Dark yellowish brown (10YR4/4, dry) to very dark grayish brown (10YR3/2, moist); clay loam; weak fine subangular blocky; slightly sticky and slightly plastic wet; firm (moist), slightly hard (dry); many fine to medium continous pores; few fine to medium roots; moderate effervescence;, clear smooth boundary;
50 - 100	Darik yellowish brown (10YR4/4, dry) to very dark grayish brown (10YR3/2, moist); silty clay loam; weak fine subangular blocky; sticky and plastic wet; firm (moist), hard (dry); many fine continous pores; weak efferescence; clear smooth boundary;
100 - 150	Dark yellowish brown (10YR4/4, dry) to dark brown (10YR3/3, moist); silty clay loam; moderate medium subangular blocky; sticky and plastic wet; firm (moist), hard dry; many fine continous pores; weak effervescence.

Profile No. : (18)

Location : El-Koom El-Taweel, Kafr El-Sheikh Governorate

Elevation : 2.0 m.a.s.l.

Topography : Almost flat

Slope : Nearly level

Land use : Cultivated with clover

Water table : at 100 cm

Depth (cm)	Description
0 - 30	Brown (10YR4/2, dry) to dark brown (10YR3/3, moist); silty clay; massive; sticky and plastic; slightly friable, very hard; many fine pores; many fine to medium roots; moderate effervescence; clear smooth boundary;
30 - 60	Dark grayish brown (10YR4/2, dry0 to very dark grayish brown (10YR3/2, moist); clay loam; weak fine subangular blocky; slightly sticky and slightly plastic; slighatly friable. slightly hard; many fine to medium pores, few fine roots; weak effervescence; clear smooth boundary;
60 - 100	Yellowish brown (10YR5/6, dry) to dark yellowish brown (10YR4/6, moist); sandy clay loam; weak fine subangular blocky; slightly sticky and slightly plastic; slightly friable, slightly hard; common fine pores; weak effervescence.

Profile No. : (23)

Location : Minshat Abbas, Sidi Salim, Kafr El-Sheikh Governorate

Elevation : 1.5 m.a.s.l.

Topography : Almost flat

Slope : Nearly level

Land use : Cultivated with clover

Water table : at 100 cm

Depth (cm)	Description
0 - 30	Brown (10YR4/2, dry) to dark brown (10YR3/3, moist); clay; massive; very sticky and very plastic wet; firm (moist), hard (dry); many fine continous pores; many fine and medium roots; weak effervescence; clear smooth boundary;
30 - 60	Dark grayish brown (10YR4/2, dry) to very dark grayish brown (10YR3/2, moist); clay loam; weak fine subangular blocky; slightly sticky and slightly plastic wet; firm (moist), slightly hard (dry); many fine to medium continous pores; few fine and medium worms; weak eefervescence; gradual wavy boundary;
60 - 100	Dark grayish brown (10YR4/2, dry) to very dark grayish brown (10YR3/2, moist); clay loam; weak fine subangular blocky; slightly sticky and slightly plastic wet; firm (moist), slightly hard (dry); many fine to medium continous pores; weak effervescence.

Profile No.	:	(24)
Location	:	Shalma, Sidi Salim. Kafr El-Sheikh Governorate
Elevation	:	2.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	uncultivated (after rice)
Water table	:	at 100 cm

Depth (cm)	Description
0 - 25	Very dark grayish brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; massive; very sticky and very plastic wet; friable (moist), very hard (dry); many fine pores; many fine and medium roots; weak effervescence; gradual wavy boundary;
25 - 50	Dark brown (10YR3/3, dry) to very dark brown (10YR2/2, moist); clay; moderate medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); slickensides, wedge-shaped aggregates; many fine pores; few fine roots; weak effervescence; gradual wavy boundary;
50 - 100	Brown (10YR4/3, dry) to very dark brown (10YR2/2, moist); clay; strong medium subangular blocky; very sticky and very plastic wet; friable (moist), very hard (dry); slickensides, wedge-shaped aggregates; many fine pores; weak effervescence.

Profile No.	:	(29)
Location	:	Shabas Al-Malh, Disuq, Kafr El-Sheikh Governorate
Elevation	:	2.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with clover
Water table	:	at 110 cm

Depth (cm)	Description
0 - 25	Brown (10YR4/2, dry) to very dark grayish brown (10YR3/2, moist); silty clay; massive; sticky and plastic wet; firm (moist), hard (dry); many fine continous pores; many fine to medium roots; few fine to medium worms; moderate effervescence; clear smooth boundary;
25 - 75	Dark brown (10YR3/3, dry) to very dark grayish brown (10YR3/2, moist); clay loam; weak fine subangular blocky; slightly sticky and slightly plastic wet; firm (moist), slightly hard (dry); many fine to medium continous pores; few fine roots; few fine to medium warms; weak effervescence; clear smooth boundary;
75 - 110	Dark yellowish brown (10YR4/4, dry0 to very dark grayish brown (10YR3/2, moist); sandy clay loam; weak fine granular; slightly sticky and slightly plastic wet; slightly firm (moist), slightly hard (dry); common fine pores; weak effervescence.

Profile No.	:	(30)
Location	:	Al-Dahria, Shirbin, El-Dakahlia Governorate
Elevation	:	2.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with clover
Water table	:	at 130 cm

Depth (cm)	Description
0 - 40	Dark grayish brown (10YR4/2, dry) to very dark grayish brown (10YR3/2, moist); clay loam; weak fine granular; slightly sticky and slightly plastic wet; friable (moist), hard (dry); many fine to medium pores; many fine to medium roots; weak effervescence; gradual wavy boundary;
40 - 80	Dark grayish brown (10YR4/2, dry) to very dark grayish brown (10YR3/2, moist); clay loam; moderate fine subangular blocky; sticky and plastic wet; friable (moist), slightly hard (dry); many fine to medium pores; few fine roots; weak effervescence; clear smooth boundary;
80 - 130	Yellowish brown (10YR5/6, dry) to dark yellowish brown (10YR4/6, moist); sandy clay loam; weak fine subangular blocky; sticky and plastic wet; very friable (moist), slightly hard (dry); common fine pores; weak effervescence.

Profile No.	:	(31)
Location	:	Sendion, Fuwa, Kafr El-Sheikh Governorate
Elevation	:	2.0 m.a.s.l.
Topography	:	Almost flat
Slope	:	Nearly level
Land use	:	Cultivated with tomatoes
Water table	:	at 120 cm

Depth (cm)	Description
0 - 35	Dark grayish brown (10YR4/4, dry) to very dark grayish brown (10YR3/2, moist); clay loam; weak fine granular; slightly sticky and slightly plastic wet; slightly firm (moist), hard (dry); many fine to medium continous pores; many fine to medium roots; weak effervescence; clear smooth boundary;
35 - 80	Yellowish brown (10YR5/4, dry) to dark yellowish brown (10YR3/4, moist); sandy clay loam; weak fine subangular blocky; slightly sticky and slightly plastic wet; firm (moist), slightly hard (dry); common fine continous pores; few fine roots;f weak effervescence; gradual wavy boundary;
80 - 120	Yellowish brown (10YR5/6, dry) to dark yellowidh brown (10YR4/6, moist); sand clay loam; weak fine subangular blocky; slightly sticky and slightly plastic wet; slightly firm (moist), slightly hard (dry); common fine pores; weak effervescence.

4.2. Soil physical properties:

4.2.1. Particle size distribution:

The results of particle size distribution and texture class of the studied soil profiels are given in Tables (8, 9) and graphically illustrated in Fig (1). Data of these tables show that the different geomorphic units vary in their textural classes. Clay content ranges from 1.20 to 9.75, 35.02 to 64.33 and 21.43 to 59.03% with the averages of 3.64, 53.35 and 39.48% in the coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The obtained results indicate generally that soils of fluvio marine deposits have the highest clay coantent, while the soils of coastal barrier plains and beaches have the lowest clay content.

Silt content varies from 1.38 to 7.45, 23.26 to 43.02 and 12.15% to 54.54 with the averages of 3.59, 32.84 and 31.34% in the coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. Fluvio marine deposits have relatively higher amounts of silt than the Nile alluvial deposits. On the other hand, soils of the coastal barrier plains and beaches have the lowest amounts of silt. No clear trend is observed in silt distribution among the different layers of the soil profiles, as it decreases downwards in some profiles and increases with depth in the others.

As for sand fraction, the results indicate that it varies widely from 82.80 to 97.25, 4.46 to 30.78 and 10.82 to 64.72% with the averages of 92.86, 13.03 and 28.68% in the coastal barrier plains and beaches, fluvio marine deposits and

Table (8) : Particle size distribution , texture class , $CaCO_3$, O.M, and gypsum contents of the soil profiles represnting the studied geomorphic units.

Geom. unit	Prof. No.	Depth (cm)	Sand Coarse %	Sand Fine %	Silt %	Clay %	Texture Class	$CaCO_3$ %	O.M %	Gypsum %
Coastal barrier plains and beaches	1	0-25	20..55	65.60	4.35	8.70	Loamy sand	0.42	0.29	3.65
		25-50	24.90	67.55	2.23	5.22	Sand	0.34	0.23	2.32
		50-70	24.80	65.70	2.77	7.52	Sand	0.46	0.20	1.44
	2	0-30	11.85	76.10	4.07	7.38	Loamy sand	0.25	0.72	0.34
		30-60	14.70	77.60	2.00	3.05	Sand	0.59	0.20	0.11
		60-80	15.10	78.15	2.58	3.97	Sand	0.17	0.06	0.52
	6	0-30	29.82	58.90	6.40	4.88	Sand	0.39	0.17	1.07
		30-65	22.65	70.34	4.23	2.78	Sand	0.45	0.08	0.65
	7	0-30	22.45	74.15	2.19	1.21	Sand	0.25	0.09	0.97
		30-60	19.30	77.95	1.38	1.37	Sand	0.25	0.06	0.83
		60-100	18.60	77.65	1.95	1.8	Sand	0.42	0.06	1.05
		100-130	19.70	76.40	2.10	1.8	Sand	0.08	0.6	1.68
	8	0-30	3.30	79.50	7.45	9.75	Loamy sand	0.17	0.14	0.25
		30-60	3.90	88.35	5.67	2.08	Sand	0.25	0.08	0.25
		60-100	3.85	85.73	6.83	3.64	Sand	0.42	0.29	0.79
	12	0-20	43.20	50.50	3.84	2.46	Sand	0.25	0.17	0.83
		20-50	50.45	46.95	1.40	1.20	Sand	0.50	0.12	0.67
		50-70	38.70	56.50	2.86	1.84	Sand	0.84	0.14	1.25
	13	0-25	24.65	68.90	4.34	2.11	Sand	0.42	0.65	0.12
		25-50	31.45	65.45	1.52	1.58	Sand	0.25	0.12	0.24
		50-70	26.00	70.70	2.01	1.29	Sand	0.10	0.08	0.26
	19	0-30	16.61	76.09	4.55	2.75	Sand	0.6	0.17	0.27
		30-60	17.80	76.30	3.72	2.18	Sand	0.22	0.10	0.32
	25	0-20	3.05	90.35	3.37	3.23	Sand	0.42	0.36	0.83
		20-50	3.90	91.05	2.45	2.60	Sand	0.25	0.41	0.97
		50-75	1.95	87.75	3.05	7.25	Sand	0.17	0.26	1.65

Table (8) : Cont.

Geom. unit	Prof. No.	Depth (cm)	Sand Coarse %	Sand Fine %	Silt %	Clay %	Texture Class	$CaCO_3$ %	O.M %	Gypsum %
Fluvio marine deposits	3	0-25	1.85	3.45	30.85	59.10	Clay	1.76	2.40	0.35
		25-50	0.65	4.68	37.14	57.27	Clay	0.67	0.78	0.41
		50-100	0.55	6.22	33.39	59.38	Clay	0.25	0.72	0.56
		100-150	0.50	3.96	33.16	62.19	Clay	0.17	0.98	0.45
	4	0-25	2.45	6.69	30.79	58.10	Clay	2.52	1.97	0.11
		25-50	0.85	8.92	28.80	61.43	Clay	1.93	0.78	00.25
		50-100	0.75	9.22	27.33	62.68	Clay	0.42	0.72	0.17
		100-150	0.30	12.11	23.26	64.33	Clay	0.17	0.75	0.43
	9	0-25	1.25	10.99	36.78	50.68	Clay	0.92	1.94	0.17
		25-50	0.10	16.33	34.12	49.25	Clay	0.59	1.16	0.21
		50-100	0.10	21.77	31.46	46.17	Clay	0.50	0.67	0.35
	10	0-25	0.85	12.67	39.18	47.77	Clay	0.67	2.04	0.18
		25-50	0.20	10.10	37.62	50.03	Clay	0.42	1.22	0.18
		50-100	0.15	11.05	35.65	53.65	Clay	0.50	0.94	0.16
		100-150	0.10	22.08	33.43	44.70	Clay	0.50	0.71	0.25
	14	0-25	0.50	5.39	33.25	57.75	Clay	5.01	1.36	0.76
		25-50	0.10	5.33	36.87	57.80	Clay	2.25	0.84	0.93
		50-100	0.20	12.72	33.99	54.23	Clay	1.17	0.85	1.05
	15	0-25	0.25	11.74	36.62	51.88	Clay	0.50	2.29	0.77
		25-50	0.15	10.02	43.02	47.13	Silty Clay	0.50	1.04	0.63
		50-80	0.15	6.05	36.32	57.98	Clay	0.50	0.87	0.85
		80-130	0.15	12.64	32.17	54.48	Clay	0.67	1.06	0.89
	16	0-30	0.10	16.60	25.94	57.36	Clay	1.20	2.10	0.35
		30-60	0.07	19.16	22.72	58.05	Clay	0.50	0.95	0.22
		60-100	0.07	12.27	24.90	62.76	Clay	0.35	0.83	0.47
	17	0-25	0.60	11.57	38.03	50.02	Clay	1.01	2.00	0.40
		25-50	0.25	9.79	35.36	54.92	Clay	0.17	1.00	0.40
		50-95	0.15	7.97	33.20	58.90	Clay	0.34	0.87	0.62

Table (8) : Cont.

Geom. unit	Prof. No.	Depth (cm)	Sand Coarse %	Sand Fine %	Silt %	Clay %	Texture Class	$CaCO_3$ %	O.M %	Gypsum %
Fluvio-marine deposits	20	0-25	0.70	19.97	32.78	44.72	Caly	8.38	1.39	0.29
		25-50	0.55	24.40	31.83	43.15	Clay	7.14	1.12	0.85
	21	0-30	0.40	6.54	32.75	55.53	Clay	5.26	2.13	0.75
		30-75	0.15	7.97	38.57	53.73	Clay	4.05	1.00	0.92
	22	0-25	2.40	20.73	31.78	44.88	Clay	2.42	1.33	0.75
		25-50	1.10	21.01	33.99	42.92	Clay	2.10	0.68	0.75
		50-100	1.90	28.72	32.82	36.78	Clay Loam	0.97	0.55	135
		100-150	1.25	29.53	33.87	35.02	Clay Loam	0.85	0.84	2.09
	26	0-25	0.10	17.53	26.62	51.83	Clay	5.26	1.10	0.73
		25-50	0.10	15.32	30.17	51.43	Clay	3.59	0.80	0.85
		50-100	0.10	6.98	35.55	53.23	Clay	4.42	0.74	1.00
		100-150	0.38	13.21	34.42	51.63	Clay	2.08	0.87	1.49
	27	0-30	0.15	11.72	31.75	56.38	Clay	0.99	1.97	0.65
		30-60	0.57	13.15	31.17	55.11	Clay	0.87	0.89	0.53
		60-100	0.84	16.50	28.07	54.59	Clay	0.35	0.60	0.88
	28	0-25	0.15	9.02	35.18	52.70	Clay	1.26	1.42	0.11
		25-50	0.15	8.05	35.75	53.93	Clay	1.76	0.83	0.37
		50-100	0.15	8.24	34.20	57.10	Clay	0.42	0.59	0.25
		100-150	0.20	11.66	24.98	62.60	Clay	0.25	0.64	0.97
Recent Nile alluvial deposits	5	0-25	1.80	11.17	30.47	57.42	Clay	2.35	2.66	0.22
		25-50	0.95	9.87	30.69	57.75	Clay	2.77	1.04	0.24
		50-100	2.95	16.99	30.84	49.58	Clay	2.94	0.81	0.15
		100-150	0.45	11.39	29.13	59.03	Clay	1.76	0.78	0.12
	11	0-25	0.65	23.68	36.45	36.08	Clay Loam	1.43	2.29	0.18
		25-50	0.20	20.40	48.32	28.45	Clay Loam	1.35	1.01	0.17
		50-100	0.10	11.14	54.54	33.73	Si.Clay Loam	1.00	0.96	0.25
		100-150	0.20	16.89	45.62	37.55	SiClay Loam	0.25	0.97	0.32

Table (8) : Cont.

Geom. unit	Prof. No.	Depth (cm)	Sand		Silt %	Clay %	Texture Class	$CaCO_3$ %	O.M %	Gypsum %
			Coarse %	Fine %						
Recent Nile alluvial deposits	18	0-30	1.25	17.05	39.47	42.23	Silty Clay	1.07	2.00	0.33
		30-60	2.87	30.29	31.83	35.01	Clay Loam	0.45	0.95	0.25
		60-90	6.15	58.57	12.15	22.93	S. Clay Loam	0.32	0.56	0.52
	23	0-30	0.10	18.08	36.22	45.60	Clay	0.77	2.05	0.16
		30-60	0.12	25.92	35.39	38.21	Clay Loam	0.65	0.87	0.11
		60-100	0.08	31.20	32.94	35.78	Clay Loam	0.22	0.62	0.11
	24	0-25	0.80	18.74	24.28	54.75	Clay	0.92	2.49	0.17
		25-50	0.23	18.56	27.03	53.64	Clay	0.53	1.05	0.25
		50-100	0.15	15.56	25.95	58.45	Clay	0.34	0.58	0.31
	29	0-25	0.70	19.56	35.27	40.68	Silty Clay	2.10	2.17	0.22
		25-75	0.90	29.78	33.95	35.21	Clay Loam	0.55	0.62	0.22
		75-110	1.10	54.00	22.20	21.43	S. Clay Loam	1.26	0.10	0.15
	30	0-40	3.05	27.08	32.75	37.12	Clay Loam	0.35	1.85	0.21
		40-80	3.79	26.34	34.15	35.72	Clay Loam	0.35	1.05	0.12
		80-130	7.20	45.82	19.83	27.15	S. Clay Loam	0.27	0.43	0.09
	31	0-35	2.51	30.57	30.17	36.75	Clay Loam	0.42	1.92	0.18
		35-80	6.95	38.64	22.23	32.18	S. Clay Loam	0.25	1.00	0.15
		80-120	7.31	40.92	20.10	31.67	S. Clay Loam	0.22	0.67	0.15

Table (9) : Minimum , maximum and average values of particle size distribution, $CaCO_3$, organic matter and gypsum of the studied geomorphic uints

Geom. unit / Soil Constituents	Coastal barrier plains and beaches			Fluvio- marine deposits			Recent Nile alluvial deposits		
	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.
Coarse sand %	1.95	50.45	19.88	0.07	16.50	0.50	0.08	7.31	2.11
Fine sand %	46.95	91.05	72.98	3.45	29.53	12.43	9.87	58.57	26.57
Silt %	1.38	7.45	3.59	23.26	43.02	32.84	12.15	54.54	31.34
Clay %	1.20	9.75	3.64	35.02	64.33	53.35	21.43	59.03	39.48
CaCO3 %	0.08	0.84	0.34	0.17	8.38	1.67	0.22	2.94	0.89
Organic matter %	0.06	0.72	0.20	0.55	2.40	1.16	0.10	2.66	1.20
Gypsum %	0.11	3.65	0.90	0.11	2.09	0.60	0.09	0.52	0.20

Min. = Mimimum

Max.= Maximum

Ave.= Average

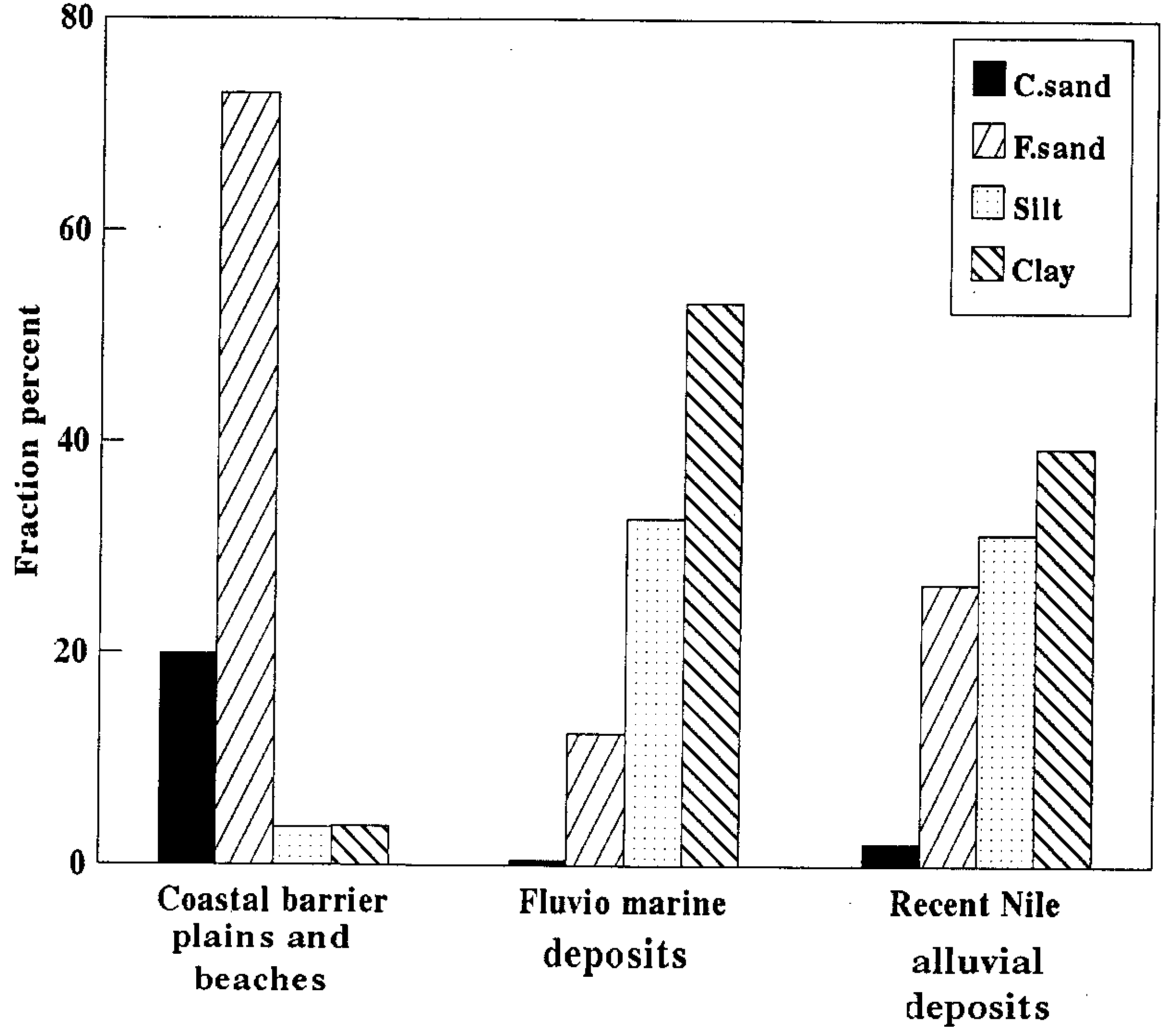


Fig. (1): The average percentages distribution of coarse sand, fine sand, silt and clay in the studied geomorphic units.

recent Nile alluvial deposits, respectively. The highest sand content is found in the coastal barrier plains and beaches because these soils are aeolian deposits and beaches. On the other hand, the fluvio marine deposits have the lowest sand content, while the recent Nile alluvial deposits come in between. The fine sand fraction is dominating in all the studied geomorphic units.

4.2.2. Calcium carbonate:

Data presented in Tables (8 & 9) reveal a rather wide variation in $CaCO_3$ content among the studied soil profiles as it coveres the range of 0.08 - 8.38%. The lower values are associated with the soils of coastal barrier plains and beaches (0.08 - 0.84%) while the higher ones are found in the soils of fluvio marine deposits (0.17 - 8.38), as these soils were formed from admixing materials from Burullus lake and Nile alluvium (El-Nahal et al, 1977). Calcium carbonate content in the soils of recent Nile alluvial deposits covers the range of 0.22 - 2.94%. As for the vertical distribution of $CaCO_3$ throughout the entire depth of the different soil profiles, the obtained data show a general increase in this component when soil surface is approached in the soils of both fluvio marine and recent Nile alluvial deposits. No clear trend is observed for $CaCO_3$ content in the soils of coastal barrier plains and beaches, as it decreases downwards in some profiles whereas it increases in the others.

4.2.3. organic matter:

Data of organic matter content in the investigated soil profiles are presented in Tables (8 & 9). It is obvious that all the studied soils exhibit low content of organic matter (ranging from 0.06 to 2.66%). This is a natural characteristic of the soils in semi arid regions, since the high temperature and dry climate encourage the decomposition of organic matter. A unique distribution pattern of organic matter with depth is attained for all soil profiles. In this pattern, organic matter content tends to be high in the uppermost layer and low in the deeper ones. This pattern of organic matter distribution is most probably related to the return of some plant residues to the surface layers.

4.2.4. Gypsum content:

Data in Tables (8 & 9) indicate that gypsum content ranges between 0.09 and 3.65% with averages of 0.90, 0.60 and 0.20% in coastal barrier plains and beaches, fluvio marine and recent nile alluvial deposits, respectively. The soils of coastal barrier plains and beaches have relatively higher gypsum content than the other two geomorphic units. Gypsum content distribution among the different layers of the soil profiles appears no a clear trend, as it decreases downwards in some profiles while it increases in the others.

According to Sys (1982), gypsum in these soils may precipitated from the high water table rich in Ca^{++} and $SO_4^{=}$ ions, or from the upward movement of ground water rich in Na_2SO_4.

4.2.5. Bulk density:

Bulk density is an important parameter to evaluate soil structure and accordingly some other associated physical properties such as total porosity and void ratio. It is affected generally by the origin, composition of the soil, and management practices.

For the soils under study, it is obvious that the values of bulk density vary generally between 1.14 and 1.78 g/cm^3 (Tables 10 & 11). The distribution of bulk density values in the three geomorphic units shows that they are high in the soils of coastal barrier plains and beaches, low in fluvio marine deposits and lowest in the recent Nile alluvial deposits.

The obtained results show that the values of bulk density range from 1.67 to 1.78, 1.14 to 1.51 and 1.20 to 1.60 with the averages of 1.73, 1.27 and 1.35 g/cm^3 in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively.

To study the relationship between bulk density and soil constituents, the correlation coefficients were calculated, (Table, 12). The increases in clay or clay plus silt contents reduces the bulk density in all the studied geomorphic units. On the other hand, the increase in organic matter content was accompanied by significant reduction in bulk density in both the fluvio marine deposits and the recent Nile alluvial deposits. Statistical analysis reveal also that the increase in sand fraction causes a significant increase in bulk density in all geomorphic units, while the increase in $CaCO_3$ content causes a significant decrease in bulk density in the soils of recent Nile alluvial deposits.

Table (10): Some soil physical properties of the soil profiles representing the studied geomorphic units.

Geom. unit	Prof. No.	Depth cm	Particle density g/cm³	Bulk density g/cm³	Total porosity %	Hydraulic conductivity (cm/hr)	Soil moisture content %		Available Water %
							Field capacity	Wilting point	
Coastal barrier plains and beaches	1	0 - 25	2.63	1.67	36.50	15.568	11.72	6.29	5.43
		25 - 50	2.64	1.69	35.98	14.720	7.29	3.99	3.30
		50 - 70	2.63	1.70	55.36	13.923	8.70	4.42	4.28
	2	0 - 30	2.68	1.71	36.19	17.135	11.67	6.55	5.12
		30 - 60	2.65	1.77	33.21	18.005	8.42	4.16	4.26
		60 - 80	2.69	1.77	34.20	18.854	8.23	4.72	3.51
	6	0 - 30	2.65	1.71	35.47	17.503	7.25	3.28	3.97
		30 - 65	2.64	1.74	34.09	17.125	6.17	3.35	2.92
	7	0 - 30	2.63	1.76	33.08	19.650	5.97	3.95	2.02
		30 - 60	2.64	1.77	32.95	19.203	6.14	3.99	2.15
		60 - 100	2.63	1.78	32.32	18.515	6.79	4.40	2.39
		100 - 150	2.65	1.78	32.83	17.325	7.17	4.75	2.42
	8	0 - 30	2.68	1.69	36.94	11.375	11.70	6.28	5.42
		30 - 60	2.65	1.75	33.96	15.514	8.12	4.29	3.83
		60 - 100	2.63	1.67	36.50	14.005	9.18	4.82	4.36
	12	0 - 20	2.65	1.71	35.47	19.960	7.65	4.35	3.30
		20 - 50	2.64	1.70	35.61	19.125	6.52	4.27	2.25
		50 - 70	2.68	1.74	35.07	18.743	6.87	4.22	2.65
	13	0 - 25	2.65	1.71	35.47	16.210	7.64	4.20	3.44
		25 - 50	2.64	1.72	34.85	15.935	7.20	4.31	2.89
		50 - 70	2.65	1.74	34.34	15.117	6.99	4.58	2.41
	19	0 - 30	2.65	1.67	36.98	17.255	8.15	4.65	3.50
		30 - 60	2.65	1.71	35.47	16.860	7.85	4.55	3.30
	25	0 - 20	2.63	1.75	33.46	13.214	8.94	4.85	4.09
		20 - 50	2.63	1.76	33.08	13.005	8.15	3.87	3.32
		50 - 75	2.65	1.78	32.83	11.930	8.19	4.12	4.79
Fluvio marine deposits	3	0 - 25	2.71	1.14	57.93	0.175	38.59	19.17	19.42
		25 - 50	2.70	1.31	51.48	0.136	38.05	19.82	18.23
		50 - 100	2.70	1.25	53.70	0.095	39.40	20.53	18.87
		100 - 150	2.72	1.23	54.78	0.041	41.02	22.57	18.45
	4	0 - 25	2.70	1.19	55.93	0.232	38.19	19.42	18.77
		25 - 50	2.71	1.25	53.87	0.186	39.58	20.95	18.63
		50 - 100	2.72	1.20	55.88	0.037	40.51	22.17	18.34
		100 - 150	2.74	1.20	56.20	0.025	40.95	22.55	18.70
	9	0 - 25	2.74	1.25	54.38	0.544	37.27	19.22	18.05
		25 - 50	2.72	1.37	49.63	0.218	36.02	19.00	17.02
		50 - 100	2.72	1.45	46.69	0.115	37.77	20.95	16.82
	10	0 - 25	2.73	1.29	52.75	0.412	36.68	18.87	18.01
		25 - 50	2.72	1.45	46.69	0.135	37.11	19.93	17.18
		50 - 100	2.72	1.47	45.96	0.117	36.50	19.91	16.59
		100 - 150	2.72	1.51	44.49	0.099	29.10	17.18	11.92

Table (10): cont.

Geom. unit	Prof. No.	Depth cm	Particle density g/cm^3	Bulk density g/cm^3	Total porosity %	Hydraulic conductivity (cm/hr)	Soil moisture content %		Available Water %
							Field capacity	Wilting point	
Fluvio marine deposits	14	0 - 25	2.72	1.14	58.09	0.232	40.51	20.09	20.42
		25 - 50	2.72	1.23	54.78	0.082	40.29	20.99	19.30
		50 - 90	2.74	1.27	53.65	0.037	39.24	21.80	17.44
	15	0 - 25	2.73	1.19	56.41	0.453	40.50	21.05	19.45
		25 - 50	2.71	1.31	51.55	0.179	38.21	20.21	18.00
		50 - 80	2.74	1.29	52.92	0.065	41.02	21.89	19.13
		80 - 130	2.71	1.27	53.14	0.087	40.79	21.92	18.87
	16	0 - 30	2.72	1.14	58.09	0.279	42.92	23.25	19.67
		30 - 60	2.72	1.25	54.04	0.112	43.87	25.85	18.02
		60 - 100	2.74	1.25	54.38	0.033	45.73	24.79	20.94
	17	0 - 25	2.71	1.16	57.20	0.372	38.45	20.14	18.31
		25 - 50	2.74	1.25	54.38	0.179	40.33	21.31	19.02
		50 - 95	2.72	1.27	54.04	0.045	41.86	22.20	19.66
	20	0 - 25	2.73	1.25	54.21	0.614	39.23	19.92	19.31
		25 - 50	2.73	1.33	51.28	0.502	38.18	19.86	18.32
	21	0 - 30	2.72	1.17	56.99	0.112	42.09	21.02	21.07
		30 - 75	2.73	1.25	54.21	0.052	41.53	22.40	19.13
	22	0 - 25	2.72	1.22	55.15	0.512	38.87	18.93	19.94
		25 - 50	2.74	1.29	52.92	0.283	36.62	17.75	18.87
		50 - 100	2.70	1.35	50.00	0.510	32.27	17.52	14.75
		100 - 150	2.70	1.33	50.74	0.475	30.11	15.74	14.37
	26	0 - 25	2.71	1.19	56.09	0.326	38.32	19.15	19.17
		25 - 50	2.71	1.26	53.51	0.111	39.30	20.42	18.88
		50 - 100	2.73	1.24	54.48	0.095	41.21	21.99	19.22
		100 - 150	2.72	1.31	51.84	0.032	40.15	21.62	18.53
	27	0 - 30	2.72	1.18	56.62	0.309	41.17	20.92	20.25
		30 - 60	2.72	1.25	54.04	0.163	39.52	20.87	18.65
		60 - 100	2.72	1.25	54.04	0.087	38.85	20.05	18.80
	28	0 - 25	2.73	1.20	56.04	0.352	38.95	19.15	19.80
		25 - 50	2.72	1.25	54.04	0.115	39.22	20.38	18.84
		50 - 100	2.72	1.28	52.94	0.090	40.63	21.50	19.13
		100 - 150	2.74	1.33	51.46	0.027	42.89	22.63	20.26
Recent Nile alluvial deposits	5	0 - 25	2.72	1.23	54.78	0.418	38.97	20.65	18.34
		25 - 50	2.70	1.25	53.70	0.275	40.36	21.27	19.09
		50 - 100	2.70	1.31	51.48	0.289	37.82	20.72	17.10
		100 - 150	2.72	1.23	54.78	0.107	41.12	21.47	19.65
	11	0 - 25	2.70	1.30	51.85	1.028	30.67	18.42	12.25
		25 - 50	2.70	1.32	51.11	0.814	28.38	16.64	11.75
		50 - 100	2.72	1.42	47.79	0.312	29.92	17.87	12.05
		100 - 150	2.70	1.45	46.30	0.143	30.59	18.17	12.42

Table (10): cont.

Geom. unit	Prof. No.	Depth cm	Particle density g/cm^3	Bulk density g/cm^3	Total porosity %	Hydraulic conductivity (cm/hr)	Soil moisture content % Field capacity	Wilting point	Available Water %
Recent Nile alluvial deposits	18	0 - 30	2.70	1.29	52.22	0.456	38.65	21.50	17.15
		30 - 60	2.71	1.32	51.29	1.042	29.29	17.13	12.16
		60 - 100	2.69	1.59	40.89	2.119	26.59	15.55	11.04
	23	0 - 30	2.71	1.25	53.87	0.495	38.06	21.07	16.99
		30 - 60	2.70	1.32	51.11	0.314	30.04	17.69	12.35
		60 - 100	2.70	1.34	50.37	0.206	29.52	17.34	12.18
	24	0 - 25	2.71	1.20	55.71	0.267	40.47	21.45	19.02
		25 - 50	2.72	1.23	54.78	0.099	39.04	20.49	18.55
		50 - 100	2.72	1.25	54.04	0.053	41.09	21.68	19.41
	29	0 - 25	2.71	1.28	52.77	0.412	38.39	21.25	17.14
		25 - 75	2.71	1.32	51.29	0.914	30.55	18.25	12.30
		75 - 110	2.67	1.59	40.45	2.043	26.43	15.77	10.66
	30	0 - 40	2.71	1.30	52.03	1.106	29.35	17.22	12.13
		40 - 80	2.71	1.32	51.29	0.972	28.16	16.21	11.95
		80 - 130	2.67	1.58	40.82	2.007	26.12	15.21	10.91
	31	0 - 35	2.71	1.31	51.66	1.127	29.06	16.91	12.15
		35 - 80	2.68	1.58	41.04	2.263	27.36	15.75	11.61
		80 - 120	2.68	1.60	40.30	2.285	26.87	15.58	11.29

Table (11) : Minimum , maximum and average values of bulk density , total porosity, hydraulic conductivity , soil moisture contents at field capacity and wilting point , and available water % in the three geomorphic units.

Geom. unit / Soil porperties	Coastal barrier plains and beaches			Fluvio- marine deposits			Recent Nile alluvial deposits		
	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.
Bd (g/cm3)	1.67	1.78	1.73	1.14	1.51	1.27	1.20	1.60	1.35
T.P %	32.32	36.98	34.70	44.49	58.09	53.48	40.30	55.71	49.91
H.C. (cm/h)	11.375	19.96	16.37	0.025	0.614	0.202	0.053	2.285	0.828
M.C at F.C	6.14	11.72	68.05	29.10	45.73	39.14	26.12	41.12	32.80
M.C. at W.P	3.28	6.55	4.51	15.74	25.85	20.63	15.21	21.68	18.51
A.W. %	2.02	5.43	3.51	11.92	21.07	18.52	10.66	19.65	14.29

Bd = Bulk density
T.P = Total porosity
H.C = Hydraulic conductivity
M.C at F.C = Moisture content at field capacity
M.C at W.P = Moisture content at wilting point
A.W = Available water

Table (12) : Correlation coefficients between some soil physical properties and some soil constituents of the studied soil profiles.

Soil Factor		Coastal barrier plains and beaches	Fluvio-marine deposits	Recent Nile alluvial deposits
Bulk density and :				
	clay %	-0.389 *	-0.438 **	-0.775 **
	clay+silt %	-0.518 **	-0.302 *	-0.823 **
	sand %	0.523 **	0.376 **	0.829 **
	CaCO3 %	-0.187	-0.236	-0.483 *
	O.M %	-0.271	-0.496 **	-0.564 **
Total porosity and :				
	clay %	0.448 *	0.453 **	0.775 **
	clay+silt %	0.578 **	0.315 *	0.828 **
	sand %	-0.562 **	-0.375 **	-0.834 **
	CaCO3 %	0.156	0.244	0.399 *
	O.M %	0.281	0.462 **	0.562 **
Hydraulic conductivity and :				
	clay %	-0.566 **	-0.662 **	-0.723 **
	clay+silt %	-0.567 **	-0.566 **	-0.908 **
	sand %	0.554 **	0.539 **	0.907 **
	CaCO3 %	0.190	-0.364 *	-0.373
	O.M %	-0.228	0.390 **	0.303
Moisture content at field capacity and :	clay %	0.934 **	0.749 **	0.911 **
	clay+silt %	0.820 **	0.546 **	0.741 **
	sand %	-0.884 **	-0.552 **	-0.759 **
	CaCO3 %	-0.113	0.061	0.563 **
	O.M %	0.515 **	0.669 **	0.426 *
Moisture content at wilting point and :	clay %	0.799 **	0.723 **	0.867 **
	clay+silt %	0.557 **	0.494 **	0.788 **
	sand %	-0.721 **	-0.431 **	-0.798 **
	CaCO3 %	-0.341	-0.139	0.567 **
	O.M %	0.205	0.103	0.471 *
Available water and :				
	clay %	0.937 **	0.574 **	0.925 **
	clay+silt %	0.897 **	0.474 **	0.692 **
	sand %	-0.919 **	-0.538 **	-0.697 **
	CaCO3 %	-0.122	0.267	0.549 *
	O.M %	0.389 *	0.302 *	0.389 *

Within the studied soil profiles, the bulk values of density in general, tend to be lower in the surface layers than in the deeper ones. However, the regularity of bulk density distribution within the soil profiles were different and depends on soil origin. Thus it tended to be most regular in the soils of coastal barrier plains and beaches and recent Nile alluvial deposits and least regular in the fluvio marine deposits. These results are in agreement with those obtained by Sharma et al (1980), Hagag (1994) and Khalil (1995).

4.2.6. Total soil porosity:

Data presented in Tables (10 & 11) show percentages of total porosity of the soils under consideration. It is obvious that total soil porosity ranges from 32.32 to 36.98; 40.30 to 55.71 and 44.49 to 58.09% in the soils of coastal barrier plains and beaches, recent Nile alluvial deposits and fluvio marine deposits, respectively. Within soil profiles, the values of total soil porosity tend to be higher in the surface rather than the deeper layers.

Statistical analysis (Table, 12) shows a positive and significant correlations between total soil porosity and each of clay, clay plus silt and organic matter contents. Whereas negative highly significant correlations are attained for sand content. In the soils of recent Nile alluvial deposists, total porosity increases significantly with the increase of $CaCO_3$ content. These results are in agreement with those obtained by Talha et al (1978) and Khalil (1995).

4.2.7. Soil hydraulic conductivity:

Soil hydraulic conductivity is an important parameter in the planning of water use and leaching requirements for soil reclamation. The values of soil hydraulic conductivity given in Tables (10 & 11) show, generally, that hydraulic conductivity vary from 0.025 to 19.960 cm/hr, showing wide variations between the different geomorphic units. Hydraulic conductivity values vary between the minimum of 11.375, 0.025 and 0.053 and the maximum of 19.960, 0.614 and 2.285 with the averages of 16.376, 0.202 and 0.828 cm/hr in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. It appears clearly that the minimum hydraulic conductivity values are associated with the soils of fluvio marine deposits, while the maximum ones are found in the soils of coastal barrier plains and beaches. This finding could be attributed to the variations in soil texture.

Statistical analysis (Table 12) shows a negative and highly significant correlations between hydraulic conductivity and both of clay and the clay plus silt contents, wherease a positive and highly significant ones are attained for sand contents in all the studied geomorphic units. The effect of both $CaCO_3$ and organic matter contents on hydraulic conductivity appeared only in the soils of fluvio marine deposits. These results are in aggrement with those of Hagag (1994).

4.2.8. Soil moisture characteristics:

Soil moisture characteristics are a very important parameter in determining the irrigation requirements of the cultivated crops as well as the selection of the cultivated crops. Soil moisture constants, i.e. field capacity, wilting point and available water are generally affected by many factos particulary soil texture, structure, mineralogical composition, total soluble salts and exchangeable cations, (Hillal, 1971).

Soil moisture contents at field capacity and wilting point and available water are shown in Tables (10 & 11). The obtained results show that the soil moisture contents at field capacity (@ 0.33 atm) range from 6.14 to 11.72, 29.10 to 45.73 and 26.12 to 41.12 with the averages of 8.05, 39.14 and 32.80% in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The values of soil moisture content at wilting point (@ 15.0 atm) range from 3.28 to 6.55, 15.74 to 25.85 and 15.21 to 21.68 with the averages of 4.51, 20.63 and 18.51% in the soils of the same geomorphic units, respectively. The calculated contents of the available water range from 2.02 to 5.43, 11.92 to 21.07 and 10.66 to 19.65% with the averages of 3.51, 18.52 and 14.29% in the three respective geomorphic units. These results indicate that soils moisture contents at field capacity and wilting point, and subsequently the calculated available water contents are higher in the soils of fluvio marine deposits and recent Nile alluvial deposits than in the soils of coastal barrier plains and beaches. This finding is due to the higher clay and organic matter contents in soils of the former geomorphic units than in the latter one, which contained relatively higher contents of sand fractions which enable the soils to drain their water rapidly. Sekhon and Arora (1967), Talha et al (1978) and

Lavti and Paliwal (1980) went almost to similar results.

Statistical analysis (Table 12) show positive highly significant correlations between the soil moisture contents at field capacity, wilting point as well as available water % and each of clay and clay plus silt contents in the all geomorphic units, wherease inverse correlations are attained with sand contents. Highly significant and positive correlations were found between moisture contents at both field capacity and wilting point and $CaCO_3$ contents in the soils of recent Nile alluvial deposits only. Also, a significant and positive correlation was attained between the calculated available water of soils of this geomorphic unit and their $CaCO_3$ contents. Statistical analysis reveales also a significant positive correlations between each of soil moisture contents at field capacity and available water contents and organic matter contents in all geomorphic units. Only the soils of the recent Nile alluvial deposits appeare the significant positive correlation between their moisture contents at wilting point and their organic matter contents.

4.3. Soil chemical properties:

4.3.1. Distribution of soluble salts:

The results of chemical analysis of the soil saturation extract of the studied area are presented in Table (13). The values of electrical conductivity (ECe) vary widely from one geomorphic unit to another and range from 1.3 to 74.9, 1.6 to 61.7 and 1.1 to 3.7 with the averages of 22.6, 7.5 and 2.4 dSm^{-1} in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile

Table (13): Chemical analysis of the soil saturation extract of the profiles representing the studied geomorphic units.

Geom. unit	Prof. No.	Depth cm	SP	pH	EC $dS\ m^{-1}$	Soluble cations meq/100g soil				Soluble anions meq/100g soil				SAR	TSS %
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$		
Coastal barrier plains and beaches	1	0 - 25	29	8.3	78.8	125.9	170.6	1170.0	25.00	---	2.0	1265.0	224.5	96.1	1.46
		25 - 50	25	8.3	48.3	110.6	129.8	765.0	19.00	---	2.0	875.0	147.4	69.8	0.77
		50 - 70	23	8.2	44.1	100.5	120.6	640.0	12.00	---	1.5	750.0	121.6	60.9	0.65
	2	0 - 30	30	7.9	1.9	5.1	7.9	5.7	0.30	---	3.0	13.0	3.0	2.2	0.04
		30 - 60	29	7.8	1.3	3.3	5.3	4.9	0.20	---	2.0	8.0	3.7	2.4	0.02
		60 - 80	28	7.8	1.8	4.7	6.8	6.8	0.30	---	1.5	12.5	4.6	2.8	0.03
	6	0 - 30	28	7.9	72.5	112.5	185.9	980.0	24.00	---	2.5	1005.0	294.9	80.2	1.30
		30 - 65	25	7.9	53.1	107.1	151.3	791.0	20.40	---	1.5	902.0	166.3	69.6	0.85
	7	0 - 30	25	7.5	4.1	11.1	12.4	17.4	1.40	---	2.0	30.0	10.3	5.1	0.07
		30 - 60	25	7.5	5.8	10.0	18.6	28.1	1.35	---	1.5	53.5	3.1	7.4	0.09
		60 - 100	25	7.7	11.6	18.1	29.9	91.8	2.90	---	1.5	134.0	7.2	18.7	0.19
		100 - 150	25	7.7	27.3	35.2	109.0	217.0	6.40	---	1.5	325.0	41.1	25.6	0.44
	8	0 - 30	32	7.8	4.5	10.7	12.5	21.4	0.43	---	1.5	40.0	3.5	6.3	0.09
		30 - 60	29	7.8	5.7	16.1	17.5	22.9	0.79	---	1.5	45.0	10.8	5.6	0.11
		60 - 100	30	7.8	2.5	7.5	8.3	9.1	0.05	---	2.0	22.5	0.5	3.2	0.05
	12	0 - 20	25	8.2	52.5	90.5	116.2	675.0	13.00	---	1.5	800.0	93.2	66.4	0.84
		20 - 50	24	8.2	25.7	45.2	65.3	314.0	7.10	---	1.5	360.0	70.1	42.2	0.39
		50 - 70	24	8.1	37.8	64.2	70.4	596.0	15.00	---	1.5	620.0	124.1	72.7	0.58
	13	0 - 25	27	7.5	1.4	3.8	4.1	6.5	0.35	---	4.0	8.0	2.8	3.3	0.02
		25 - 50	24	7.5	2.1	4.3	5.1	11.5	0.15	---	2.0	17.0	2.1	5.3	0.03
		50 - 70	24	7.7	2.8	5.3	5.8	17.0	0.17	---	1.5	25.0	1.8	7.2	0.04
	19	0 - 30	27	7.6	26.0	24.6	43.7	261.3	5.90	---	1.5	242.0	92.0	44.7	0.45
		30 - 60	27	7.5	74.9	76.9	194.3	955.0	27.50	---	1.0	939.0	313.7	82.0	1.29
	25	0 - 20	27	7.7	9.6	19.8	37.7	45.3	1.60	---	1.5	57.0	45.9	8.4	0.17
		20 - 50	27	7.6	18.9	47.6	77.3	167.0	3.70	---	1.0	225.0	69.6	21.1	0.33
		50 - 75	28	7.6	48.3	90.5	130.6	740.0	15.30	---	1.0	740.0	235.4	70.4	0.87

Table (13): cont.

Geom. unit	Prof. No.	Depth cm	SP	pH	EC $dS\ m^{-1}$	Soluble cations meq/100g soil				Soluble anions meq/100g soil				SAR	TSS %
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$		
Fluvio marine deposits	3	0 - 25	100	7.7	4.1	10.0	10.5	20.1	0.50	---	2.5	37.5	1.1	6.3	0.26
		25 - 50	108	8.0	5.6	7.5	12.6	37.1	0.75	---	1.5	52.5	3.4	11.7	0.39
		50 - 100	117	7.9	10.5	28.6	27.5	61.4	1.78	---	1.5	90.0	27.8	11.6	0.79
		100 - 150	130	7.9	17.3	42.3	41.3	130.8	2.70	---	1.0	210.0	6.1	20.2	1.44
	4	0 - 25	104	8.0	2.8	5.0	7.5	16.0	0.24	---	1.5	19.5	7.7	4.6	0.19
		25 - 50	125	8.1	2.6	5.0	6.5	14.9	0.15	---	1.5	17.0	8.1	6.2	0.21
		50 - 100	127	8.0	3.1	6.5	6.9	16.7	0.42	---	1.5	22.5	6.5	6.5	0.25
		100 - 150	126	7.9	2.9	7.5	5.9	15.5	0.65	---	1.0	20.0	8.6	6.0	0.22
	9	0 - 25	73	7.8	1.1	4.3	3.2	3.1	0.10	---	2.5	4.5	3.7	1.6	0.05
		25 - 50	73	7.7	1.1	4.1	2.7	3.8	0.10	---	2.5	4.5	3.8	2.1	0.05
		50 - 100	66	7.7	1.1	3.1	2.8	4.6	0.15	---	2.0	4.7	4.0	2.7	0.05
	10	0 - 25	77	7.8	1.1	3.4	2.7	4.4	0.15	---	2.0	5.0	3.7	2.5	0.05
		25 - 50	90	7.8	1.6	4.0	3.3	8.5	0.10	---	2.5	7.0	6.4	4.4	0.09
		50 - 100	98	7.9	1.9	4.4	4.0	10.0	0.15	---	3.5	10.5	4.6	4.9	0.12
		100 - 150	96	7.9	2.5	5.0	4.3	15.6	0.22	---	2.5	17.5	5.1	7.2	0.15
	14	0 - 25	100	8.0	5.3	8.8	9.2	35.0	0.65	---	2.0	49.0	2.7	11.7	0.34
		25 - 50	150	8.1	4.2	3.5	3.9	34.1	0.45	---	1.5	35.0	5.5	17.4	0.40
		50 - 90	130	8.1	6.8	4.8	5.6	57.3	0.80	---	2.0	65.0	1.5	25.1	0.57
	15	0 - 25	87	7.4	4.2	10.0	11.2	20.5	0.40	---	2.0	30.0	10.1	6.3	0.23
		25 - 50	105	7.6	4.2	6.0	6.5	29.0	0.50	---	2.0	35.0	5.0	11.6	0.28
		50 - 80	125	7.8	4.8	4.5	5.1	38.2	0.60	---	2.0	43.0	3.4	17.4	0.38
		80 - 130	120	7.9	11.3	7.5	14.6	112.9	1.10	---	2.0	120.0	14.1	34.0	0.87
	16	0 - 30	115	7.5	4.9	11.4	15.5	21.7	0.55	---	2.0	30.7	16.4	5.9	0.36
		30 - 60	112	7.7	7.3	8.1	18.7	45.9	0.72	---	1.5	53.5	18.4	12.5	0.52
		60 - 100	128	7.7	12.1	12.5	19.4	116.5	1.25	---	1.5	125.0	23.2	29.2	0.99
	17	0 - 25	82	7.4	3.7	8.0	5.5	23.2	0.35	---	2.0	29.0	6.1	8.9	0.19
		25 - 50	106	7.8	2.7	3.7	3.0	20.5	0.22	---	2.0	20.0	5.4	11.2	0.18
		50 - 95	125	7.8	2.8	4.1	2.9	20.7	0.22	---	2.0	20.0	5.9	11.1	0.22

Table (13): cont.

Geom. unit	Prof. No.	Depth cm	SP	pH	EC $dS\ m^{-1}$	Soluble cations meq/100g soil				Soluble anions meq/100g soil				SAR	TSS %
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$		
Fluvio marine deposits	20	0 - 25	84	7.7	13.1	13.6	18.1	128.2	2.20	---	3.0	156.0	3.1	32.2	0.70
		25 - 50	85	7.6	27.8	27.4	45.7	417.5	7.10	---	2.5	425.0	70.2	69.1	1.51
	21	0 - 30	95	7.6	5.9	8.7	12.1	39.9	0.40	---	2.5	47.5	11.1	12.4	0.36
		30 - 75	92	7.8	14.7	20.5	38.7	122.1	0.40	---	2.0	138.4	41.3	22.4	0.87
	22	0 - 25	85	7.6	4.2	7.0	8.4	27.5	0.45	---	2.5	38.0	2.9	9.9	0.23
		25 - 50	85	7.6	5.2	6.0	9.4	37.1	0.50	---	2.0	47.0	2.0	13.4	0.28
		50 - 100	75	7.6	6.2	5.6	7.9	50.8	0.65	---	1.5	57.0	6.5	19.6	0.30
		100 - 150	73	7.5	14.1	21.4	36.2	120.0	1.90	---	1.5	125.0	53.0	22.4	0.66
	26	0 - 25	95	8.0	14.2	28.7	48.2	142.0	2.90	---	2.0	190.0	29.8	22.9	0.87
		25 - 50	101	8.0	15.8	14.7	28.5	190.5	2.90	---	1.5	225.0	10.1	41.0	1.02
		50 - 100	107	8.0	18.9	17.9	30.2	227.4	3.10	---	1.5	270.0	7.1	46.4	1.29
		100 - 150	98	8.2	27.3	25.8	46.3	370.4	4.80	---	1.0	430.0	16.3	61.7	1.71
	27	0 - 30	110	7.9	6.2	8.2	10.1	43.5	0.45	---	2.0	49.5	10.8	14.4	0.44
		30 - 60	108	7.9	8.4	10.5	18.7	59.0	0.93	---	1.5	65.0	22.6	15.4	0.58
		60 - 100	108	7.8	15.6	18.7	32.9	120.2	2.55	---	1.5	135.0	37.9	23.7	1.08
	28	0 - 25	103	7.9	3.1	4.5	4.3	22.9	0.39	---	2.0	13.0	16.1	11.6	0.20
		25 - 50	105	7.9	4.1	5.5	7.9	29.0	0.42	---	1.5	24.0	17.3	11.2	0.28
		50 - 100	108	8.0	4.2	5.5	6.0	30.2	0.84	---	1.5	29.0	12.0	12.6	0.29
		100 - 150	115	7.8	10.5	24.3	26.6	73.8	2.10	---	1.5	55.0	70.3	14.6	0.77
Recent Nile alluvial deposits	5	0 - 25	89	7.8	1.9	6.5	3.4	9.0	0.15	---	2.5	12.0	4.6	4.0	0.11
		25 - 50	102	7.8	2.4	7.4	5.8	10.5	0.35	---	1.5	14.0	8.6	4.1	0.16
		50 - 100	95	7.7	2.6	7.1	5.0	13.9	0.35	---	1.5	16.5	8.4	5.7	0.16
		100 - 150	105	7.7	3.5	8.0	4.6	22.0	0.43	---	1.0	25.0	9.0	8.8	0.24
	11	0 - 25	72	7.5	1.6	5.8	2.7	7.4	0.10	---	2.0	8.0	6.0	3.6	0.07
		25 - 50	67	7.5	1.3	5.0	2.2	5.9	0.07	---	2.0	6.5	4.7	3.1	0.06
		50 - 100	76	7.4	2.0	6.5	4.6	9.8	0.05	---	2.0	11.0	8.0	4.2	0.10
		100 - 150	85	7.4	3.1	7.5	5.5	15.9	0.15	---	1.5	18.0	9.6	6.2	0.17

Table (13): cont.

Geom. unit	Prof. No.	Depth cm	SP	pH	EC $dS\ m^{-1}$	Soluble cations meq/100g soil				Soluble anions meq/100g soil				SAR	TSS %
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$		
Recent Nile alluvial deposits	18	0 - 30	88	7.8	2.5	9.0	5.5	10.1	0.40	---	1.5	12.0	11.5	3.8	0.14
		30 - 60	81	7.7	2.8	8.7	6.2	12.8	0.35	---	1.0	15.0	12.1	4.7	0.15
		60 - 90	45	7.7	3.7	9.5	5.7	21.5	0.35	---	1.0	23.5	12.6	7.8	0.11
	23	0 - 30	73	7.4	2.4	9.1	4.9	9.9	0.15	---	2.5	11.5	10.1	3.7	0.11
		30 - 60	61	7.4	2.9	10.4	6.5	12.0	0.10	---	1.5	14.0	13.6	4.1	0.11
		60 - 100	64	7.5	3.5	12.5	7.3	15.1	0.15	---	1.5	18.0	15.6	4.8	0.14
	24	0 - 25	73	7.4	1.8	9.5	5.1	4.1	0.15	---	2.0	5.0	11.9	1.5	0.08
		25 - 50	73	7.5	1.9	9.9	5.6	3.5	0.15	---	2.0	5.0	12.2	1.3	0.09
		50 - 100	74	7.5	2.1	10.3	6.1	5.0	0.20	---	2.0	5.5	14.1	1.7	0.10
	29	0 - 25	85	7.6	1.8	5.6	4.0	8.2	0.24	---	2.0	9.0	7.0	3.7	0.10
		25 - 75	80	7.6	1.6	4.0	2.7	9.2	0.15	---	2.0	11.5	2.6	5.0	0.08
		75 - 110	47	7.6	3.6	7.2	4.8	23.8	0.30	---	1.5	26.0	8.6	9.7	0.11
	30	0 - 40	75	7.5	1.1	3.8	1.6	5.5	0.15	---	2.0	6.0	3.1	3.3	0.05
		40 - 80	72	7.4	2.3	6.9	4.1	12.0	0.25	---	1.5	13.5	8.3	5.1	0.11
		80 - 130	50	7.4	2.5	7.2	4.8	12.9	0.25	---	1.5	15.0	8.7	5.3	0.08
	31	0 - 35	74	7.4	2.4	6.9	4.1	12.7	0.30	---	2.0	15.0	7.0	5.4	0.11
		35 - 80	51	7.4	1.9	7.9	3.8	7.2	0.15	---	1.0	8.5	9.6	3.0	0.06
		80 - 120	51	7.4	2.8	8.0	5.8	14.0	0.20	---	1.5	16.0	10.5	5.3	0.09

alluvial deposits, respectively. The obtained data reveal that the soils of recent Nile alluvial deposits are non saline. The fluvio marine deposits are non saline soils (profiles 4, 9, 10 and 17); moderately saline soils (profiles 14, 15, 22 and 28); highly saline soils (profiles 3, 16, 21 and 27) and very highly saline soils (profiles 20 and 26). The soils of coastal barrier plains and beaches include also four soil categories according to salinity i.e non saline (profiles 2 and 13); moderately saline (profile 8); highly saline (profile 7) and very highly saline (profiles 1, 6, 12, 19 and 25). The above mentioned classification based on the limits given by Richards (1954). In general, the high and very high salinity in these two geomorphic units may be rendered to the seepage of saline water from Mediterranean sea or Burullus lake water and the floculation of water tables that might lead to salt accumulation under the prevailing arid conditions.

The cationic composition of the recent Nile alluvial deposits followed the order: $Na^{+} > Ca^{++} > Mg^{++} > K^{+}$, while in the other two units, sodium ions dominate followed by Mg^{++}, Ca^{++} and finally k^{+} ions.

The anionic composition of the soil saturation extract of the all geomorphic units displays the domination of Cl^{-} followed by $SO_4^{=}$ and HCO_3^{-} ions, with exception of profile 23, where $SO_4^{=}$ ions dominate followed by Cl^{-} and HCO_3^{-}. Carbonate anions were not found in any detectable concentration in the soil saturation extract of all the geomorphic units.

As for soil reaction (pH), the obtained data indicate to the slightly and moderately alkaline conditions in the soils representing the three geomorphic units where the pH values fluctuate between 7.4 and 8.2.

Values of sodium adsorption ratio (SAR) in the soils of coastal barrier plains and beaches range from 2.2 to 96.1. In general, the cultivated soils (represented by profiles Nos 2, 8 and 13) have SAR values less than 13, thus, these soils are classified as non sodic soils. The barren soils (represented by profiles Nos 1, 6, 7, 12, 19 and 25) have SAR values more than 13, therefore they are classified as sodic soils. The fluvio marine deposits include non sodic soils (represented by profiles Nos 4, 9, 10, 17 and 28); and sodic soils (represented by profiles Nos 3, 14, 15, 16, 20, 21, 22, 26 and 27). The results of SAR value also reveal that all the soil profiles representing the recent Nile alluvial deposits are non sodic.

Although SAR values are very high in some soils, pH values appear not to be very high. This finding could be attributed to existence of sodium carbonates in these soils which go unnoticed when extracted with water. This may be due to that, a portion of the dissolved carbonates reacts with Ca^{++}, released from different sources such as exchange sites, mineral weathering and gypsum, and precipitates immediately as $CaCO_3$ in the course of preparation of paste extract (Gupta and Abrol, 1990). On the other hand, a sodic soil with soil solution of high SAR does not necessarily mean a high pH. In many saline-sodic soils that do not contain sodium carbonate minerals, pH in the saturation paste is observed to be less than 8.2 (Gupta and Abrol, 1990).

4.3.2. Cation exchange capacity (CEC) and exchangeable cations:

Data in Table (14) show that the soils of fluvio marine deposits have the highest CEC values while the lowest ones are attained by the soils of coastal barrier plains and beaches. The CEC values are arranged in the order of: fluvio marine deposits > recent Nile alluvial deposits > coastal barrier plains and beaches, with the averages of 48.80, 35.08 and 2.38 me/100 g, respectively. Within the different soil profiles of the recent Nile alluvial deposits and coastal barrier plains and beaches, the CEC values tend, generally, to be higher in the surface layers than in the deeper ones. On the other hand, the CEC values are mostly irregularly distributed within the different profiles of the fluvio marine deposits.

The obtained results show that CEC values are related to both soil texture and organic matter content, yet the effect of soil texture on the CEC values is more pronounced. Such an observation is evident by the statistical analysis which shows a highly significant and positive correlations between clay content and CEC values in the soils of fluvio marine, recent Nile alluvial deposits and coastal barrier plains and beaches ($r = 0.89^{**}$, 0.85^{**} and 0.77^{**}, respectively). The same significancies are achieved between the CEC values and clay plus silt contents ($r = 0.69^{**}$, 0.91^{**} and 0.82^{**}). On the other hand, inverse relations are attained between the CEC values and sand contents ($r = -0.66^{**}$, -0.91^{**} and -0.88^{**}). The relation between CEC values and organic matter contents is highly significant in the second geomorphic unit ($r = 0.57^{**}$), while it is significant only in the former and last geomorphic units ($r = 0.34^{*}$ and 0.42^{*}).

Table (14) : Cation exchange capacity (CEC) and exchangeable cations of the soil profiles representing the studied geomorphic units .

Geom. unit	Prof. No.	Depth (cm)	CEC me/100g soil	Exchangeable cations me/100 g soil Ca^{++}	Mg^{++}	Na^{+}	K^{+}	ESP
Coastal barrier plains and beaches	1	0-25	5.35	1.72	2.45	0.97	0.20	18.13
		25-50	2.88	0.80	1.23	0.56	0.16	19.44
		50-70	3.50	1.09	1.42	0.67	0.30	19.14
	2	0-30	3.70	1.18	1.71	0.49	0.29	13.24
		30-60	2.70	0.86	1.26	0.35	0.22	12.96
		60-80	1.72	0.51	0.81	0.21	0.17	12.79
	6	0-30	2.05	0.52	0.75	0.56	0.21	27.32
		30-60	1.65	0.44	0.59	0.53	0.18	32.12
	7	0-30	1.10	0.31	0.44	0.26	0.09	23.63
		30-60	1.25	0.37	0.51	0.27	0.09	21.60
		60-100	1.40	0.43	0.59	0.25	0.12	17.85
		100-130	1.35	0.39	0.55	0.28	0.12	20.74
	8	0-30	5.30	1.99	2.43	0.66	0.27	12.45
		30-60	3.45	1.10	1.54	0.49	0.28	14.20
		60-100	4.40	1.02	1.44	0.60	0.30	13.64
	12	0-20	1.35	0.30	0.45	0.38	0.21	28.18
		20-50	1.10	0.27	0.41	0.25	0.16	22.73
		50-70	1.15	0.31	0.49	0.26	0.08	22.61
	13	0-25	3.75	1.17	1.85	0.42	0.28	11.20
		25-50	2.25	0.80	1.08	0.25	0.08	11.11
		50-70	1.55	0.50	0.76	0.20	0.08	12.90
	19	0-30	1.69	0.41	0.59	0.42	0.16	24.85
		30-60	1.50	0.39	0.53	0.45	0.12	30.00
	25	0-20	1.70	0.56	0.62	0.35	0.15	20.59
		20-50	1.10	0.22	0.30	0.37	0.21	33.64
		50-75	2.93	0.90	1.35	0.58	0.09	19.80

Table (14) : Cont.

Geom. unit	Prof. No.	Depth (cm)	CEC me/100g soil	Exchangeable cations me/100 g soil Ca^{++}	Mg^{++}	Na^{+}	K^{+}	ESP
Fluvio-marine deposits	3	0-25	50.45	17.90	21.15	8.86	2.29	17.56
		25-50	48.72	15.98	20.83	9.62	2.09	19.75
		50-100	51.27	14.22	25.74	8.15	2.94	15.89
		100-150	56.19	16.71	27.19	8.93	3.15	15.89
	4	0-25	47.65	19.56	21.05	5.27	1.47	11.05
		215-50	51.55	20.61	22.89	6.01	1.94	11.66
		50-100	54.08	20.42	23.99	6.56	3.01	12.13
		100-150	58.43	20.00	28.11	6.57	3.42	11.24
	9	0.25	46.50	20.19	23.10	2.11	0.83	4.54
		25-50	45.68	18.15	22.75	3.31	0.73	7.25
		50-100	41.25	15.57	20.77	3.72	0.94	9.02
	10	0.25	42.97	20.00	18.50	3.03	1.00	7.05
		25-50	46.51	22.20	18.62	4.11	0.97	8.84
		50-100	46.99	18.70	21.19	5.42	1.19	11.53
		100-150	40.48	13.28	19.49	5.79	1.62	14.30
	14	0-25	49.57	13.65	22.17	9.78	3.62	19.73
		25-50	46.80	11.21	19.45	10.99	4.93	23.48
		50-90	44.85	7.93	20.05	11.85	4.89	26.42
	15	0-25	48.72	19.48	22.16	5.15	1.41	10.57
		25-50	45.39	13.71	18.52	10.54	2.41	23.22
		50-80	47.54	14.31	17.45	12.66	2.83	26.63
		80-130	48.75	13.71	17.15	14.20	3.46	29.13
	16	0-30	49.65	17.32	21.74	8.50	1.79	17.12
		30-60	48.16	16.59	19.78	9.07	2.53	18.83
		60-100	54.38	16.66	20.55	13.97	2.87	25.69
	17	0-25	46.50	14.02	25.12	6.15	0.93	13.23
		25-50	51.60	18.87	24.85	6.35	1.25	12.31
		50-90	50.40	16.67	25.19	6.87	1.50	13.63

Table (14) : Cont.

Geom. unit	Prof. No.	Depth (cm)	CEC me/100g soil	Exchangeable cations me/100 g soil Ca^{++}	Mg^{++}	Na^{+}	K^{+}	ESP
Fluvio-marine deposits	20	0-25	41.70	11.05	20.00	7.62	2.72	18.27
		25-50	40.20	7.50	21.15	8.45	2.93	21.02
	21	0-30	44.40	13.16	18.83	9.25	2.87	20.83
		30-75	41.70	11.04	17.38	10.15	2.96	24.34
	22	0.25	42.65	14.54	21.81	7.82	1.26	18.34
		25-50	37.88	9.20	18.74	7.95	1.66	20.99
		50-100	38.70	11.80	18.56	6.19	1.95	15.99
		100-150	32.50	8.22	13.82	8.05	2.29	24.77
	26	0-25	45.70	11.54	22.09	8.63	3.19	18.88
		25-50	42.15	9.11	19.00	10.59	3.30	25.12
		50-100	43.85	9.42	18.73	11.74	3.73	26.77
		100-150	44.60	8.64	20.15	12.65	2.89	28.36
	27	0-30	49.15	16.33	23.15	7.47	2.05	15.20
		30-60	45.95	14.20	20.29	8.48	2.75	18.45
		60-100	44.73	10.18	22.11	9.19	3.02	20.55
	28	0-25	48.65	18.49	20.17	7.50	2.18	15.42
		25-50	47.78	16.21	20.55	8.17	2.52	17.10
		50-100	49.35	13.41	21.83	10.89	2.97	22.07
		100-150	57.15	16.43	24.38	13.07	3.12	22.87
Recent Nile alluvial deposits	5	0-25	47.65	24.19	16.66	4.86	1.93	10.20
		25-50	39.47	20.11	13.86	4.11	1.38	10.41
		50-100	32.75	13.25	11.85	5.92	1.72	18.08
		100-150	45.18	22.73	14.96	5.03	2.45	11.13
	11	0-25	38.70	19.93	14.48	3.34	0.94	8.63
		25-50	33.25	17.07	12.20	3.10	0.87	9.32
		50-100	41.53	19.58	15.69	5.37	0.88	12.93
		100-150	40.17	20.35	12.84	6.28	0.69	15.63

Table (14) : Cont.

Geom. unit	Prof. No.	Depth (cm)	CEC me/100g soil	Exchangeable cations me/100 g soil				ESP
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	
Recent Nile alluvial deposits	18	0-30	39.23	17.45	15.55	4.14	1.08	10.55
		30-60	31.17	14.95	10.29	3.92	1.00	12.58
		60-90	20.41	10.56	6.02	2.53	0.72	12.40
	23	0-30	40.26	21.17	13.04	4.89	1.15	12.15
		30-60	32.15	15.75	12.41	3.05	0.93	9.49
		60-100	29.87	15.01	11.18	2.95	0.72	9.88
	24	0-25	44.87	24.62	16.37	3.03	0.84	6.75
		25-50	43.90	25.15	14.43	3.42	0.89	7.79
		50-100	44.10	26.08	13.10	3.94	0.97	8.93
	29	0-25	38.70	21.82	11.17	3.53	1.17	9.12
		25-75	36.15	21.10	9.39	3.72	0.93	10.29
		75-110	19.05	9.78	5.55	1.99	0.60	10.45
	30	0-40	34.29	23.12	8.46	1.25	1.19	3.65
		40-80	30.65	20.99	7.37	0.87	0.75	2.84
		80-130	21.72	15.11	5.16	0.72	0.65	3.31
	31	0-35	32.19	21.72	7.53	1.57	1.15	4.88
		35-80	28.90	19.25	7.29	1.05	0.90	3.63
		80-120	25.82	17.37	6.12	0.93	0.82	3.60

The values of individual exchangeable cations shown in Table (14) reveal that magnesium is the dominant cation in the soils of fluvio marine deposits and coastal barrier plains and beaches. The exchangeable cations in these two geomorphic units are in the descending order of $Mg^{++} > Ca^{++} > Na^{+} > K^{+}$. However, calcium is dominated over magnesium in the soils of the recent Nile alluvial deposits. Therefore the exchangeable cations in this unit maintained the descending order of $Ca^{++} > Mg^{++} > Na^{+} > K^{+}$.

The obtained data also reveal that, the exchangeable sodium percentages (ESP) in all profiles represent the recent Nile alluvial soil are less than 15%, i.e., non alkali soil profiles. ESP values of soil profiles representing the other two geomorphic units are more than 15% (except for profiles 2, 8 and 13) in the coastal barrier plains and beaches and profiles 4, 9, 10 and 17 in the fluvio marine deposits). Therefore, these soils are considered moderately alkali soils (as their pH values did not exceed 8.5).

4.4. Status of macro nutrients:

4.4.1. Nitrogen:

4.4.1.1. Total nitrogen:

The total nitrogen contents in the studied soil profiles (Table, 15) reveal that it ranges from 39.7 to 272.2; 179.8 to 1655.8 and 124.7 to 1704.2 with the averages of 96.9; 556.3 and 555.6 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The highest content is found in the surface layers of all profiles, while the lowest

Table (15) : Total and available nitrogen, phosphorus and potassium contents in the soil profiles representing the studied geomorphic units.

Geom. unit	Prof. No.	Depth (cm)	N (ppm)		P (ppm)		K me/100g	
			Total	Avail.	Total	Avail	Total	Avail.
Coastal barrier plains and beaches	1	0-25	90.7	15.1	367.6	3.7	7.1	0.88
		25-50	85.1	13.2	312.2	3.6	5.1	0.67
		50-70	83.9	12.6	332.7	4.4	6.9	0.63
	2	0-30	272.2	32.9	335.5	6.3	4.6	0.30
		30-60	137.6	25.7	381.6	4.9	3.8	0.23
		60-80	92.8	18.3	206.4	4.7	4.1	0.18
	6	0-30	79.3	13.5	315.4	4.1	3.5	0.88
		30-65	52.8	10.7	286.1	5.3	3.2	0.68
	7	0-30	56.7	15.6	237.5	4.9	2.4	0.13
		30-60	51.0	8.1	183.8	4.0	2.3	0.13
		60-100	62.4	7.6	172.5	2.6	2.5	0.20
		100-130	39.7	6.2	186.6	2.7	2.1	0.28
	8	0-30	113..4	22.1	340.3	3.3	4.6	0.29
		30-60	76.8	15.4	206.4	5.8	3.5	0.30
		60-100	147.3	14.9	251.7	3.0	3.1	0.30
	12	0-20	107.5	10.5	312.9	3.1	3.1	0.54
		20-50	86.1	17.8	263.2	4.7	3.4	0.34
		50-70	95.8	15.4	245.4	4.9	3.4	0.44
	13	0-25	187.1	23.7	248.8	8.7	2.9	0.30
		25-50	107.5	19.5	316.1	5.5	2.3	0.09
		50-70	96.8	17.0	192.3	4.3	2.1	0.09
	19	0-30	62.4	8.9	296.8	3.2	5.2	0.32
		30-60	53.7	3.5	268.1	1.4	5.8	0.86
	25	0-20	96.8	13.3	345.6	2.1	3.4	0.19
		20-50	102.1	12.5	294.1	1.8	2.9	0.31
		50-75	80.6	9.1	401.2	1.3	6.8	0.52

Table (15) : Cont.

Geom. unit	Prof. No.	Depth (cm)	N (ppm) Total	N (ppm) Avail.	P (ppm) Total	P (ppm) Avail	K me/100g Total	K me/100g Avail.
Fluvio-marine deposits	3	0-25	793.8	87.4	1247.2	13.9	24.4	2.34
		25-50	289.5	45.6	936.1	7.6	28.1	2.91
		50-100	204.1	39.5	913.5	10.5	27.3	3.16
		100-150	283.5	35.6	941.7	6.4	27.3	3.50
	4	0-25	623.2	60.4	913.5	15.0	26.5	1.50
		25-50	260.8	43.2	845.6	5.2	29.0	1.96
		50-100	235.9	41.6	953.1	12.4	29.0	3.06
		100-150	207.5	40.7	882.3	19.5	27.8	3.50
	9	0-25	907.2	93.5	984.2	9.6	20.4	0.84
		25-50	442.3	67.1	831.4	6.7	20.4	0.74
		50-100	209.8	39.6	803.1	4.5	20.1	0.95
	10	0-25	759.8	80.5	919.1	17.1	21.0	1.02
		25-50	470.6	58.2	834.3	8.5	20.4	0.98
		50-100	243.8	45.3	975.7	6.3	18.8	1.34
		100-150	294.8	43.4	905.0	7.7	17.4	1.64
	14	0-25	580.6	67.2	811.6	10.3	26.5	3.69
		25-50	518.2	63.4	806.0	12.9	28.1	5.00
		50-90	478.5	51.9	755.4	13.1	26.0	5.00
	15	0-25	1655.8	167.8	769.2	15.1	23.9	1.45
		25-50	607.2	63.9	873.9	16.5	25.1	2.47
		50-80	417.5	47.2	1040.7	19.9	25.5	2.91
		80-130	446.2	46.9	772.1	20.3	25.1	3.59
	16	0-30	1193.7	112.3	913.5	16.8	20.9	1.85
		30-60	399.2	51.9	955.7	12.4	25.4	2.61
		60-100	301.5	46.3	1116.4	9.1	27.1	3.03
	17	0-25	1387.0	142.1	803.2	8.4	20.4	0.96
		25-50	424.7	47.5	786.5	10.1	21.0	1.28
		50-95	580.6	45.1	811.7	15.9	22.5	1.53

Table (15) : Cont.

Geom. unit	Prof. No.	Depth (cm)	N (ppm) Total	N (ppm) Avail.	P (ppm) Total	P (ppm) Avail	K me/100g Total	K me/100g Avail.
Fluvio-marine deposits	20	0-25	825.8	27.8	724.8	15.1	19.9	2.92
		25-50	409.2	21.4	689.5	9.5	18.5	3.53
	21	0-30	1489.2	162.7	789.1	22.1	21.0	1.30
		30-75	542.9	57.5	862.6	16.3	22.8	1.96
		0-25	935.4	94.9	836.3	11.9	21.0	1.30
	22	25-50	327.9	39.1	757.5	12.1	20.4	1.70
		50-100	225.8	34.5	718.2	28.4	20.8	2.00
		100-150	284.9	31.8	683.4	10.5	20.8	2.47
	26	0-25	694.6	42.1	964.5	9.3	26.9	3.41
		25-50	542.9	46.5	876.7	13.2	27.8	3.59
		50-100	473.1	38.4	1312.2	15.2	27.1	4.06
		100-150	408.6	35.9	756.19	8.4	23.5	3.31
	27	0-30	915.2	55.4	912.9	13.4	25.3	2.10
		30-60	430.0	43.1	789.1	11.7	24.1	2.85
		60-100	229.4	32.8	702.5	9.1	24.9	3.30
	28	0-25	696.8	45.5	761.8	9.5	26.9	2.22
		25-50	383.5	33.6	692.5	7.3	26.9	2.56
		50-100	179.8	24.8	766.4	8.1	29.1	3.06
		100-150	192.4	25.7	895.7	5.4	30.6	3.36
Recent Nile alluvial deposits	5	0-25	1486.1	99.3	1148.2	17.9	21.4	0.95
		25-50	462.9	65.9	1040.7	8.5	23.9	1.28
		50-100	215.5	44.7	907.8	14.3	22.5	1.41
		100-150	272.2	39.4	1078.5	4.8	20.8	1.30
	11	0-25	1043.5	115.65	964.4	16.2	18.3	0.55
		25-50	453.6	6.0	661.8	7.6	17.6	0.38
		50-100	283.5	39.7	763.6	6.8	18.1	0.38
		100-150	147.4	27.9	791.5	13.3	20.0	0.70

Table (15) : Cont.

Geom. unit	Prof. No.	Depth (cm)	N (ppm) Total	N (ppm) Avail.	P (ppm) Total	P (ppm) Avail	K me/100g Total	K me/100g Avail.
Recent Nile alluvial deposits	18	0-30	914.5	97.8	763.4	12.1	21.9	1.12
		30-60	536.7	42.6	614.5	10.4	20.1	1.03
		60-90	205.8	25.1	505.9	7.9	13.5	0.74
	23	0-30	996.5	84.2	733.5	23.5	22.1	1.16
		30-60	419.8	63.1	612.7	11.9	19.6	0.94
		60-100	278.2	47.5	653.8	15.1	17.9	0.73
	24	0-25	1704.2	175.1	972.8	18.4	20.5	0.85
		25-50	496.5	51.5	815.4	12.9	20.0	0.90
		50-100	252.7	33.0	588.2	15.6	18.9	0.98
	29	0-25	850.5	92.4	1020.9	10.2	21.5	1.19
		25-75	271.8	37.2	673.1	10.9	19.4	0.95
		75-110	124.7	22.9	647.6	6.4	12.8	0.61
	30	0-40	783.4	84.9	722.8	15.1	20.4	1.20
		40-80	399.3	71.5	700.5	12.7	16.0	0.77
		80-130	217.8	45.1	589.3	10.2	14.2	0.66
	31	0-35	80.5.6	89.2	677.2	13.9	18.7	1.17
		35-80	452.1	69.5	598.7	13.0	16.3	0.91
		80-120	369.5	40.3	562.4	10.7	15.9	0.83

one is recorded in deepest layers.

The values of both organic matter and consequently total nitrogen coantent are strongly texture dependent (Jenny, 1962). The finer the soil is the richer its organic carbon and total nitrogen content. This may explain the great variations in total nitrogen content in the soils of the first geomorphic unit than in the others.

Highly significant and positive correlations are established between total nitrogen and oganic matter content in the soils of the three geomorphic units, with r values of 0.87^{**}, 0.86^{**} and 0.94^{**}, respectively.

4.4.1.2. Available nitrogen:

Data presented in Table (15) indicate that the values of available nitrogen range between 3.5 and 175.1 ppm with the values being higher in the soils of the recent Nile alluvial deposits and fluvio marine deposits than the soils representing the coastal barrier plains and beaches. They vary between the minimum of 3.5, 21.4 and 22.9 and the maximum of 32.9, 167.8 and 175.1 with the averages of 14.7, 61.6 and 63.9 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. Many investigators came to the conclusion that the rate of nitrogen release was greater with finer size of soil fractions (Tan, 1983; Williams, 1983 and Nordmeyer and richter, 1985).

Statistical analysis shows a highly significant and negative correlations between total soluble salts and available nitrogen in the soils of the three geomorphic units, ($r = -0.51^{**}$, -0.37^{**} and -0.51^{**}, respectively). Such results are in agreement with those obtained by Laura (1974), who pointed out that increasing soluble salts in soil depresses the decomposition of organic matter.

Statistical analysis shows also a highly significant and positive correlations between total and available nitrogen in the soils of the three geomorphic units, with r values of 0.84^{**}, 0.69^{**} and 0.93^{**}, respectively. Carpenter et al (1952), found that the higher the total nitrogen in the soil, the more mineral nitrogen is provided in incubation experiments and under field conditions.

4.4.2. Phosphorus:

4.4.2.1. Total phosphorus:

Values of total phosphorus content range from 172.5 to 401.2, 683.4 to 1312.2 and 505.9 to 1148.2 with the averages of 280.8, 863.7 and 761.9 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively (Table, 15).

Statistical analysis shows a highly significant positive correlations between total phosphorus and clay content in the soils of all the studied geomorphic units, with r values of 0.66^{**}, 0.42^{**} and 0.67^{**}, respectively. The statistical analysis reveals also a highly significant positive correlation between total phosphorus and organic matter content in the soils of recent Nile alluvial deposits ($r = 0.58^{**}$), while the same relation is only significant in the soils of coastal barrier plains and beaches (r = 0.41*). These results mean that the finer the soil texture and the higher its organic matter content the higher is its total phosphorus content, Black (1965).

4.4.2.2. Available phosphorus:

Data presented in Table (15) indicate that available phosphorus ranges from 1.3 to 8.7, 4.5 to 28.4 and 4.8 to 23.5 corresponding to the averages of 4.0, 12.1 and 12.6 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively.

Statistical analysis shows negative realtion between either soluble ca^{++} or Mg^{++} and available phosphorus, but the reltion is only significant and negative with soluble Mg^{++} in the soils of coastal barrier plains and beaches (r = -0.41*). This may be due to the presence of rather high concentration of soluble Mg^{++} in these soils. In this respect, Shalabbi (1977), studed the effect of soluble Ca^{++} and Mg^{++} on available phsophorus in saline soils of Egypt and found that the correlation coefficients between either soluble Ca^{++} or Mg^{++} and available phsophorus are significant and negative. He stated that increasing soluble Ca^{++} or Mg^{++} in saline soils enable phosphorus to be transformed into immobile forms.

4.4.3. Potassium:

4.4.3.1. Total potassium:

Data in Table (15) indicate that total potassium ranges from 2.1 to 7.1, 17.4 to 30.6 and 12.8 to 23.9 with the averages of 3.9, 24.1 and 18.9 me/100 g in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The higher values are presented in the fine textured soils, while the lower ones are associated with the coarse textured ones.

Highly significant and positive correlations have been found between total potassium and soil clay content in all the geomorphic units with r values of 0.75^{**}, 0.70^{**} and 0.74^{**}. Also, total potassium correlates positively with silt content in the soils repsresenting the recent Nile alluvial deposits ($r = 0.45^{*}$).

4.4.3.2. Available potassium:

The available potassium contents in the studied soil profiles are presented in Table (15). Data reveal that available k content ranges from 0.09 to 0.88, 0.74 to 5.0 and 0.38 to 1.41 with the averages of 0.39, 2.46 and 0.91 me/100g in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively.

Statistical analysis shows a significant and positive correlations between available K and clay content in the soils of coastal barrier plains and beaches and fluvio marine deposits with r values of 0.43^{*} and 0.32^{*}, respectively. A highly significant positive relation was attained between available K and clay content of the soils of the recent Nile alluvial deposits with r value of 0.53*.

4.5. Status of micro nutrients:

4.5.1. Total iron:

Data in Table (16) show that the total iron content in the soil profiles represent the coastal brrier plains and beaches have a range from 1.12 to 2.15%. Generally, the highest Fe content is recorded in the surface layers of soil profiles, while the lowest value is associated with the deepest ones, except profile No. 25 where the highest value is found in the deepest layer. This may be due to the relatively higher clay content in this layer.

Total Fe content in the soils of fluvio marine deposits varies from 5.30 to 6.95%. The highest values are found in the deepest layers of profiles 4, 16 and 28, while the lowest value is recorded in the deepest layer of profile 20. Concerning Fe content in the soils of recent Nile alluvial deposits, it ranges from 4.13 to 6.60%. The highest value is found in the surface layer of profile 5, while the lowest one is associated with the deepest layer of profile 29.

To work out a relationship between the distribution of trace elements and locality of the studied soil profiles, the statistical measures, i.e., weighted mean, trend and specific range were calculated according to Oertel and Giles (1963).

According to Oertel and Giles (1963) the weighted mean concentration of

Table (16): Total and available iron, manganese, zinc, copper and boron in the soil profiles representing the studied geomorphic units.

Geom. unit	Prof. No.	Depth cm	Fe Total %	Fe Avail. ppm	Mn Total ppm	Mn Avail. ppm	Zn Total ppm	Zn Avail. ppm	Cu Total ppm	Cu Avail. ppm	B Total ppm	B Avail. ppm
Coastal barrier plains and beaches	1	0 - 25	2.15	3.5	187.4	1.8	68.9	0.6	45.7	0.4	38.1	7.4
		25 - 50	1.90	2.9	145.5	1.3	51.5	0.5	34.9	0.4	31.5	6.9
		50 - 70	1.95	2.5	178.1	2.6	55.4	0.5	39.2	0.4	27.6	5.1
	2	0 - 30	1.95	4.1	185.6	3.6	52.1	1.6	43.2	1.1	21.3	3.1
		30 - 60	1.25	3.5	153.5	2.8	47.0	0.7	32.6	0.9	18.2	2.2
		60 - 80	1.25	3.2	159.9	2.1	48.5	0.7	31.1	0.5	18.7	1.5
	6	0 - 30	1.50	2.5	105.4	3.1	63.5	1.1	36.8	0.4	35.2	6.8
		30 - 65	1.25	2.3	82.6	1.6	49.8	0.6	33.9	0.4	30.4	5.4
	7	0 - 30	1.17	2.5	73.5	2.1	52.1	0.5	29.5	0.5	19.6	3.2
		30 - 60	1.12	2.1	82.3	1.5	51.4	0.3	28.5	0.3	19.6	3.5
		60 - 100	1.15	2.1	87.5	1.7	51.4	0.3	29.3	0.2	22.5	3.9
		100 - 150	1.15	2.1	87.5	1.5	53.7	0.2	30.5	0.2	24.1	4.5
	8	0 - 30	2.10	4.5	175.9	3.1	53.9	0.7	46.8	0.8	14.6	1.5
		30 - 60	1.25	3.6	155.1	4.2	46.5	0.4	35.1	0.5	13.2	1.1
		60 - 100	1.35	2.9	157.5	4.7	46.5	0.6	36.3	0.9	12.5	1.4
	12	0 - 20	1.75	5.1	175.2	1.7	47.8	0.5	38.5	0.8	27.8	5.5
		20 - 50	1.32	1.5	167.4	2.0	38.9	0.3	35.1	0.2	22.1	4.0
		50 - 70	1.27	2.3	153.9	3.4	45.1	0.3	36.6	0.1	25.3	4.6
	13	0 - 25	1.65	3.1	152.7	2.0	49.4	0.6	37.5	0.5	15.2	0.9
		25 - 50	1.50	2.2	145.8	1.8	45.6	0.5	31.8	0.1	16.1	0.9
		50 - 70	1.25	2.1	147.2	0.6	42.7	0.3	28.4	0.2	17.2	1.1
	19	0 - 30	1.40	2.9	145.9	0.6	53.7	0.4	32.7	0.2	25.3	4.3
		30 - 60	1.35	2.5	139.2	0.5	51.9	0.3	29.5	0.1	31.5	6.9
	25	0 - 20	1.35	3.9	115.4	0.8	55.4	0.5	34.4	0.1	22.8	3.5
		20 - 50	1.25	3.1	143.5	0.5	52.1	0.4	35.6	0.1	24.5	4.1
		50 - 75	2.05	2.1	165.7	0.7	59.6	0.4	39.7	0.1	30.4	5.7
Fluvio marine deposits	3	0 - 25	6.75	25.0	989.0	7.0	112.4	3.3	81.2	7.6	87.6	2.1
		25 - 50	5.92	6.9	948.0	5.3	124.5	2.8	79.5	3.9	81.2	3.3
		50 - 100	6.05	4.5	913.0	5.1	100.9	2.3	80.1	4.1	90.4	3.8
		100 - 150	6.75	3.8	1025.0	11.6	147.1	2.6	86.5	4.4	92.8	4.1
	4	0 - 25	6.25	11.1	975.0	4.0	165.6	1.4	83.3	5.9	82.6	1.6
		25 - 50	6.15	5.3	789.0	2.8	151.4	1.9	82.5	4.2	83.9	1.5
		50 - 100	6.35	4.7	813.0	3.5	153.5	1.9	87.1	3.6	90.4	1.7
		100 - 150	6.95	4.2	1043.0	4.9	179.1	3.8	92.4	5.7	100.9	1.6
	9	0 - 25	6.15	10.5	892.0	5.6	102.5	1.9	75.4	6.6	81.5	1.1
		25 - 50	6.00	8.1	813.0	8.3	96.7	1.4	71.6	6.9	75.6	1.0
		50 - 100	5.85	7.3	854.0	5.8	96.7	2.6	72.5	6.7	74.1	1.0
	10	0 - 25	6.25	24.9	914.0	5.1	149.1	4.2	81.9	8.2	79.3	1.0
		25 - 50	6.15	10.1	865.0	4.3	117.8	1.4	72.5	4.1	75.4	1.5
		50 - 100	6.07	8.7	870.0	4.7	138.5	1.2	75.3	7.4	72.1	1.6
		100 - 150	5.82	9.3	795.0	11.3	113.4	4.3	69.4	3.5	70.5	1.8

Table (16): cont.

Geom. unit	Prof. No.	Depth cm	Fe Total %	Fe Avail. ppm	Mn Total ppm	Mn Avail. ppm	Zn Total ppm	Zn Avail. ppm	Cu Total ppm	Cu Avail. ppm	B Total ppm	B Avail. ppm
Fluvio marine deposits	14	0 - 25	6.85	7.2	1143.0	7.0	142.5	1.1	92.1	3.6	81.7	4.1
		25 - 50	6.57	6.1	115.0	4.4	115.7	1.3	85.4	3.5	73.5	5.3
		50 - 90	6.42	7.1	992.0	5.9	123.8	2.1	79.5	6.2	70.8	4.6
	15	0 - 25	6.32	25.1	943.0	6.9	141.9	3.8	89.6	7.7	79.9	2.0
		25 - 50	5.75	6.9	897.0	5.1	133.1	1.9	72.4	4.3	71.3	2.0
		50 - 80	6.50	4.8	1013.0	5.2	145.3	1.9	85.3	4.4	75.6	2.4
		80 - 130	6.20	9.2	996.0	7.4	139.8	2.0	81.1	5.1	78.1	3.5
	16	0 - 30	6.55	15.8	988.0	7.1	150.4	4.1	75.6	6.2	78.7	2.1
		30 - 60	6.50	7.1	993.0	5.0	143.5	1.8	72.8	4.1	78.1	2.5
		60 - 100	6.90	5.3	1078.0	5.2	157.6	2.1	80.3	4.1	82.6	3.7
	17	0 - 25	6.48	12.1	907.0	4.4	102.4	2.1	86.1	6.1	82.5	1.7
		25 - 50	5.95	7.3	813.0	3.6	105.9	1.4	85.2	4.7	77.3	1.3
		50 - 95	6.17	7.5	932.0	7.4	139.1	1.5	87.4	4.6	79.4	1.5
	20	0 - 25	5.75	9.7	685.0	6.4	103.8	2.8	81.5	7.5	87.1	4.1
		25 - 50	5.30	6.5	599.0	5.1	99.6	2.1	76.6	5.3	95.8	6.5
	21	0 - 30	6.50	11.5	933.0	5.3	155.2	3.1	84.9	5.8	84.3	2.7
		30 - 75	6.40	7.4	937.0	4.2	149.7	2.2	75.3	3.4	89.5	4.5
	22	0 - 25	5.95	8.1	843.0	5.4	143.5	3.5	73.4	7.6	79.2	1.6
		25 - 50	5.90	2.9	818.0	4.6	125.6	3.1	70.5	5.8	75.0	2.0
		50 - 100	5.75	2.1	735.0	3.8	116.9	2.0	68.9	4.5	75.3	2.6
		100 - 150	5.52	3.2	712.0	3.5	115.3	2.7	68.1	4.5	78.9	4.2
	26	0 - 25	6.55	5.2	824.0	4.3	149.2	2.0	79.3	5.7	90.4	5.5
		25 - 50	6.32	4.3	793.0	3.1	122.4	1.3	74.1	3.8	85.1	4.3
		50 - 100	6.69	3.1	810.0	2.6	135.8	2.2	75.6	3.9	103.1	6.8
		100 - 150	6.15	4.1	790.0	3.5	124.3	1.9	72.9	6.3	110.3	7.1
	27	0 - 30	6.90	8.1	913.5	6.8	153.8	2.5	90.1	5.1	81.5	1.9
		30 - 60	6.65	4.9	887.6	5.4	147.9	2.0	82.5	4.3	75.3	2.3
		60 - 100	6.40	4.5	873.7	4.0	145.2	1.3	80.2	4.0	84.9	4.1
	28	0 - 25	6.85	8.9	876.0	6.5	157.1	0.8	82.3	4.4	83.6	1.5
		25 - 50	6.63	5.8	913.0	4.4	160.0	1.2	80.4	4.1	80.5	1.7
		50 - 100	6.65	4.2	925.0	4.3	162.3	1.7	85.6	5.0	85.4	1.7
		100 - 150	6.90	4.4	1057.0	3.7	173.2	3.2	90.5	6.7	89.1	2.4
Recent Nile alluvial deposits	5	0 - 25	6.60	11.9	976.0	4.5	139.5	2.8	81.2	6.7	69.5	0.9
		25 - 50	5.95	7.5	893.0	4.3	143.7	1.7	79.1	5.0	62.7	0.9
		50 - 100	5.70	5.6	763.0	2.9	125.8	1.9	71.0	5.1	55.4	0.7
		100 - 150	6.45	4.2	945.0	2.1	152.9	4.5	78.9	6.1	60.9	1.2
	11	0 - 25	5.56	18.1	745.0	5.2	135.8	3.1	68.7	6.1	52.9	0.7
		25 - 50	5.12	7.3	683.0	5.0	127.5	2.4	62.1	4.6	48.1	0.7
		50 - 100	5.43	2.9	747.0	3.9	118.1	1.3	65.4	4.2	48.9	0.7
		100 - 150	5.45	6.2	771.0	5.1	143.4	1.6	69.0	4.3	49.7	0.8

Table (16): cont.

Geom. unit	Prof. No.	Depth cm	Fe Total %	Fe Avail. ppm	Mn Total ppm	Mn Avail. ppm	Zn Total ppm	Zn Avail. ppm	Cu Total ppm	Cu Avail. ppm	B Total ppm	B Avail. ppm
Recent Nile alluvial deposits	18	0 - 30	5.85	12.9	745.0	4.5	127.8	3.5	75.8	7.9	58.9	0.8
		30 - 60	5.00	5.9	648.0	3.8	112.1	2.7	71.9	5.8	51.5	0.8
		60 - 90	4.15	3.5	559.0	2.9	93.7	1.1	65.1	2.5	47.7	0.5
	23	0 - 30	5.95	19.2	793.0	5.4	128.1	2.9	74.2	6.4	56.3	0.8
		30 - 60	5.50	7.1	722.0	3.9	120.5	2.0	70.1	4.9	49.5	0.7
		60 - 100	5.40	5.2	713.0	2.3	115.9	1.8	68.3	3.8	49.1	0.9
	24	0 - 25	6.27	12.3	835.0	4.2	158.1	2.6	85.6	7.4	63.7	1.1
		25 - 50	6.02	7.6	768.0	3.8	149.2	2.3	81.3	5.1	60.1	1.0
		50 - 100	6.60	4.1	842.0	3.5	155.3	2.3	88.5	3.9	55.3	1.2
	29	0 - 25	5.90	13.5	827.0	4.9	136.4	4.4	79.6	8.1	57.3	0.5
		25 - 75	5.25	6.8	650.0	4.0	125.1	3.6	72.5	7.5	52.4	0.5
		75 - 110	4.13	4.2	544.0	3.2	92.5	2.3	63.8	3.3	48.6	0.6
	30	0 - 40	5.50	25.1	619.0	3.9	122.5	3.1	75.0	6.5	56.8	0.9
		40 - 80	5.00	9.2	568.0	3.1	107.8	2.9	70.3	5.1	53.0	0.8
		80 - 130	4.32	6.8	499.0	2.4	89.9	1.5	62.1	2.9	49.5	0.6
	31	0 - 35	5.42	26.7	605.0	3.8	123.4	3.0	73.9	6.8	58.1	0.9
		35 - 80	5.05	8.1	581.0	3.7	105.6	2.6	70.5	4.9	53.7	0.7
		80 - 120	4.45	6.4	483.0	2.6	97.3	1.3	64.8	3.5	52.3	0.6

a certain element in a profile is obtained by multiplying its concentration in each sampled horizon of the solum by the thickness of horizon or layer and then dividing the sum of these products by the total thickness of all analyzed horizons or layers. That is the analytical result of each horizon is weighted in according with the thickness of the horizon.

In this respect, they mentioned that the weighted mean appears to be the most satisfactory measure of trace elements status in a soil profile that can be obtained from samples normally taken by soil surveyors.

Some information on any change in concentration with depth is provided by a measure called the trend and defined by $T = (W-S)/W$, when W is greater than S, or $T = (W-S)/S$, when W is less than S. In these equations, T denotes the trend, W the weighted mean concentration and S the concentration in the surface layer.

Oertel and Giles (1963), also stated that all values for T lie in the range from -1 to +1 and are in a sense, sysmmetrical when T is small.

This symmetry is distorted when T is large because a value of +1 is possible but a value of -1 is impossible. A small value for T does not necessrily imply a small range in the concentration throughout the profile. Definite information on this feature is therefore provided by the specific range, defined by:

$$R = (H - L)/W$$

where, R is the specific range, H is the highest and L is the lowest observed concentration in the solum, and W is the weighted mean. In this connection, a small value for T may be associated with any value for R. But a large value for T is necessarily associated with at least a moderately large value for R. Values for R can not be negative, but there is no definite upper limit. Values greatger than 1 are common and a value as greater as 0.99 has been noted.

While the weighted mean concentration for a trace element in a soil profile is probably determined as much by pedogenic processes as by the original concentration in the parent material, Oertel (1961), the trend (T) and specific range (R) are obviously determined by pedogenic processes alone (except where the parent material is markedly heterogenous in trace element content). Table (17) presents the statistical measures of Fe in the studied soil profiles. The computed weighted mean of total Fe in the soils of coastal barrier plains and beaches ranges betwen 1.15 and 2.00% with a tendency of increase in profile 1. The computed trend indicates more symmetrical distribution of total Fe in profiles 1, 6 and 13. The specific range indicates that the soils of profiles 8 and 25 are composed of homogeneous soil material, while other profiles are heterogeneous.

Concerning the computed weighted mean of Fe in the soils of Fluvio marine deposits, it ranges from 5.52 to 6.76% and the highest value is found in

Table (17) : Weighted mean , Trend and specific range of iron in the soil profiles representing the studied geomorphic units.

Geom. unit	Prof. No.	Weighted mean (W)		Trend (T)		Specific range (R)	
		Tot.%	Av,ppm	Tot.	Av.	Tot.	Av.
Coastal barrier plains and beaches	1	2.00	3.00	-0.07	-0.14	0.13	0.33
	2	1.51	3.65	-0.23	-0.11	0.46	0.25
	6	1.37	2.39	-0.09	-0.04	0.18	0.08
	7	1.15	2.19	-0.02	-0.12	0.04	0.18
	8	1.55	3.59	-0.26	-0.20	0.55	0.45
	12	1.43	2.76	-0.18	-0.49	0.34	1.30
	13	1.48	2.49	-0.10	-0.20	0.27	0.40
	19	1.38	2.70	-0.01	-0.07	0.04	0.15
	25	1.54	2.98	0.12	-0.04	0.52	0.60
Fluvio-marine deposits	3	6.38	8.08	-0.05	-0.68	0.13	2.62
	4	6.50	5.70	0.04	-0.49	0.12	1.21
	9	5.96	8.30	-0.03	-0.21	0.05	0.39
	10	6.03	11.83	-0.04	-0.52	0.7	1.32
	14	6.58	6.85	-0.04	-0.05	0.07	0.16
	15	6.21	10.80	-0.02	-0.57	0.12	1.88
	16	6.68	8.99	0.02	-0.43	0.06	1.17
	17	6.19	8.66	-0.04	-0.28	0.09	0.55
	20	5.52	8.10	-0.04	-0.16	0.08	0.40
	21	6.44	9.04	-0.01	-0.21	0.02	0.45
	22	5.73	3.60	-0.04	-0.56	0.08	1.67
	26	6.42	3.98	-0.02	-0.23	0.08	0.53
	27	6.62	5.70	-0.04	-0.30	0.08	0.63
	28	6.76	5.32	-0.01	-0.40	0.04	0.88
Recent Nile alluvial deposits	5	6.14	6.50	-0.07	-0.45	0.15	1.18
	11	5.41	7.27	-0.03	-0.60	0.08	2.09
	18	5.00	7.43	-0.15	-0.42	0.34	1.27
	23	5.60	9.97	-0.06	-0.48	0.10	1.40
	24	6.37	7.03	0.02	-0.43	0.04	1.17
	29	5.42	7.88	-0.08	-0.42	0.33	1.18
	30	4.89	13.17	-0.11	-0.45	0.24	1.39
	31	4.96	12.96	-0.08	-0.51	0.20	1.57

profile 28 while the lowest one is recorded in profile 20. The computed trend indicates symmetrical distribution in all profiles, except for profiles 4 and 16. The specific range indicates that the soils of all profiles are composed of homogeneous soil material.

The computed weighted mean of Fe in the soils of recent Nile alluvial deposits ranges from 4.89 to 6.37%, where the lowest value is found in profile 30, and the highest one is found in profile 24. The computed trend indicates symmetrical Fe distribution in all profiles, except for profile 24. The specific range indicates that the soils of profiles 18 and 29 have homogenous soil material, while the other profiles are heterogeneous.

The variations in the total Fe content among the studied soils are probably due to the differences in soil texture and organic matter content. It seems that the finer the texture and the higher the organic matter content, the higher is the total Fe content in the soil.

Statistical analysis was carried out to clarify the relationship between total Fe content and some soil variables in the soils of coastal barrier plains and beaches, Table (18). The obtained results indicate that total Fe is positively and highly significant correlated with each of clay and sum of clay+silt content, while it positively and significantly correlated with organic matter and available Fe. On the other hand, total Fe negatively and highly significant correlates with sand content as shown from the following multiple regression equation:

Total Fe = - 6.20 + 0.134 (clay%) + 0.0528 (clay+silt%) + 0.375(O.M%) - 0.0728(sand%)

The correlation coefficients between some soil constituents and total Fe in the soils of fluvio marine deposits are shown in Table (18). Data reveal total Fe is positively and highly significant correlated with each of clay and sum of clay+silt, and negatively highly significant with sand. The multiple regression equation is found to be:

Total Fe = 10.7 + 0.0451(clay%) + 0.0691(clay+silt) - 0.0662(sand%)

Relating the values of total Fe to the different constituents of the soils of recent Nile alluvial deposits, it could be seen from Table (18), that total Fe is positively and highly significant correlated with each of clay, sum of clay+silt and aorganic matter content. The obtained results also show a significant and positive correlation with $CaCO_3$. In contrast, total Fe is negatively and highly significant correlated with sand content. The obtained results are in close agreement with those of Holah (1977) and El-Toukhy (1987). The multiple regression equation has been computed to read:

Total Fe = 4.06 + 0.0364(clay%) + 0.0025(clay+silt%) + 0.153(O.M%) - 0.0150(sand%)

4.5.2. Available iron:

The amounts of available Fe extracted with DTPA in the soils of coastal barrier plains and beaches ranges from 2.1 to 5.1 ppm (Table, 16), while the weighted means (Table, 17) ranges from 2.19 to 3.65 ppm. The highest values are recorded in the surface layer of profiles 8 and 12, while the lowest ones are associated with the deepest layer of profiles 6, 7, 12, 13 and 25. Depthwise distribution of DTPA-extractable Fe indicates a tendency of decrease downwards in all profiles.

Considering the levels of available Fe in the surface layers of the studied profiles, it is evident that the surface layer of profile 12 is adequately supplied with Fe (containg > 4.5 ppm), while the surface layers of other profiles are within the marginal range, as they contain from 2.5 to 4.5 ppm, (Lindsay and Norvell, 1978).

Further informations about the relationship between available Fe content and soil variables in the soils of coastal barrier plains and beaches could be elucidated from the correlation coefficients presented in Table (18). The obtained data reveal that there is a significant positive correlation between available Fe and each of clay, silt and organic matter contents, while the correlation with clay+silt is highly significant. Available Fe is correlated negatively and high significantly with sand content.

Multiple regression analysis is calculated to evaluate the quantitative relationships between DTPA-extractable Fe and other soil variables as shown from the following multiple regression equation:

$$\text{DTPA-Fe} = 41.4 + 0.167(\text{clay\%}) + 0.186(\text{clay+silt\%}) + 1.13(\text{O.M\%}) - 0.396(\text{sand\%})$$

Soils of fluvio marine deposits have available Fe content in the range between 2.1 and 25.1 ppm (Table, 16), while the weighted mean ranges from 3.6 to 11.83 ppm, (Table, 17). The highest values are recorded in the surface layers of profiles 3, 10 and 15, while the lowest ones are found in the deepest layers of all profiles. Depthwise distribution of Fe indicates a tendency of decrease downwards in all profiles.

According to the critical levels reported by Lindsay and Norvell (1978), it is evident that the surface laryers of all profiles contain adequate amount of available Fe.

Statistical analysis shows a highly significant positive correlation between available Fe and organic matter content only. The presence of organic matter is known to increase the availability of Fe by binding with chelating compounds occuring naturally in the soils (Sillanapaa, 1962 and El-Gala and hendawy, 1972).

The DTPA extractable Fe in the soils of recent Nile alluvial deposits varies widely from 2.9 to 26.7 ppm. The weighted mean ranges between 6.50 and 13.17 ppm. The highest values are found in the surface layers of profiles 30 and 31, while the lowest ones are associated with the deepest layers of all profiles.

According to the critical levels reported by Lindsay and Norvell (1978), the surface layers of all profiles contain adequate amount of available iron.

The statistical analysis reveals a highly significant positive correlation between available Fe and organic matter content, while the realtionship is significant only with EC values. Similar results for available Fe in the Egyptian soils were reproted by Holah (1977) and Abdel-Razaik (1994).

4.5.3. Total manganese:

The results of total Mn in the soils under consideration are shown in Table (16). The data indicate that the total Mn content in the soils of coastal barrier plains and beaches ranges between 73.5 and 187.4 ppm. The highest value of total Mn is recorded in the surface layer of profile 1, while the lowest one is found in the surface layer of profile 7. Depthwise distribution of total Mn indicates a tendency of decrease downwards in all profiles, except for profiles 7 and 25 in which total Mn increases downwards.

Table (19) shows that the computed weighted mean of total soil Mn ranges from 83.07 to 169.78 ppm, and the computed trend indicates more symmetrical

Table (19) : Weighted mean , Trend and specific range of manganese in the soil profiles representing the studied geomorphic units.

Geom. unit	Prof. No.	Weighted mean (W), ppm Tot.	Weighted mean (W), ppm Av.	Trend (T) Tot.	Trend (T) Av.	Specific range (R) Tot.	Specific range (R) Av.
Coastal barrier plains and beaches	1	169.78	1.85	-0.09	0.03	0.25	0.27
	2	167.14	2.93	-0.10	-0.19	0.19	0.51
	6	93.12	2.29	-0.12	-0.26	0.24	0.66
	7	83.07	1.70	0.12	-0.19	0.17	0.35
	8	162.30	4.07	-0.08	0.24	0.13	0.39
	12	165.77	2.31	-0.05	0.26	0.13	0.74
	13	148.66	1.53	-0.03	-0.24	0.05	0.92
	19	143.41	0.65	0.20	-0.08	0.05	0.18
	25	142.55	0.55	-0.02	-0.19	0.35	0.46
Fluvio-marine deposits	3	968.83	7.62	-0.02	0.08	0.12	0.85
	4	896.00	3.93	0.02	0.02	0.28	0.53
	9	853.25	6.38	-0.04	0.12	0.09	0.42
	10	851.50	6.90	-0.07	0.26	0.14	1.01
	14	1068.11	5.79	-0.07	-0.17	0.14	0.45
	15	970.69	6.35	0.03	-0.08	0.12	0.36
	16	1025.50	5.71	0.04	-0.20	0.09	0.37
	17	894.11	5.61	-0.01	0.22	0.13	0.68
	20	642.00	5.75	-0.06	-0.11	0.13	0.23
	21	959.40	4.64	-0.03	-0.12	0.06	0.24
	22	759.17	4.10	-0.10	-0.24	0.17	0.46
	26	802.83	3.27	-0.03	-0.24	0.04	0.52
	27	889.81	5.26	-0.03	-0.23	0.04	0.53
	28	958.83	4.48	0.09	-0.31	0.19	0.63
Recent Nile alluvial deposits	5	880.83	3.13	-0.10	-0.30	0.24	0.77
	11	744.00	4.70	-0.001	-0.10	0.12	0.28
	18	650.67	3.73	-0.13	-0.17	0.28	0.43
	23	739.70	3.71	-0.07	-0.31	0.11	0.83
	24	821.75	3.75	-0.02	-0.11	0.09	0.19
	29	656.50	3.95	-0.21	-0.19	0.43	0.43
	30	557.15	3.0.8	-0.10	-0.21	0.22	0.49
	31	555.33	3.36	-0.08	-0.12	0.22	0.36

Mn distribution in profiles 1, 2, 6 and 8. The specific range of Mn dictates that the soil materials of profiles 8 and 12 are homogeneous, wherease other profiles are heterogenous.

With respect to the relation between total Mn and some soil constitutents in the soils of coastal barrier plains and beaches, data presented in Table (18) illustrate a positive and highly significant correlation between total Mn and clay content. The data also reveal a positive signifciant correlation between total Mn and sum of clay+silt and organic matter content, while a negative and highly significant correlation is found with sand content. The multiple regression equation reads:

$$\text{Total Mn} = 653 + 6.09(\text{clay}\%) + 5.3(\text{clay+silt}\%) + 48.0(\text{O.M}\%) - 5.5(\text{sand}\%).$$

The total Mn content in the soils of fluvio marine deposits ranges from 599.0 to 1143.0 ppm, Table (16). The highest value is found in the surface layer of profile 14, while the lowest one is recorded in the deepest layer of profile 20.

The computed weighted mean of total soil Mn ranges between 759.17 and 1068.11 ppm, the data of computed trend indicates more symmetrical Mn distribution in profiles 10, 14 and 20, while other profiles reveal non symmetrical distribution. The specific range of Mn in the soils of this geomorphic unit shows that the soil materials of sprofiles 3, 10, 14, 15, 17, 20 and 22 are homogeneous, whereas other profiles are heterogenous, Table (19).

To substantiate the role of some soil constituents on controlling total Mn content, the correlation coefficients between total Mn and each of these factors in the soils of fluvio marine deposits are calculated, Table (18). The obtained coefficients imply that the total Mn is positively and high significantly correlated with clay and sum of clay+silt, while it negatively and high significantly correlated with sand content. The data also reveal that there is a negative significant correlation between total Mn and $CaCO_3$ content. The multiple regression equation between total Mn and these soil constituents is:

$$\text{Total Mn} = 820 + 7.45(\text{clay\%}) + 2.5(\text{clay+silt}) - 6.65(\text{sand\%}) - 11.8(CaCO_3\%)$$

The results of total Mn in the soils of recent Nile alluvial deposits are given in Table (16) and indicate that the values of total Mn range from 483.0 to 976.0 ppm. The highest value is found in the surface layer of profile 5, while the lowest one is recorded in the deepest layer of profile 31. The distribution of total Mn in profiles 5, 11 and 24 does not show a regular pattern, while the rest profiles show similar pattern of total Mn distribution through the soil profiles as it decreases downwards.

Data in Table (19) indicate that the computed weighted mean of total Mn ranges from 555.33 to 880.83 ppm, and the computed trend indicates more symmetrical Mn distribution in profiles 5 and 23. The specific range of Mn shows that the soil material of profiles 5, 30 and 31 are homogeneous, whereas the soil materials of the other profiles are heterogeneous.

Concerning the relationships between total Mn and each of caly, clay+silt, sand, organic matter and $CaCO_3$ contents, statistical analysis (Table 18) shows a highly significant and positive correlation between total Mn and each of clay, sum of clay+silt and $CaCO_3$ content. Statistical analysis also reveals a significant positive correlation between total Mn and organic matter and highly significant and negative correlation is found concerning sand content. These results are in close agreement with those of Awadallah et al (1982) and Abdel-Razik (1994).

Multiple regression analysis engaging total Mn with clay, clay+silt, organic matter and sand, has yielded the following equation:

$$\text{Total Mn} = 1992 + 6.54(\text{clay\%}) + 14.4(\text{clay+silt\%}) + 2.0(\text{O.M\%}) - 18.3(\text{sand\%})$$

<u>4.5.4. Available manganese:</u>

The results of DTPA-extractable Mn in the soils of coastal barrier plains and beaches are given in Table (16) and indicate that available Mn ranges from 0.5 to 4.7 ppm. In the same true, the weighted mean of available Mn (Table, 19), ranges from 0.55 to 4.07 ppm.

Taking into consideration the deficiency limits of DTPA-extractable Mn (0.5 ppm) given by Lindsay and Norvell (1978), all of the studied soils of this geomorphic unit contain adequate to high levels of Mn to support normal plant growth.

Statistical analysis proves a highly significant and positive correlation between available Mn and silt content, while a significant and negative correlation is found concerning sand content, Table (18). The multiple regression equation has taken the form:

DTPA-Mn = 1.882 + 0.3311(silt%) - 0.0109(sand%).

The available Mn content in soils of fluvio marine deposits have varies from 2.6 to 11.6 ppm. The highest value is recorded in the deepest layer of profile 3, while the lowest one is found in the third layer (50-100 cm) of profaile 26. No clear trend is observed as regard to the available Mn distribution among the different layers of soil profiles, as it decreases downwards in some profiles while it increases in the others. The weighted mean of available Mn in the soils of this geomorphic unit ranges between 3.27 and 7.62 ppm, Table (19).

Considering to the deficiency limits of DTPA-extractrable Mn (0.5 ppm) given by Lindsay and Norvell (1978), all the studied soils of this geomorphic unit contain high levels of Mn to support normal plant growth.

The relationship between available Mn and some soil constituents in fluvio marine deposits could be elucidate from the correlation coefficients presented in Table (18). The obtained data reveal no significant correlation between available Mn and any soil constituent.

As regard to the available Mn content in the soils of recent Nile alluvial deposits, Table (16) indicates that it ranges from 2.1 to 5.4 ppm, while the weighted mean ranges between 3.08 and 4.70 ppm, Table (19). The highest value is found in the surface layer of profile 22 while the lowest one is recorded in the deepest layer of profile 5. Depthwise distribution of DTPA-extractable Mn indicates a tendency of decrease downwards in all profiles.

According to the deficiency limits of DTPA-extractable Mn (0.5 ppm) given by Lindsay and Norvell (1978), all the studied soils of this geomorphic unit contain high levels of Mn to support normal plant growth,

With respect to the relation between available Mn and some constituents in the soils of recent Nile alluvial deposits, data presented in Table (18) illustrate a highly significant positive correlation between available Mn and each of silt and organic matter content and significant positive correlation with sum of clay+silt. On the other hand available manganese has a highly significant negative correlation with EC and significant negative correlation with sand content. These results are in harmony with those obtained by Safwat (1980), Taha (1980) and El-Toukhy (1987).

Multiple regression analysis has carried out to obtain the relation between silt, clay+silt, organic matter and sand and DTPA-extractable Mn. The multiple regression equation is:

$$\text{DTPA-MN} = 20.88 + 0.0392(\text{silt}\%) + 0.1933(\text{clay+silt}\%) + 0.6814(\text{O.M}\%) - 0.1905(\text{sand}\%).$$

4.5.5. Total zinc:

The results of total Zn content in the soils under consideration are given in Table (16). The data show that the total Zn content in the soils of coastal barrier plains and beaches ranges from 38.9 to 68.9. The highest value of total Zn is found in the surface layer of profile 1, while the lowest one is found in the second layer of profile 12.

The obtained data show that the total Zn content in the soils of fluvio marine deposits varies between 96.7 and 179.1 ppm. The highest value is recorded in the deepest layer of profile 4, while the lowest one is observed in the deepest layer of profile 9.

The results of total Zn content in the soils of recent Nile alluvial deposits ranges from 89.9 to 158.1 ppm. The highest value is found in the surface layer of profile 24, while the lowest one is recorded in the deepest layer of profile 30.

No clear trend is observed as regards Zn distribution among the different layers of the soil profiles of the three geomorphic units, as it decreases downwards in some profiles while increases in the others.

The data of weighted mean, trend and specific range of total Zn in the investigated soils are shown in Table (20). The data reveal that the computed weighted mean in the soils of coastal barrier plains and beaches ranges from 43.21 to 58.83 ppm with a tendency of increase in profile 1. The computed trend indicates more symmetrical distribution of total Zn in profiles 6, 8, 12 and 13. The specific range reveals that the soils of profiles 8, 13 and 25 are composed of homogeneous soil material, while other profiles are heterogeneous.

The computed weighted mean of total Zn in the soils of fluvio marine deposits ranges between 98.15 and 164.68 ppm. The highest value is found in profile 28, while the lowest one is associated with profile 9. The computed trend indicates more symmetrical distribution of Zn in profiles 10, 22 and 26. The specific range shows that the soils of profiles 9, 20, 21 and 27 are composed of homogeneous soil material, while other profiles are heterogeneous.

The computed weighted mean of total Zn in the soils of recent Nile alluvial deposits ranges from 99.01 to 154.38 ppm. The lowest value is found in profile 5, while the highest one is recorded in profile 24. The computed trend indicates more symmetrical Zn distribution in profiles 18, 29, 30 and 31. The specific range indicates that the soils of profiles 5, 18, 30 and 31 are composed of homogeneous soil materials, while other profiles are heterogeneous.

Table (20) : Weighted mean , Trend and specific range of zinc in the soil profiles representing the studied geomorphic units.

Geom. unit	Prof.	Weighted mean (W) , ppm		Trend (T)		Specific range (R)	
	No.	Tot.	Av.	Tot.	Av.	Tot.	Av.
Coastal barrier plains and beaches	1	58.83	0.54	-0.15	-0.10	0.30	0.19
	2	49.29	1.04	-0.05	-0.35	0.10	0.87
	6	56.12	0.83	-0.12	-0.25	0.24	0.60
	7	52.09	0.32	-.0002	-0.36	0.04	0.94
	8	48.72	0.57	-0.10	-0.19	0.15	0.53
	12	43.21	0.36	-0.10	-0.28	0.21	0.56
	13	46.13	0.48	-0.07	-0.20	0.15	0.63
	19	52.80	0.35	0.02	-0.13	0.03	0.29
	25	55.48	0.43	0.001	-0.14	0.14	0.23
Fluvio-marine deposits	3	122.15	2.65	0.08	-0.20	0.38	0.38
	4	163.70	2.45	-0.01	0.43	0.17	0.98
	9	98.15	2.13	-0.04	0.11	0.06	0.56
	10	128.45	2.77	-0.14	-0.34	0.28	1.12
	14	126.74	1.60	-0.11	0.31	0.21	0.63
	15	140.18	2.30	-0.01	-0.39	0.09	0.83
	16	151.21	2.61	0.01	-0.36	0.09	0.88
	17	120.71	1.63	0.15	-0.22	0.30	0.43
	20	101.70	2.45	-0.02	-0.13	0.04	0.29
	21	151.90	2.56	-0.02	-0.17	0.04	0.35
	22	122.25	2.67	-0.15	-0.24	0.23	0.78
	26	131.97	1.92	-0.12	-0.04	0.20	0.47
	27	148.59	1.87	-0.03	-0.25	0.06	0.64
	28	164.68	1.97	0.05	0.59	0.10	1.22
Recent Nile alluvial deposits	5	99.01	2.88	-0.29	0.03	0.27	0.97
	11	131.05	1.88	-0.03	-0.39	0.19	0.96
	18	111.20	2.43	-0.13	-0.31	0.31	0.71
	23	120.94	2.19	-0.06	-0.24	0.10	0.50
	24	154.48	2.38	-0.02	-0.08	0.06	0.13
	29	117.30	3.37	-0.14	-0.23	0.37	0.62
	30	105.44	2.42	-0.14	-0.22	0.31	0.66
	31	108.03	2.28	-0.12	-0.24	0.24	0.75

Concerning values of trend and specific range in the three geomorphic units, the obtained data indicate that the soils of fluvio marine deposits attain the highest symmetry for Zn distribution, as indicated by their small T and R values.

Variation in the total Zn content among the studied soils are probably due to variation in soil texture and organic matter content. It seems that the finer the texture and the higher the organic matter content, the higher is the total Zn content of the soil.

To clarify the relationship between total Zn content and some soil constituents in the soils of coastal barrier plains and beaches could be elucidated from the correlation coefficients presented in Table (18). The data shows that total Zn is positively and high significantly correlated with each of clay, sum of clay+silt and EC. On the other hand, total Zn has a negatively and highly significant correlation with sand content. The multiple regression equation has calculated as:

$$\text{Total Zn} = -0.5 + 1.492(\text{clay\%}) + 0.527(\text{clay+silt\%}) - 0.460(\text{sand\%})$$

The correlation coefficients between some soil variables and total Zn in the soils of fluvio marine deposits are shown in Table (18). The data reveal that a positively and highly significant correlation has found between total Zn and clay content, positively significant with sum of clay+silt and negatively significant with sand content. The multiple regression equation is:

Total Zn = 133.4 + 2.55(clay%) + 1.49(clay+silt%) - 0.49(sand%)

Relating the values of total Zn to the different constituents of the soils of recent Nile alluvial deposits, it could be seen from Table (18), that total Zn content is positively and highly signifciant correlated with each of clay and sum of clay+silt, and positively significant with organic matter content and available Zn. The data also show a highly significant and negative correlation is found concerning sand content. These results are in close agreement with those of El-Kadi (1970) and Aboul-Roos et al (1981). The multiple regression equation has been computed to read:

Total Zn = 484 + 1.11(clay%) + 3.92(clay+silt%) + 0.09(O.M%) - 4.40(sand%)

4.5.6. Available zinc:

The results of DTPA-extractable Zn of the studied soils are given in Table (16). The data indicate that the values of available Zn range from 0.2 to 1.6, 0.8 to 4.2 and 1.1 to 4.4 ppm in the soils of coastal barrier plains and beaches, fluvio marine and recent Nile alluvial deposits, respectively. The weighted mean of available Zn for these soils ranges from 0.32 to 1.04, 1.6 to 2.77 and 1.88 to 3.37 ppm, Table (20).

Lindsay and Norvell (1978) found that the levels of DTPA-extractable Zn in soils that separate deficient, marginal and sufficient soil are < 0.5, 0.5-1.0

and >1.0 ppm, respectively. Considering these limits, all the studied soils of fluvio marine and recent Nile alluvial deposits are within the sufficient range to support normal plant growth. In the soils of coastal barrier plains and beaches, profiles 2 and 6 are sufficient, profile 19 is deficient, while other profiles are within the marginal range.

Further information about the relationship between available Zn content and some soil constituents in coastal barrier plains and beaches could be elucidate from correlation coefficients presented in Table (18). The obtained data show that available Zn is positively and highly significant correlated with each of clay, sum of clay+silt, organic matter and negatively with sand content. The multiple regression equation is found to be:

$$\text{DTPA-Zn} = 12.518 + 0.0113(\text{clay}\%) + 0.0831(\text{clay+silt}\%) + 0.677(\text{O.M}\%) - 0.1239(\text{sand}\%)$$

Available Zn in the soils of fluvio marine and recent Nile alluvial deposits has a positive significant correlation with organic matter, Table (18). These results ar in harmony with those of Kamh (1977); El-Sayad (1983); Rashad (1986) and Abdel-Razik (1994).

4.5.7. Total copper:

The results of total Cu content in the investigated soils are given in Table (16). The obtained data show that total Cu content in the soils of coastal barrier plains and beaches ranges from 28.4 to 46.8 ppm. The highest value is found in the surface layer of profile 8, while the lowest one is observed in the deepest layer of profile 13.

The total Cu content in the soils of fluvio marine deposits ranges between 69.4 and 92.4 ppm. The highest value is recorded in the deepest layer of profile 4 and the lowest one is found in the deepest layer of profile 10.

The total Cu content in the soils of recent Nile alluvial deposits varies from 62.1 to 88.5 ppm. The highest value is found in the deepest layer of profile 24, while the lowest one is recorded in the deepest layer of profile 30. These results are in harmony with those of Salama (1981) and El-Sayad (1983).

The data of weighted mean, trend and specific range of Cu in the soils under consideration are given in Table (21). The data indicate that the computed weighted mean in the soils of coastal barrier plains and beaches ranges between 29.03 and 39.99 ppm with a tendency of increase in profiles 1 and 8. The computed trend indicates more symmetrical distribution of total Cu in profiles 1, 6 and 13. The specific range reveals that the soils of profiles 6, 12 and 19 are composed of homogeneous soil material, while other profiles are heterogeneous.

The computed weighted mean of Cu in the soils of fluvio marine deposits ranges between 69.65 and 87.47 ppm. The highest value is recorded in profile 4, while the lowest one is found in profile 22. The computed trend indicates

Table (21) : Weighted mean , Trend and specific range of copper in the soil profiles representing the studied geomorphic units.

Geom. unit	Prof. No.	Weighted mean (W) , ppm		Trend (T)		Specific range (R)	
		Tot.	Av.	Tot.	Av.	Tot.	Av.
Coastal barrier plains and beaches	1	39.99	0.40	-0.12	0.00	0.27	0.00
	2	36.20	0.88	-0.16	-0.20	0.33	0.68
	6	32.24	0.40	-0.12	0.00	0.09	0.00
	7	29.03	0.29	0.02	-0.42	0.07	1.03
	8	39.09	0.75	-0.16	-0.06	0.30	0.40
	12	36.50	0.34	-0.05	-0.58	0.09	2.06
	13	32.86	0.27	-0.12	-0.46	0.27	1.48
	19	31.10	0.15	-0.05	-0.25	0.10	0.67
	25	36.65	0.10	0.06	0.00	0.14	0.00
Fluvio-marine deposits	3	70.32	4.75	-0.13	-0.38	0.10	0.78
	4	87.47	4.78	0.05	-0.19	0.11	0.48
	9	73.00	6.72	-0.03	0.02	0.05	0.04
	10	73.97	5.68	-0.10	-0.31	0.17	0.83
	14	84.63	4.72	-0.08	0.24	0.15	0.57
	15	82.03	5.28	-0.08	-0.31	0.21	0.64
	16	76.64	4.73	0.01	-0.24	0.10	0.44
	17	86.48	5.02	0.1	-0.33	0.03	0.30
	20	79.05	6.40	-0.03	-0.15	0.06	0.34
	21	79.20	4.36	-0.07	-0.25	0.12	0.55
	22	69.65	5.23	-0.05	-0.31	0.08	0.59
	26	75.07	4.98	-0.05	-0.13	0.09	0.05
	27	83.86	4.42	-0.07	-0.13	0.12	0.25
	28	85.82	5.32	0.04	0.17	0.12	0.49
Recent Nile alluvial deposits	5	76.68	5.68	-0.06	0.15	0.13	0.30
	11	66.60	4.62	-0.03	-0.24	0.10	0.41
	18	70.93	5.40	-0.06	-0.32	0.15	1.00
	23	70.61	4.91	-0.05	-0.23	0.08	0.53
	24	85.98	5.08	0.004	-0.31	0.08	0.69
	29	71.35	6.30	-0.10	-0.22	0.22	0.76
	30	68.59	4.68	-0.09	-0.28	0.19	0.77
	31	69.59	4.99	-0.06	-0.27	0.13	0.66

more symmetrical distribution of Cu in profiles 14, 15, 21, 22, 26 and 27. The specific range shows that the soils of profiles 3, 4, 16, 21, 27 and 28 are composed of homogeneous soil material, while other profiles are heterogeneous.

The computed weighted mean in the soils of recent Nile alluvial deposits ranges from 66.60 to 85.98 ppm. The lowest value is found in profile 11, while the highest one is recorded in profile 24. The computed trend indicates more symmetrical distribution in profiles 5, 18, 23 and 31. The values of specific range indicate that the soils of profiles 11, 23 and 24 are composed of homogeneous soil material, while other profiles are heterogeneous.

Concerning values of trend and specific range in the three geomorphic units, the obtained data indicate that the recent Nile alluvial deposits attain the highest symmetry for Cu distribution, as indicated by their small T and R values.

With respect to the relation between total Cu and some soil constituents in the soils of coastal barrier plains and beaches, data presented in Table (18) illustrate a highly significant and positive correlation between total Cu and clay, sum of clay+silt and organic matter contents; a significant and positive correlation with available Cu and a highly significant and negative correlation with sand content. The multiple regression equation has computed as:

$$\text{Total Cu} = 22.3 + 0.633(\text{clay}\%) + 0.702(\text{clay+silt}\%) + 7.58(\text{O.M}\%) - 0.043(\text{sand}\%)$$

Relating the values of total Cu to the different variables of the soils of fluvio marine deposits, it could be seen from Table (18), that total Cu is highly significant positively correlated with clay and sum of clay+silt and negatively with sand content. The multiple regression equation has computed to be:

$$\text{Total Cu} = 34.047 + 0.585(\text{clay\%}) + 0.134(\text{clay+silt\%}) + 2.74(\text{O.M\%})$$

The correlation coefficient between soil variables and total Cu in the soils of recent Nile alluvial deposits are computed, Table (18). The obtained results show highly significant and positive correlation between total Cu and clay, sum of clay+silt; significant and positive correlation with organic matter and available Cu and highly significant and negative correlation with sand content. These results are in agreement with those of Aboul-Roos and Abdel-Wahid (1978); Salama (1981) and El-Toukhy (1987). The multiple regression equation between total Cu and these soil constituents is:

$$\text{Total Cu} = 92.97 + 0.690(\text{clay\%}) + 0.539(\text{clay+silt\%}) + 1.56(\text{O.M\%}) - 0.397(\text{sand\%})$$

4.5.8. Available copper:

The data of DTPA-extractable Cu of the investigated soils are shown in Table (16). The results indicate that available Cu ranges from 0.1 to 1.1, 3.4 to 8.2 and 2.5 to 8.1 ppm in the soils of coastal barrier plains and beaches, fluvio marine and recent Nile alluvial deposits, respectively. The weighted mean of available Cu in these soils ranges from 0.10 to 0.88, 4.36 to 6.72 and 4.62 to 6.30 ppm, Table (21). These results are in close agreement with those of El-Sayad (1983) and Rashad (1986).

Taking into consideration the deficiency limits of DTPA-extractable Cu (0.2 ppm) given by Lindsay and Norvell (1978), all of the studied soils, except for profile 25, contain adequate to high levels of Cu to support normal plant growth.

The correlation coefficients between some soil variables and DTPA-extractable Cu in the soils of coastal barrier plains and beaches are computed, Table (18). The obtained results show a positive and significant correlation between available Cu and silt and clay+silt, while available Cu is negatively correlated highly significant with sand. The multiple regression equation is :

$$\text{DTPA-Cu} = 22.984 + 0.059(\text{silt\%}) + 0.213(\text{clay+silt\%}) - 0.229(\text{sand\%})$$

The correlation coafficient between available Cu and some soil properties in the soils of fluvio marine deposits are computed in Table (18). The results imply that available Cu has a highly significant and positive correlation with organic matter content.

Further information about the relationship between available Cu and some soil constituents in the soils of recent Nile alluvial deposits could be extrapolated from Table (18). The obtained data reveal that available Cu is highly significant positively correlated with sum of clay+silt and organic matter content; significant and positively correlated with clay content and highly significant and negatively correlated with sand conten and EC. The multiple regression equation is found to be:

$$\text{DTPA-Cu} = 8.27 + 0.0017(\text{clay\%}) + 0.041(\text{clay+silt\%}) + 1.434(\text{O.M\%}) - 0.064(\text{sand\%})$$

4.5.9. Total boron:

Data of total and available boron are given in Table (16). The obtained results indicate that the total B content in the soils of coastal barrier plains and beaches ranges between 12.5 and 38.1 ppm. The highest value is found in the surface layer of profile 1, while the lowest one is associated with the deepest layer of profile 8. No clear trend is observed as regards B distribution among the different layrs of the soil profiles, as it decreases downwards in some profiles while increases in the others.

As shown in Table (22), the computed weighted mean ranges between 13.34 and 32.74 ppm. The computed trend indicates that B distribution in profiles 2, 6, 8 and 12 is more symmetrical. The specific range shows that the soils display some homogenity of their soil materials in profiles 2, 6, 8 and 13.

Variations in total B content are due to variations in soil texture, organic

Table (22) : Weighted mean , Trend and specific range of boron in the soil profiles representing the studied geomorphic units.

Geom. unit	Prof.	Weighted mean (W) , ppm		Trend (T)		Specific range (R)	
	No.	Tot.	Av.	Tot.	Av.	Tot.	Av.
Coastal barrier plains and beaches	1	32.74	6.56	-0.14	-0.11	0.32	0.35
	2	19.49	2.36	-0.08	-0.24	0.16	0.68
	6	32.62	6.05	-0.07	-0.11	0.15	0.23
	7	21.53	3.78	0.09	0.15	0.21	0.34
	8	13.34	1.34	-0.09	-0.11	0.16	0.30
	12	24.64	4.60	-0.11	-0.16	0.23	0.33
	13	16.09	0.96	0.06	0.06	0.12	0.10
	19	28.40	5.60	0.11	0.23	0.22	0.46
	25	26.01	4.47	0.12	0.22	0.29	0.49
Fluvio-marine deposits	3	89.20	3.53	0.02	0.41	0.13	0.57
	4	91.52	1.62	0.10	0.01	0.20	0.12
	9	76.32	1.03	-0.06	-0.06	0.10	0.10
	10	73.32	1.55	-0.08	0.35	0.12	0.52
	14	74.58	4.66	-0.09	0.12	0.15	0.26
	15	76.56	2.67	-0.04	0.25	0.12	0.56
	16	80.08	2.86	0.02	0.27	0.06	0.56
	17	79.66	1.50	-0.03	-0.12	0.07	0.27
	20	91.45	5.30	0.05	0.23	0.10	0.42
	21	87.42	3.78	0.04	0.29	0.6	0.48
	22	77.10	2.87	-0.03	0.44	0.05	0.91
	26	100.38	6.27	0.10	0.12	0.25	0.45
	27	81.00	2.90	0.01	0.34	0.12	0.76
	28	85.52	1.90	0.02	0.21	0.10	0.47
Recent Nile alluvial deposits	5	60.80	0.93	-0.13	0.03	0.23	0.54
	11	49.70	0.73	-0.06	0.04	0.10	0.14
	18	52.70	0.70	-0.11	-0.13	0.21	0.43
	23	51.38	0.81	-0.09	0.01	0.14	0.25
	24	58.60	1.13	-0.08	0.03	0.14	0.18
	29	52.30	0.53	-0.09	0.06	0.17	0.19
	30	52.82	0.75	-0.07	-0.17	0.14	0.40
	31	54.52	0.73	-0.06	-0.19	0.11	0.41

matter content and total soluble salts. It seems that the finer the texture, the higher the organic matter, and the higher the total soluble salts, the higher is the total boron content of the soils.

The statistical analysis shows a positive correlation between total B and clay and highly significant and positive correlations with EC and avialble B, Table (18). The multiple regression equation is:

$$\text{Total B} = 16.5662 + 0.1373(\text{clay\%}) + 0.2438(\text{EC})$$

The total B content in the soils of fluvio marine deposits ranges from 70.5 to 110.3 ppm. The lowest value is observed in the deepest layer of profile 10, while the highest one is found in the deepest layer of profile 26.

The computed weighted mean of B in the soils of fluvio marine deposits varies from 73.32 to 100.38 ppm. The values of trend indicate that B distribution in profiles 9, 15, 17 and 22 is more symmetrical than that of the other profiles. The specific range dictates that the soils of profiles 16, 17, 21 and 22 have homogeneous soil material while the other profiles are heterogeneous.

The correalation coefficients between some soil constituents and total B in the soils of fluvio marine deposits are shown in Table (18). The obtained results illustrate a positively correlation between total B and clay content; a positively and significant correlation with $CaCO_3$ and positively and highly significant correlations with EC and available B. The multiple regression equation is:

$$\text{Total B} = 48.947 + 0.494(\text{clay\%}) + 0.826(\text{EC}) + 0.649(\text{CaCO}_3\%)$$

The total B content in the soils of recent Nile alluvial deposits ranges between 47.7 and 69.5 ppm. The highest value is recorded in the surface layer of profile 5, while the lowest one is found in the deepest layer of profile 18.

The computed weighted mean of B in the soils of recent Nile alluvial deposits varies from 49.70 to 58.60 ppm. The values of trend range from - 0.13 to -0.06, indicating symmetrical distribution in all soil profiles. The sspecific range dictates that the soil materials of profiles 11, 23, 24, 30 and 31 are homogeneous, whereas other profiles are heterogeneous.

Concerning values of trend and specific range in the three geomorphic units, the data indicate that the recent Nile alluvial deposits attain the highest symmetry for B distribution, as indicated by their small T and R values.

To substantiate the role of some soil variables on controlling total B content, the correlation coefficient between total B and each of these factors in the soils of recent Nile alluvial deposits are computed, Table (18). The obtained coefficients imply that the total B content is positively and high significantly correlated with caly; sum of clay+silt; organic matter and available B and negatively and high significantly correlated with sand content. The data also reveal that there is a significant positive correlation between total B and $CaCO_3$. These results are in agreement with those of El-Seewi and El-Malky (1979); Helal (1982) and El-Toukhy (1987). The multiple regression equation has found to be:

$$\text{Total B} = -58.06 + 0.417(\text{clay}\%) + 0.856(\text{clay+silt}\%) + 3.825(\text{O.M}\%) + 1.018(\text{sand}\%) + 1.937(CaCO_3\%)$$

4.5.10. Available boron:

The results of available B in the studied soils are given in Table (16). The obtained data indicate that available B ranges from 0.9 to 7.4, 1.0 to 7.1 and 0.5 to 1.2 ppm in the soils of coastal barrier plains and beaches, fluvio marine and recent Nile alluvial deposits, respectively. The weighted mean of available boron in these soils ranges from 0.96 to 6.56, 1.03 to 6.27 and 0.70 to 1.13 ppm. These results are in close agreement with those of Awad and Mikhael (1980) and El-Toukhy (1987).

Considering the limits proposed by Richards (1954), available boron in the soils of coastal barrier plains and beaches (except for profiles 8 and 13) and fluvio marine deposits (except for profile 9) are within unsafe limits (> 1.5 ppm). This may be due to contamination by the seepage from Mediterranean sea or Burullus lake, saline and high water table and dry climate.

The correlation coefficients between some soil constituents and available B in the studied soils are shown in Table (18). The obtained results indicate that available B in the soils of coastal barrier plains and beaches is positively and high significantly correlated with EC and insignificant with clay. The multiple regression equation is :

Av. B = 1.945 + 0.0011(clay%) + 0.0732(EC)

The correlation coefficients between available B and some soil variables in the soils of fluvio marine deposits are given in Table (18). The results imply that available B has a highly significant and positive correlation with $CaCO_3$ percentage and EC values. The multiple regression equation is :

Av. B = 1.10 + 0.198(EC) + 0.145($CaCO_3$%)

The highly significant and positive correlations found between available B and total soluble salts indicate that boron concentration in soils increases with the advancement in the degree of salinization. Such a relation confirms previous findigns of many authors (EL-Rashidi, 1965; El-Kholi et al, 1970; Awad and Mikhael, 1980 and El-Toukhy, 1987).

Relating the values of available B to the different constituents of the soils of recent Nile alluvial deposits, it could be seen from Table (18), that available B is high significantly and positively correlated with clay and sum of clay+silt and negatively with sand content. The multiple regression equation has computed to read:

$$\text{Av. B} = -2.64 + 0.0138(\text{clay}\%) + 0.0289(\text{clay+silt}\%) - 0.0291(\text{sand}\%)$$

4.6. Land evaluation:

4.6.1. Qualitative rating of land:

4.6.1.1. the USDA system of land capability classification:

The prime aim of the system is to assess the degree of limitation to land use or potential imposed by land characteristics on the basis of permanent properties. A scale of land capability grades can thus be envisaged with the degree of limitation and hazard defining the classes. This concept is illustrated in Fig. 2 with the eight classes of the USDA system.

For convenience, type and degree of limitations of capability classes are summarized in Table (5) and the capability classes of the soil profiles in the studied area are listed in Table (23).

Applying the USDA system of land capability classification, the studied area could be calssified into five land classes as follows:

Class I:

Soils in this class have few limitations that restrict their use. These soils are suited to a wide range of plants, they are level and the erosion hazard from

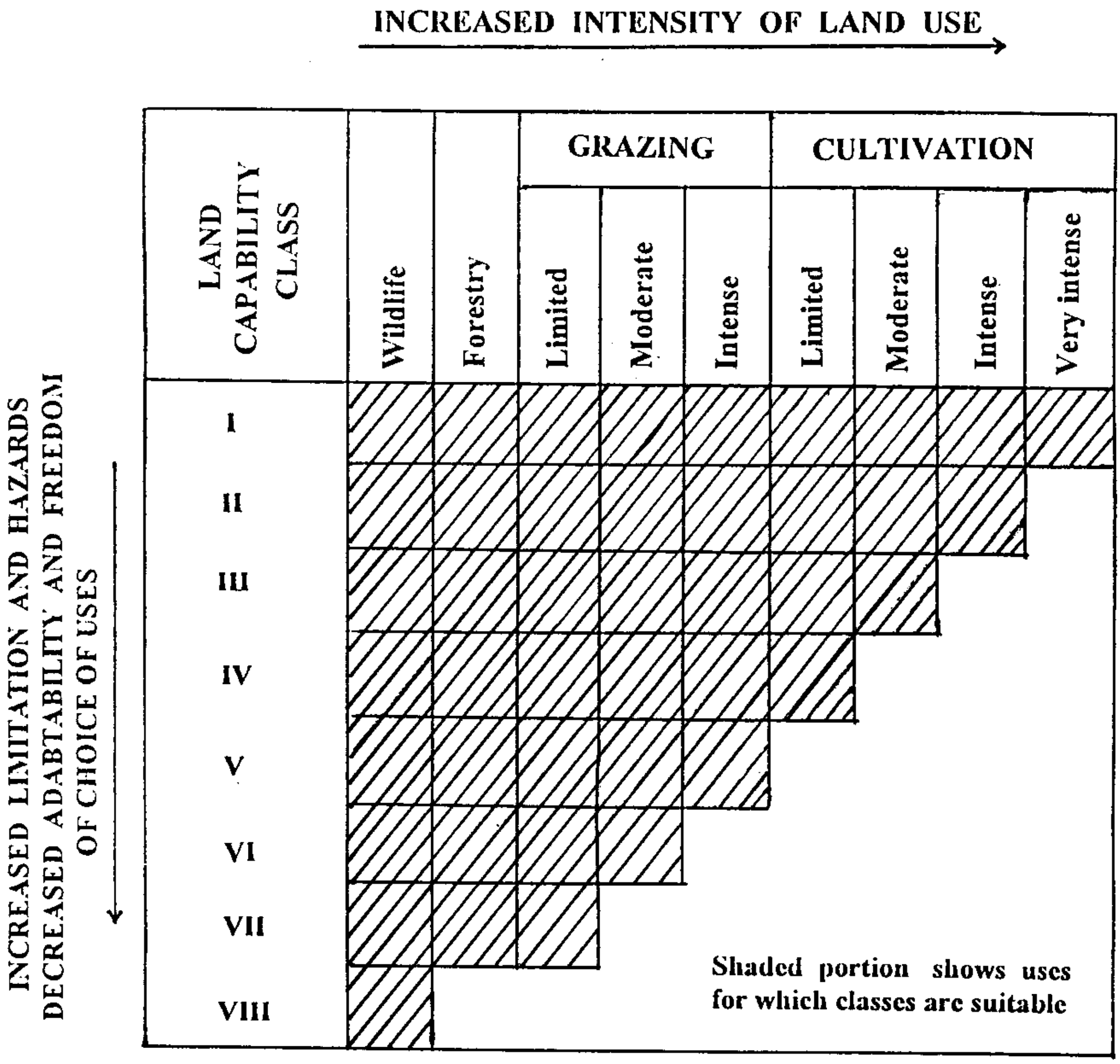


Fig. (2): Intensity with which each land capability class can be used with safety. (Brady, 1974).

Table (23): Land evaluation of the studied area following qualitative systems.

Geom. unit	Prof. No.	Qualitative systems Classes USDA	FAO
Coastal barrier Panins and beaches	1	V	N2
	2	IV	S3
	6	V	N2
	7	IV	S3
	8	IV	S3
	12	V	N2
	13	IV	S3
	19	V	N1
	25	IV	N1
Fluvio-marine deposits	3	II	S2
	4	II	S2
	9	II	S2
	10	II	S2
	14	III	S3
	15	II	S2
	16	III	S3
	17	II	S2
	20	IV	N1
	21	IV	N1
	22	II	S2
	26	IV	S3
	27	III	S3
	28	II	S2
Recent Nile alluvial deposits	5	II	S2
	11	I	S1
	18	II	S2
	23	II	S2
	24	II	S2
	29	II	S2
	30	I	S1
	31	I	S1

wind or water is very low. The soils are deep, generally well drained and easily worked. They hold water well and are either fairly well supplied with plant nutrients or highly responsive to inputs of fertilizers. The soils of this class are not subject to over flow hazard. They are productive and suited to intensive cropping. The local climate is favourable for growing many of the common field crops. In irrigated areas, soils may be placed in class I if the limitation of the arid climate has been removed by relatively irrigation works.

Class II:

These soils are deep, generally well drained and easily worked. They are productive to many field crops. Some of these soils have some limitations including low to moderate wetness and slight to moderate salt or sodium hazard.

Class III:

These soils have severe limitations that reduce the choise of crops or require special conservation practices, or both.

Limitations within this capability group include:

- Moderate climatic limitation.
- Moderately unfavourable structure and workability.
- Moderate salinity or sodium hazard.

Class IV:

Soils within this category have severe limitations that restrict the choice of crops, or require very careful management, or both. The soils of this class include:

- Coarse textured soils of coastal barrier plains.
- Shallow clayey soils of fluvio marine deposits.

Limitations of this category include:

- Moderate climatic limitations.
- Moderate susceptibility to erosion.
- Moderately unfavourable structure and workability.
- Slight to moderate salinity or sodium hazard.
- Very poor fertility level.
- Low available water capacity.

Class V:

Soils in class V have very severe limitations, impractical to remove, that limit their use largely. The soils belonging to this class are those occuping the sandy beaches. They are nearly level, frequently overflowed by streams and highly saline with expected sodium, magnesium and boron hazard. It is neither feasible nor practical to consider these soils as arable land.

Figure (3) presents the calculated area of each class, and map (4) shows the practical application of land capability system of the USDA in the studied area.

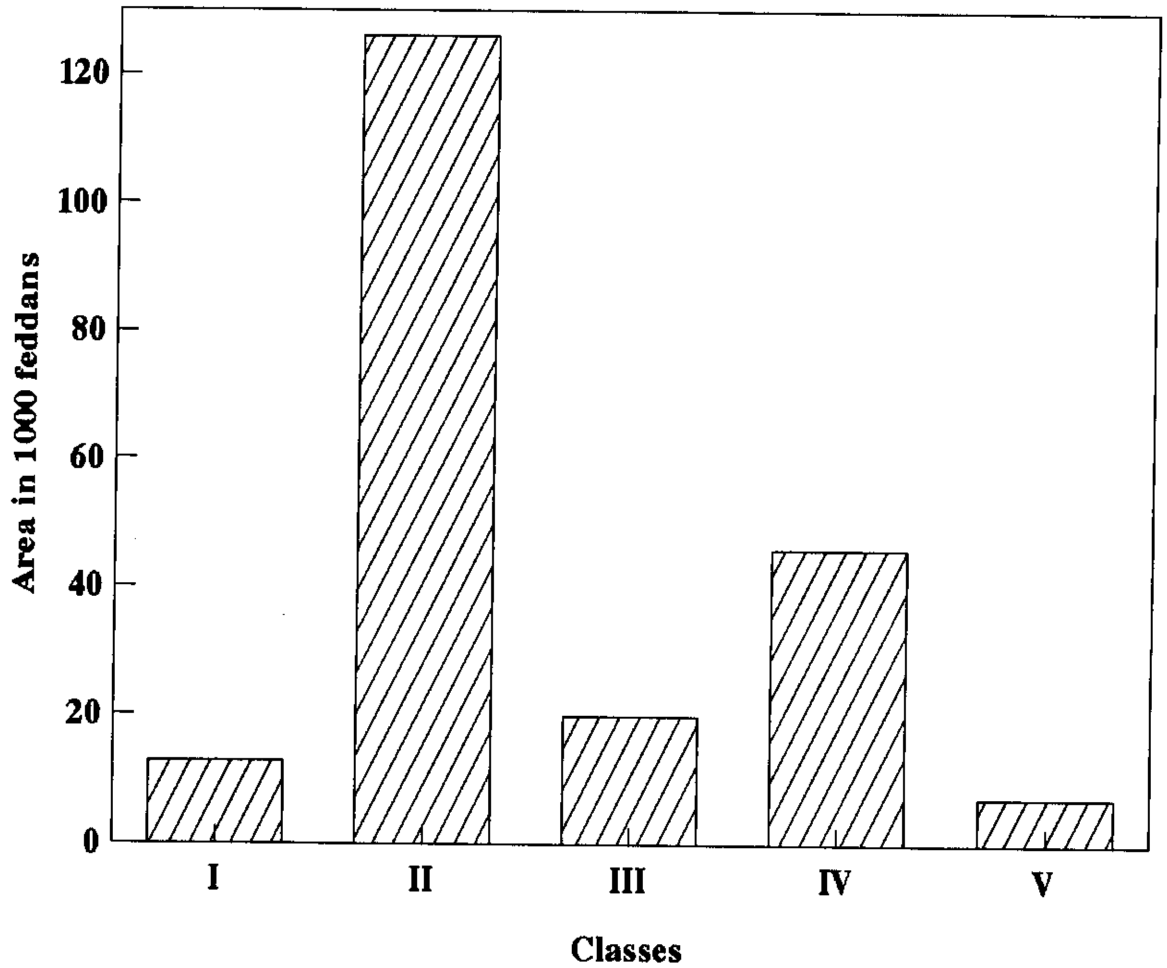
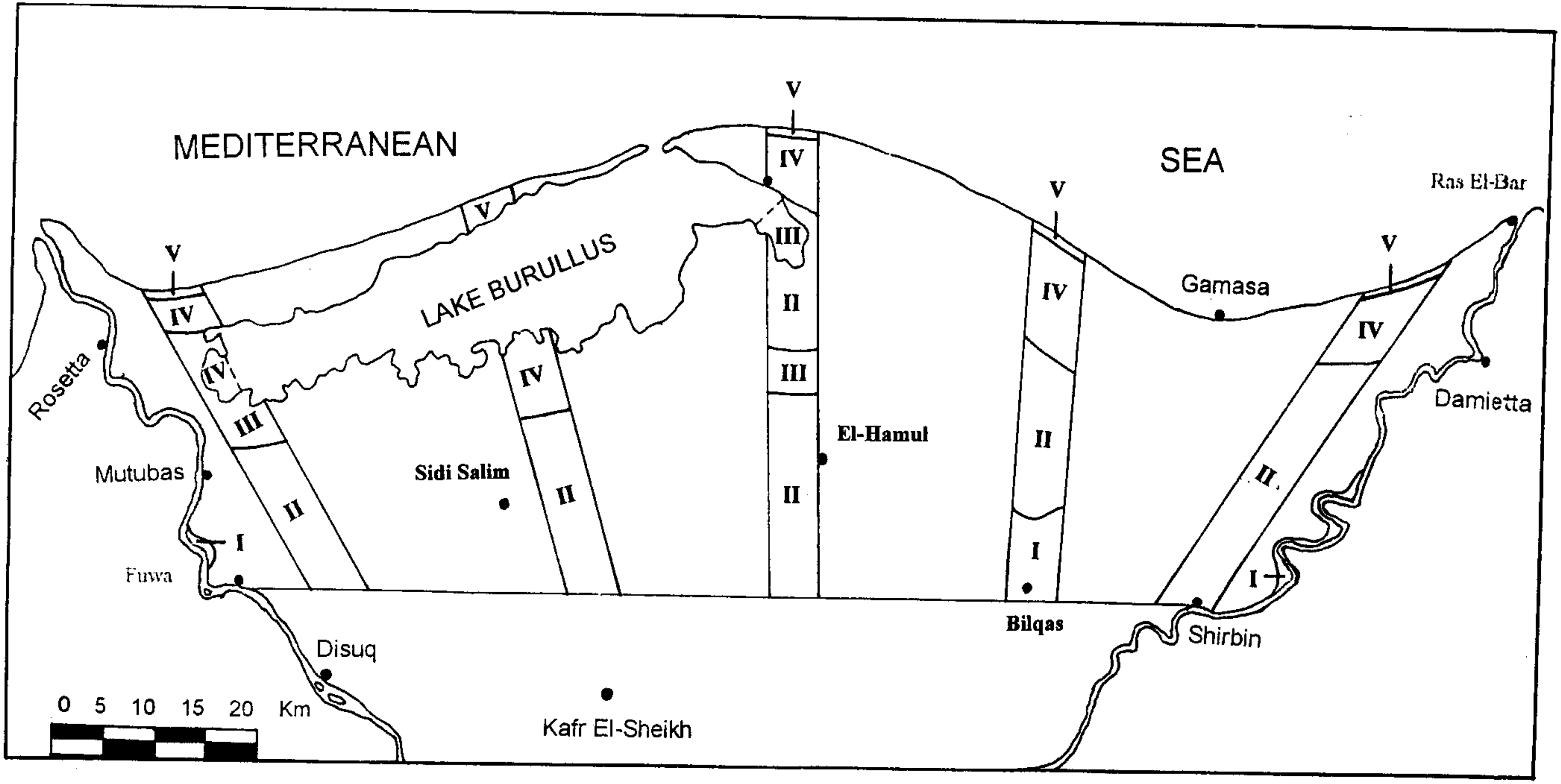


Fig. (3): The area of each class following the USDA system of land capability classification.



Map (4): Land use sketch map of the studied area following the USDA system of land capability classification.

4.6.1.2. the FAO land suitability classification:

According to this system soils of the investigated area are classified from the suitability point of view as follows, Table (23);

1- Highly suitable (S1), including the deep moderately fine-textured soils.

2- Moderately suitable (S2), including the fine-textured soils that are not suffering from salinity hazard.

3- Marginaly suitable (S3), including; the moderately deep to deep fine-textured soil that have some wetness and sodium hazard limitations, and the moderately deep coarse textured soils.

4- Currently not suitable (N1), including the shallow fine and coarse textured soils.

5- Permanently not suitable (N2), it includes a rather narrow strip adjacent to the shore line. These soils are flooded frequently by sea water, therefor they are considered as permanently not suitable for irrigated agriculture.

Figure (4) gives the relative area of each land class, and map (5) shows the FAO system of land suitability evaluation in the studied area.

4.6.2. Quantitative rating of land:

Two quantitative land evaluation systems are tested on the studied area. These systems are;

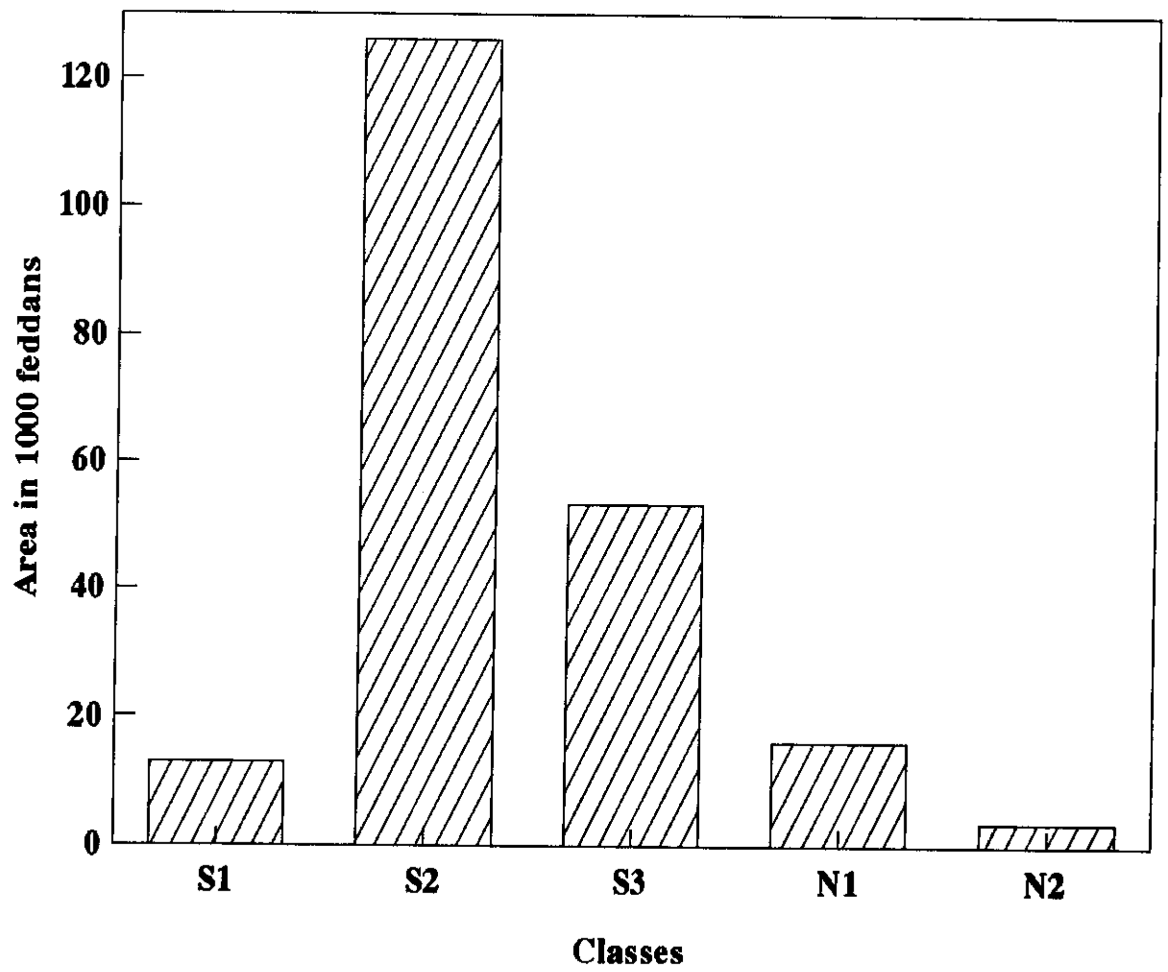
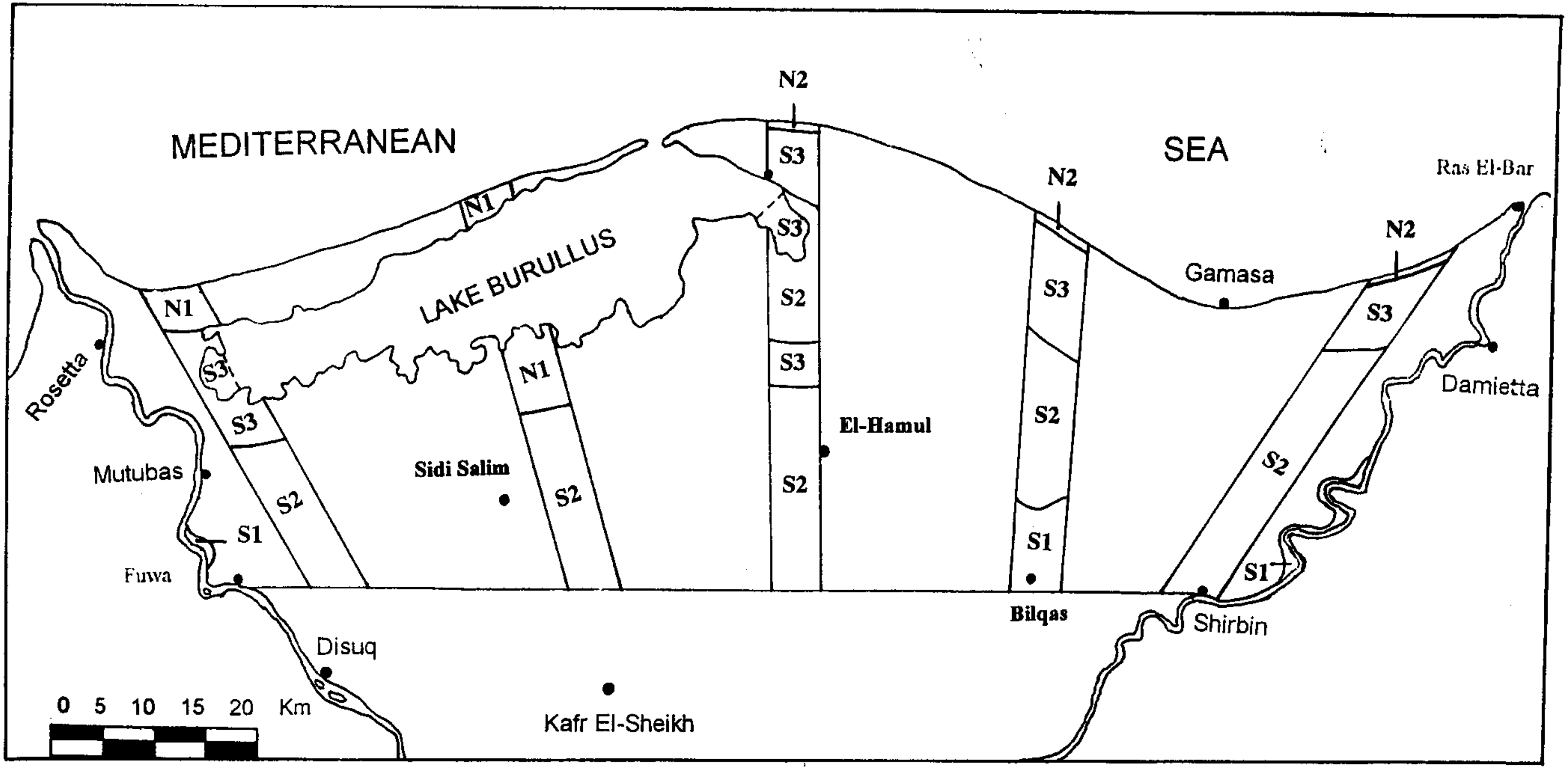


Fig. (4): The area of each class following the FAO system of land suitability evaluation.



Map (5): Land use sketch map of the studied area following the FAO system of land suitability evaluation.

Table (24): Percentage rating of individedual formula factors, land productivity indices and master productivity rating (MPR) of the studied soils.

Geom. unit	Prof. No.	A	B	C	Element of X					X	Y	Land Productivity index	MPR
					pH of surf.	Salinity %	Fertility level	Erosion torrent	Wind level				
Coastal barrier Panins and beaches	1	60-70	85-95	100	85-89	55-65	65-84	90-94	95-100	30-46	55-79	8-24	E
	2	60-70	85-95	100	85-89	86-100	65-84	90-94	95-100	41-70	55-79	12-36	D
	6	60-70	65-75	100	85-89	55-65	65-84	90-94	95-100	26-46	55-79	6-19	E
	7	71-85	65-75	100	90-100	75-85	65-84	90-94	95-100	38-67	55-79	10-34	D
	8	60-70	85-95	100	85-89	75-85	65-84	90-94	95-100	35-60	55-79	10-32	D
	12	60-70	65-75	100	85-89	55-65	65-84	90-94	95-100	26-46	55-79	6-19	E
	13	60-70	65-75	100	90-100	86-100	65-84	90-94	95-100	43-79	55-79	9-33	D
	19	60-70	65-75	100	85-89	55-65	65-84	90-94	95-100	26-46	55-79	6-19	E
	25	60-70	65-75	100	85-89	55-65	65-84	90-94	95-100	26-46	55-79	6-19	E
Fluvio-marine deposits	3	92-100	82-92	100	85-89	75-85	85-94	95-100	95-100	49-71	55-79	20-52	D
	4	92-100	82-92	100	85-89	86-100	85-94	95-100	95-100	55-84	55-79	23-61	C
	9	80-91	82-92	100	85-89	86-100	85-94	95-100	95-100	55-84	55-79	20-56	C
	10	92-100	82-92	100	85-89	86-100	85-94	95-100	95-100	55-84	55-79	23-61	C
	14	80-91	82-92	100	85-89	75-85	85-94	95-100	95-100	49-71	55-79	18-47	D
	15	92-100	82-92	100	90-100	75-85	85-94	95-100	95-100	52-80	55-79	22-58	C
	16	80-91	82-92	100	90-100	75-85	85-94	95-100	95-100	52-80	55-79	19-53	D
	17	80-91	82-92	100	90-100	86-100	85-94	95-100	95-100	59-94	55-79	21-62	C
	20	60-70	82-92	100	85-89	55-65	85-94	95-100	95-100	42-54	55-79	11-28	E
	21	60-70	82-92	100	85-89	55-65	85-94	95-100	95-100	36-54	55-79	10-27	E
	22	92-100	82-92	100	85-89	75-85	85-94	95-100	95-100	49-71	55-79	20-52	D
	26	92-100	82-92	100	85-89	55-65	85-94	95-100	95-100	36-54	55-79	15-39	D
	27	80-91	82-92	100	85-89	75-85	85-94	95-100	95-100	49-71	55-79	18-47	D
	28	92-100	82-92	100	85-89	86-100	85-94	95-100	95-100	56-84	55-79	23-61	C
Recent Nile alluvial deposits	5	92-100	82-92	100	85-89	86-100	85-94	95-100	95-100	56-84	55-79	23-61	C
	11	92-100	85-98	100	90-100	86-100	85-94	95-100	95-100	59-94	55-79	25-73	B
	18	80-91	85-98	100	85-89	86-100	85-94	95-100	95-100	56-84	55-79	21-59	C
	23	80-91	82-92	100	90-100	86-100	85-94	95-100	95-100	59-94	55-79	21-62	C
	24	80-91	82-92	100	90-100	86-100	85-94	95-100	95-100	59-94	55-79	21-62	C
	29	80-91	85-98	100	85-89	86-100	85-94	95-100	95-100	56-84	55-79	21-59	C
	30	92-100	85-98	100	90-100	86-100	85-94	95-100	95-100	59-94	55-79	25-73	B
	31	92-100	85-98	100	90-100	86-100	85-94	95-100	95-100	59-94	55-79	25-73	B

4.6.2.1. Modified Storie index (Nelson, 1963):

Applying the lower and higher rating of the criteria to the soils of the studied area leads to land productivity indices for the various factors involved, Table (24). Master productivity ratings, Table (25) are assigned after evaluation of all the land types in the studied area.

Table (25): Master productivity ratings for land productivity indices of the studied area.

Rangs in land productivity indices	Master productivity rating
percent	
85 - 100	A
70 - 84	B
55 - 69	C
30 - 54	D
< 30	E

The obtained land productivity indices, Table (24) reveal that the identified soil types can be categorized as follows :

1- The productivity rating (B) includes some soils of the recent Nile alluviald deposits, represented by profile 11, 30 and 31. These soils are deep, the nature of surface and subsurface layers are favourable, the nutrients supplying capacity, physical properties such as soil structure, aeration, and moisture supplying capacity are within the adequate rate. The soils under this productivity rating are suitable for many field crops, vegetables and fruit trees.

2- The productivity rating (C) includes some soils of the recent Nile alluvial deposits, represented by profiles 5, 18, 23, 24 and 29; and some soils of fluvio marine deposits represented by profiles 4, 9, 10, 15, 17 and 28. These soils are fine-textured, deep to very deep as their depth ranging from 100 to more than 150 cm. The nutrient and moisture supplying capacity are within the adequate rate, but may be these soils have some limitations in aeration conditions. The soils under this productivity rating are suitable for many common field crops, vegetables and fruit trees.

3- The productivity rating (D) includes the moderately and highly saline, clayey soils of fluvio marine deposits represented by profiles 3, 14, 16, 22, 26 and 27; and the sandy cultivated soils of the coastal barrier plains, represented by profiles 2, 7, 8 and 13. Most of the low percentage ratings in this land productivity group are related to the factor (X) which is a composite component of soil reaction, salinity, fertility level and wind damage hazard. High salinity in the clayey soils and low fertility in the sandy ones, are associated with lower values of factors (X). On the contray, the general character of soil profile, texture of surface soil and slope of land are within the favourable limits for sustained production except for the fine-textured soils having physical characteristics somewhat undesirable for the best potential productivity.

4- The productivity rating (E) includes the rather shallow, saline and clayey soils in the fluvio marine deposits represented by profiles 20 and 21, and the very highly saline sandy soils of coastal barrier plains and beaches. The lowest productivity indices have mainly resulted in from the lower (X) values already explained in the previous paragraph.

Figure (5) shows the area for each productivity rating, and map (6) represents the application of modified Storie index in the studied area.

4.6.2.2. Sys and Verheye's system (1978):

Applying the land classification system of Sys and Verheye (1978), to the soils of the studied area, Table (26) reveals that these soils can be placed at the following orders and classes:

Order S : Suitable land for irrigation, the soils related to this order can be further distinguished into:

Class S2: including some of the medium to fine-textured soils of the fluvio marine deposits and recent Nile alluvial deposits. Ci values of these soils vary from 51 to 69. The rating of land characteristics in these profiles indicates that the intensity of limitations is non to slight. The soils of this class are represented by profiles 4, 5, 10, 11, 29, 30 and 31.

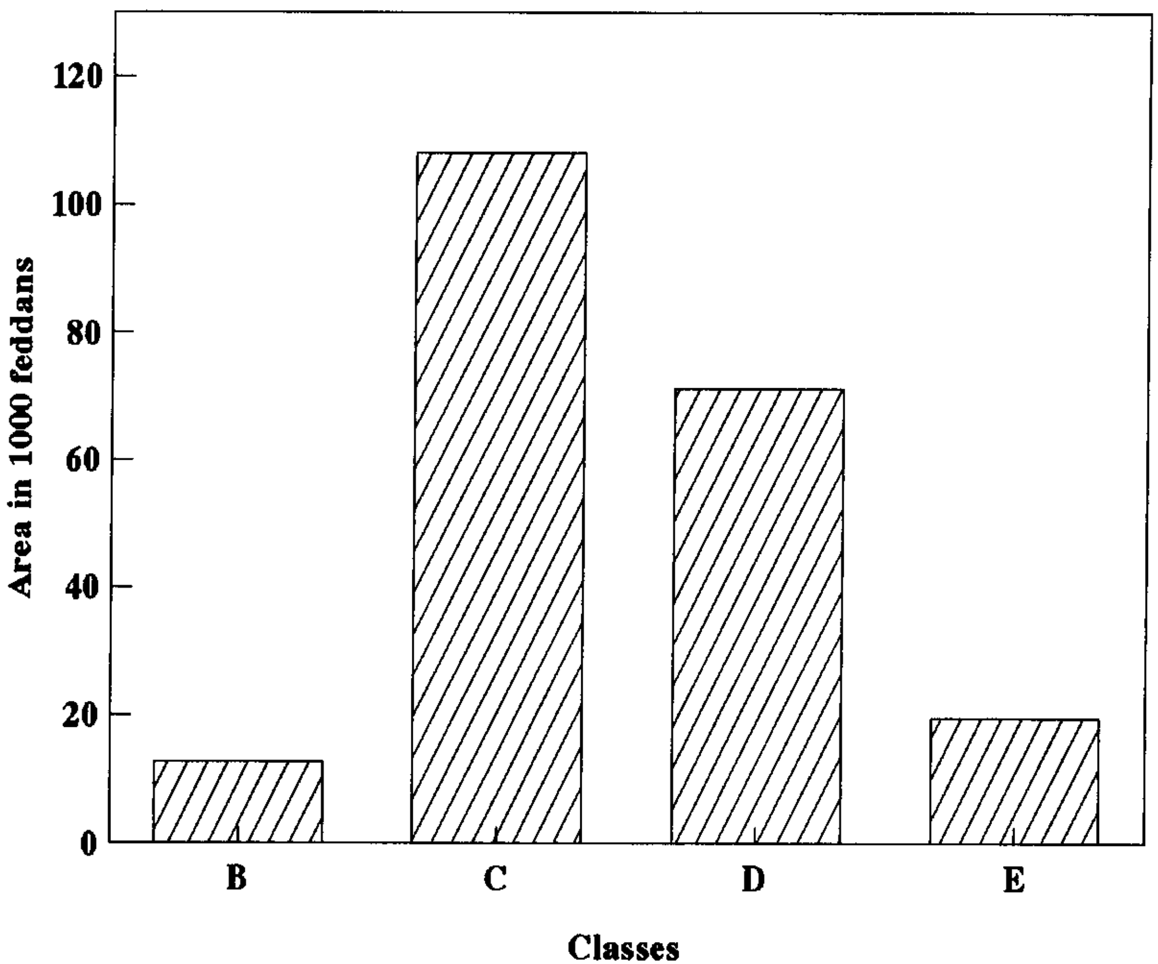
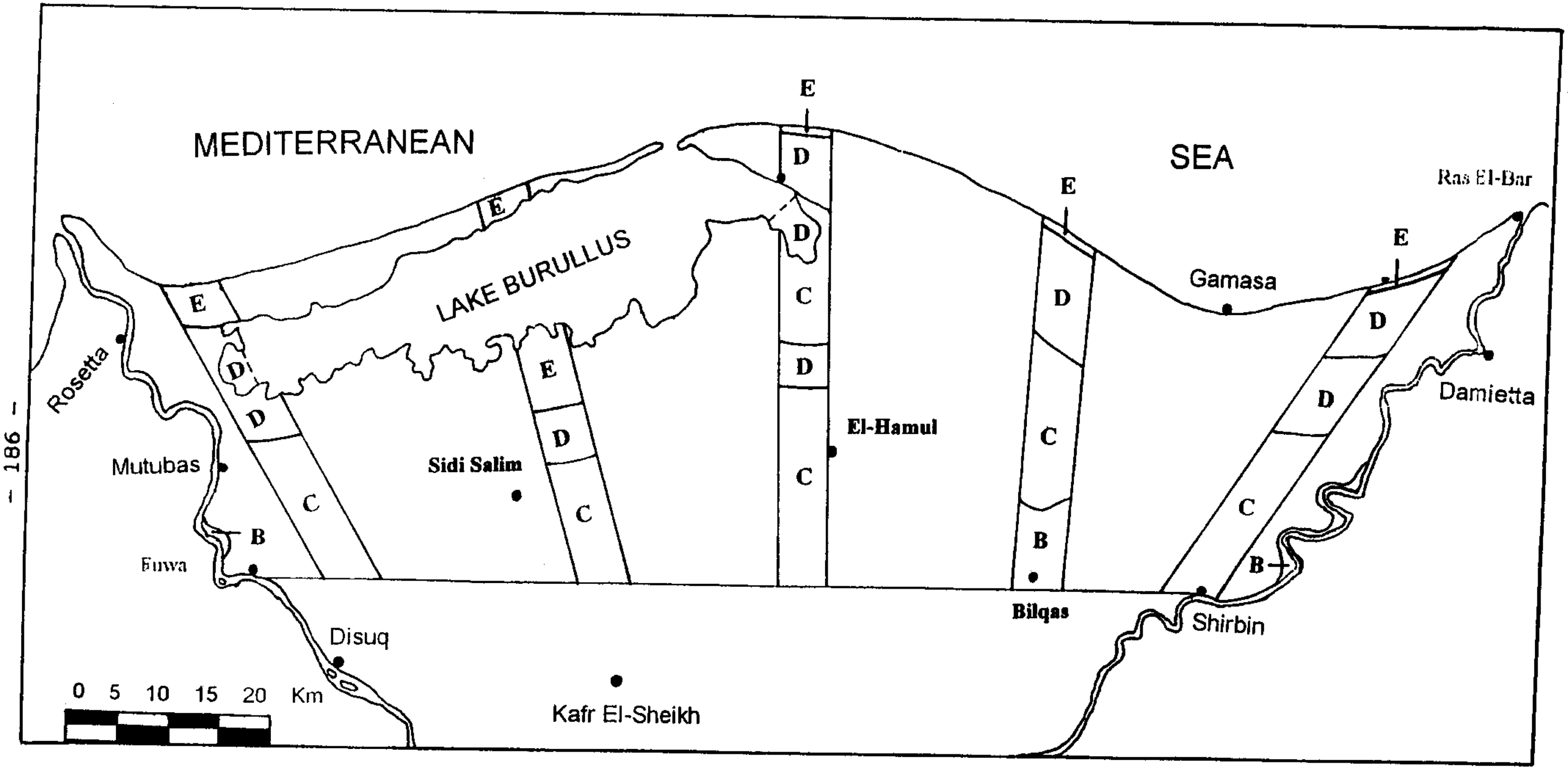


Fig. (5): Relative area of each productivity rating according to modified Storie index.



Map (6): Land use sketch map of the studied area according to modified Storie index.

Table (26): Intensity of limitations and suitability classes of the studied soils (calculated according to Sys & Verheye, 1978).

Geom. unit	Prof. No.	t	w	s_1	s_2	s_3	s_4	n	Ci	Sutability class
Coastal barrier plains and beaches	1	100	55	34.3	75	85	100	58	7	N2
	2	100	80	37.4	75	85	90	90	15	N1
	6	100	55	23.4	75	85	90	58	4	N2
	7	100	95	30.0	100	85	100	85	20	N1
	8	100	80	40.2	90	85	90	90	20	N1
	12	100	55	24.4	75	85	90	58	4	N2
	13	100	80	24.4	75	85	90	96	11	N1
	19	95	55	22.5	75	85	90	58	4	N2
	25	100	55	25.3	75	85	100	75	7	N1
Fluvio marine deposits	3	100	80	85.0	100	85	90	85	44	S3
	4	100	90	85.0	100	95	90	90	59	S2
	9	100	80	81.4	90	85	90	100	45	S3
	10	100	90	85.0	100	85	90	90	53	S2
	14	100	55	77.9	90	95	90	70	23	N1
	15	100	80	85.0	100	85	90	70	36	S3
	16	100	50	81.5	90	85	90	60	17	N1
	17	100	80	79.7	90	85	90	90	40	S3
	20	100	35	56.7	55	95	90	50	5	N1
	21	100	35	71.7	75	95	90	60	10	N1
	22	100	80	90.0	100	95	100	70	48	S3
	26	100	80	85.0	100	95	90	50	29	S3
	27	100	50	81.5	90	85	90	60	17	N1
	28	100	80	85.0	100	95	90	80	47	S3
Recent Nile alluvial deposits	5	100	90	85.0	100	95	90	90	59	S2
	11	100	90	100.0	100	95	90	90	69	S2
	18	100	80	84.0	90	85	90	90	42	S3
	23	100	80	89.0	90	85	90	90	44	S3
	24	100	80	81.5	90	85	90	90	40	S3
	29	100	80	91.3	90	95	90	90	51	S2
	30	100	90	97.6	100	85	90	90	60	S2
	31	100	90	99.4	90	85	90	90	55	S2

Class S3: including some of the fine-textured soils of the fluvio marine deposits and recent Nile alluvial deposits represented by profiles 3, 9, 15, 17, 22, 26, 28, 18, 23 and 24. Ci values of these soils vary widely from 29 to 48. The soils of this class have some limitations of textural, soil depth, wetness, and salinity and alkalinity.

Order N: not suitable land, attaining one or more severe limitations that exlude their use. The soils belonging to this order can be further distinguished into two classes as:

Class N1: lands with severe to very severe correctable limitations. This class includes some sandy soils of coastal barrier plains and some fine-txtured soils of fluvio marine deposits that adjacent to Burullus lake. These soils have severe limitations of textural, soil depth, wetness, salinity and alkalinity. Ci values are very low, being in the range of 5 to 20.

Class N2: lands with severe or very severe non-correctable limitations. These includes some of the sandy soils of the beaches. The rating of land characteristics indicates very severe salinity and alkalinity limitations associated with severe limitations of texture, wetness and soil depth.

Figure (6) shows the relative area of each land class and map (7) represents the practical application of Sys and Verheye's system in the studied area.

Summary of the land evaluation of the studied area following qualitative and quantitative systems is shown in Table (26).

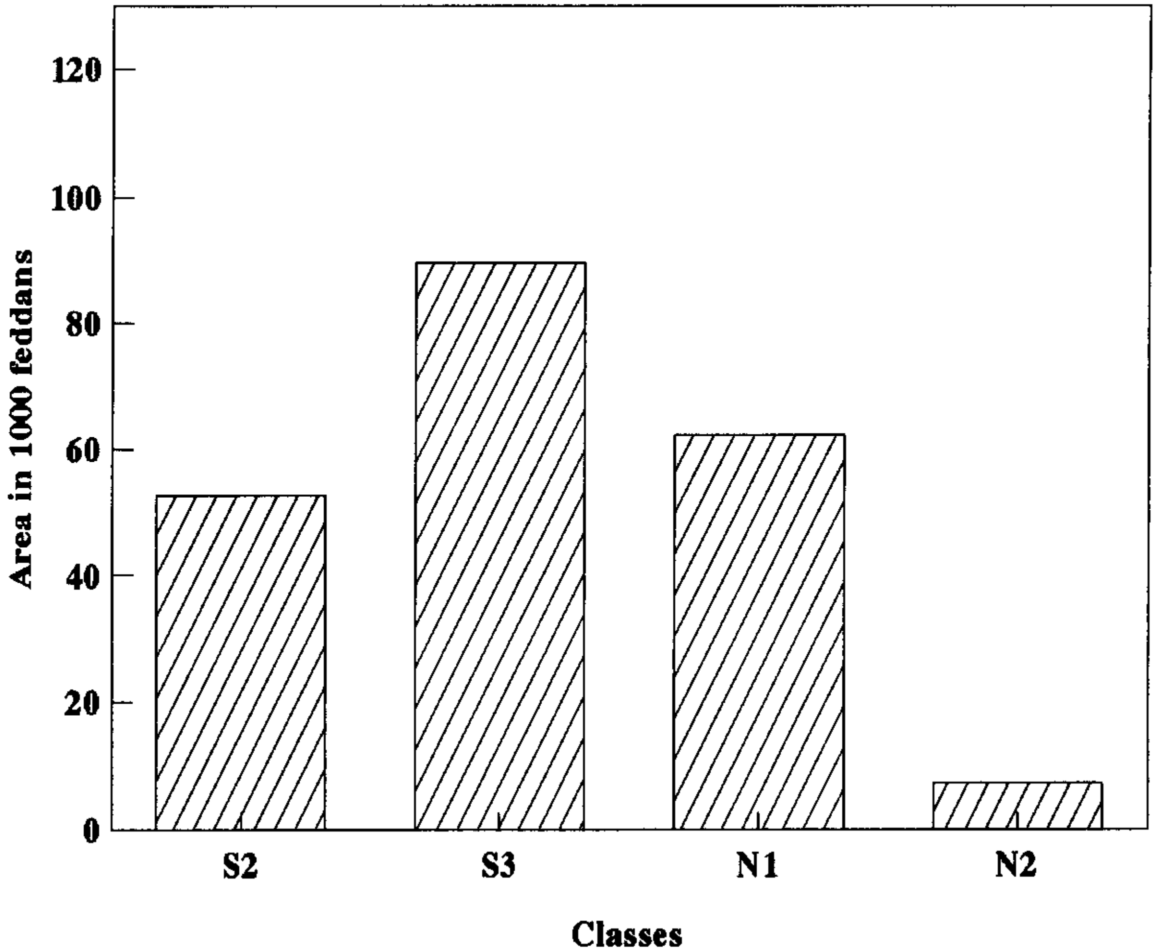
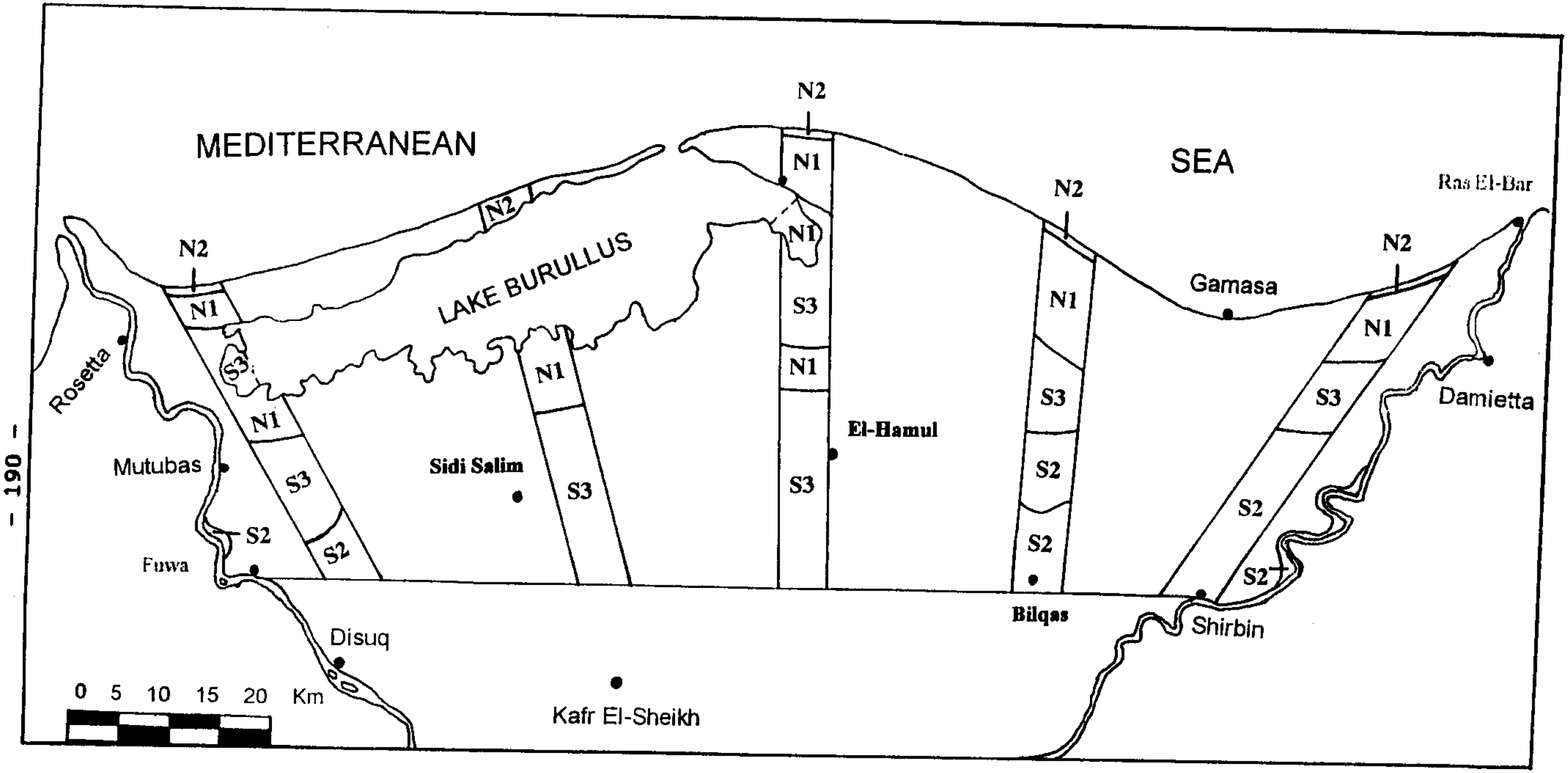


Fig. (6): The area of each class according to Sys and Verhey's system.



Map (7): Land use sketch map of the studied area according to Sys and Verheye's system.

Table (27): Land evaluation of the studied area following qualitative and quantitative systems.

Geom. unit	Prof. No.	Qualitative systems		Quantitative systems	
		Classes		M.P.R.	Classes
		USDA	FAO	Storie	Sys & Verheye
Coastal barrier Panins and beaches	1	V	N2	E	N2
	2	IV	S3	D	N1
	6	V	N2	E	N2
	7	IV	S3	D	N1
	8	IV	S3	D	N1
	12	V	N2	E	N2
	13	IV	S3	D	N1
	19	V	N1	E	N2
	25	IV	N1	E	N1
Fluvio-marine deposits	3	II	S2	D	S3
	4	II	S2	C	S2
	9	II	S2	C	S3
	10	II	S2	C	S2
	14	III	S3	D	N1
	15	II	S2	C	S3
	16	III	S3	D	N1
	17	II	S2	C	S3
	20	IV	N1	E	N1
	21	IV	N1	E	N1
	22	II	S2	D	S3
	26	IV	S3	D	S3
	27	III	S3	D	N1
	28	II	S2	C	S3
Recent Nile alluvial deposits	5	II	S2	C	S2
	11	I	S1	B	S2
	18	II	S2	C	S3
	23	II	S2	C	S3
	24	II	S2	C	S3
	29	II	S2	C	S2
	30	I	S1	B	S2
	31	I	S1	B	S2

5. SUMMARY AND CONCLUSION

The aim of the current investigation is to evaluate some soils located in north Delta for the agricultural purpose. These soils occupy an area runs generally from Damietta branch in the east to Rosetta branch in the west, penetrating the old cultivated lands in the south and stretching between longitudes 30° 20' and 31° 50' east and latitudes 31° 10' and 31° 36' north.

The area is characterized by three geomorphic units, namely, coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits. To fulfill the purpose of this study, thirty one soil profiles were dug along five transects within the studied area to represent all the possible variations between the soils consisting the three geomorphic units. Soil profiles were morphologically described and subjected to the physical and chemical analyses required to attain qualitative and quantitative evaluation for the studied area. The following is a brief summary of the obtained results:

1- Soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits were sandy, clay and clay loam to clay, respectively.

2- $CaCO_3$ content ranged from 0.08 to 0.84; 0.17 to 8.38 and 0.22 to 2.94% whereas gypsum content varied from 0.11 to 3.65; 0.11 to 2.09 and 0.09 to 0.52% in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively.

3- Organic matter content was very low in all soil profiles and ranged from 0.06 to 0.72; 0.55 to 2.40 and 0.10 to 2.66% in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively.

4- Bulk densities ranged from 1.67 to 1.78; 1.14 to 1.51 and 1.20 to 1.60 g/cm^3 in soils of the abovementioned three geomorphic units, respectively.

5- Total porosity ranged from 32.32 to 36.98; 44.49 to 58.09; and 40.30 to 55.71% in the soils of the respective three geomorphic units.

6- Hydraulic conductivity varied widely from one geomorphic unit to another. It fluctuated between 11.375 and 19.960 in soils of the coastal barrier plains and beaches; 0.025 and 0.614 in the fluvio marine deposits and 0.053 and 2.285 cm/hr in the soils of the recent Nile alluvial deposits.

7- Soil moisture contents at field capacity, wilting point and available water increased by increasing silt, clay and organic matter contents. The highest values of moisture contents at field capacity, wilting point and available water were 45.73, 25.85 and 21.07% in the soils of fluvio marine deposits, while the lowest ones were 6.14, 3.28 and 2.02% in the soils of coastal barrier plains and beaches.

8- Soil salinity differed widely from one locality to another. EC values ranged between 1.3 and 78.9; 1.1 and 27.8 and 1.1 and 3.7 in the soils of the coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. Soluble cations were dominated by Na^{+} followed by Mg^{++}, Ca^{++} and K^{+} in the soils of the coastal barrier plains and beaches and fluvio marine deposits. In the soils representing the recent Nile alluvial deposits, Ca^{++} dominated over magnesium. Soluble anions generally followed the descending order: $Cl^- > SO_4^{--} > HCO_3^-$. CO_3^{--} was not found in any detectable amount.

9- Soil reaction of the studied soils (pH) was slightly to moderately alkaline conditions of all the soils representing the different geomorphic units where these values fluctuated between 7.4 and 8.2.

10- SAR values ranged from 2.1 to 93.1; 1.6 to 69.1 and 1.3 to 9.7 in the soils representing the coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively.

11- The values of cation exchange capacity were in the order of fluvio marine deposits > recent Nile alluvial deposits > coastal barrier plains and beaches and had the averages of 48.80, 35.08 and 2.38 me/100g soil, respectively. The exchangeable cations of the soils of coastal barrier plains and beaches and fluvio marine deposits followed the descending order: $Mg^{++} > Ca^{++} > Na^{+} > K^{+}$. However, calcium dominated over magnesium in the soils of the recent Nile alluvial deposits. ESP values of soils representing the recent Nile alluvial deposits were less than 15% whereas the ESP values of the soils representing the other two geomorphic units exceeded 15% (except for the soil profiles No. 2, 8 and 13 in the coastal barrier plains and beaches and profiles No 4, 9, 10 and 17 in the fluvio marine deposits.

12- Total nitrogen content ranged from 39.7 to 272.2; 179.8 to 1655.8 and 124.7 to 1740.2 with the averages of 96.9; 556.3 and 555.6 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. Highly significant positive correlations were established between total N and organic matter content of all the soils representing the three geomorphic units. Available nitrogen ranged between minimum values of 3.5; 21.4 and 22.9 and maximum ones of 32.9; 167.8 and 175.1 and averaged 14.7; 61.6 and 63.9 ppm in the soils of the respective three geomorphic units. Highly significant positive correlations were found also between total and available N contents of the soils representing the three geomorphic units.

13- Total phosphorus content ranged from 172.5 to 401.2; 683.4 to 1312.2 and 505.9 to 1148.2 with averages of 280.8; 863.7 and 761.9 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. Highly significant positive correlation were established between total P and clay content in the soils of the three geomorphic units. Available P ranged from 1.3 to 8.7; 4.5 to 28.4 and 4.8 to 23.5 corresponding to averages of 4.0, 12.1 and 12.6 ppm in the soils of the respective three geomorphic units. Significant negative correlation was found between available P and soluble Mg^{++} in the soils representing the coastal barrier plains and beaches.

14- Total potassium content ranged from 2.1 to 7.1; 17.4 to 30.6 and 12.8 to 23.9 with averages of 3.9, 24.1 and 18.9 me/100g in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. Highly significant positive correlations were found between total K and soil clay content of all the geomorphic units. Available K content ranged from 0.09 to 0.88; 0.74 to 5.0 and 0.38 to

1.41 and averaged 0.39; 2.46 and 0.91 me/100g in the soils representing the respective three geomorphic units. Significant positive correlations were established between available K and soil clay content of all the geomorphic units.

15- Total iron content ranged from 1.12 to 2.15; 5.30 to 6.95 and 4.13 to 6.60% in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The corresponding computed weighted mean of total Fe ranged from 1.15 to 2.00; 5.52 to 6.76 and 4.89 to 6.37%. Highly significant positive correlations were found between total Fe and each of clay, sum of clay + silt and organic matter content. In contrast, total Fe was negatively highly significantly correlated with soil sand content of all the geomorphic units. The DTPA-extractable Fe ranged from 2.1 to 5.1; 2.1 to 25.1 and 2.9 to 26.7 ppm in the soils representing the respective three geomorphic units.

16- Total manganese content ranged from 73.5 to 187.4; 599.0 to 1143.0 and 483.0 to 976.0 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The corresponding computed weighted mean ranged from 83.07 to 169.78; 759.17 to 1068.11 and 555.33 to 880.83 ppm. Total Mn was positively highly significantly correlated with sum of clay + silt and negatively highly significantly correlated with soil sand content of all the geomorphic units. The DTPA-extractable Mn ranged from 0.5 to 4.7; 2.6 to 11.6 and 2.1 to 5.4 ppm in the soils representing the three geomorphic units, respectively.

17- Total zinc content ranged from 38.9 to 68.9; 96.7 to 179.1 and 89.9 to 158.1 in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The corresponding computed weighted mean ranged from 43.21 to 58.83; 98.15 to 164.68 and 99.01 to 154.48 ppm. Highly significant positive correlations were established between total Mn and soil clay content of all the studied geomorphic units. In contrast, total Mn was negatively highly significantly correlated with soil sand content. The DTPA-extractable Mn ranged from 0.2 to 1.6; 0.8 to 4.2 and 1.1 to 4.4 ppm in the soils representing the three geomorphic units, respectively.

18- Total copper content ranged from 28.4 to 46.8; 69.4 to 92.4 and 62.1 to 88.5 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The corresponding computed weighted mean ranged from 29.03 to 39.99; 69.65 to 87.47 and 66.60 to 85.98 ppm. Highly significant positive correlations were established between total Cu and each of clay and sum of clay + silt. In contrast, total Cu was negatively highly significantly correlated with sand content of all the soils representing the three geomorphic units. The DTPA-extractable Cu ranged from 0.1 to 1.1; 3.4 to 8.2 and 2.5 to 8.1 ppm in the soils representing the respective three geomorphic units.

19- Total boron content ranged from 12.5 to 38.1; 70.5 to 110.3 and 47.7 to 69.5 ppm in the soils of coastal barrier plains and beaches, fluvio marine deposits and recent Nile alluvial deposits, respectively. The corresponding computed weighted mean ranged from 13.34 to 32.74; 73.32 to 100.38

and 49.70 to 58.60 ppm. Total B was positively highly significantly correlated with total soluble salts content of the soils of the coastal barrier plains and beaches and fluvio marine deposits. The hot water soluble boron ranged from 0.9 to 7.4, 1.0 to 7.1 and 0.5 to 1.5 ppm in the soils representing the three geomorphic units, respectively.

20- Based on the abovementioned soil characteristics and recognized agricultural limitations, qualitative land capability classification was performed according to the USDA system (1973) and FAO framework of land suitability classification (1976). Qualitative land capability classification was also worked out following both the modified Storie index (Nelson, 1963) and Sys and Verheye's system (1978).

According to these systems, the soils of the studied area could be classified as follows:

A. The area suitable for agriculture utilization.

1. Using the USDA system, an area equals 204449 feddans, representing 96.63% of the studied area, is suitable.
2. Using the FAO system, an area equals 191949 feddans, representing 90.72% of the studied area, is suitable.
3. Applying modified Storie index, the suitable area equals 120799 feddans, representing 57.09% from the studied area.
4. Applying Sys and Verheye's system, an area amounting to 142289 feddans, representing 62.25% from the studied area, is suitable.

B. The non suitable area recorded with the different systems can be summarized as follows:

1. Using the USDA system, the non suitable area equals 7141 feddans, representing 3.37% of the studied area.
2. Using the FAO system, the non suitable area equals 19641 feddans, representing 9.28% of the studied area.
3. Applying modified Storie index, an area equals 90791 feddans, representing 42.91% of the studied area, is non suitable.
4. Applying Sys and Verheye's system, an area equals 69301 feddans, representing 32.75% of the studied area, is non suitable.

C. Results may suggest that the quantitative systems more suitable under the Egyptian conditions, where their results are compatible with the studied area conditions.

D. Sys and Verheye's system, could be considered as favourable system under the conditions prevailing in the soils of Egypt.

As a general conclusion, it can be said that the soils of north Delta vary widely in their suitability for the agricultural purpose. A consequent detailed or semi detailed survey is required to attain reliable evaluation for such a wide area.