INT. J. BIOL. BIOTECH., 9 (1-2): 123-137, 2012.

GEOMORPHOLOGY OF KARACHI WITH A BRIEF NOTE ON ITS VEGETATION

Gulraiz Hamid[1], Khalil A. Mallick[1], M. Bilal[1], Ibraheem Azma[1], S. Zohaib Ishaq[1]and R.R. Zohra[2]

[1]*Department of Geology, University of Karachi, Karachi-75270, Pakistan.*
[2]*Department of Biotechnology, University of Karachi, Karachi, Pakistan.*

ABSTRACT

The Karachi region presents the landforms of varied nature and origin ranging from the arid to fluvial and marine landscapes. This assemblage of landscape reflects polygenesis in origin. Structurally the whole region of Karachi presents a series of plunging folds trending NE-SW which is name after the localities as Cape Monze, Pir Mangho, Drigh road and Landhi-Korangi anticlines. These four anticlines are alternated with three synclines named as Laljee, Lyari and Malir synclines which are traversed by these sizeable seasonal streams. The landscape features show a marked structural and lithological control although much of land surface is irregularly blanketed by aeolian sandy/silty cover and spotted with gravely mounds of variable dimensions depicting the remnants of former fluvial terraces. The whole area of Karachi region can be divided into six morphological zones from the hinterland to the coastal margin based on the nature and origin of the surface, relief conditions and the landform assemblages. Apart from the other processes of sub-aerial erosion, the process of differential erosion played a dominant role in shaping the landform on the alternately placed folded beds of hard and soft nature. Ridge and valley type topography is well developed whereby the transcurrent faulting has off-setted and truncated the ridges. Through the fault gaps, the opposite pediments are communicating and joined. The coast line is mostly cliffed and conspicuous signs of emergence in near geological past are present. Regression and degradation phenomenon is commonly along the coast line, although some parts show clear signs of progradation. Cumulatively the shoreline is of mixed type. The drainage networks mostly show adjustment with the regional and local grains of area. Presently, the region is passing through an immense phase of degradation in general. A brief note on the vegetation of various habitat types of Karachi is included. *Euphorbia caducifolia, Acacia nilotica, A. senegal, Capparis decidua, Commiphora wightii, Salvadora persica, S. oleioides, Prosopis juliflora, P. glandulosa, Tamarix indica, Arthrocnemum indicum, Urochondra setulosa, Ipomoea pes-caprae, Halopyrum mucronatum, and Avicennia marina are the important characteristic species of various habitats. P. juliflora*, a species of high ecological amplitude is the most dominant species throughout the area.

Key Words: Geomorphology, Stratigraphy, Denudation chronology, Drainage Pattern, Vegetation, Karachi.

INTRODUCTION

The Karachi embayment lies approximately between longitude 66°35'00"-67°30'00" E and latitude 24°45'00" to 25°05'00" N, the southern most part of Sindh Kohistan. The Karachi region presents a variety of landforms of diverse nature and origin. The assemblage of landscape portrays an interesting and complicated denudational chronology.

Geologically this region represents the variable sedimentary rocks of late tertiary period unconformably over-lain by fluviatile and aeolian sediments of Quaternary times. Structurally the Karachi region forms part of Kirthar fold belt of lower Indus basin and presents a series of plunging folds trending NE-SW. A cross section from the west to east transects four major anticline structures with three intervening synclines. The synclinal troughs are alluvial filled basins, which forms a drainage network of three ephemeral stream systems. The plunging tips of the anticlines form well-developed headlands and spurs of en-echelon nature.

The landscape features show a marked structural and lithological control. However much of land surface is irregularly blanketed by aeolian sandy/silty cover and at places gravely mounds of variable dimensions are exposed as remnants of former fluvial terraces. In general the maturity is exhibited in the relief condition of the area.

GENERAL STRATIGRAPHY OF THE AREA

The area under present study forms the south western part of Karachi Embayment. It was formed by the collision of Indian with Eurasian Plates in Eocene time. The bedrock material filling the Karachi Embayment comprises of marine and estuarine sediments with subordinate lacustrine and lagoon deposits. Geologically younger deposits or the surface soils are mainly comprised of fluvial and aeolian origins and are composed of conglomerates, consolidated and semi consolidated gravels.

Karachi area is mainly composed of three formations namely Nari Formation of Oligocene age, Gaj Formation of Miocene age, the Manchar Formation of Mio-Pliocene age and the recent - Sub recent sediments mainly of aeolian nature (Fig.1). The stratigraphic sequence of these formations in the study area is summarized as under (Table 1)

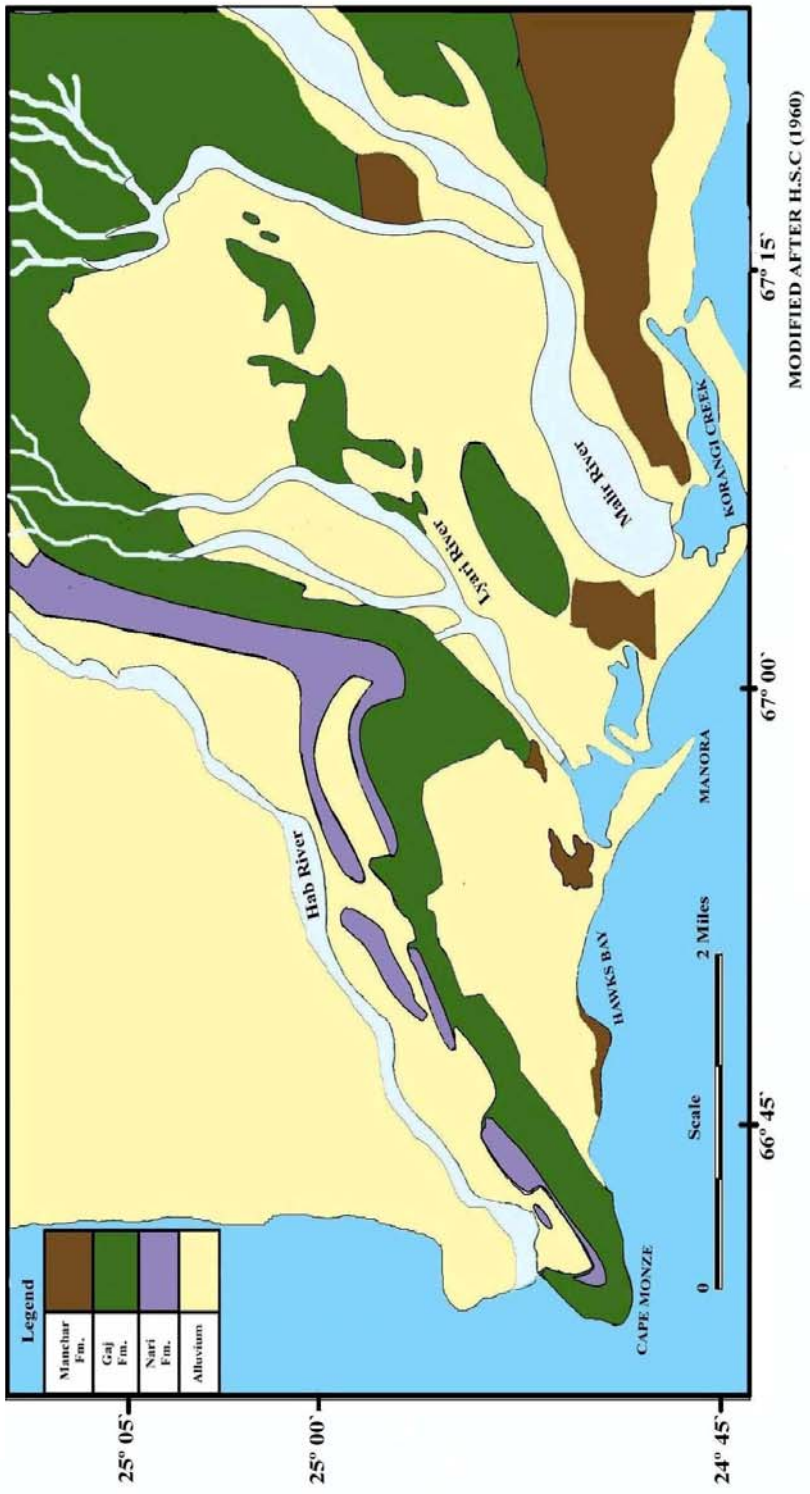

Fig. 1. Map Showing the Outcrop Distribution in Karachi Urban Areas.

PROCESSES

Apart from other processes of sub aerial erosion, the process of differential erosion has played a dominant role in shaping the landforms on the alternating hard and soft beds. The ridge and valley type of topography is well developed. Transcurrent faulting has off settled and truncated the ridges. Through the fault gaps the opposite pediments are communicating and are often joined.

DRAINAGE

The drainage network mostly shows the adjustment with the regional and local structural grains of the area, although there occurs noticeable divergence from it. Beheading and capturing of the main stream of early drainage in the recent geological past have possibly occurred in this region. Perhaps in consequence of this phenomenon this region shows quite significant terrace remnants.

The structural control in drainage manifests itself in the form of well-developed trellis, radial and partly annular drainage nets in the area of Pir Mangho northwest of Karachi city where these patterns are expressed in differentially eroded plunging up folding. The parallel and sub parallel patterns can also be seen on the gently sloping coastal pediment at the pied of the ridges on eastern flank of the cape Monze anticline and along the transcurrent faulting which is cutting cross the hogbacks and cuesta ridges in Orangi, Surjani and Jhill hills. It is also clearly developed on the long shallow synclinal trough of Laljee area south west of Pir Mangho. The gentle warps, which constitute the bedrock exposures in central and southeastern part of Karachi exhibit typically dendritic patterns of drainage (Fig 2)

The trunk stream of the region also follow the major synclinal troughs of the area and appear to be adjusted with the regional structural grain of the area and oriented to NE-SW. these are exotic in nature where as most of the torrents drainage down either from the scarp or dip slopes are lost in aeolian and or silt cover and thus endoric in nature.

Everywhere in the Karachi region the drainage shows incision. The degree of incision is variable in correspondence with the nature of the material over which the drainage line runs which may be silty cover colluvial material of soft argillaceous bed rock, etc.

MORPHOLOGICAL ZONES

The Karachi region can be divided into seven morphological zones on the nature and origin of the surface right from the hinterland to the coastal margin, namely (1) Zone of Structurally Controlled Relief, (2) Pediment Zone (3) Zone of Alluvial Filling (Alluvial Plain) (4) Zone of Dissected Erosional Surface (5) Zone of Dissected Plateau (6) Coastal Zone (7) Peripediment (Sub Zone). In each of these zones the dominant process of denudation, relief conditions and the landform assemblages have been distinguished, which are summarized in a tabular form (Table 2). Brief description of each above mentioned zone is given in Fig.3.

1. Zone of structurally controlled relief:

Geographically this zone forms the southern end of the Sindh Kohistan hills and founded on late tertiary folded sedimentary rocks of variable resistance. Main topography expression is alternate valley and ridge type. The ridges are asymmetric and are capped by the harder beds of limestone whereas the narrow strike valley are the sites of soft shales or sandstones. The zone encompasses the hills of Cape Monze , Jhill, Moach ,Orangi and Pir Mangho, north Karachi and its northern extension. The ridges are often offsetted and truncated because of transcurrent faulting. Morphologically these can be grouped as hogback and cuesta ridges. The main process of erosion is selective erosion, peeling radiation, mass wasting and gully incision. The intervening valley is covered with variable thickness of sand or silt. In general this zone represents a denudational/destructional complex surface of uneven and hilly nature.

2. Pediment zone:

This zone forms an eskar along the lower edges of the ridges and hills on their either side. Genetically it is truncated surface which gently sloped within the limits of 1-2 degree. It also abuts with the dip slopes of the ridges and makes a clear break of slope. To the east and south-east it merges into the Lyari river basin. A similar junction is seen

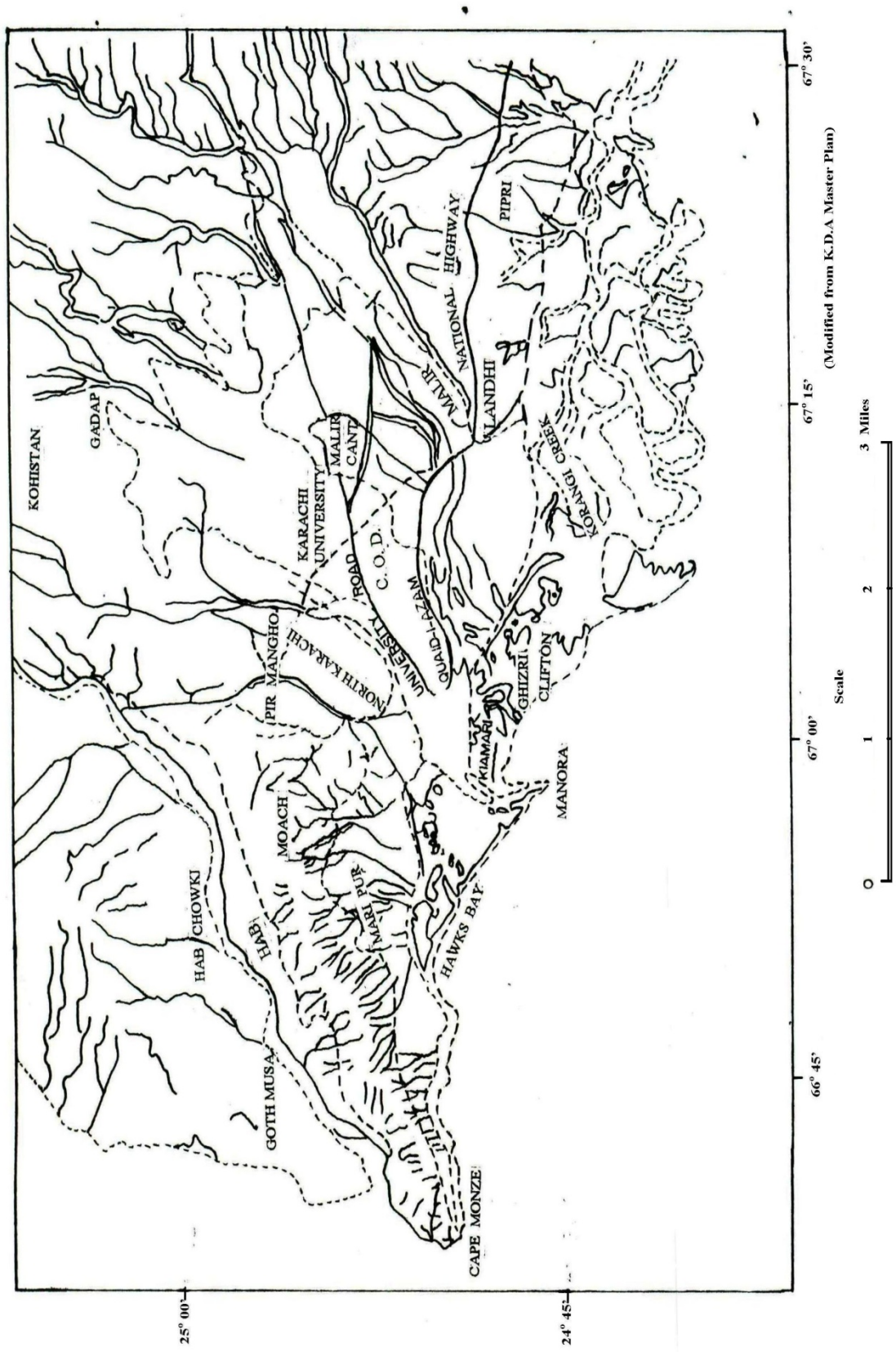

Fig.2 Map showing Drainage Pattern of the Karachi region

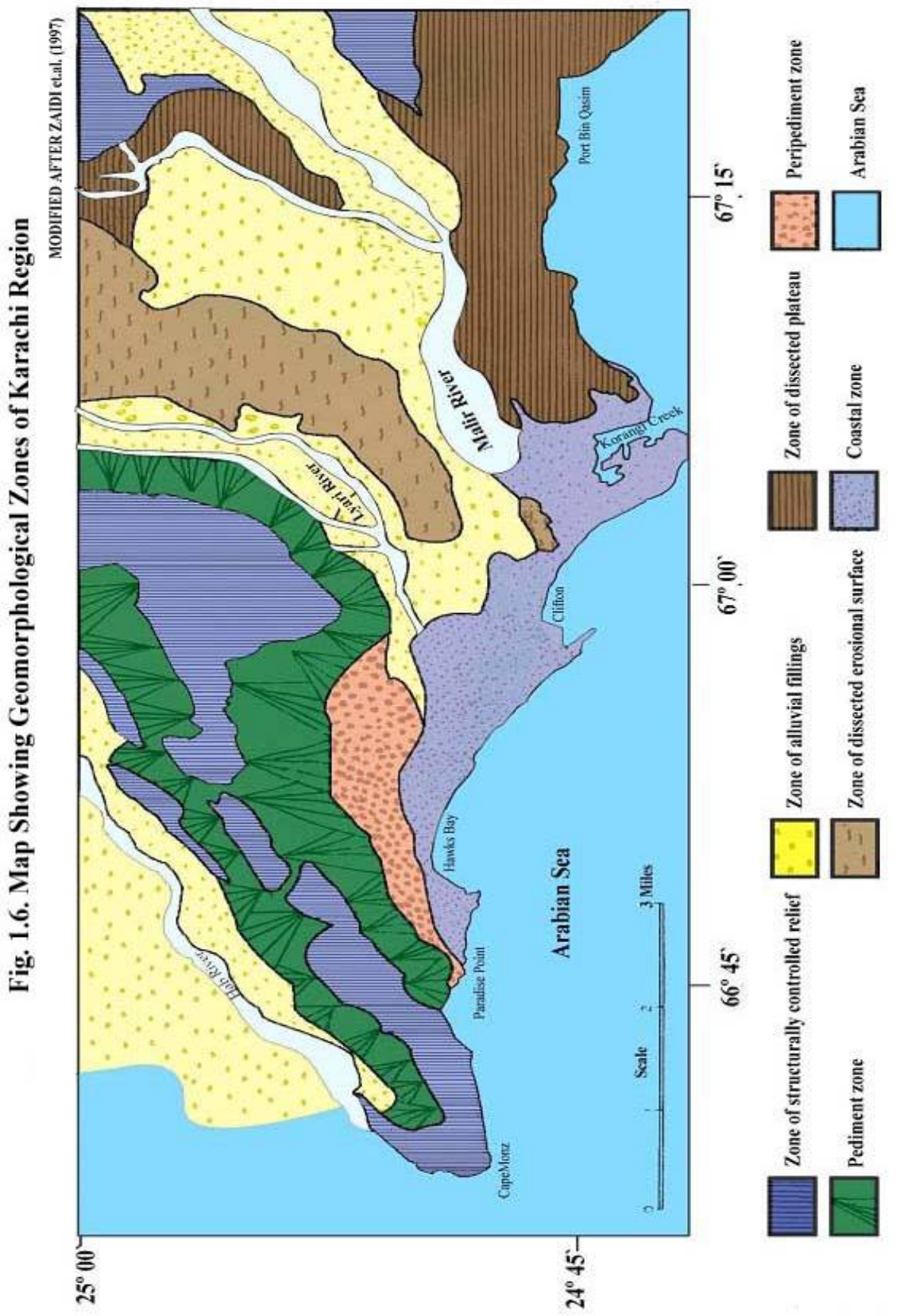

Fig. 1.6. Map Showing Geomorphological Zones of Karachi Region

with the hub river basin towards north and west. The surface of this tract of land is blanketed with thin veneer of slope wash material and with an overall cover of variable thickness of aeolian sand / silt. It is dotted with subdued ridges or small hillocks of bedrock exposures, which occur sporadically. The upper margin of this zone occasionally shows a thin and consolidated layer of piedmont colluvial- alluvial deposits. Rill wash and sheet wash are most active processes at the moment along with aeolian action. The actual causes of its origin can only be conjectured. However presently it represents an erosional surface with very minor depositional elements.

3. Zone of Alluvial Filling

The undulating plain tract of Karachi is an integration of the two alluvial filled valleys i.e. the basins of ephemeral Lyari and Malir rivers. These two valleys represent the earlier synclinal lows which become leveled by the deposition of coarse fluvial gravels and sand of calcareous nature. To the west of it the Hub river basin also shows quite similar conditions. Once again the alluvial material is overlain by sandy/silty cover of variable thickness. The alluvial cover has been estimated in drilled and hand dug wells more than 40 ft in general. In most of the drilled water wells in the central district of Karachi yield the thickness of fluvial sediments up to 30'. The river channels and even the hilly areas are very well entrenched. The present wide and incised flood plains and cliffed banks where the exposure of the gravels from cliffed banks of more than 20' height.

Numerous flood plain terraces, narrow bar uplands, small gravely and silty flats are found along the channel of these two rivers and their tributaries. The dominant processes are normal fluvial (channel flow), sheet flooding, bank erosion undercutting and limited lateral planation and some estuarine action. On the eastern margin of this plain thaddo nala, sukkan nala, Malir river have built expanses of terrace plain.

4. Zone of Dissected Erosion Surface

The central part of Karachi embayment is spindle oblong shaped complex surface which represents erosional remnants of a gentle domal warp which is surrounded by an undulatory gravely surface. This surface is marked by subduced gentle mounds. The gravels are deposited over eroded bedrocks of variable nature for example shales sandstones and limestones. The intermound patches of covered either by silty or weathered gravely material. It appears that the gravely deposits represents the lateral planated depositional surface which was developed across the eroded bedrocks by some freely meandering and ever shifting river system. There are more than one level (possibly three) of these gravels which might be the result of successive change of base level of erosion and could be the terrace remnants, thus produced. Besides these gravel mounds, other landforms are isolated mesa and butte, gentle cuesta ridges, denuded scarps, etc. all these are developed on the differentially eroded, folded beds of upper gaj formation of Miocene age. The general altitude of these landforms is within 250 ft above sea level. This zone comprises of following areas like COD hills, Mulri hills, Gulshan-e-Iqbal, Societies area, scheme 33, NED University, Gulshan-e-Maymar, university of Karachi, T.B sanitarium, Malir Cantonment and parts of Super Highway. The main processes of erosion are sheet washing on slopes, rill action, differential erosion and angular disintegration. On the upper reaches on the surface of the mesas the limestone beds show signs of deep weathering where red clayey soil is developed.

5. Zone of dissected plateau

The zone is situated to the east of Malir River and beyond. The general level of the surface is within 150 ft or so. It ends as a dissected cliff in the south which runs parallel to the coast and in the north it ends with the pied of Sindh Kohistan. It includes the almost all the area of Korangi, Landhi and Pipri Morphologically it appears to be a dissected uplifted, almost flat and wide expand plateau covered with sand / silt and patches of gravel. This surface is developed on the eroded edges of soft, friable sandstone and shales of Manchar formation of Plio-Pleistocene age. Manchar formation shows very gentle warping. Pleistocene conglomerates lies unconformably on the erosional surface of the Manchar formation and appears as scattered, subdued mound. The other landscape features are small mesa, butte and cuesta ridges. The plateau is deeply gullied and rilled on the peripheries. It shows also the effects of sheet flooding, rill action and incision. The aeolian action on near geological past has created an overall sandy/ silty cover of variable thickness (5-8 ft) in the area. Some of the gullies incise their channels within this limit. Another phenomenon of cut and fill is also typical of this area which is expressed by thick valley fills composed of fluviatile gravel which are being cut by the present setup of the drainage lines. The main processes are local sheet folding, channelized flow and aeolian action.

6. The Coastal Zone

The zone makes thin fringe in the south and south west of the Karachi region. A cross section from the east to west includes the following area: Rehri, Ibrahim Haidri, Gizri, Clifton, Kemari, Mauripur, Sandspit, Hawks bay and Cape Monze. The boundary with the hinterland is marked by a dissected abandoned marine cliff more than 40 ft of height and which is invariably cut in to the bed rocks or consolidated fluviatile gravels and screed material. The main landscape features of variable magnitude are Tidal flats, Mangrove farms, abandoned embayment, marine bars, spits, tidal deltas, estuaries, tidal inlets, abrasion platforms, sand mounds, ridges, rocky bed lands, raised beached, sea arches, caves and active beaches, etc.

The coastal margin is of compound type showing regressional effects and progradational phenomenon at the same time. Emergence of the coast line in the near geological past is evident, as growth of Ostrea is seen on the western part of the rocky coast. Near Hawks bay, the Ostrea bed is situated at 10-15 ft above the present sea level. On the other hand, the similar growth is also seen on the dip slope of limestone near Cape Monze at a height of approximately more than 50 ft. The marine terraces of shell concrete are also found along the western coast nearly at the same level as the lower level of the Ostrea growth.

The main processes of landscape shaping in this zone are the dominant wave action and other allied marine processes. Fluvial action (progradation and delta formation) minor aeolian action in the deltas and on the beaches are also noticeable.

7. Peripediment (Sub zone)

It is an integral part to the periphery of the pediment in the western part of the Jhill hills near the Cape Monze between Hawks bay (Bulejee) to Paradise point and beyond. This forms a typically developed plain surface which can be differentiated from a normal pediment surface. Here the truncated bedrocks are overlain by thick, unsorted and very coarse colluvial material. The texture of the material reflects the powerful and dynamic nature of the transporting agent. It appears that it owes its origin from the torrential slopes and sheet wasting processes from the nearby Jhill hills. The thickness of this material is also measured into tens of feet which is also quite contrary to the thin veneer of the sediments which is normal feature of the pediments. Actually, this debris/ colluvial material appears to form an unconformable junction with the eroded bedrock layers of sandstone and shale. The junction is quite clearly seen in parallel gullies, which opens along the coast. The gullies are deeply incised up to 8-13ft and appear to be superimposed from the thin silty/ sandy cover. The incision appears to be the result of the recent uplifting of the region in response to the neotectonic activity in this region. The drainage had to incise as to reach the nearby ultimate base level, the Arabian Sea.

THE DENUDATION CHRONOLOGY

1. General:

The sculpturing of the landscape of the region under the present study appears to date back as early as the post Mio-Pliocene tectonic activity which resulted in the warping, uplifting and faulting of the late tertiary and early quaternary. These rocks belong to Nari, Gaj and Manchar formation of Oligocene, Miocene and Plio-Pleistocene age. Geologically speaking the denudational activity is not very old although the drainage and the landforms show marked tendency of adjustment with the regional and local structural and tectonic setup. This fact reflects a remarkable advancement towards the maturity in relief.

2. Regional Geological setup:

A regional cross section from NW-SE of the Karachi embayment shows a marked progressive tendency of decreasing in tightness or severity of the folding as one proceeds to the east and the south east. The folding indicates the gentleness and becomes broader warping type within a span of 55-60 km from cape Monze to Landhi-Korangi area. The dips of the folded strata becomes gentler starting from 20-25o in the NW than coming down up to 8-12o in the central part and finally remains 3-5o in the SE. this sharpness of the relief and the landforms too in the west and subdued conditions in the east is a reflection of this condition.

3. Post Tertiary Events (Planation / Erosion):

The post Plio-Pleistocene tectonics, which resulted in warping, tilting and faulting, is followed by **sub areal** erosional activity. During the uppermost tertiary and in Quaternary time, the denudational activity appears to have attended its maximum as evident by the expression of erosional and depositional levels in the area of study.

Erosional or topographic levels (planation and truncation) are developed on the bedrock of tertiary and quaternary periods ranging from Oligocene to Plio-Pleistocene times which are expressed along NW-SE cross section near Pir Mangho shrine to Korangi-Landhi area at the coastal fringe.

The highest erosional topographic level is the one 582 ft (the so called Pir Mangho anticline) falls on the beds of Nari formation of Oligocene, exposed in the core of Pir Mangho anticline. The two middle one at 400ft and 240 ft pertain to the beds of Gaj Formation of Miocene age at the eastern flank of Pir Mangho Anticline (the Orangi hills and the Jhill hills) and at the eroded top of the P.E.C.H.S anticline (the COD hill and the Mulri hill) respectively. The further lower one 140 ft is on the beds of Manchar formation of Plio-Pleistocene age which form the eroded top of Landhi-Korangi anticline (the hillocks near Korangi Creek). The fifth one 50-60 ft above sea level is on the conglomerate of dada formation of quaternary time forming the low mounds of Landhi plateau. Lastly, the lowest sixth level at 10-12 ft or a little more forms the scattered spots of the small remnant hill rocks of conglomerate and small flattish stretches near the coast above the present sea level. This height almost corresponds with present day high tide level.

4. Quaternary Events

The process of aggradations in the area of study is expressed in the form of remnant of terraces composed of coarse boulder and gravel deposits of fluvial nature. The extensive valley filling was the result of aggradations on a post tertiary surface of erosion/ surface of truncation by powerful fluvial action. Lateral planation attended by base level shifting created a number of terrace level which are presently expressed by convex crusted, high to low mounds and hills as well as subdued swells of different dimension which show very little local relief difference and it appears that the ancestral stream responsible for the development of terraces was flowing from the NW and was freely meandering on the erosional surface which was developed across the truncated edges of the beds of variable resistance belonging to the Gaj Formation of Miocene age. This surface was developed between the structural high of Drigh road / P.E.C.H.S anticline and Pir Mangho anticline. The wind gap at Unt Palan, a gap in the hilly tract that is the extension of Orangi hills north east of the Bund Murad is said to be the elbow of captured through which the ancestor river was flowing to south east and later on was beheaded by the present courses of the Hab River which presently flows only a few kilometers to the west through a big strike valley having reasonable low relief the Unt Palan point (Grass root by R.A. Khan). The capturing of the south east flowing river appears to be result of uniclinal shift of the present Hab River along Pab range up to Unt Palan point level. So in the light of the above, the Quaternary periods appear to be the period of immense cutting and filling whereby the coarse, gravely alluvium was deposited and entrenched more than once giving rise to the mentioned terrace levels. So, apart from the lateral planation and the changes in the base level, the event of the said river piracy happens to be the major event of the Quaternary time. The depositional levels in the form of boulder conglomerates are presently witnessed at different heights in Karachi region. Almost all of them belong to Quaternary time, the period of most prominent fluvial activity. Along the western coastal margin, the subdued gravel mounds making an abrasional platform near the locality of Mauripur and Sand Spit area are approximately 20 ft above sea level which show a relative relief difference of about 5 ft or so. The next higher level expressed as isolated pinnacles is around 50 to 60 ft above sea level in many localities; for example, Buffer zone and Gulshan-e-Iqbal area especially along the Gujar Nala and Songal Nala. Similarly along the eastern cost, the abandoned coastal cliff is almost of the same height. The next higher one is further to the east and northeast of the central districts of Karachi and is expressed as small hill rocks, ridges and isolated convex crest mounds and it ranges 80 to 100 ft above sea level. Furthermore, the next higher level forms the small mesas and hills is approximately 120 to 160 ft above sea level. The isolated hills of Nila Pahar and Rai Butti etc, composed of thick and well cemented conglomerate are of 200 to 250ft above sea level. The last one the highest in this sequence is the top of Taiser ridge and is of the magnitude of 340 ft or more. It appears that at least more than 300ft of up heaving has been attended upon since the close of Quaternary period.

Event of Recent and Sub Recent Time (Uplifting and Neotectonical Effects)

The present trunk of streams and their tributaries show marked incisions and down cutting even through their own deposits of gravelliferous alluvium and assorted stream debris. Thus they either form cliffs along their course at different places or small terraces composed of assorted colluvial and alluvial material thus indicating recent change in base level due to neotectonics. The incision entrenchment at different localities along the course of the trunk streams and their tributaries has been measured and recorded as follows:

The Lyari River shows incision up to 22 ft nearly in the middle course at the village Haji Jorak (Sheet No. 35 O/4) and cut a cliff in reddish gravel cum boulder compact deposit which is directly resting on the jointed limestone of Gaj Formation of Miocene age and forming the local base level of erosion. The same river further downstream near

Soharb Goth (Karachi Guide Map Sheet No. 3) about 15 to 16 km from Haji Jorak has developed a similar cliff within the same material. The Mokhi Nala, the eastern tributary to Lyari River also shows a similar condition at the pied of Taiser ridge, a little upstream from its junction with Lyari river. In the eastern part of the Karachi embayment, the Malir River shows an incision of 18 to 20 ft and a cliff is cut on its right bank exposing layers of consolidated reddish gravels. An eastern tributary of Malir River, the Sukkan Nala also shows the exposures of the similar material forming cliffs approximately 10 to 12 ft high on its either sides (Sheet No. 35 P/1 and 35 P/5).

Similar exposures of almost same dimensions are also witnessed in the western tributaries of Lyari River and Malir River viz. the Gujar, Orangi, Thado and Langheji Nalas etc. the small rills going to the tributaries of Lyari and Malir river also show incision on noticeable magnitude. Apart from the land area, the coastal margin shows the clear evidence of uplifting in very near geological past in the form of marine terraces, raised beaches, abandoned marine cliffs, abrasion platforms and spits etc. the eastern section of the Karachi coast appears to be markedly passive whereas the western section is active one. It has been reported (personal communication with R.A. Khan) that near Goth Mubarak (Sheet No. 35 L/13) a coastal locality, marine terraces have been measured at 14ft, 22ft and 44ft above sea level near Hawks bay the Ostrea growth is seen directly attached to the bedrock at the height of approx. 10ft that is at higher level than present high tide range, thus indicating of recent uplifting.

A very rough estimate about the amount of uplift since the Pleistocene time can be made keeping in view of the heights and lowest levels of deposition of the boulder conglomerates and the uplifting in the recent and sub recent times can be estimated in accordance with the strandlines which show the Ostreal growth at two levels described earlier. The shell concrete bed exposed at an uplifted beach near Hawks bay approx. 10 to 11 ft (A.S.L) (Sheet No. 35 L/13), has yielded an age of 37000years (personal communication with R. A. Khan small hanging valleys are also seen along the coast cut in the friable sandstone and even in the aeolian sand/ silty cover near Cape Monze and Gadani Valley.

An overall aridity marks the recent time and the windblown sand cover blankets are almost all plain surface and valley flat in Karachi region. This cover is witnessed to have a variable thickness ranging up to 12ft or more o valley flats and plains surfaces. The wet weather rills are well incised in this cover and show reasonable local relief difference sometimes up to 8 to 10 ft. neotectonics effects are also evident as the coastal plain appears to show a little landward tilting.

Presently the region is undergoing fast degradation under effective sub aerial processes through differential erosion, scarp retreat and restricted fluvial action in the form of surface runoff or sheet flooding and channelized runoff. The marine denudational processes are also very active along the coastal margin in this region.

VEGETATION

Karachi division may physiographically be divided into three categories – Hilly region, Alluvial plain deposited by Hab, Lyari and Malir rivers and by seasonal flow and low lying areas and Coastal areas – representing a variety of habitat types. Hussain (1970) studied the ecology of coastal dunes in Karachi and neighborhood, and related successional sequence with the environmental gradient. Karim (1970) developed an objective classification of various plant communities of the coastal swamps in Karachi and its vicinity. Shaukat and Qadir (1971) performed multivariate analysis of vegetation of calcarious hills around Karachi. The description of vegetation of Karachi is found in relation to the physiographic or Edapho-topographic features. Geological relations of vegetation have not been described anywhere to our knowledge except that Snead (1966) stated that in Las Bela District, adjacent to Karachi, *Euphorbia caducifolia* abounds with older surfaces occasionally in the alluvial plains. It is more abundant on the foothills and mountain slopes. It is found only on more indurate stabilized older materials surrounding the recent alluvial plain. It grows on the cones along the base of Pleistocene cliffs, but very rarely on the recent coastal or alluvial plains. This plant is thus useful in identifying Pleistocene or older material. This cactoid spurge forms the highest evolutive stage of succession on calcarious hills along with *Acacia senegal* and *Commiphora wightii* (Shaukat *et al.*, 1981). Vegetational-environmental complex of Dhabeji, Gharo, Shujabad, and Manghopir industrial areas were studied by Ahmad *et al.*, (1978). They reported 51 species pf plants from this area. There were, however, 10 important species (*Commiphora wightii, Tamarix indica, Ziziphus nummularia, Grewia tenax, Cressa cretica, Fagonia indica, Euphorbia caducifolia, Heliotropium ophioglossum, Prosopis cineraria, and Atriplex griffthii*) whose distribution pattern was described along three environmental gradients viz. moisture, calcicolous and silt-clay gradients. Shaukat *et al.* (1976) studied vegetation of Gadap area and identified three communities in the area. 1) *Pteropyrum oliveiri-Cordia gharaf – Capparis decidua* community in sandy plains; 2*) Euphorbia caducifolia-Rhazya stricta—Prosopis cineraria* community in dry stream beds and 3) *Prosopis cineraria- Lycium depressum-Leptadenia pyrotechnica* community on sand dunes. Khan (1987) studied the vegetation of Pakistan coast (from Gharo to Kantani khor, Makran) and recognized 35 plant communities constituting the perennial vegetational

framework. The inland halophytic vegetation is composed of *Suaeda, Tamarix, Haloxylon, Prosopis, and Salsola* etc. (Mehmood and Iqbal, 1995).

The vegetation of Karachi as given for various habitats in this region (Qadir *et al.*, 1966; Karim, 1970; Hussain, 1970; Shuakat and Qadir, 1972; Shaukat *et al.*, 1976; 1980), Ahmad *et al*, 1978, Hussain *et al.*, 1984; Khan, 1987; Shafiq and Iqbal, 1988; Khan and Ahmad, 1992; Khan *et al*., 1994; Iqbal *et al*., 1983; 1998; 2008; Nazim *et al.*, 2011) is briefly described in Table 3. Several species which are characteristics to the various Edapho-topographic habitats are *Euphorbia caducifolia, Acacia nilotica, A. senegal, Capparis decidua, Commiphora wightii, Salvadora oleioides, S. persica; Prosopis juliflora, P. glandulosa, Tamarix indica, Arthrocnemum indicum, Urochondra setulosa, Ipomoea pes-caprae, Halopyrum mucronatum, and Avicennia marina are the important characteristic species of various habitats.* Mangroves of various creek systems of Karachi region (Sandspit, Port Qasim, Kaemari and Korangi have recently been studied by Nazim *et al.* (2011). The mangroves of these areas reflect deteriorating and unstable conditions due to anthropogenic reasons. The size distribution is generally positively skewed. *P. juliflora*, a species of high ecological amplitude, is the most dominant species throughout the area at present. It is a disturbance indicator species and may be seen growing in diverse types of habitats (Khan and Ahmad, 1992) including the polluted areas (Iqbal *et al.*, 1978; 2008).

The herbaceous communities arising after summer and winter rains are generally dominated by grasses and legumes. The composition and structure and phytomass of grass- dominated communities are given by Khan *et al.*, 1999; Khan and Shaukat, 2005). There are some120 species composing the summer aspect of 22 grass-dominated communities with high percentages of therophytes. Flora of winter aspect of grass-dominated communities is not much different from the summer aspect (Khan and Shaukat, 2005).

The biomass based functional studies of vegetation of Karachi are only a few and mostly conducted with respect to the grass communities (Khan *et al.*, 1999; 2000; 2001; 2002; 2005, 2006; Khan, 2009).

A number of weeds in the cultivated fields have been reported (Hussain, 1984). A few of them are *Amaranthus* spp., *Argemone mexicana, Convolvulus* spp., *Chenopodium* spp., *Datura alba, Digera muricata Erigeron Canadensis, Heliotropium* spp. *Peristrophe bicalyculata, Puppalia lappacea, Portulaca* spp., *Peganum hermala, Sonchus asper, Solanum nigrum, , Launaea nudicaulis, Trifolium* spp., *Xanthium* spp. , etc.

In view of prevalence of the high degree of disturbance in and around Karachi, a comprehensive survey of vegetation of Karachi is needed to be undertaken afresh.

ACKNOWLEDGEMENTS

We are thankful to Dr. S.S. Shaukat and Dr. D. Khan for discussion on the vegetation of Karachi and providing us the published material on the subject and going through the manuscript and suggesting its improvement.

REFERENCES

Ahmed, M., S.A. Qadir, and S.S. Shaukat (1978). Multivariate approaches to the analysis of the vegetational-environmental complex of Gharo, Dhabeji and Manghopir industrial areas. *Pak. J. Bot*. 10: 31-51.

Colombo Plan Cooperative Project Report (1961), *The Reconnaissance Geology of parts of West Pakistan*, Maracie Press, Ontario, Canada (Geological Survey of Pakistan 1983, Geological Map of Karachi Region- 1:50,000).

Hussain, H. (1970) *Phytosociological studies on coastal dunes around Karachi*. M.Sc. Thesis, Dept. Botany, Karachi University.

Hussain, S.S. (1984). *Pakistan manual of Plant Ecology*. National Book Foundation, Islamabad. Vi + 242 pp.

Iqbal, M.Z., S.A. Qadir and M. Ahmed (1983). Phytosociological studies around the polluted disposal channels of industrial areas of Karachi. *Pak. J. Sci. Ind. Res.* 26 (3): 134-139.

Iqbal, M.Z., D. Gill and M. Shafiq (1998). Plant communities of sewage effluent channels of Lyari River in Pakistan. *Taiwania* 43(1(: 1-11.

Iqbal, M.Z., S.Z. Shah and M. Shafiq (2008). Ecological survey of certain plant communities around urban areas of Karachi. *J. Appl. Sci. Environ. Manage*. 12 (3): 51-60.

Karim, A. (1970). *Phytosociological studies on coastal swamps of Karachi and its vicinity*. M.Sc. Thesis, Univ. Karachi.

KDA, (1971). Master Plan Department (1971.Karachi Development Authority.) Report No.11 (MP-RR/11). *Geological characteristics of Karachi region*, compiled by Ahsanullah.

KDA (1971). Master Plan Department (1971). Karachi Development Authority. Report No.11 (MP-RR/9). Landforms and Drainage Basins in Karachi region compiled by Ahsanullah.

Khan, A., (1979). River piracy and diversion in Karachi basin. *Grass Roots Biannual Research Journal*, Pakistan Studies Center, University of Sind, Jamshoro.

Table 3. Important elements of vegetation of Karachi**.**

Edapho-topographic / Physiographic Types of Habitats				
Calcarious Hills	**Plains in slight depression**	**Calcarious plains**	**Non-calcarious plains**	**Highly saline coastal plains & Dunes near shoreline**
Riccia rafiqii, Kicxia ramosissima, Linderbergia indica, Vernonia cinera, Barleria acanthoides, Dipterocanthus petulus, Pulicaria hookeri, Grewia tenax, Grewia villosa, Rhus mysurensis, Commiphora wightii, Euphorbia caducifolia, Acacia senegal, P. juliflora	*Acacia senegal, Euphorbia caducifolia, Commiphora Wightii, Rhus mysurensis, Vernonia cinerescens, Grewia villosa, Cordia gharaf, P. juliflora*	*Fagonia indica, Lasiurus scindicus, Sporobolus Arabicus, Pulicaria hookerii, Prosopis cineraria, Salvadora oleioides, Capparis decidua, P. juliflora*	*Capparis decidua Rhazaya stricta Pterocarpum Oliveiri, Ochradanus buccatus, Convolvulus spp., Tribulus terresdtris, Corchorus depressus, Euhorbia spp., Pulicaria spp. P. juliflora*	*Salvadora persica, Tamarisks, Sporobolus arabicus, Limonium stocksii, Suaeda spp., Halopyrum mucronatum ** Salsola baryosma, Aeluropus lagopides, Urochondra setulosa* Arthrocnemum indicum * Cressa cretica, Prosopis juliflora,*
Dry Stream Beds	**Disturbed Plains**	**Ponds & Ditches**	**Mangrove Vegetation**	**Species of Polluted Sites**
Gymnosporia Montana Nerium odorum Rhus mysurensis Tamarix articulate Euphorbia caducifolia Acacia senegal P. juliflora Rhazya stricta Prosopis cineraria	*Launaea nudicaulis Tribulus terrestris Euphorbia hirta Abutilon indicum C. holosericea Solanum surettense Echinophus echinatus Boerhavia diffusa Calotropis procera Prosopis juliflora etc.*	*Hydrilla, verticillata, Potomageton, Najus minor, Oedogonium, Spirogyra, Nymphaea Panicum turgidum, Phyla nodiflora Juncus maritimus, Cyperus rotundus, Nerium odorum, Prosopis cineraria, Prosopis juliflora, P. glandulosa*	*Avicennia marina* Aegiceras corniculatum* (Rare)*	*Paspalidium germinaceum, Prosopis juliflora, Solanum surettense, Cenchrus sp,. Dactyloctenium sp., Mollugo cerviana, Chloris barbata, Sueda spp., Alhagi maurorum, Haloxylon recurvum, C. cretica, Calotropis procera, Desmostachya bipinnta,*

*, Strictly shoreline plants; **, a plant of coastal sand. Sources of Information: Hussain (1970); Karim (1970); Hussain and Qadir (1970); Shaukat and Qadir (1972); Qaiser and Qadir, 1972); Shaukat *et al.* (1976; 1981); Hussain (1984); Khan (1987), Shafiq and Iqbal, 1988; Khan and Ahmad, 1992); Khan *et al. (*1994), Iqbal et al. (1983; 1998), Nazim, *et al.* (2011).

Khan, D. (1987). *Phytosociological survey of Pakistan coast with special reference to pasture and forest development through biosaline technique.* Ph. D. Thesis, Dept. Botany, University of Karachi, Pakistan. Pp. v + 543.

Khan, D. (2009). Structure, composition, phytomass and net primary productivity in a *Cenchrus setigerus* Vahl. Dominated community in a moist-saline habitat of Karachi, Pakistan. . Dominated semi-moist site of Karachi. Pakistan. *Intern. J. Biol. & Biotech*. 6(3): 197-214.

Khan, D. and R. Ahmad (1992). Floristics, life-form leaf-size and halo-physiotypic spectra of coastal flora of Pakistan.. (pp. 158 – 189). In: *Proc. 3-day National Conf. on Problems and Resources of Makran Coast and Plan of Action for its Development* (28-30 Sept. 1991. PCST, Islamabad,

Khan, D. and S.S. Shaukat (2005). Aboveground standing biomass of some grass dominated communities of Karachi: Winter aspect. *Intern. J. Biol. & Biotech*. 2(1): 85-92.

Khan, D., M.M. Alam and M. Faheemuddin (1999). Structure, composition and aboveground standing biomass of some grass-dominated communities of Karachi. Summer aspect. *Hamdard Medicus* XLII (2): 19-52.

Khan, D., R. Ahmad and S. Ismail (1994). Stabilization of sandy deserts through man made succession of commercially important plants using saline water for irrigation. *Proc. IV International Conf. on Desert Development* (July 25-30, 1993), Mexico, Mexico. (Edited by- M. Anaya-Garduno, M.A. Pascual- Moncayo and Rafael Zarate-Zarate). Pp. 344-356.

Khan, D., M. Faheemuddin, M.M. Alam and S.S. Shaukat (2000). Seasonal variation in structure, composition, phytomass and net primary productivity of *Lasiurus scindicus* Henr. And Cenchrus setigerus Vahl, dominated dry sandy desert site of Karachi. *Pak. J. Bot.* 32 (1): 171-210.

Khan, D., M. Faheemuddin and M.M. Alam (2001). Temporal variation in structure and phytomass of an old grass community of Dichanthium annulatum (Forssk.) Stapf. *Hamdard Medicus* XLIV (1): 83-95.

Khan, D., M. Faheemuddin and M.M. Alam (2002). Aspect variation of vegetation and phytomass in five grass dominated communities of Karachi. *Hamdard Medicus* XLV (1): 105-117.

Khan, D. S.S. Shaukat, M.M. Alam and M. Faheemuddin (2006). Structure, composition, phytomass and net primary productivity in a *Lasiurus scindicus* Henr. Dominated semi-moist site of Karachi. Pakistan. *Intern. J. Biol. & Biotech.* 3(1): 173-189.

Khan, D. S.S. Shaukat, M.M. Alam and M. Faheemuddin (2005). Seasonal variation in structure, composition, phytomass and net primary productivity in a *Dichanthium annulatum* (Forssk,) Stapf. dominated coastal non-saline site of Karachi, Pakistan. *Intern. J. Biol.. & Biotech*. 2(2): 329-350.

King, A.M., (1967), *Techniques in Geomorphology*. Edward Arnold Publishers Ltd, London.

Mehmood, T. and M. Z. Iqbal (1995). Vegetation and soil characteristics of the wasteland of Valika Chemical industries near Manghopir, Karachi. *J. arid Environments* 30: 453 -462.

Muhammad, M.J., S.M.S. Zaidi and N. Ibrahim (1992). A preliminary study of some terrace remnants in eastern Karachi. *Karachi University Journal of Science, Karachi.*, Vol. (1+2) No. 20..

Nazim, K., M. Ahmed, S.S. Shaukat, M. U. Khan and S.K. Sherwani (2011). Population structure of some mangrove forests of Pakistan Coast. *FUUAST J. Biol.* 1 (2): 71-81.

Pithawala, M.B. and P. Martin Kaye, (1946), *Geology and geography of Karachi and its neighborhood*, Part I+ II.

Qadir, S.A., S.Z. Qureshi and M. Ahmed (1966). A phytosociological survey of Karachi University Campus. Vegetatio 23: 339-362.

Qaiser, M. and S.A. Qadir (1972). A contribution to the autecology of *Capparis decidua* Forssk. Edgew. II, Effect of edaphic and biotic factors to growth and abundance. *Pak. J. Bot*. 4: 137-156.

Shafiq, M. and M.Z. Iqbal (1988). Phytosociological studies around the industrial areas of Korangi Karachi. *Pak. J. Sci. Ind. Res.* 31(8): 569-573.

Shaukat, S.S. and S.A. Qadir (1971). Multivariate analysis of the calcarious hills around Karachi .I. An indirect gradient analysis. *Vegetatio* 23: 235-253.

Shaukat, S.S. and S.A. Qadir (1972). Life-form, leaf-size spectra of the flora of calcarious hills around Karachi. *J. Sci. Univ. Karachi*. 1(2): 126-132.

Shaukat, S.S., A. Khairi, R. Ahmad (1976). A phytosociological study of Gadap area, Southern Sindh, Pakistan. *Pak. J. Bot*. 8: 133-146.

Shaukat, S.S., A. Khairi, D. Khan and J. A. Qureshi; 1980. Multivariate approaches to the analysis of the vegetation of Gadap area, southern Sind, Pakistan. Tropical Ecology 21(1): 81-102.

Shaukat, S.S., D. Khan and S. A. Qadir (1981). On the vegetational dynamics of calcarious hills around Karachi. *Pak. J. Bot.* 13: 17-37.

Snead, R.E. (1966). *Physical geography reconnaissance - Las Bela Coastal Plain, West Pakistan*. Louisiana State University Studies. Coastal Studies Series Number Thirteen, Baton Rouge, USA.

Snead, R.E. (1969), *Physical geography reconnaissance-West Pakistan, coastal zone*. University of New Mexico publication geography No. 1 Albuquerque, New Mexico.

Survey of Pakistan (1958). *Topographic Map Sheet No.35P/1* at the scale 1:50000. Second edition appeared in 1975.

Survey of Pakistan (1965) *Topographic Map Sheet No.35P/5* (Emergency issue) at the scale 1:50000.
Survey of Pakistan (1975), *Topographic Map Sheet No.35O/4* (Emergency issue) at the scale 1:50000.
Survey of Pakistan (1927). *Topographic Map Sheet No.35L/13 (Old Edition)* at the scale 1:63360. (1"=1mile).
Survey of Pakistan (1955), *Karachi Guide Map, Sheet No.1, 2, 3, 4* at the scale 1:21120. (3"=1mile).
Zaidi, S.M.S. and Mohammad, M.J. (1988). Geomorphic zones and land complexes of Karachi embayment area. *Karachi University Journal of Science*, No. 17, Vol. 1.

(*Accepted for publication December 2011*)