CHAPTER-3

APPROACH TO THE STUDY OF GEOMORPHODYNAMICS AND MORPHO-ECOLOGICAL MANAGEMENT IN THE LITTLE RANN OF KUTCH

3.1 INTRODUCTION

Geomorphologists would certainly like to see the contemporary geomorphological research work occupying a seat much more steadfastly within the mainstream of work with environmental approach and one should not disagree with their sentiments and expectations. However this is not the first work in the line, several work has been done with the expansion of interest in the climatic geomorphology and its implications, with the need to establish linkages between the other branches of physical geography such as phytogeography, zoogeography and ecology, not to mention about the climate-process-form linkages. These entire expansions in this field have broadened the continuum of geomorphological research and this will certainly help in the progress of subject, in both pure and applied. The unknown areas on the earth with a potentiality for human settlement can be more accurately identified and evaluated with such an approach.

The research works under taken deals with the impact of seasonal reversal (wet and dry) climatic environment on landforms through the various geomorphic processes, which has sculptured the present landscape of the Little Rann of Kutch. Much of literature has been referred in order to have a sound theoretical base of the old widely accepted concept of climate-process-form linkages. The concept of climate- process-form linkages was introduced for the first time in connection with the glacially controlled

geomorphic regime and was enshrined in Sir William Moris Davis's work, an American Geomorphologist; however, the Franco-German school of Geomorphologists such as Birote, Budel, Cailleus, Tricart, Troll etc. have played a wider role in popularizing the concept. The understanding of the climate-process-form linkages in the study area suggests that it has a variety of unique pieces of landforms which is the result of assemblage of geomorphic processes (fluvial, marine & aeolian). These landforms collectively exhibit a classic terrain as an entity. Beyond any doubt, the concept is all pervasive in a way that it can be applicable on any empirical study.

The long explanation of the geological structure is not superfluous in the initial stage of the study because our derived and deduced geomorphological knowledge is based on it. Also the existing landscape of the studied area cannot be wholly explained in the light of contemporary dynamics alone, as both tectonic and climatic variables have their impression though on varying magnitude.

The inborn characteristics of the area are considered as initial landscape. And these given landscape have been sculptured by a more stable morpho-climatic environment. The characteristics of geomorphic process include process in combination with the surface materials and climatic variables and thus the process- form relations pattern shows a spatio-temporal change.

Semi-arid area is often used as an example where there is high level of morpho-dynamic activity. One of the reasons for this is the presence of both precipitation as well as high ambient temperature. Much of its precipitation falls in the form of frequent heavy rain storms. The other is the

widespread and often because of excessive impact of man. The entire Kutch district on an average receives less than 500mm of rainfall, which still skews towards both the Ranns, making it absolute water stressed district of Gujarat.

3.2 LITERATURE REVIEW

Literature review pertaining to the subject has been carried out on three aspect that is, (i) in order to understand the trends in the geomorphological works in the present context, leading to the conceptualization of term Geomorphodynamics, (ii) review of morpho-ecological works on arid and semi-arid climatic zone and (iii) review of the works done on Rann of Kutch in various disciplines, such as geology, geography, zoology, botany etc.

There is not much literature on the Little Rann of Kutch and the available literature largely addresses the Great Rann of Kutch. A very less significance has been given to the Little Rann of Kutch, may be because of its lesser dimension and most important is its less strategic location.

There are many old reports in the gazetteers and railway reports, which is in fact an eye witness accounts of traveler, descriptive in nature and is more location oriented. Peoples like Oldham, Mac Murdo, Wynee etc., investigated the geological and seismological phenomenon of the Kutch as a whole. It is necessary to mention that no literature was encountered with a geographical or geomorphological approach which could be considered having a close affinity with the present study. However to provide a suitable base to the present research work an extensive literature survey has been conducted and some linkages with present study area has been established.

As stated in the Bombay Gazetteer, the Rann of Kutch exist since ancient times and during this period many upheavals occurred and a greater part of the Rann witnessed subsequent upliftment and subsidence. Alexander the Great in 325 B.C. found the Rann, a great lake that was

navigable. The Indus River was draining in the Rann and ultimately finding its way into the Arabian Sea through Gulf of Kutch and Khambat.

The presence of sea sediments in the form of marine shells in various places as high as 80 feet above present Rann level, archeological evidences, linkages of Dhaulavira and Lothal and the most recent history of Lakhpat etc. all these facts strengthen the derived geological past of the area. Most of the studies and report claims that during recent past Rann was a part of sea.

Mac Murdo (1824) a British army officer prepared an outstanding eye witness account of Rann. His observation of the pre and post Kutch earthquake of 1819 is by far the most excellent in a way that he described how the Rann morphology was significantly changed. He described how the rivers and valleys with sandy beds, which generally remained dry get flooded with water within a very less time ranging between few minutes to half an hour. "Spots of ground in circles from twelve to twenty feet of diameter threw out water to considerable height and subsided in a slough"[21]. He also mentioned that the earthquake had raised an earthen mound about 80 miles in an east west direction and a mile wide, with a steep face on the south side but no perceptible slope on the north, this elevated portion in the Rann is called Allah Bundh.

Mac Murdo (1824) described the subsequent earthquake after 1819 and its impact on the physiography and drainage in the Rann of Kutch. He also mentioned about the change in the salinity content of the stream flowing near Allah Bundh. He found saline water in the place of fresh water

[21] Mac Murdo, J., (1824), "The earthquake which occurred in India in 1819". Royal Asiatic Society of London and Dublin (1823), Bombay branch, V-3, Pp.90-116.

just within an interval of four months that is before and during monsoon. It implies that south west monsoon wind drags the saline water upon the fresh water.

Burnes (1839), a traveler, has claimed that his account is the first account of the Rann. "I am not aware of any other account having been published. It is not saturated with water except at certain periods that it has no weeds or grasses except on the islands, that it has a bed, which instead of being slimy, is hard, dry and sandy, of such a consistency as never to become clayey……. a vast expanse of flat hardened, sand encrusted with salt sometime an inch deep"[22]. Burns quotes Mac Murdo that "The Rann has every appearance of the sea having shortly withdrawn from it"[23]. According to Burns, "The people of Kutch believe that the Rann was once a bay with harbor along its edges"[24].

Burnes account of 1819 earthquake revels "That a large lake formed on the south side of the Allah Bundh, completely submerging the small villages of Sindree in about eighteen feet of intensely saline water. The land in the vicinity is so flat that the lake extended as far as the eye could see both east and west. It was later determined to be more than thirty miles in diameter. The earthquake made numerous cracks and fissures in the Rann, and I state on the authority of eye witness, that immense quantity of black muddy water were ejected from these opening for a period of three days and that water bubbled out of the wells of the tract bordering the Rann called

[22] Burnes, A., (1839) "Travels of Bokhara" 3 Volumes. John Murray, London, V-1, p-308

[23] Ibid. p-325

[24] Ibid. p-319

Bannee, till it over whelmed the country in some places with six and even ten feet of water"[25].

Lyell (1855) stated that "during the monsoon when the sea runs high, the salt water driven up from the Gulf of Kutch and the creeks at Lakhpat overflows a large part of the Rann"[26], which is similar in the area of Little Rann of Kutch through the Gulf of Kutch. He described Rann as "that singular flat terrain called the Rann of Cutch…...it is neither land nor sea, but is dry during a part of year and again covered by salt water during monsoons. Some parts of it are liable after long period to be overflowed by river water"[27].

Frere (1870) described Rann as "many sq. miles of barren ground covered with a solid cake of hard transparent ice-like salt, from a couple of inches to in some cases two feet in thickness"[28]. Again he perceives the landscape as "The surface apparently for all practical purpose, a dead level. When the surface is dry, imperceptible is the slope, that a shower of rain falling on the hard, polished surface, neither sinks nor runs off, but lies like a vast slop on the plain, and may sometimes be seen moving along with wind, till it gradually dries up by evaporation"[29]. "the Rann of Kutch was a gulf of

[25] Ibid. p-311

[26] Lyell, C., (1855), "A manual of elementary geology". John Murray, London. P-436

[27] Ibid. p-346

[28] Frere, H.B.E. (1870) "Notes on the Runn of Cutch and neighboring region". Journal of Royal Geographical society, V-40, p- 188

[29] Ibid. p-184

the sea, with surrounding coastal towns, a few recognizable relicts of which still exist"[30].

He also mentions about origin of Rann salt that "various theories put forward to account for these thick sheets of solid salt, on a perfectly level surface of dry sand and clay, the most probable and most consistent with observed facts appears to be, that it is formed by the gradual evaporation of the intensely saline salt water which is always present in the sub soil, and which oozes to the surface by capillary action or under pressure, from rain in the upper country, and from high tides in the creeks which intersects the plains where the sheets of salt are found"[31]. "The constant recurrence of surface agitation from earthquakes, especially during the time when the surface is annually covered with a couple of feet of water, supplies exactly the kind of cause which would account for the uniformity of the level. We have evidences that under the action of earthquake mounds of such sandy soil as that of Rann melted down, as it were, into the water which then covered the Rann, and that in place of the mound there is now the usual firm, smooth level of the rest of the Rann. There seems no reason why the same sort of process frequently repeated, should not obliterate all traces of creeks and water courses, and reduce the Rann to the surface which is now find. The Rann is in fact, a great basin subjected to frequent earthquake agitation"[32].

Wynne's (1872) thought contradict with the idea of sea floor rising to form Rann. "The surface of the Rann differs much from that beneath the neighboring sea as shown, by the coast survey chart, on which are marked

[30] Ibid. p-193

[31] Ibid. p-188

[32]Ibid. p-196

descents of 84 feet within less than a mile, besides various inequalities which do not exist in Rann"[33].

In the railway report (1946) Rowland has made the remarks on the movement of water in the Rann, the most searching local enquiries could obtain no evidence of an outward flow of water from the Rann basin through Kori Creek. The natural configuration of the ground together with the side extent of the Rann depression, are sufficient to explain this, while at the same time there are evidences on record of an easterly flow of the Rann water and of their escape via Little Rann.

The same report includes the work of Gules that the Rann presents a level and featureless floor of sand as far as the horizon in all direction the whole way. In the monsoon it is said to be covered with sea-water to a depth of two to three feet. The flooding of this part of the Rann is independent of tides and is entirely due to the wind.

Sivewright (1907) describes the nature of the silt of the Lesser Rann as "this silt, when wet, becomes clayey. Whereas the silt of the Greater Rann is unmistakably an Indus valley deposit; that of the Lesser Rann is as easily recognized as the black cotton soil of its source of origin in Kathiawar"[34].

Oldham, R.D. (1926) was also in the opinion that Rann is a result of obliteration of tectonic basin. According to him, "three types of surfaces are recognized in the Rann. The first as Rann gives its name to the whole tract;

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[33] Wynne, A.B., (1872) "Memoir on the Geology of Kutch". Memoirs Geological Survey of India. V-19, P- 28.

[34] Sivewright (1907), "Cutch and the Rann". Geographical Journal, V-29, Pp-518-539.

the second known as 'dhoi' or 'bet', is a sandy soil free from salt, bearing a growth of grass and occasional stunted trees and bushes is found around the margins of the 'Rann' and rising as island of various sizes from surrounding tract of Rann; the third known as 'Kalar' may be regarded as a transition between Rann and Dhoi; it is less impregnated with salt than the Rann and bears some scattered vegetation. The distinction between Rann and Dhoi is evidently due to the fact that all vegetation on the former is killed by periodic flooding, which keeps the surface soil impregnated with salt"[35].

Wadia (1926), in his book on Indian Geology, has given an account on the geology of Kutch and the Rann. He says that Rann is underlain by a substratum of peninsular genesis and owes its present condition to the geological processes of Pleistocene age. "The tract is a saline marshy plain scarcely above sea level, dry at one part of the year and covered by water at other part. It was once an inlet of the Arabian Sea, which has now been silted up by the enormous volume of detritus poured into it by the small rivers discharging into it from the east, north and northeast. From November to March that is, the period of northeast and retreating monsoons, the Rann is barren tract of salt encrusted mud. During the other half of the year it is flooded by water of the river that is held back by the rise of sea by southwest monsoon gales"[36].

Satyanarayana (1951) did some Petrographic analysis and observed that the soil profiles though from different places in the Rann have higher

[35] Oldham, R.D. (1926), "The Kutch earthquake of 16th June 1819 with a revision of the great earthquake of 12th June 1897". Memoirs Geological Survey of India, V-46, p-81.

[36] Wadia, D.N., 91926), "Geology of India". Mac Millan and Co., London. P- 169

content of salt and gypsum. He also mentioned about the presence of high water table in the area. His analysis showed a bimodal nature of the load indicating the sediment transportation by traction and suspension.

According to Platt (1962) "The space where this sediment collected was a bay about twenty three centuries ago. The energy to bring the sediment was supplied by the Indus River, and the energy to smooth, the surface was supplied by frequent earthquakes, some of which have been sever. No need has been found to call upon extraordinary processes. The Rann of Cutch is extraordinary, however, because it has been observed to change from marine bay to alluvial plain in a geologically short time and without any complication from Pleistocene changes in the sea level"[37].

Roy (1973) has also done a exhaustive work on pattern and causes of inundation of the Rann of Kutch particularly in the western most part of the Great Rann considering various parameters such as grain size analysis, hygroscopic coefficient, moisture absorbing capacity, total soluble salt content etc.

[37] Platt, L.B., (1962), "The Runn of Cutch". Journal of sedimentary and Petrology, V-32, p-92

Literature review on ecological significance:

The available literatures on the Little Rann of Kutch are more with biological significance rather than that of dealing with the relationship between biotic and abiotic phenomenon pertaining to the area. Apart from a few studies on the wild ass of Little Rann of Kutch and articles dealing with floristic description and distribution, there are some travelogue describing Rann's landscape, its flora and fauna, some ecological works have also been carried out by Gujarat Ecological Society and has been documented such as Salinisation and Ecological Degradation around the Ranns, Gujarat; Current Ecological Status of Kachchh and Process of Desertification in Kachchh and Banaskantha Districts of Gujarat, India etc.

Ecology of an area not only includes the organic elements such as micro and macro flora and fauna (as have been highlighted in most of the ecological studies) but also soil which is at large the result of morphodynamic processes.

As per the view of Thornes and Bundsen (1977), Geomorphological process brings about spatial & temporal changes to the soil and thereby landscape.

Colin E. Thorn (1982) also advocates that "Geomorphological Processes brings about the changes in the Characteristics and distribution of soil and ultimately to ecosystem"[38]

[38] Colin E. Thorn, (1982), ed. "Space & Time in Geomorphology". Department of Geography, Univ. of Illinois at Urbana, p-25.

Bharucha and Meher-Homji (1965), identified two zones of semi arid climate as recognized in India, "One, in the north, is contiguous with the Thar Desert, extending into Rajasthan, Punjab, parts of Uttar Pradesh and in Gujarat state, Kutch, Saurashtra (excluding Gir) and north Gujarat. The other semi arid zone is situated in the south. It includes Deccan plateau, Coimbatore plateau and extreme south east corner of Tamilnadu. The semi arid zone of north and south are separated by a narrow humid strip (Satpura range and plains of Tapti River). The pattern of distribution of floral elements is explained on the basis of bioclimatic conditions prevailing in Afro-Asian continents".[39]

According to Rao (1981), The Rann of Kutch is phytogeographically interesting, since it is located at the junction of several phytogeographic provinces and is composed of diverse floristic elements .Floristically the area is more akin to Sindh (Pakistan) and North West. Rajasthan, the high percentage of general element is explained by high incidence of biotic factors which is causing the destruction of natural vegetation and facilitating invasion by other plants.

As per Champion and Seth (1968), "the vegetation of Little Rann of Kutch is classified into Rann saline thorn scrub, Salvador scrub and tropical Euphorbia scrub (scrub in its degradation stage)"[40]. According to Meher-Homji (1972) "the vegetation types present in semi arid zones of India are characterized according to there degree of aridity. He classified the

[39] Bharucha,F.R. and V.M. Meher-Homji (1965) on the floral elements of the semi arid zones of India and their ecological significance. The Phytologist, Vol.-64, Pp-330-342

[40] Champion, H.G. and Seth, S.K., (1968) A revised survey of the forest types of India. Government of India, New Delhi, p-404.

vegetation of Kutch under the prosopis cineraria (a small to medium-sized thorny tree, with slender branches armed with conical thorns and with light bluish-green foliage), Capparis deciduas (a small much branched tree or shrub of arid regions. It bears a mass of slender, leafless branches, the small leaves being found only on young shoots, it rarely exceeds a height of 5 meters) and Zizyphus-Salvadora type"[41]. Gupta and Saxena (1971) categorized this vegetation as "Halophytic scrubland"[42]. According to Dargie and El. Demerdash (1991), "soil moisture is recognized as one of the principle determinant of grassland"[43].

Karl (1977) says, "The soil pattern must be seen in context to its ecological function, not only as a medium in which plant grow but also as a structure in which many chemical changes takes place"[44].

The vegetation types in the area undergoes perpetual change as per the statements of the native people of the area and this may be attributed to the twin processes of autogenic (an autogenic succession describes a succession where the stimulus for change is an internal one. For example gradual soil improvement could allow a new species to develop) and allogenic (an allogenic succession describes a succession

[41] Meher-Homji, V.M.(1972) an approach to the problem of defining aridity in the India-pakistan subcontinent, Geographical Review of India, Vol.- 34, p-2.

[42] Gupta,R.K. and Saxena, S.K. (1971) Ecological studies on the protected and overgrazed lands in the arid zone of west Rajasthan. Indian Botany Society, Vol.-30, Pp-382-388

[43] Dargie, T.C.D. & M.A.El. Demerdash (1991), A Quantitative study of vegetation environmental relationship in two Egyptian desert. Journal of Vegetation science-2, Pp-2-10

[44] Karl-Friedrich Schreiber (1977), "Landscape Planning and Protection of the Environment", Journal Applied Sciences and Development, Vol-9, page 127-139.

where the stimulus for change is an external one as for example natural catastrophe, climate, animal grazing, human interferences) which decide the vegetative succession of an area. Le. Houerou (1981) describe "autogenic succession due to micro environmental effect of the fauna and allogenic succession due to geomorphic process of glyptogenesis and sedimentation plays an important role in determining vegetation association in arid land"[45].

As per Sinha (1993) Little Rann of Kutch, a resource crunch area with inhospitable climatic condition and geomorphology had the human density of around 63.77 person/sq. km. during 1981 census. The economy of the peoples of Little Rann of Kutch is solely dependent on the manufacturing of salts from the Rann. A sum total of 603 villages along the fringe area of Little Rann of Kutch have been documented by him. The density of population is very high in the area largely because of the salt making industry in the area. Further the density increases in the area due to the influx of migrants along with their cattle during the monsoon season.

Shah (1993), emphasizing on the increasing urbanization and development associated with its large stretches of southern fringe, states that a large area has been converted into irrigated croplands supported by lift irrigation facilities. A sizeable portion of the Rann has been converted into salt manufacturing area and in the fringes into agricultural croplands due to the increase in human activities in the last two to three decades.

In view of Gray (1977), the outcome of field studies collectively with an understanding of natural developments & human manipulate, an individual can settle on the best approach to the management of a site.

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[45] Le Houerou, H.N. (1981) Long term dynamics in arid-land vegetation and ecosystem of N. Africa, International Biological Programme, vol-17, pp-357-384 (Edited by D.W. Goodall and R.A. Perry) Cambridge University press.

V. Selvan (2003), has also done a comparative study of eastern and western coastal wetlands of India, his paper also gives some insight to the geomorphic, environmental setting of mangroves. Apart from it he has also classified the mangroves and floristic changes therein. "The mangrove wetlands of Gujarat fall under the category of drowned-river valley type. Change in some of the environmental factor, particularly changes in the periodicity and quantity of freshwater that flows into mangrove wetlands …… would lead to reduction in the diversity of exclusive mangrove plant species"[46].

Morpho-ecology is therefore described as a new frame work, combining morphogenesis (the development of structure and form) and ecology, which is firmly rooted within a geographical and biological paradigm.

[46] Selvam V. (2003), Environmental classification of mangrove wetlands of India, CURRENT SCIENCE, VOL. 84, NO. 6, 25 MARCH 2003, p-757

3.3 DATA BASE & METHODOLOGY

The research work on "Geomorphodynamics & morpho-ecological management in the Little Rann of Kutch" has been proposed after an intensive pilot investigation of the terrain, and realizing geological, physiographical and ecological problems of the area. In spite of the known fact that the Geomorphological phenomena depend on a large number of variables, which is one of the major difficulties in analyzing geomorphic features, the present work is designed to give an insight to the geomorphological characteristics with emphasis on dynamics of the geomorphology in relation to it eco-climatic condition in the Little Rann of Kutch and its resultant landforms. The study also focuses on the ecological management of the area through the better understanding of soil characteristics.

***Data collection*:**

(i) The field study being the very foundation of this work was carried out in order to understand the geomorphic characteristics of the area. Details of field study have been covered under chapter-4.

(ii) Collection of soil profile samples were done from various geomorphic regions.

(iii) The data base on climatic parameters was collected from various secondary sources.

(iv) Basic information on the study area has been collected from published and unpublished reports, journals, books etc. In addition to it uncounted interviews with various experts, officers and workers of salt industries and villagers were also carried out. Offices such as Gujarat Institute of Desert Ecology,

Gujarat Ecology Commission, Gujarat Institute of Desert Ecology in Vadodara, Department of Forest in Vadodara etc. were visited during the initial stage of the study.

(v) Toposheets prepared by Survey of India on quarter inch have been referred for preparing base map and one inch to mile for detailed interpretation.

(vi) Satellite imageries available on website of Google Earth, Resmap and Wikimapia have been used to crosscheck the ground reality and interpretation.

Methodology:

The radical configuration of reasoning which follows in the thesis from the conceptual background is based on the following methodological steps:

- To illustrate the concept of Geomorphodynamics and morpho-ecology in terms of those variables which have direct relevance with geomorphology.

- To select and introduce the study area in terms of its morpho-climatic and morpho-ecological characteristics with reference to the varying landforms.

- The study relies on the extensive field study. As possible, required data pertaining to climatic condition has been collected so as to fabricate the relationship between morpho-dynamic process which are taking place at present & the prevailing climatic condition.

- Investigation of forms i.e., Geomorphological features is carried out in order to relate it with the ongoing processes and to specify and separate the

inherited properties of landscape from those produced under contemporary morphogenetic processes.

- To identify the intrinsic qualities and intensity of fluvial, aeolian and marine action (in terms of erosion & deposition) under the given morpho-climatic environment.

- To select the processes and landforms which are prominent and have a significant place in the study area.

- To work out the fundamentals that governs the pattern of processes transforming the given landscape as for example in terms of dominance of types of processes during different season, inundation of Rann sediments.

- The work is also substantiated by i) comparing the remotely sensed data, maps, toposheets & ii) filtering of satellite imageries for a general evaluation of vegetation, soil moisture, land-cover etc.

- Base map for the mapping has been generated through the digitization of topographical sheets of quarter inch to miles. The representation of various phenomena has been done through Arc GIS tool. The available maps from secondary sources were geo-referenced with the base map in order to show attributes on a self generated map.

- Petrographic analysis have been carried out to built the relationship between the soil type its geomorphic characteristics & the floral & faunal cover i.e., Morphoecological relationship.

- Assessment of statements by natives concerning changes in the last few decades

- Study of traditional & modernized land use system in order to have a better understanding of the relation between the natural potential and its present day exploitation

3.4 AIMS & OBJECTIVE

1. To assess the impact of geomorphic process in transforming the landforms of the area.

2. To study the spatial & temporal morpho-dynamics (changes, dominance & intensity of processes at work in different seasons) with respect to the environmental factors of Topography, Climate, Inundation pattern, Parent material and Vegetation in the Little Rann of Kutch.

3. To study the morphological & ecological component of the area & to fabricate its relationship i.e., Morpho-ecology that will help in the management.

4. To put forth certain essential guidelines that will cater in the smooth functioning of eco-system of the study area.

3.5 SCOPE OF STUDY

Arid and semi arid regions are characterized by a climate with no or insufficient rainfall to sustain vegetation. Spasmodic storm water drainage, its regulation and water resource management is an important phenomenon to deal with in the semiarid regions. An important feature of the study area is the higher proportion of incoming water that is returned to the atmosphere through evaporation, mainly from the soil surface. Therefore evaporation is a major factor in reducing water storage in the study areas. The amount of moisture recharge in the ground depends upon the intensity and duration of rainfall and the surface configuration of the ground. The recurrent drought and flood make the ecosystem of the area more fragile. Anthropogenic activities reduces the vegetation cover, subsequently, the soil is lost through erosion and thus the environmental degradation results. The programme for morpho-ecological management must be based on the survey of historical land use pattern and potential productivity of the region, which is a difficult task to asses.

Geomorphological knowledge can help in alleviating many environmental problems concerned with soil erosion, flooding, road building as well as natural hazard of many kinds. There can be little doubt that as geomorphologists learns more about the behavior of material they should be better fitted both to understand landforms and to converse with engineers and conservationists. The study by its very nature will focus on the Little Rann of Kutch as an entity which has been sculptured in the past and is still in the process, under varying climatic conditions and seasons. A great deal has been done in order to understand the geological, physical, and ecological characteristics of the area and there by there role in the process transforming the given landscape to its present relief. On the other hand,

the general relief of the area has also dominant role to play in deciding the nature and intensity of the morphodynamic processes. There is much variation in the morphodynamic processes in different part of the year resulting because of the varying inundation pattern in the area. Much of the space has been given to discuss the various geomorphic processes working at different part of an year or with respect to season. The imperceptible relief of the area is inundated by marine water and rain water at different place and at different point of time, resulting into the increase in the salinity in water and soil. The work is also intended to address the problem of salinity. The study area is known for the salt making small and large units. These salt making industries have their own associated ecological problems like over salinisation of the area, death of mangroves, not to mention about the health problems of the workers working in the salt factories. Abundance of salt in the area has hampered the growth of vegetation directly causing its indirect implication on fauna of the area.

The regional description of the area will certainly help in the understanding of the physical environment of the area its evaluation in terms of physical resource potential and there by its utilization. The addressed problem in the area through this research work with geographical approach will certainly act as eye opener for the planners and NGO working in the area.

3.6 LIMITATIONS

The greatest limitation of the geomorphological studies is its dependence on a large number of variables, which is a major hurdle in terms of listing, gathering, organizing and presentation. However, as much possible variables are taken into consideration in the general evaluation of the terrain of study area.

Apart from the hostile climatic condition, the area also hosts several dead end in terms of slipping sand and depression filled with sluggish mud and silt. One can not traverse across the area without the help of native dwellers. The extreme north eastern, eastern and southern part is much more reliable in its surface configuration and perception where as the perception becomes indistinct in the more interior areas.

Physical accessibility to the area is another challenging aspects, a very less length of motorable road separates the area, partly from west and north. Apart from these there are some roads in the south eastern part approaching towards the salt industries. The traveling in the Rann is also restricted during rainy season. Much of the interior sites were visited through jeep, motorbike and off course on foot and that's too during the intermediate season that is when the surface is dried enough to walk on except for some still wet depression but not so dried that the salt extraction starts. Movement is restricted during rainy season because of water stagnation and the mud which develops on the Rann floor. Where as during dry part of the year, the gateways of Rann are busy throughout the day and visibility is also reduced to minimum because of the suspended dust and dusty winds. The vehicle engaged in the salt mining has to turn on their

lights even during day time. Since there is no defined path or lane and therefore number of accidents are also very high.

The availability of literature on the said area is limited and is of less significance to the subject undertaken. Large scale map of the Little Rann of Kutch is available only in the form of Toposheet, half a century old. The free images available on the internet are of low resolution. However, the work is based on these only available data.

3.7 ORGANIZATION OF THE STUDY

The research problem undertaken has been synthesized under various themes and sub themes which ultimately finds there place in the following chapters.

Chapter –1
INTRODUCTION:

In this chapter an attempt has been made to understand and explain the concept of Geomorphodynamics and Morpho-ecology bearing in mind the climatic and other geographical phenomenon of the study area.

Chapter-2
ENVIRONMENTAL OUTLINES OF THE LITTLE RANN OF KUTCH:

This chapter deals with the geological and environmental outline of the Little Rann of Kutch. Going by the notion of majority of geologists, this area was once connected to the Gulf of Kutch and has emerged out in the recent past. Geographically this area is monotonously flat with extreme of climatic condition. There are many island/bet in the midst of Rann, which practically hosts life on it.

Chapter- 3
APPROACH TO THE STUDY OF GEOMORPHODYNAMICS & MORPHO-ECOLOGICAL MANAGEMENT OF THE LITTLE RANN OF KUTCH:

This chapter starts with the introduction of the nature of study and the works that were carried out. Considerable literatures on the subject i.e, general geomorphology of arid areas, arid ecology and geology & geography of the study area have been reviewed to have an insight to the study area. The vital things such as Aim & Objective, Data base and methodology followed also finds its place in this chapter. Scope and limitation of the study

has also been covered under this chapter. Further more, this chapter also includes the entire chapterization scheme of the study undertaken.

Chapter-4
STUDIED VARIABLES OF THE GEOMORPHIC PHENOMENON:

Chapter-4 has been devoted in bringing out all the variables that were collected either personally or from the secondary sources in order to gather facts and thereby reasonable interpretation in the proceeding chapters.
Various methods of analysis such as field method and laboratory methods have been discussed followed by the analysis of sediment samples that were collected from the field through various techniques and results were generated under grain size analysis, plasticity of the soil, Total moisture content, Porosity and Permeability, Total soluble salt content, Natural volume and Compact volume, Water holding capacity, Bulk density and Hygroscopic Absorption.

Chapter-5
REGIONALIZATION OF THE STUDIED AREA & ITS GEOMORPHIC CHARACTERISTICS:

Considering the prevailing climatic, geomorphological, ecological condition and in line with Passarges, S. (1919) scheme, study area that is Little Rann of Kutch and its frontier zone of minimum two miles has been divided. Identification of four regions viz.; (i) Fringe zone, two miles of frontier around the Little Rann of Kutch (ii) Dry Rann, Eastern and Central part of Rann (iii) Wet Rann with numerous creeks, western part and (iv) Islands (Bet) followed by the description of their sediment properties and significant geomorphological characteristics are incorporated in this chapter.

Chapter-6
MORPHO-ECOLOGICAL PLANNING & MANAGEMENT IN THE LITTLE RANN OF KUTCH

In this chapter the identified four regions are studied on ecological context giving prime importance to the type of soil and its properties. All the four geomorphological units have been discussed considering elevation, surfacial expression, landuse and management measures. Soil protection, management of water resources and land restoration being the three identified priority has also been focused briefly

Chapter-7
SUMMARY & CONCLUSION:

A sincere attempt has been made in this chapter in order to fulfill the aim and objective of the research work under taken. Proper attention has been given to see that the work did not deviate from its objectivity.