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Monitoring Landform Dynamics of Mahi River Estuary at Gulf of Cambay, Gujarat Using RS-GIS Techniques

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Abstract: ***The Gulf of Cambay (GoC), the extension of the Arabian Sea, is the valuable asset and is importantfor the economic progress of the state and the nation.This study is focused on estuary of Mahi River and its tributary at Gulf of Cambay (GoC).The studiesshows arising complications of mix nature in a regiondue to several reasons.To detect and assess the decadal landform changes for the 1978-2017 time frame and Level I & II Classification System for Coastal Land Use Mapping for the geology and geomorphological features were considered. Satellite data were used in ArcGIS environment to construct the geo-data sets and produce LULC classified thematic maps and geo-statistics. Statistical analysis generated were materialised to reveal the outcomes. Industries (7%), mangroves (>1%), settlements (>1%) depict a growth from 1978 to 2017. Sandbars have negative and mudflats have positive but fluctuating trend. Further association of classified and predictable features on image were established with Ground Control Points (GCP). The spatial extent of mud flats, salt encrusted land and sand bars have transformed indicating the natural parameters are under pressure over this region. The trend of fluvial water and rejuvenation through sediment flux in gulf in the recent time is declining compare to previous and in contradictory, the spatial extent of mud of marine nature and its deposition and change in its quality is striking and evident.***

Keywords: Gulf of Cambay, Landform features, Landform dynamics, River estuaries, RS & GIS

I. INTRODUCTION

There is no single definition of the coastal zone. Some have referred to it as “that part of the land most affected by its proximity to the sea and that part of the ocean most affected by its proximity to the land”. According to Carter [2] the coastal zone includes river basins and catchments, estuaries and coastal seas and extends to the continental shelf. It is a broad transitional area in which terrestrial environments influence direct marine environments and vice-versa [2]. The coastal zone comprises a suite of unique ecosystems adapted to high concentrations of energy, sediments and nutrients that stimulate both high biological productivity and a diversity of habitats and species. [1]. The Pilot Analysis of Global Ecosystem (PAGE) study defines coastal regions to be the intertidal and sub-tidal area on and above the continental shelf (to a depth of 200 meters) area routinely inundated by saltwater and immediately adjacent lands [3]. Crosland [4] treats coastal zones as the narrow transition areas that connect terrestrial and marine environments, earths most productive and valued ecosystems. The estuary is a transitional zone where freshwater from the Mahi River mixes with saltwater from the Gulf of Khambhat, creating unique ecological conditions.The Mahi estuary plays a crucial role in the ecosystem of the region, providing habitats for diverse species and supporting local communities. The estuarine area is vulnerable to pollution from industrial effluents, waste disposal, and fishing activities. Over the last century, humans with their improving technological capabilities have accelerated the rate of change, increasing their influence on the dynamics of already highly variable ecosystems [4].Sixty percent of the world’s major cities are located in coastal zones, and 40% of the all the people on the planet live within 100 km of a coastal zone [6].Total coast line of the world is 35, 6000 km and the coastal area covers more than 10% of the earth surface. In India, 500 m distance from the high tide line towards landward is taken for demarcating the coastal zone [5]. This feature makes the Gulf second in the world in terms of tidal amplitude [9].Because of the economic benefits that accrue from access to ocean navigation, coastal fisheries, tourism, recreation and industrialization, human settlements are often more concentrated in the coastal zone than elsewhere. About 40% of the world’s population lives within 100 km of the coast. About 10% of the world’s population resides in low elevation coastal zone (<10 m) making their lives highly vulnerable to coastal disasters. About 35% of Indians live within 100 km of the country’s coast line measuring 7517 km [7]. Here is the statistics summarised in TABLE: 1 stating the share of Indian cost to the world.

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Table 1 Share of coastal area of India to the world: (Courtesy: PAGE:WRI, 2000)

	Coastal Length (km)	Area of Continental Shelf (up to 200 m depth)	Territorial Sea (Up to 12 nm)	Claimed Exclusive Economic Zone	Exclusive Fishing Zone	Total Potential Maritime Area	Population within 100 km from the coast
	a	000 km2	000 km2	000 km2	000 km2	000 km2	Percent
World	1634701	24287.1	18816.9	102108.4	12885.2	X	39.0
India	17181	372.4	193.8	2103.4	X	2297	26.3

The results from the Pilot Analysis of Global Ecosystem (PAGE) show that human activities have extensively altered coastal ecosystem worldwide. Nearly 30 % of the land area in the world's coastal ecosystems had already been extensively altered or destroyed by growing demand for housing, industry and recreation [3]. Gulf of Cambay part of Gujarat coastal belt,Western coast of India too, facing the environmental challenges like human encroachment, transforming land use land cover pattern, landform dynamics, wet land loss, and shore line erosion.Along the Gujarat coastal belt, the population in coastal talukas of Gujarat Coast has increased by nearly 18.3 percent from 2001 [8]. Theurban Populationincreased by about 34 percent in thesix major coastal districts of Gujarat [9].Over the last century, humans with their improving technological capabilities have accelerated the rate of change, increasing their influence on the dynamics of already highly variable ecosystems [1]. The RS tool provides a valuable source of multi-temporal data, and the GIS is useful for mapping and assessing the associated patterns. Thus, these tools provide a unique opportunity to develop information sources and support decision-making activities in a plethora of coastal zone applications [5].Pioneering the work focusing on Coastal zones and Remote sensing technology, Nayak & Sahai [14] on the basis of Landsat Imagery has described the tidal as well as seasonal sea level changes, current patterns and sediment transport and the relationship of these phenomena with some erosional and depositional- coastal geomorphic features,coastal Mapping [10][15]; IRS 1A: Application for Coastal and Marine Resources, mapping of the tidal wetlands, coastal landforms, suspended sediments, understanding the process of estuary dynamics, shoreline changes, degradation of coral reefs etc. [16] ; mapping of salt affected land in parts of Gujarat [17], monitoring mangroves and other coastal vegetation [18] are worth to be recognised here. Availability of repetitive, synoptic and multi-spectral data from various satellite platforms, viz. IRS, LANDSAT, SPOT, have helped to generate information on varied aspects of the coastal and marine environment [18]. This paper is an effort to study the Mahi River Estuary at Gulf of Cambay,part of Gujarat coastal belt, focusing mainly on estuaries and or deltaic estuary formed by Mahi River GoCwith some additional approach and dataset, to reach out the close trend of change of landform features.

II. OVER VIEW OF THE STUDY AREA:

A. General

Gujarat, one of the longest maritime states of India have two gulfs, Gulf of Kachchh and Gulf of Khambhat respectively within its boundaries. Both the gulfs owe their own peculiarities in terms of physiography, hydrography, biodiversity and the surrounding confluences [9].The Gulf of Cambay (GoC) also referred as Gulf of Khambhat, is geographically located between latitude 20° 30' and 22° 20' N and longitude 71° 30' and 73° 10' E. (Fig.1). The Gulf of Cambay (Khambhat) in the state of Gujarat, is an inverted funnel shaped highly indenting, constituting western Continental shelf of India. The trumpet shaped gulf has separated Saurastra peninsular to the Main land Gujarat crafting western flank of Gulf i.e. Saurastra and eastern flank of Gulf i.e. Main land Gujarat. The mouth of this Gulf opening to Arabian Sea is having width of 70-75 kms and attaining length of 130-135 kms [12],[24]. As a part of research work of GoC, it is found that the width drastically reduces to 25 km at Bhavnagar and then approximately 15 km [24]or even less up to ~ 6 km [9] towards the tail of the Gulf while towards the mouth width attains almost 200 km [7]. The Mahi River Estuary located in the Gulf of Khambhat, on the western coast of Gujarat, India. The estuary spans approximately 50 kilometres and passes through districts like Anand, Vadodara, and Bharuch. Geographically the limits of the GoC is covered by Survey of India Toposheet No.46 B/8 and 46C /6, C/9, 10, 11, 12 and 14 at scale of 50,000 of 1968 to 1974 years and the Naval Hydrographic Chart No.208 (Hydrographic Chart of Gulf of Khambhat at scale 1:50,000, Original published in 31.07.2006 by National Hydrographic Office-Dehradun, GOI. [24].

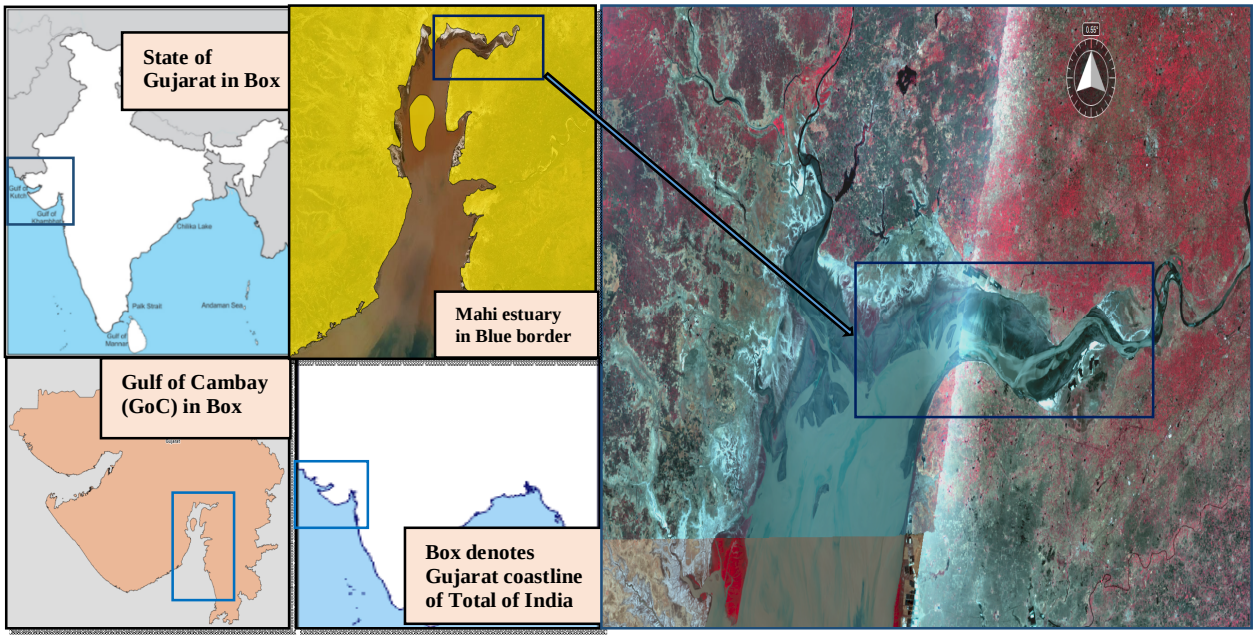


Figure: 1 Study Area

III. METHODOLOGY

A. Data Used

While selecting the data, it was preferred to have a data of same season/period and tidal height at specific interval of temporal resolution to estimate the spatial and temporal variations in the LULC pattern over the past few decades. In order to ensure consistency in comparison studies, it is imperative to select imageries with similar characteristics (season, tidal conditions, etc.). Landsat TM; Landsat ETM, and Landsat OLI_TRS datasets with universal transverse Mercator (UTM) zone 43 north Projection – WGS '84 projection system have been used for this study region. Areais selected along the coast, based on the vulnerability entrusted due to change in shoreline and over thrusting of urban development and industrialisation or even terra forming to Anthropogenic act of human in the vicinity. Data used are shown in TABLE: 2

Table: 2 Satellite data used for the study

Satellite	Date	Sensor	Resolution (mts)	Band (Nos.)	Time Pass	Path	Row	Zone/ projection
Landsat 3	16.10.1978	MSS	60	04	04:38:00	159	45	Datum: WGS 84 Map Projection: UTM Zone 43
Landsat 5	19.10.1990	TM	30	07	04:38:00.	148	45	
Landsat 7	22.10.2000	ETM+	30	08	05.23.26	148	45	
Landsat 5	14.11.2011	TM	60	07	5.20.41	148	45	
Landsat 8	29.10.2017	OLI-TIRS	30	11	5.33.30	148	45	
IRS-R2	11.03.14	LISS 4 (NRSC)	5.8	03	5.20	093	057	
Additional support of Google earth Pro (2018); Bhuvan-NRSC, High resolution satellite images (new-2018) and open street map during process and analysis of work.								

B. Methodology

Satellite Imageries is affected by the solar incidence angle, solar azimuth, earth-sun distance, viewing angle, atmospheric effects, bidirectional reflectance distribution function (BRDF) of the surface sensed, and sensor band spectral response functions, thus these factors in combination produce significant band radiometric differences [29].To correct this the most essential step is conversion of digital number to reflectance of each dataset, used for interpretation. It is desirable to implement these steps to bring in consistency of the time-series data set.

After radiometric correction geocoded Landsat digital data series (1978-2017) were then analysed using onscreen visual interpretation techniques using major key elements along with ancillary information through topo maps, hydrographic charts, published thematic maps to interpret landforms and LULC of North ofGoC, Gujarat. LULC maps were prepared on 1:50,000 scale in Geographical Information System (GIS) environment. Geo-data base was created in GIS using ARC GIS10.3. Software package based on Nation Spatial Framework on 1:250000 with LCC projection and WGS 84 datum. An exclusivelandform features classification was evolved due to spatio-temporal data set to facilitate an appropriate assessment of all the land use/land cover categories and landform features over the study area. This outcome is the part of research work of whole Gulf of Cambay and intensely selected this part to check the natural dynamics and anthropogenic influence of the whole study area over this selected region. The chosen areais based on the uniqueness of geology, geomorphology and physiography of the region with consideration of presence of estuarine delta. Here the dimensions, size and shape of the cell and or district boundaries are not taken into consideration. Attributes of the cell for chosen area is given in TABLE: 3.Adaptation of Level I & II - Classification System for Coastal Land Use Mapping [30], [31] for each cell could help to recognise some of the eight landforms for Mahi – Sabarmaticonfluence at Gulf, North of GoC while extracting the information from the available satellite data sets which are considered for the Land Use/ Land Cover changeas well forming the landform features partly(Landform dynamics). The different landforms features used here are having essence of geomorphology as well as ecology as referred into various papers, not defined here.

Table: 3 Attributes of the selected area

S.N	Vertices	Latitude	Longitude	S.N	Vertices	Latitude	Longitude
01	LT	22 36N	72 30E	03	RB	22 11N	72 89E
02	RT	22 35N	72 90E	04	LB	22 10N	72 28E
Average Length (km): 67.00 Average Width (km): 28.60 Area (Sq,Km):1075			NOTE: (i) The dimensions of each cell are Non Uniform and having variable Length (L) and Width (W) even for individual cell. (ii) LT: left top; RT: right top (iii) LB: left bottom; RB: right bottom				

IV. RESULTS AND DISCUSSION

A. Landform cover change: General overview of the region

It is important to supplement brief evidences of geological and structural influence on the existing geomorphological and landforms features that has developed in past along the GoC. The structural faults have shaped up the drainage morphology, landforms and subsequent geology [32]. The rocks are not exposed and are covered by huge accumulated alluvium onshore[28].This aspect is needed to understand the genesis of landform feature and progression of mudflats. The rivers entering the Gulf do not carry too much of water, mainly after the constructions of various small, medium civil structure. Theriver Mahi entering from NE.Out of 50 nos. of major, minor and small dam structures, 12 weirs for Sabarmati river basin almost85% (counted) have executed after the year of 1985. In case of Mahi river entering GoC from NE direction, out of 134 dam structure and 4 weir structures almost 65% (counted) are functional after the year of 1985 [33]. Mudflats represent the most dominant landform stretching Mahi river mouth to as far as Khambhat. Being under the constant influence of tides, these mudflats are criss-crossed by a network of tidal channels. One study is based on suspended sediment concentration, flow structure, geomorphic features and hydrodynamics reveals that the fine grained sediments are transported to the inner Gulf and sandy sediments are transported south words as the tides here are largest in the Indian coast[34]. Yet another study based on Physico-chemical parameters in three main estuaries viz. Sabarmati, Mahi an Narmada of Gulf concludes DO and BOD and level are lowest in Sabarmati then increasing for Mahi to Narmada. Similarly Nitrates and Phosphate concentration is in reverse order. This is how organic activities are highest in Sabarmati followed by Mahi. This is surely due to release of sewage water as well as industrial waste [35]. At many places the flats are seen supporting growth of mangroves. Here is the geostatistical analysis TABLE: 4 carried out for the years of 1978, 1990, 2000, 2011, 2017.

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Category	1978	1990	2000	2011	2017	Category	1978	1990	2000	2011	2017
Agriculture Land	32	35	31	34	32	Sandbar	0	0	0	0	0
Industrialisation	0	0	0	0	0	Scrubland	1	1	0	1	1
Mangrove	0	0	0	0	0	Settlement	0	0	0	0	0
MudFlats	2	4	2	2	2	Waterbody	60	56	61	59	60
Salt encrusted land & Saltpan	4	5	4	3	4	TOTAL	100	100	100	100	100

Table 4: geostatistical analysis of different land features identified (Area covered by feature of total in %)

Geostatistical graphs are presented for the area in figure: 2 for the timeframe 1978-2017 and spatio-temporal mapping of the same timeframe for selected area has been presented in Fig.3 for understanding the change in landforms.

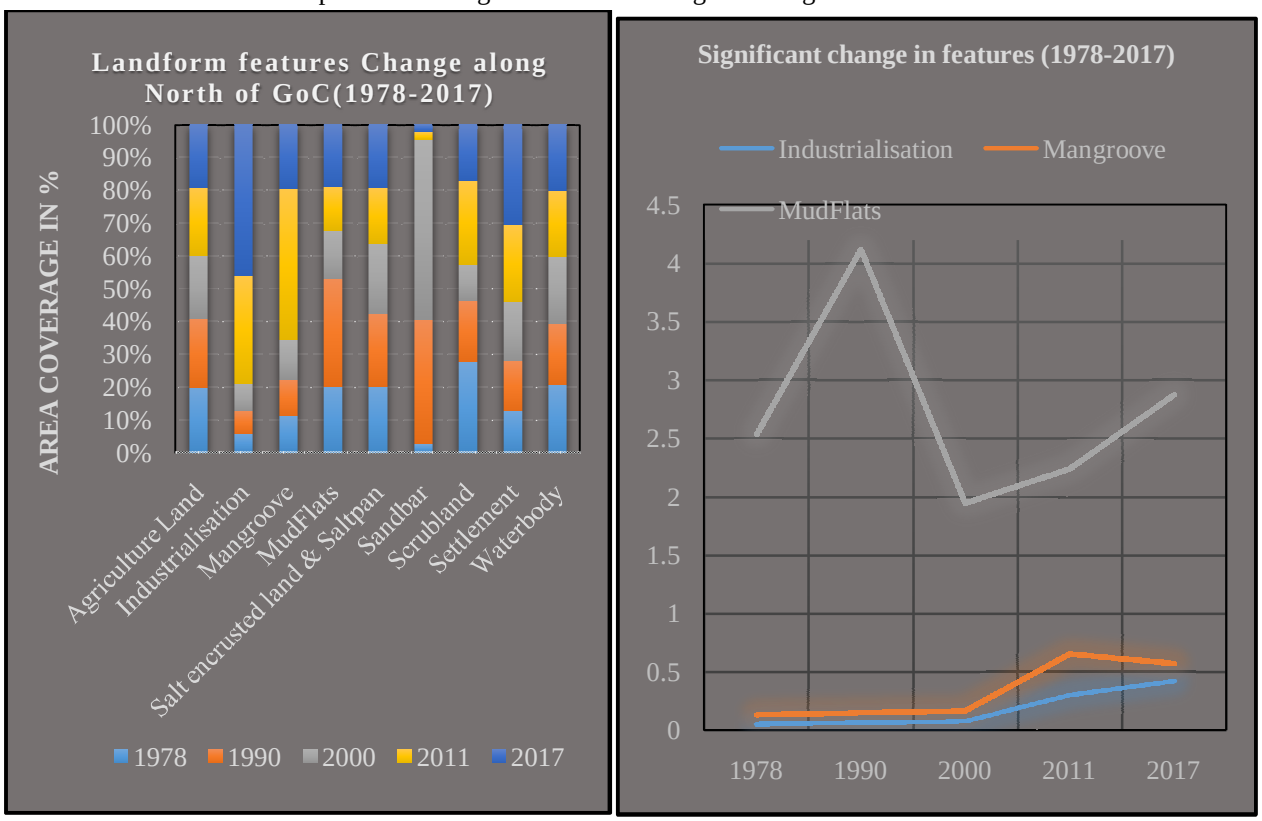


Fig: 2 Geostatistical graphs

It could be observed from Geostatistical graphsthat the agricultural activity and vegetation cover is unaffected and that has remained almost 30% to 35% of the total area for the selected region and for given time frame. Similarly at the spatio-temporal scale the population has growth of <1.5%. These both the parameter clearly indicates that the region is comparatively least attracted.The significant change that could be seen is for industry (7.4 %), mangrove up to 1% while mudflats have high fluctuating trend but from the year 2000 onwards it is increasing.In connection to increasing mudflats, we are tempted to focus some of the eye opener truth for this region, eventually, the study area is selected.Since last few decades, the rivers were not endanger and they were rejuvenating but the threat of civil structures, population encroachment, chemical pollution from industry, agriculture, huge dose of sewage water just to quote terraforming and Anthropocene human act has created issues not only to the rivers but also to their connections and here is the Gulf as well as the surrounding landforms.Some concerned facts as reported [33], [34], [35] earlier, make a sense that the rejuvenation of sediments brought by rivers in to Gulf has checked and become infrequent supply.

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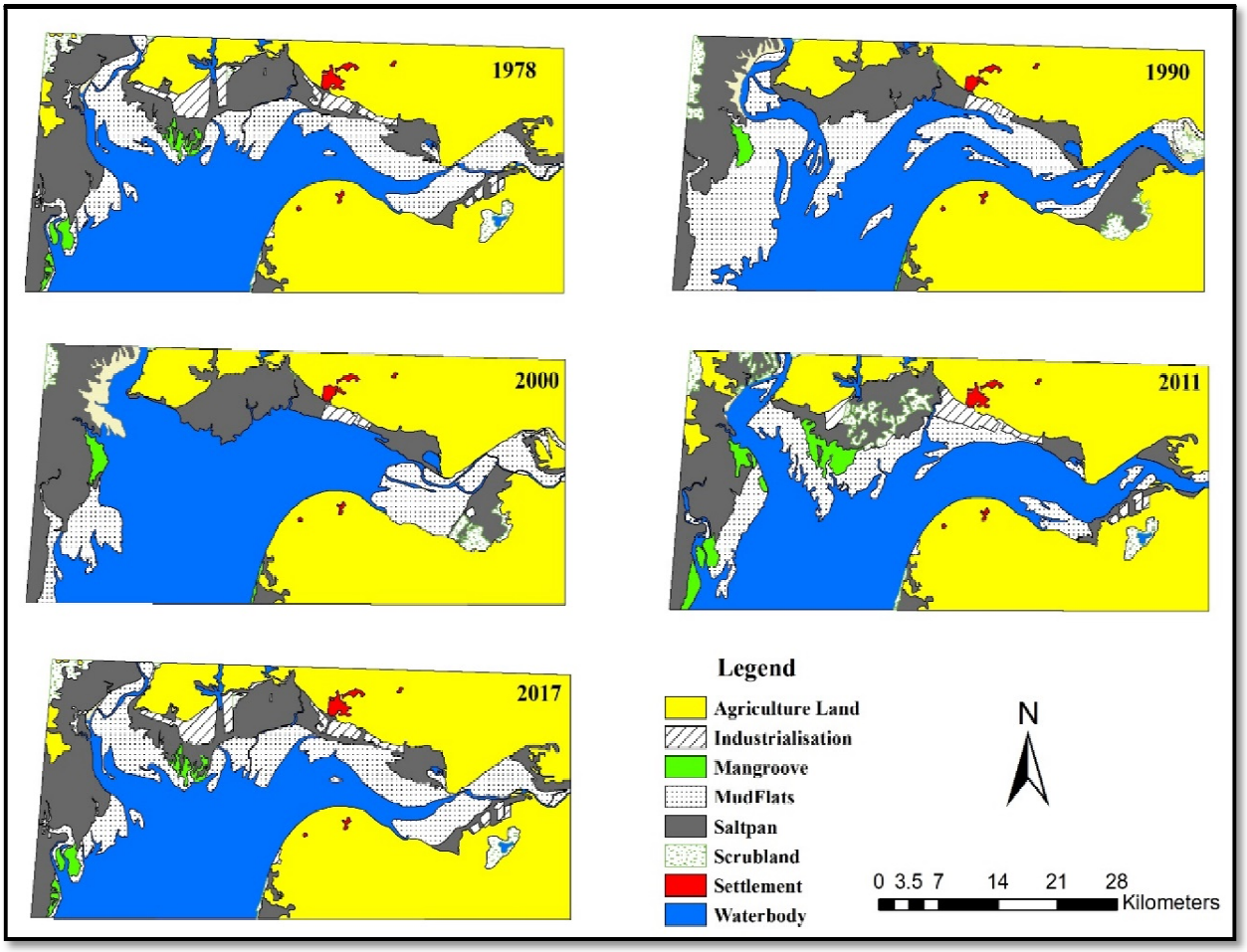


Fig: 3 Spatio-temporal landform feature change for the study area (1978-2017)-Digital processed Landsat Images

V. VALIDATION

Photograph description in favour of ground Truthing in figure 4 are given below:

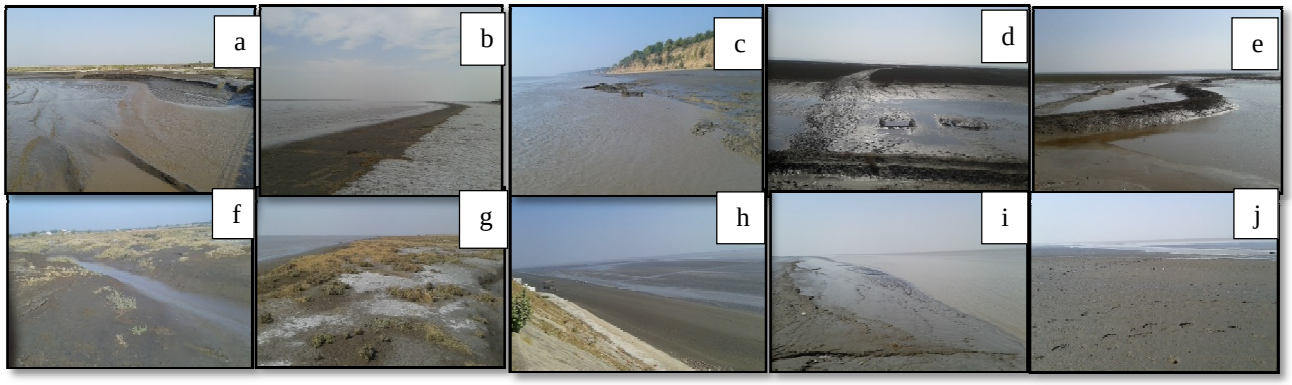


Fig .4 field photographs ground truth validation

(a,b,c) Creek flooded with tide water, Inundation region during high tide , leaving behind the salt affected land bounded by thick accumulation of alluvial (d) Aquaculture activity at Khambhat (e) Aquaculture activity at Khambhat receiving the tide water (f) Intertidal zone with dry scrubs and tide channels (g) Salt encrusted dried land (Inter tidal zone) (h) Vast mudflats at Dhuvaran thermal power station site, Mahi river (i,j) Mud deposition, channel formations by powerful tide water at Kavi site (Mahi river)

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VI. CONCLUSION

Different spatial classes are represented here in image for temporal resolution of 1978, 1990, 2000, 2011, 2017 along with the statistics and graphical bar charts on decadal scale. Followings are the conclusion:the climate, socio-economic condition has more influence on agriculture and settlements which has remained unchanged or marginally changed. Mangroves are taken care of by the nature. The contribution of water and sediments flux from river side is comparatively (based on referred research work) compare to mud flat expansion through tides within the gulf and along estuaries, encouraging more marine deposition and saline in nature. The quality degradation and quantity of mud flats in this region at the tail of Gulf is eye catching may excel prograding nature of shore line. The region is under fluvial marine deposition, but fluctuating contribution from river side, need more study on chemical analysis for refined work.

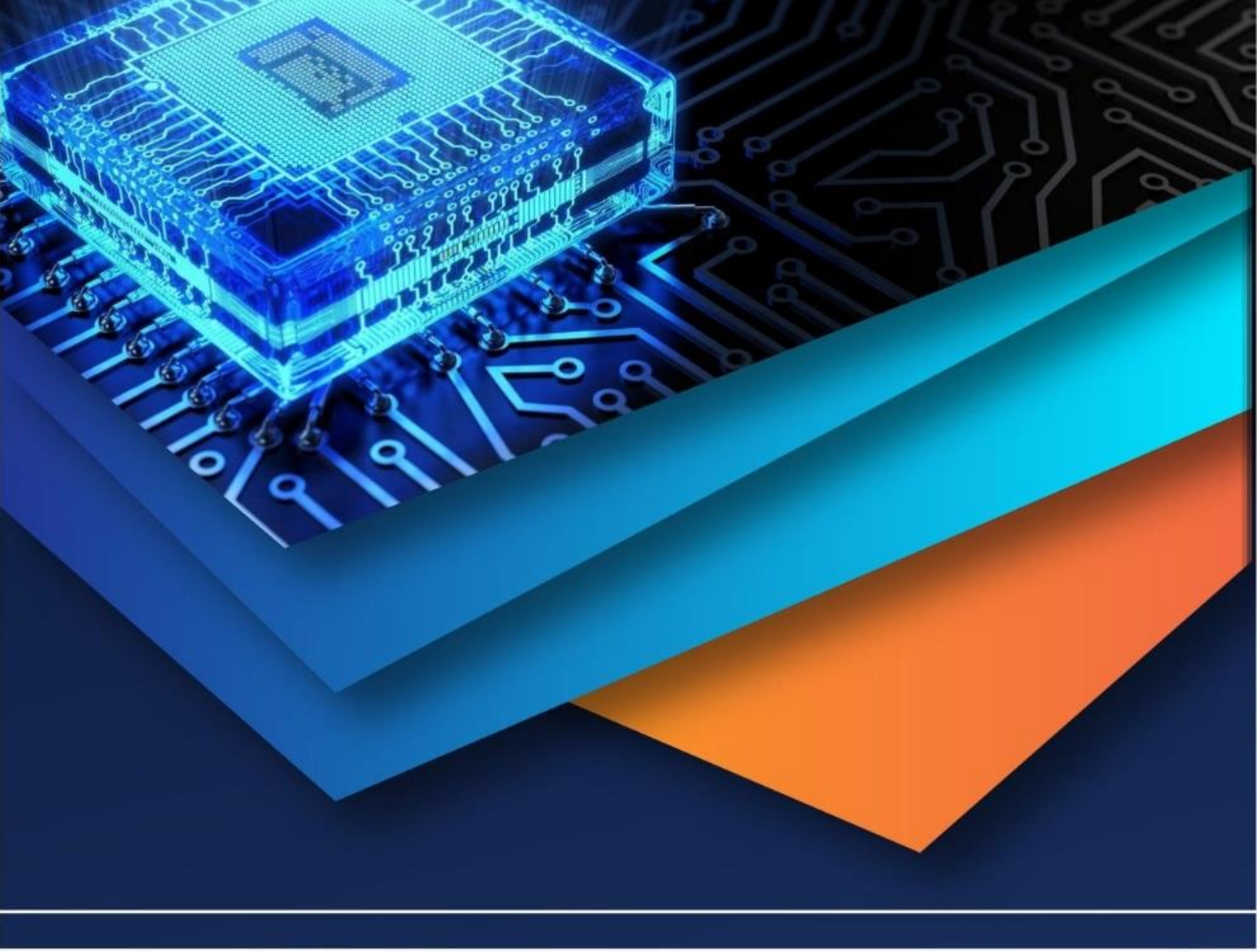
VII.ACKNOWLEDGMENT

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REFERENCES

[1] Crossland Christopher J, Baird Dan, Ducrotoy Jean Paul A, Lindeboom H J:the domain of global interactions chapter-march 2006 https://www.researchgate.net/publication/226867603
[2] Carter R. W. G. 1988, coastal environments an introduction to the physical, ecological and cultural systems of coastlines' academic press limited london.
[3] WRI: World Resources Institute (2000): Revenga, C., Brunner, J., Henninger, N., Kassem, K., & Payne, R. freshwater systems. washington, dc.page,2000 world resources institute coastal ecosystem pilot anaysis of global ecosystem published by washington dchttp://www.wri.org/wr2000
[4] Crossland, C.J., Kremer, H.H., Lindeboom, H.J., Marshall Crossland, J.I., Le Tissier, M.D.A. (Eds.), 2005. coastal fluxes in the antropocene: the land–ocean
[5] SAC: Space Applications Centre (ISRO), Ahmedabad (2012):coastal zones of india. isbn no. 978-81-90997b-9-b
[6] [6]Niholls R J, Wong P.P., Burkett V, Codignotto,J. Hay, R. and others: coastal system and low lying area climate change 2007 4th assessment report of the ipcc uk cambridge university press 2007, 315-356
[7] CZI: 2012,coastal zone of india space applications centre (isro) ahmedabad isbn no. 978-81-90997b9b
[8] Census of India, 2011, http://www.censusindia.gov.in/2011census/population_enumeration.html
[9] GEC-2011 : Gujarat Ecology Commission Ecological : profile of coastal talukas around gulf of khambhat gandhinagar, 2011
[10] Shaikh M G; Nayak S ; Shah, P.N.; Jamusaria, B B. "Coastal Landform Mapping around the Gulf of Khambahat using Landsat TM data, Photonirvachak, Journal of the Indian Society of Remote sensing, Vol.17, No:1, 1989
[11] Turner R K and Adger W N (Lead Authors): coastal zone resources assessment guidelines, land-ocean interactions in the coastal zone (loicz), (igbp), (icsu) (cserge) research centre of the uk economic and social research council (esrc).1995
[12] Mahapatra, Manik Vulnerability of Gujarat coast due to sea level rise – an investigation based on remote sensing & GIS techniques , PhD Thesis, Nirma Univerity, Ahmedabad, Feb 2015.
[13] Nina Siu-Ngan Lam, S. Liang (ed.), Methodologies for Mapping Land Cover/Land Use and its Change, Advances in Land Remote Sensing, 341–367. 341 c Springer Science + Business Media B.V., 2008
[14] Nayak, S. R and Sahai, B. (1985); Coastal morphology: a case study of the gulf of Khambhat (Cambay). Int. J. Remote Sensing, 1985, 6, 559–567
[15] Nayak Shailesh (2017) Coastal zone management in India − present status and future needs, Geo-spatial Information Science, 20:2, 174-183, ISSN: 1009-5020 (Print) 1993-5153 (Online)
[16] Desai P S, Narain A. Nayak S R. : IRS 1A: Applications for Coastal and Maine Resource, Current Science, Vol. 61, 3 & 4, 25 Aug' 1991, Special Issue on: Remote sensing for National Development
[17] Joshi, M D.; Sahai, Baldev: Mapping of salt-affected land in Saurastra coast using Landsat Satellite data, International Journal of Remote sensing, Vol:14, 1993, Issue: 10
[18] Nayak, S. & Bahuguna, A. Application of Remote sensing data to monitor mangroves and other coastal vegetation of India, Indian Journal of Marine Sciences, Vol 34, December 2001
[19] Chauhan, H. B., & Nayak, S. (2005). Land use/land cover changes near Hazira Region, Gujarat using remote sensing satellite data. Journal of the Indian society of Remote Sensing, 33(3), 413-420.
[20] Misra, A. & Balaji, R. "Decadal changes in the land use/land cover and shoreline along the coastal districts of southern Gujarat, India, Environ Monit Assess (2015), Springer International Publishing Switzerland 2015
[21] Merh: S.S. Geology of Gujarat Geological Society of Gujarat Bangalore 1995
[22] Sourav saha, Anupam ghosh, Santanu Banerjee, Pratul k Saraswatiand Stuart D Burley. Characteristics of an Open Coast Tidal Flat: Example from Daman, West Coast of India, Journal geological society of India,2011
[23] Sourav Saha, Stuart D. Burley, Santanu Banerjee, Anupam Ghosh, Pratul K.Saraswati,; The morphology and evolution of tidal sand bodies in the macro tidal Gulf of Khambhat, Western India, 2015
[24] Modi D, Subhash Bhandari, 2018: Landscape change detection of Aliabet, Mouth of Narmada river, Gujart using geospatial tchniques, Journal of Emerging Technology and Innovative Research, Vol:5, Issue 7, ISSN: 2349-5162.
[25] Merh S.S,(1995): Geology of Gujarat, Geological Society of India, Bangalore, 1995

[26] Patel M.P., Patel S.G. and Merh S.S.: Geomorphic studies on the Coastline between Mahi and Tapi river mouth paper published in Geology and Geomorphology of Quaternary Terrains of Gujarat with special reference to Coastline evolution: A report work of Dept. of Geology, M.S.University, December 1982
[27] Patel M.P., Patel S.G. and Merh S.S.: Geomorphic Evidences of Quaternary Sea-level changes in Mahi-Tapi coastal segment of Gujarat published in proceedings of the All-India Symposium, Geology Dept, M.S.University of Baroda, February 6-8, 1983
[28] Badrul Islam,Md Geological set up of the gulf of Khambhat Cambay A critical appraisal of the relevant onshore and offshore geo environmental parameters. Ph.D Thesis, Maharaja Sayajirao University of Baroda, 1986, Shodhganga. Web 16 December 2015.
[29] Royer, A., Vincent, P., & Bonn, F. (1985). Evaluation and correction of viewing angle effects on satellite measurements of bidirectional reflectance. Photogrammetric Engineering and Remote Sensing, 51(12), 1899-1914.the process at regular time intervals.
[30] Nayak S, Pandeya Anjali, Shaikh M G, Coastal Zone classification System: A Remote zone Classification system, Proceeding of the Seminar, National seminar on Quaternary Landscape of Indian Sub-Continent (1-3 December, 1988), M S University, Baroda, Gujarat (Proceeding 1991)
[31] Shaikh M G; Shailesh Nayak; P.N.Shah, B B Jamusaria "Coastal Landform Mapping around the Gulf of Khambahat using Landsat TM data, Photonirvachak, Journal of the Indian Society of Remote sensing, Vol.17, No:1, 1989
[32] Ganpathi S, the Shoreline Morphology of the Gujarat Coast: An Appraisal, Status of Coastal zone studies and future trends: Special reference to western India , 24-25, Feb 2006, Dept. of Geology and SAC
[33] WRIS,NRSC,2014: River basins of India GOI Ministry of water Resources CWC,NRSC, Sabarmati rive basin & Mahi river basin
[34] Kunte, P. D. (2008). Sediment concentration and bed form structures of Gulf of Cambay from remote sensing. International Journal of Remote Sensing, 29(8), 2169-2182.
[35] Deshkar S, Jayendra Lakhmapurkar: State of three estuaries of Gulf of Khambhat, Indian Journal of Geo-marine sciences, 2012 , 41(1): 70-75
[36] http://www.earthexplorer.usgs.gov/



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