

Landscape change detection of Aliabet, Mouth of Narmada River, Gujarat, using Geospatial techniques

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Abstract : Alia bet is the pear shaped independent land mass (delta) of the Narmada River located about 25 km west of Bharuch. Among the various bets at the estuary of Narmada River, Alia bet has its own identity and antiquity. The name is derived from the term 'AAL' means "with the lush green grass". Geologically the delta came into existence due to the silt deposition by the Narmada River, prior to debouching its water into Gulf of Cambay of Arabian Sea. The Gulf of Cambay/Khambhat, (GoC), the study area is highly influenced by the tidal currents in addition to geological and structural set up of the region. In Gulf of Cambay, a large tidal range during high and low tides give rise to strong tidal currents and develops a mechanism of sediment transportation. Interestingly the inverted funnel shape of GoC has large contribution for the sediment deposition in this region. During high tide the tide currents move into the Gulf and encroaches the river mouth whereas during low tide, they move out. This regular phenomena since long period on geological time scale has modified the geomorphological features in this region. Additionally, human interference has too largely played crucial role to alter the land scape. Almost 30 large, 135 medium and 3,000 small dams and related water infrastructure to harness the waters of the Narmada and its tributaries are either planned or constructed or even under construction. With the passage of time, on account of what so ever reason like population growth, industrialization, huge power demand and else factors have changed the river scape along with the landscape of the river basins. Alia bet is also among the highly affected land mass, drastically altered from bet to huge land mass. Using remote sensing images of different time scale and topographical map one can study the changes in geomorphological features. Satellite remote sensing technique has proven to be the paramount tool for studying surficial land features, especially for the inaccessible area or where time variable studies and regional scale studies are carried out. The attempt is made to detect the change in land scape of Alia bet using Geospatial techniques. The Landsat data, LISS-III, LISS-IV, historical Google earth images and -Quantum GIS (Q GIS) techniques are used here to understand the process, to detect the changes and to analyses the future trend of progression.

IndexTerms - Gulf of Cambay, Alia bet, Narmada River, change detection, coastal activity. Geospatial techniques

I INTRODUCTION:

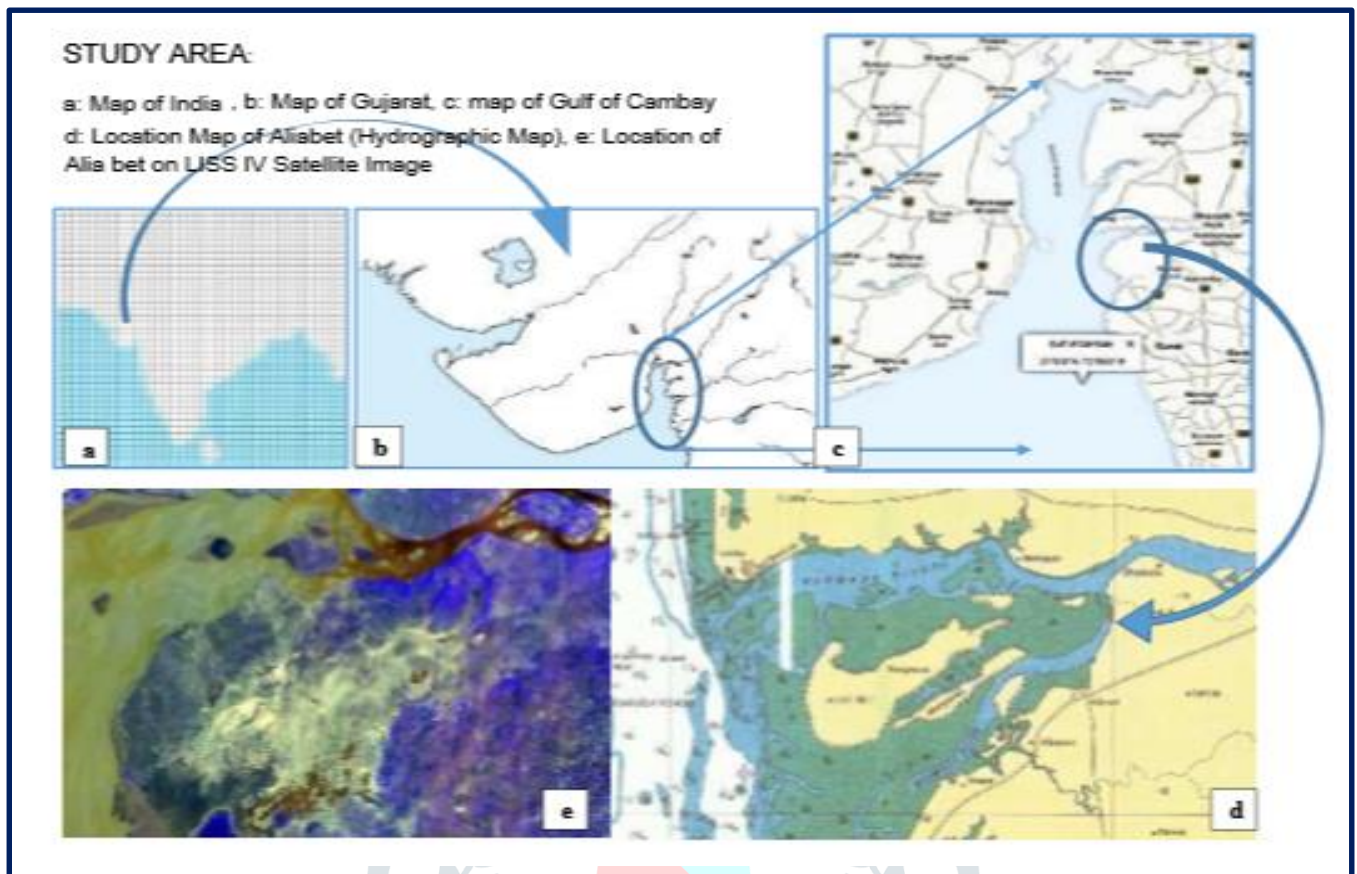
1.1 INTRODUCTION

Alia bet, officially believed as "No Man's Land", located about 25 km west of Bharuch in the estuary of Narmada River. This delta earlier was treated as an island or bet and derived the name after "AAL" means land with lush green grass. As per religious belief the name is from Aa – i.e. mother Aa, who never refuses shelter to tired pastoralists, even everything dries up, Alia bet does not. Spread over an area of about 200 Sq. km is the habitat of nomadic Tribe JAT MALDHARI.

Geologically to quote, the Narmada River is occupied by the rocks belonging to Vindhyan and Satpura towards upper reaches and Deccan basalt towards lower reaches and Alluvium of Quaternary of the coastal area. The river rises in the Amarkantak and flows over the marble rocks and widen into estuary entering the Gulf of Cambay (GOC). The resultant silt deposition of the Narmada River is deposited in to extreme lower of the lower Narmada basin, prior to debouching its water into Gulf of Cambay of Arabian Sea.

The Gulf of Cambay/Khambhat, (GoC), author's research area is highly influenced by geology and structural set up of the region, and tidal currents too. Enormous amount of sediment transportation mechanism is due to large tidal range during high and low tides results in to strong tidal currents. Interestingly the inverted funnel shape of GoC has large contribution for the sediment deposition in this region. During high tide the tide currents move into the Gulf and encroaches the river mouth whereas during low tide, they move out. The overall geomorphological alteration and landscape changes in this region are on account of prevalent regular phenomena since long period on geological time scale. The shoreline around the GOC is highly indented as well as moderately wavy (Nayak, S.R. and Shahai, B.). The shoreline of the mainland indented due to the presence of major estuaries and narrow creek. These estuaries are due to major rivers like Sabarmati, Mahi, Dhadhar, Narmada and Tapi flowing in the mainland Gujarat, finally debouching the water into GOC, hence the sediment budget at confluence of these rivers with the sea so called estuaries of mainland Gujarat of GOC, is controlled by river flow, seasonal variation and also by tide and ebb phenomena.

1.1 Location Map of Study Area:



1.2 GENERAL:

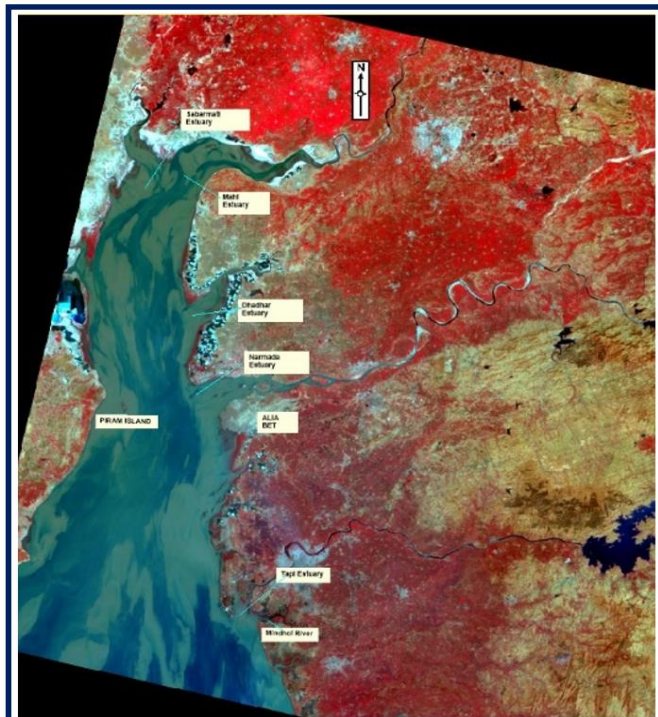
This paper will focus predominantly on Aliabet, presently a land mass transformed from an island or a bet in the lower most Basin of Narmada River. It is the part of major research area of Gulf of Cambay (GoC). The Gulf of Cambay / Khambhat (GoC), is located between latitude 20°30' to 22°20' N and longitude 71° 30' to 73° 10' E is an inverted funnel shaped (approximately 70 km wide, 130 km long). The region between Saurashtra peninsula and the mainland Gujarat of GoC is highly indented. On the western side, the Gulf starts from Gopnath to the in-between coasts of Surat and Valsad district on the eastern side. The inverted funnel shape of the GoC is the entrant of Arabian Sea lies between Gujarat Mainland and Saurashtra blocks. This west coast of India exhibits geological, geomorphological and geo environmental diversities and hence researchers and scientists have divided the coastline into different units or blocks and segments based on recognizable characteristics. Because of unique shape and configuration of GoC, much more studies are focused on the near shore estuarine environment and coastal geomorphology rather than off shore studies. Of course, the offshore studies are carried out time to time by few researchers and oil exploring groups.

In recent time the remote sensing tools and digital image processing techniques has proven to be the advanced approach to study various landform features (Nayak S). The landform features along coastline like rocky terrain, marshy land, flood plain, mud flats, cliffs, estuaries. Islands and biotic environment like mangroves, saltpan, and aqua culture can easily be recognized. An Indian and foreign Satellite missions have availed useful data for monitoring, analyzing coastal environment. The qualities of Remote sensing techniques like synoptic view on spatial resolution scale, temporal based dataset and multi-spectral, multi-sensor concept while capturing the scenes, could generate huge data and eventually useful for coastal studies.

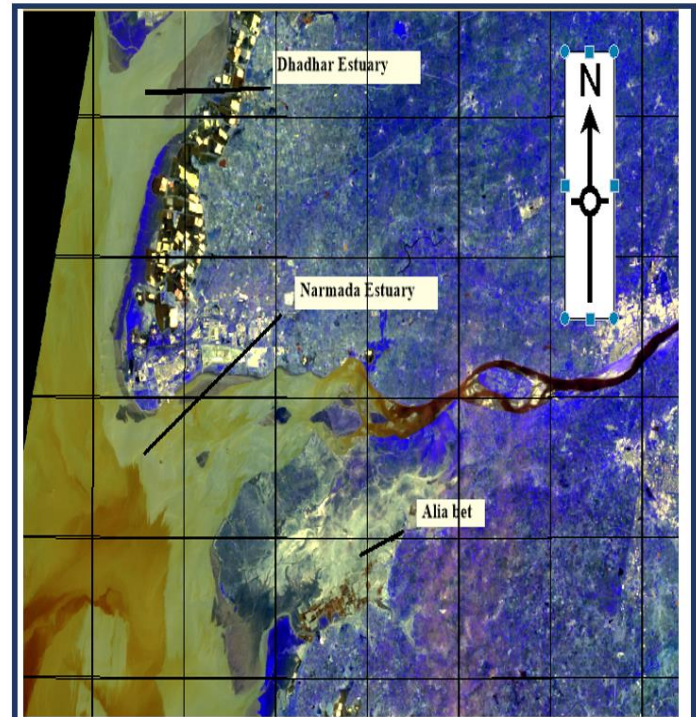
For this paper, author has tried to detect changes in landscape of Aliabet using Optical Remote Sensing and QGIS techniques. Prior to this, field visits are carried out. Some of the visited locations at Aliabet are stated below with their coordinates.

S.N.	Location	Place Visited for field work	Latitude (N)	Longitude (E)
1	ALIABET	Sea Facing	21° 35' 45.55"	72° 37' 36.26"
2		Near Taria Village South flank (left) of Narmada	21° 39' 58.86"	72° 52' 50.09"
3		Jungle area towards North flank of Narmada	21° 38' 55.04"	72° 48' 27.54"

Location of Various Major Estuaries on LANDSAT 7 and LISS IV:



LANDSAT 7 DATA shows major rivers of Gujarat along GOC and confluence of river with sea in the form of estuaries



LISS IV satellite image show East of GOC & extension of Aliabet

1.3 GEOLOGICAL INFLUENCE AND SEGMENTS:

The geological set up of Gujarat has also played vital role for shaping the coastline and spreading sediments along onshore and offshore of the GoC. Considering the fact geologically, Gujarat represents diversity and comprises deposits of Precambrian to Recent age. The sediments added in the Late Quaternary period along GoC has been derived from the different provenances. Resultant deposited material show variation in color, tone, texture and composition. Hence, knowledge of regional geological set up is essential.

Diversities in climate along the Gujarat Coast, has influenced the environment and hence based on environmental parameters the coast of Gujarat has been divided into different units and further into segments (Merh, S.S). The Gulf of Cambay can be divided into to Saurashtra, Bhal and Mainland Gujarat units and further these units/blocks have various segments based on geo environmental diversities.

Additionally, based on distinct variations in the wetland / landform categories, SAC, 1992 categorised the Gujarat Coast into five regions viz., the Rann of Kachchh, the Gulf of Kachchh, the Saurashtra Coast, the Gulf of Cambay, and the South Gujarat Coast.

II RESEARCH METHODOLOGY:

2.1 To achieve original project work, partly to accomplish this paper, initially toposheets were acquired in softcopy form and got all digitized for further work. For attainment of Ground Control Point (GCP) and ground truth, repeatedly field visits were carried out. These field visits were to obtain the information about the Ground Control Point (GCP), studying geomorphological features, observing shoreline behavior, shoreline dynamics and actions of regular tide and ebbs. Beside this geological information were also gathered.

Satellite image dataset were collected to work on geospatial platform. These raw datasets were brought under working form through layer stacking, WGS '84 Projection system and geo referencing wherever required, mosaicking, preparing subsets, image classification through supervised and unsupervised classification, image enhancements, and band changes and so on. These exercises were performed to extract more amount of information for better analysis.

2.2 Dataset Used: The data set used for the work is listed below, table wise.

Table: 1: List of Landsat data:

S.N	Satellite	Date of scene	Sensor	Bands	Path	Row	Resolution (m)
1	Landsat 8	20.12.'16	ETM+	1 to 11	148	45	30 *
2	Landsat 8	29.02.'16	ETM+	1 to 11	148	45	30
3	Landsat 5	19.10.'90	TM	1 to 7	148	45	30 , 6th band 120 m
4	IRS-R2	11.03.14	LISS 4 (NRSC)	03	093	057	5.8
5	GOOGLE EARTH	Historical data	Digital Globe		For Aliabet, Scenes were magnified		High resolution 06.28.16

Landsat 8 has ETM+ sensors, 8th band is Panchromatic with 15 m Resolution, and ETM+ sensor has Pan Band with 15 m resolution (Source: <https://earthexplorer.usgs.gov/>) & for LISS 4 (NRSC-Hyderabad)

Table: 2: List of SOI Toposheets

Sl No	Toposheet no.	Region (District)	Scale	Survey Period
2	46 C/6	Bharuch , Bhavnagar	50,000	1968
3	46 C/9	Bharuch	50,000	1973
4	46 C/10	Bharuch	50,000	1973
5	46 C/11	Bharuch , Surat	50,000	1974
6	46 C/14	Bharuch, Surat	50,000	1974

2.3. Software:

- ERDAS IMAGINE 2016 for Digital Image Processing
- QGIS Lyon (2.12.2): A free and open source Geographic Information System Software

III: FIELD WORK AND BRIEF DESCRIPTION:

3.1 As a part of research work as well as GUJCOST-Minor Research Project work, the author has visited site for (i) establishing ground control points (GCP) (ii) field observation geological and geomorphological point of view (iii) carry out levelling work with Digital level meter for getting the idea of accretion or erosion phenomena twice in year bases.

Following are the observations briefly discussed.

1. Towards Mahi to Narmada following coastal line, the trend is NNW-SSE and traversed by Dhadhar and Narmada rivers. Both have developed estuarine delta and mudflats.
2. Raised relict mud flats, raised islands (Bets), recent mud flats are observed along lower basin of Narmada and Narmada Estuary.
3. The islands are vegetated cover and occupied by farming community, since long back.
4. The nature of littoral zone is silty and attaining the low gradient.
5. Major islands like Taria, Dashan are accessible through local boats. But the left flank of Narmada River is highly affected.
6. From the left flank side, it is only during high tide, these islands are approachable. This side show high amount of deposition.
7. Moving towards the sea facing of Alia bet, island is accessible through Hansot, Ambheta villages and now connected. Which was earlier considered as an island (bet). But on account of geological activities and in support of anthropogenic activities, this island is now no more bet and has turned into large land mass.
8. Many of the local people have used this land for aquaculture farming activity.
9. Even nos. of salt pans have erupted since last few years. Previously water was fetched from creeks and some tributaries of river, on account of hyper-saline nature and favorable climatical condition of the region.
10. As this water has stopped to flow, salt farming activity is continued through fetching the ground water.
11. Towards the sea facing, Alia bet shows high degree of erosion, and locally formed terrace like structures.

3.2 Various locations visited with their respective coordinates and their representation on Google Earth Image:

S.N.	Location	Place Visited for field work	Latitude (N)	Longitude (E)	Demarcation in Google Image
1	ALIABET (A)	Sea Facing	21° 35' 45.55"	72° 37' 36.26"	(B)
2		Near Taria Village South flank (left) of Narmada	21° 39' 58.86"	72° 52' 50.09"	(C)
3		Jungle area towards North flank of Narmada	21° 38' 55.04"	72° 48' 27.54"	(D)



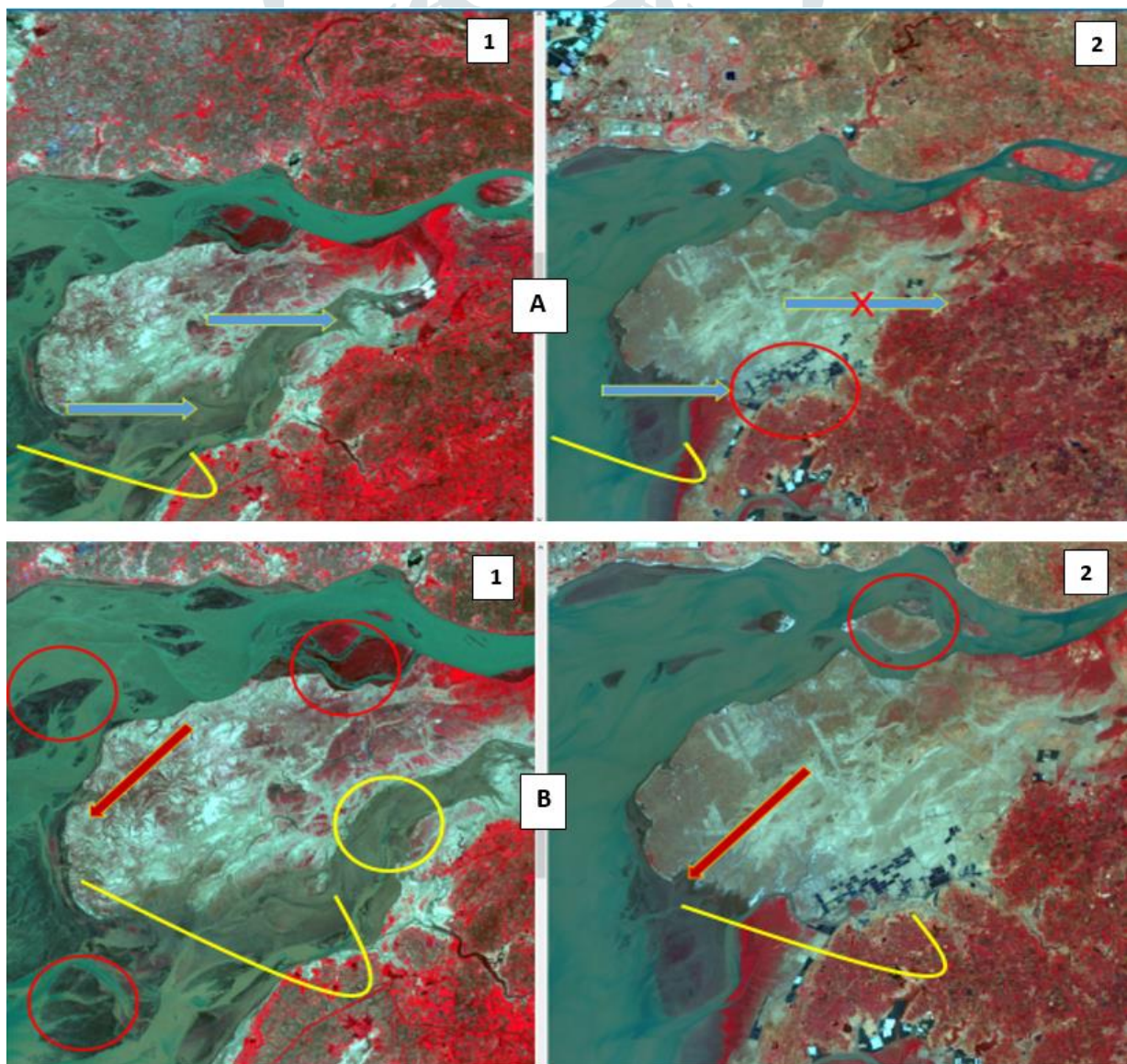
3.3 Supportive Field photographs:



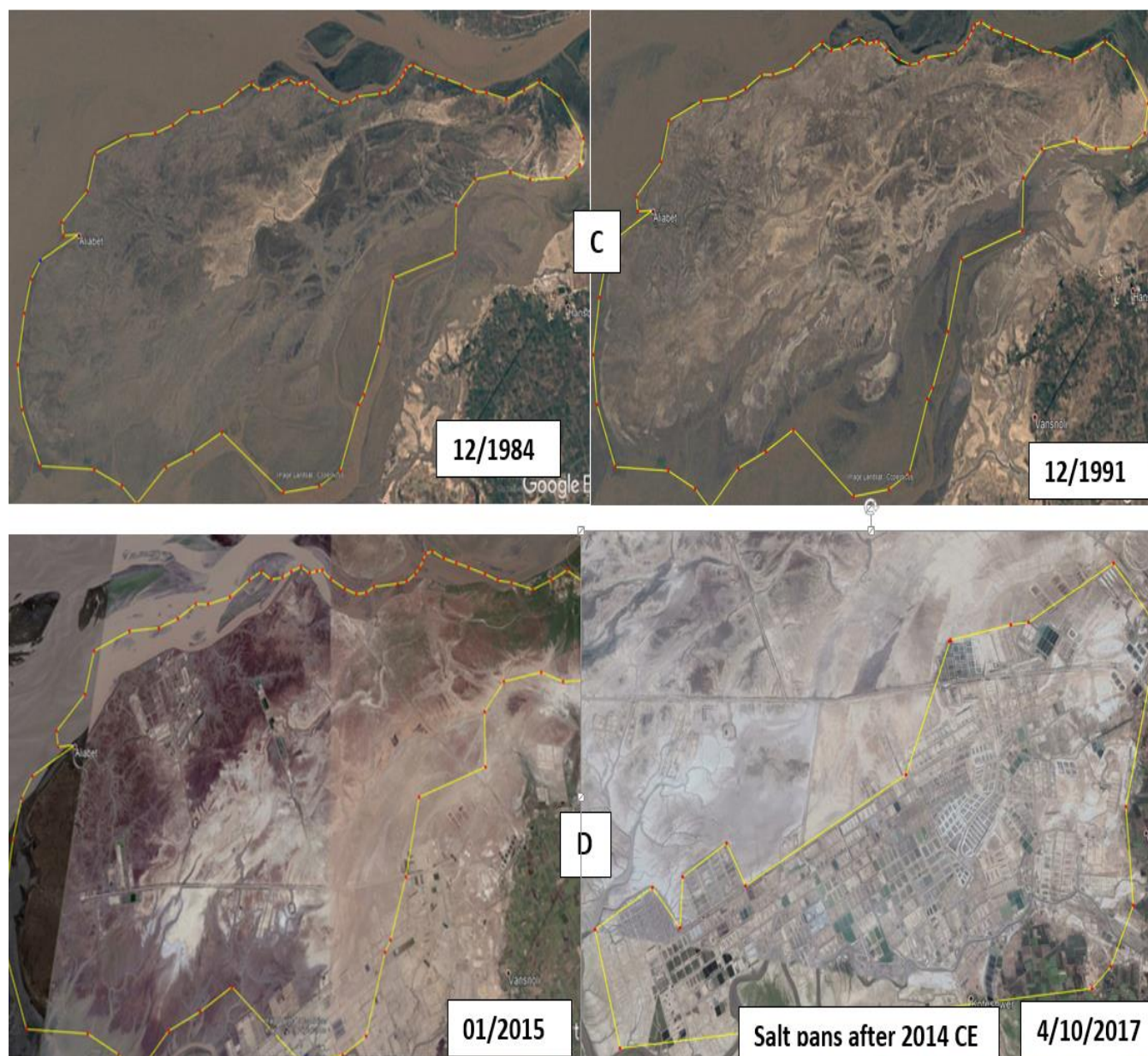


IV: SATELLITE IMAGE PROCESSING AND ANALYSIS (SPATIAL SCALE):

4.1 For Geospatial analysis, various Landsat data of the region has availed through free download facilities available due to NASA/ Earth Explorer web sites. These satellite images of temporal resolutions have been down loaded. For better result lastly Landsat 5 image dated 19th October, 1990 (A, B – 1) was compared with the Landsat 8 image of 29th Feb, 2016 (A, B-2) and that has ensured better landscape change detection as displayed below.



4.2 Supportive Google Earth Images with historical images and tools:



V RESULT AND CONCLUSION:

5.1 Result:

While generating the results, the author has overlooked the influence of season and the situation of tide during data collection through satellite. Of course these are very essential requirement, but the changes are conspicuous. These all changes are specially marked on images and described below.

The comparison between two images along mouth of Narmada river, estuary and coastal part shows severe change in river course, extent of salt encrusted land, and newly developed commercial salt farming region which were previously absent. The number of tributaries have dried or vanished. The new approaches to bet has been created. As per the record first ever attempt was made by ONGC for oil exploration work. The difference of images also represents expansion of Alia bet along the mouth of Narmada River. This notable change can be understood through developmental activities in the region. Further the river shifting, disappearance of the channels, expansion of mudflats are visible. Initially, this bet, as measured was hardly 7000 to 8000 hectares has expanded up to 19000 to 20000 hectares and become accessible from nearby villages or towns easily.

5.2 Conclusion:

The present study is an effort towards continuous observing the changes along coastal belt of Cambay. Periodic studies and monitoring can provide information about the previous to current situations. The amplified industrialization and urbanization in the last 3 decades has stressed on coastal area of Gujarat state. Again, the complex interaction of anthropogenic activity with natural events has tempted researchers and scientist to monitor the region in accordance with advance technology. It could be inferred that

the incremental rise can transform the scenario of the region. For the refined outcome, using satellite data of higher resolution at specific smaller interval and at micro level is essential.

ACKNOWLEDGEMENT:

The authors sincerely thanks USGS-Earth explorer data center for facilitating LANDSAT 1 to 8 series dataset, freely available for the researchers. The first author also heartily acknowledge the financial support extended by GUJCOST- Gujarat, Gandhinagar, through Minor Research Project.

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