

PALAEOCLIMATIC STUDY IN THE LITTLE RANN OF KACHCHH USING GEOSPATIAL TECHNIQUES.

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Abstract: India has a one of a kind geographical component in the form of Little Rann of Kachchh which is one of the harshest places on earth to dwell. Present in the region of Kachchh in the state of Gujarat, India, the region gets a normal yearly precipitation of under 300 mm. Brief inconsistent rainstorm, sweltering summers and very cold winters describe the atmosphere of the zone which has a average maximum temperature of around 42°C and average minimum temperature of around 12°C and the relative humidity is around 25 %. However, maximum temperature could be as high as 50°C and minimum temperature as low as 1°C, have also additionally been recorded. It is believed that the Rann was at one time a fertile landscape which due to certain events turned into a ruthless piece of land. But geological, archaeological and fossil evidences prove that the LRK was a fertile land with flourishing Harappan civilization with an even greater economy and agricultural growth. The objective of this study was to provide evidences on how the earth processes have altered the study area and made it the dead landscape that it has become in the present time using all the geological, geographical, socio-cultural data through the use of Remote sensing and GIS techniques. The study not only sheds light on the changes observed in the paleoclimate of the region but will also aid in providing future trends.

Keywords: *Little Rann of Kachchh(LRK), archaeological, Harappan, Remote Sensing, GIS, Palaeoclimate.*

I. Introduction

The Little Rann of Kachchh is a unique ecosystem of the world as it is a buffer land between the marine and terrestrial ecosystem and thus it is aptly called an "Eco-tone". Other than its serene salt plains it is also an epitome of historical significance whether that be the folklore of Vacchra Dada or that of king Siddhraj Jaisinh travelling across the Little Rann of Kachchh on a boat crossing a river or the naming of Nanda Bet. This is an effort to understand the various changes that occurred during a long period of time that turned this fertile land into a Rann. Since the advent of civilization, climate has been a key factor determining the social and economic development. The growth and demise of numerous civilizations, domestication of plants and animals, beginning of agriculture, migration of people and societies, growth of urban settlements all has been related directly or indirectly to changes in climatic conditions. (Singhvi A.K. and Kale V.S., 2009).

Present day records of environmental change from instrumental information (thermometers, rain measurements) cover just a limited capacity to focus time, almost under two centuries. Because of their restricted time scope, the "instrumental" or "methodical" records do not cover all the aspects of climatic shifts or change. The investigation of paleoclimatology is critical for past, contemporary, and future issues. Understanding past climates aids in clarifying how current biological communities came to be. For instance, climate of a region regularly controls what kind of vegetation grows in that specific region. Besides, paleoclimatology gives information that we can use to display, foresee and predict both present and future climate change scenarios. Computer based models can be utilized to consider the potential impact of increasing carbon dioxide concentrations on the regional atmosphere. (Carleton EDU)

With a complex system as that of the Earth's atmosphere, it is an overwhelming assignment for researchers to have the capacity to roll out projections about future atmospheric changes and how it might influence the growth of flora and fauna. In any case, paleoclimatic information are utilized as an evidence by researchers providing critical data, e.g. rates of past climate change and how the flora and fauna of that region reacted to the change.

Presently it is a common knowledge to the researchers and historians that a cataclysmic climatic change can everlastingly modify the geology and condition such as in the case of the old Mediterranean region around 1500 B.C., leaving megalithic and brick bronze age vestiges of once flourishing societies left in desolate deserts, with much proof that those old sites were once green with vegetation because of high precipitation, which empowered those people of the past to assemble and flourish in the region which transformed into

deserts within few centuries, when the Ice Age finished.. Different researches have demonstrated that the changes in the archaeological record frequently corroborate intimately with the changes in the climate, changes that affect food, water sources and also trade.

1.1 Objectives

Understand the changes that occurred in the study area.

Provide evidences of the causes of the alterations.

1.2 Location and extent of study area

The Little Rann of Kachchh (LRK) is an extremely astounding landscape. It is situated close to the Gulf of Kutch, in the west Indian state of Gujarat at 23.38134°N 71.31688°E. Rann signifies 'Desert' in Hindi, and the Rann of Kachchh is a wetland (involving for the most part of salt Flatlands) that is submerged amid the downpours and stays dry and parched amid whatever is left of it throughout the remaining year. There are various salt flats that are responsible for influencing the region to appear rather white when dry.

The Kachchh region used to be a recent royal state and, setting off to a period much before this, is said to have contained a couple of towns of the Indus Valley Civilization. Biologically, the LRK's distinguishing strength is the Indian Wild Ass Sanctuary, home of the Indian Wild Ass. It is one of the last remnants of the Indian Wild Ass (*Equus hemionus khur*), an imperiled subspecies of the Onager (*Equus hemionus*) or the Asiatic Wild Ass. Amid the rains, when the whole zone gets submerged, these Wild Asses move to the numerous islands with lifted ground, known as Bets. The LRK is likewise an extremely prominent breeding ground for Greater and Lesser Flamingos. The Rann of Kachchh (its segment lying in Pakistan) is a Ramsar site, in this manner it is protected under various wetland and environmental regulations. (<http://www.bomadg.in/2017>)

II. Materials and Methodology

The following satellite data was used:

1. Cartosat-2 Panchromatic imagery for identifying archaeological site and land use land cover mapping. (Year 2009,2010,2011)
2. LISS III imagery for observing waterbodies and vegetation in the study area. (Year 2000, 2010,2012)
3. LISS IV imagery for high resolution mapping of water bodies, vegetation and relative changes in their area. (Year 2007, 2008, 2009, 2010)

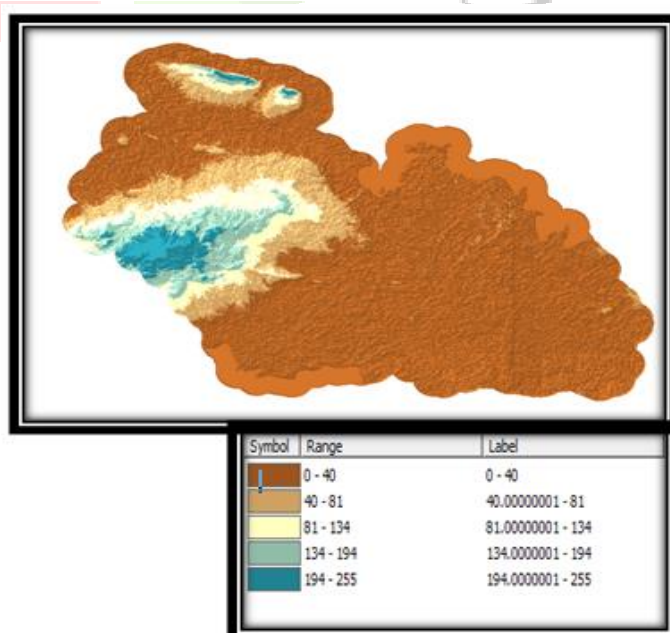


Figure-A: DEM of the study area

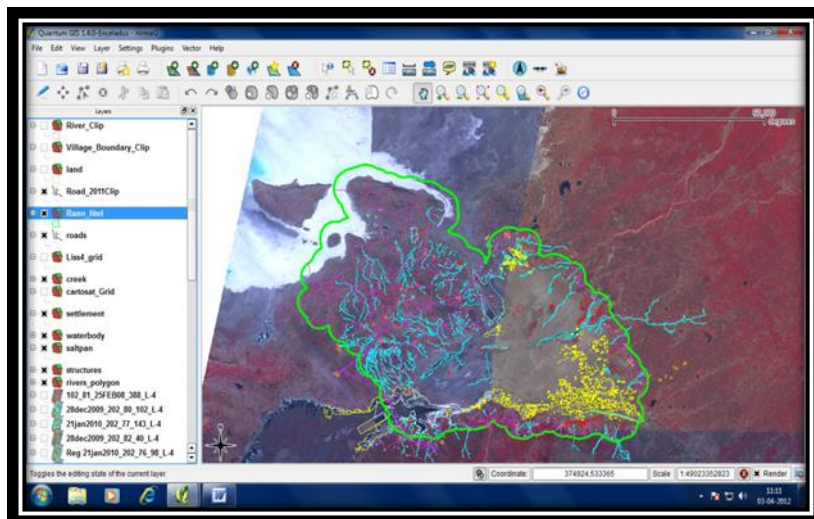


Figure-B: Digitization of LISS III image of the study area

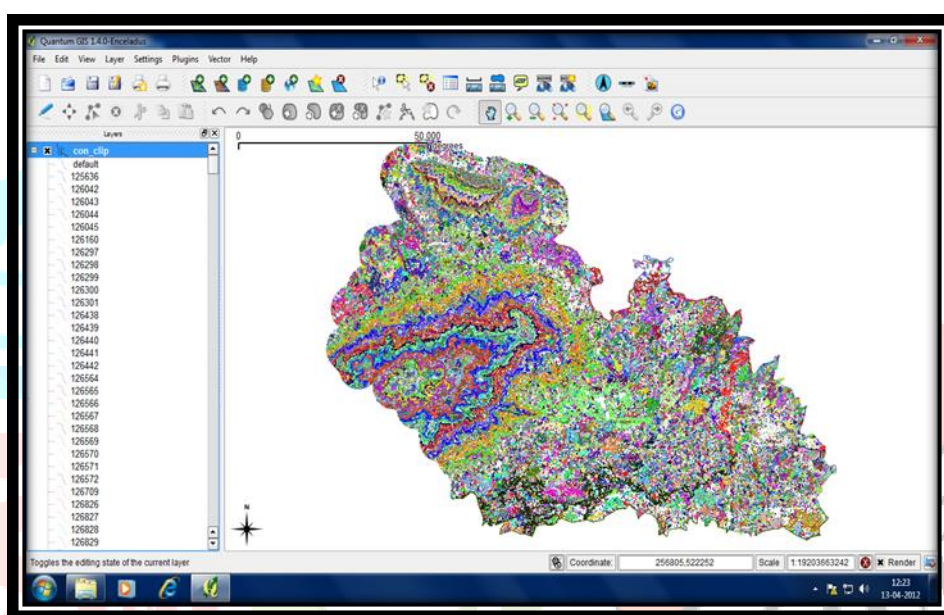


Figure-C: Five-meter elevation contours

III. RESULTS AND DISCUSSION

It seems that the region of Little Rann of Kachchh has evolved climatically. This might have happened at a time or during different periods due to various incidences might have taken place. The probable reasons for climatic changes in this region are:

- i) Earthquake/Subsidence
- ii) Tsunami
- iii) Flooding

3.1 Earthquake:

Earthquakes are responsible for vast amount of changes taking place in any region, some of the recorded earthquakes in this region are:

18th June 1819 magnitude of 8 on Richter scale caused severe damages.

15th October 1898 at Bhuj.

14th January 1903. (Gazetteer 1971)

3.2 Tsunami:

Occurrence of tsunami in north western India have not been properly recorded or documented. Large earthquakes along the Makran subduction zone are infrequent, the potential for the generation of destructive tsunamis in the northern Arabian Sea cannot be ruled out (Katariya *et al.* 2014). It has been found from various sources that about 20 tsunamis took place in north-western India along Gujarat coast

since 8000 BP. The occurrences are as follows: 7000-8000 BP, 325-326 BC, 798 AD, 898 AD, 1008? 1333, 1483? 1524, 1534, 1662, 1668, 1688, 1733, 1765, 1819, 1833, 1845, 1851, 1864, 1868, 1945 (Jordan, B. R., 2008)

3.3 Little Rann of Kachchh and its hydrology

As shown in the following image (Figure D) there are multiple sources of freshwater around and crosswise over Little Rann of Kachchh. It can likewise be seen that a large number of the streams inside or around Little Rann of Kachchh have either stopped or have changed their courses. The nearest plausibility for the changing of their courses can be coordinated towards geological reasons for the most part, seismic tremors/torrents or subsidence which may have occurred previously. Such occasions may have altered the courses of these rivers and with the change in the climatic conditions the scarcity of water became more and more evident. A standout amongst the most essential palaeo-channel being the one going appropriately over the Rann into which once Saraswati and Rupen emptied their waters into, whose flows have been confined at the fringe around the center of the Rann. Saraswati is known to have 5 courses out of which one was named Nanda which could be the only plausible reason behind the naming of Nanda Bet. According to recorded proof, Saurashtra was an island during 2000 BC. Kachchh likewise was an island up to eighteenth century AD and boats were plying in the present Rann territory. It is found from the historical writings that Thirpur Nagar, the present Tharad of Banaskantha region, was a noticeable Hindu and Jain religious focal site from the Rajput time period onwards. A photo in one of the compositions composed by Kalyanasevak Dhanyakumar demonstrates Tharad as a port. There are some scattered references to navigational instances amid the Solanki period too. Siddharaj Jaysinh went to Varahi of Santalpur taluka, Banaskantha locale in a chariot and gave over the chariot to the mahajana of Varahi town to fare thee well and went to Sanchor by ship and vessel from Varahi (Prabandh Chintamani, Merutunga 1306). There was a thriving wooden shipbuilding industry in Gujarat at Mandavi, which assumed a critical part in molding the fate of numerous kingdoms who tried to expand their territories overseas. Authentic confirmations demonstrate that the Rann of Kachchha was a Gulf and was appropriate for transportation and up to the seventh century ships were sailing throughout this region.



Figure-D: Various ancient and present sources of waterbodies in the Little Rann of Kachchh



Figure-E: Remains from the final phase of the Harappa occupation: A large well and bathing platforms at Shikarpur, Kachchh (source: <https://defence.pk/pdf/threads/indus-valley-civilization-pakistan.20619/>)

New sites of archeological interest can be found utilizing soil marks, vegetation marks and odd landforms from the satellite imagery. New sites can be discovered on the old seacoast, palaeo mudflats or present shoreline or in the old seabeds. An endeavor has been made to see if any such sign is there in the Rann of Kachchh or not. It is accounted for that the river Saraswati was flowing along the fringe of the Little Rann of Kachchh and pouring its water in the Gulf of Khambhat. It additionally revealed that the Saraswati was flowing in Kachchh up to 325 BC. The course of the Saraswati has been in Gujarat through the Rann of Kachchh up to Saurashtra from north Gujarat. Kota Venkatachalam has additionally demonstrated that Saraswati was pouring its waters in the Rann. As plainly observed from the chart beneath, the ocean level was 90 meters underneath than what it was during the study. From 14 Ka to 12 Ka BP it was 60 meters beneath the present period. This totally expels the cloase proximity of an ocean between 14 Ka to 10 Ka and furthermore denies the notion that Rann was a part of the ocean during the same time frame. Likewise, the dating of the Harappan site unearthed at Shikarpur demonstrates that it was present around 4500 years BP so this again reduces the likelihood of Rann being a part of the ocean between 14 Ka to 4.5 Ka BP or else this Harappan site would have been submerged in the ocean.

At the point when Alexander the Great reached those parts in 325 BC the Rann was never again an arm of the ocean (on the off chance that it was ever at that point or before). The eastern branch of the Indus, then the most imperative channel, emptied itself into the Rann, representing that Kutch was a sort of expansion of Sind on the opposite side of a huge freshwater lake, effortlessly to be crossed, staying that way until 1000 A.D. The various physical occurrences that may have happened between 1000 A.D and 1800 A.D. are not known but rather it is realized that Kachchh was an island upto eighteenth century and an earthquake in 1819 A.D of higher value of 8 on the Richter scale caused a subsidence in the Great Rann and around 2000sq miles of region sunk which additionally caused the upliftment in some other part of the region, for example, development of "Allah-Bund"

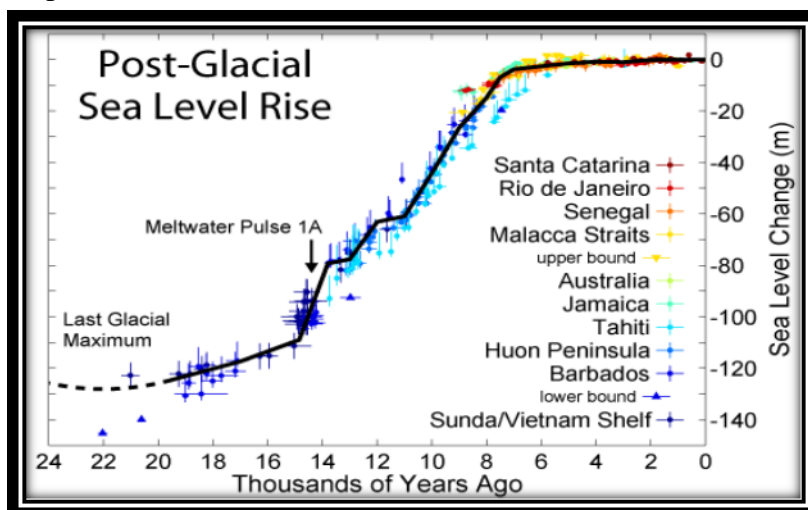


Figure-F: Changes in sea level since the end of the last glacial episode (Source: This figure was prepared by Robert A. Rohde from published data and is incorporated into the Global Warming Art project.)

- From remote sensing information, it was observed that ocean was towards the west from the Zinzuwada region in the current past. This demonstrates Zinzuwada was an old port in the current past. (Fig: G)
- As clearly seen from the previous graph(pp) the sea-level was 90 meters below than what it is now during 14 Ka to 12 Ka BP and was 60 meters below during 12 Ka to 10 Ka BP. This completely dismisses the presence of sea between 14 Ka to 10 Ka and also that Rann was part of sea then. Also, the dating of the Harappan site excavated at Shikarpur shows that it was built around 4500 years BP so this again diminishes the possibility of Rann being a part of the sea between 14 Ka to 4.5 Ka BP.
- It also seems that the Bet (Island) formation might have taken place during the same tectonic movement as the subsidence during which the bets might have retained the fertile soil of the region and thus are still vegetated as seen at the Vachhra, Jhilandhan, Nanda etc bets.



Figure-G: Shows lighthouse and fortification at Zinzuwada near Raj-Rajeshwari temple present even today

- The study showed clear signs of perennial availability of freshwater, but due to either tectonic activities the area might have subsided or Tsunami might have caused the sea water infiltrate into the Little Rann. There have been no recorded earthquakes in these regions from 1 A.D. to 1800 A.D. but there was an earthquake in 1819 A.D. with a magnitude of 8 on the Richter scale which led to the formation of “Allahbund” before which both the Ranns were part of the sea.
- The siltation in the Rann is in huge proportions. The siltation in this region has accumulated layers of sediments which extend upto 700-800 meters beneath surface. This shows that some mighty river/rivers were flowing through this region which brought huge amounts of sediments.
- Thus, this study proves evidently the changes that took place in the study regions which not only altered the landscape but with it also changed the historical land use and land cover subsequently making it a desert. Future works on dating water sources in the study area can enhance our information on how this and other regions can evolve based upon the tectonic and climatic changes that might occur in the future.

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Prabandh Chintamani, Merutunga 1306 AD excerpts

Robert A. Rohde image from published data, which is incorporated into the Global Warming Art project

Satellite image courtesy: BISAG, Google Earth Pro and Wikimapia

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