E-ISSN: 2042-5937

ANCIENT ASIA

Vol. 17, 2026, pp. 189-207

URL: https://ancient-asia-journal.com
https://doi.org/10.47509/AA.2026.v17i.11

Beyond the Coordinates: Critical Approaches to Legacy Data Case Study of Kachchh

Aishwarya Prashant Mhaske[*1,2] **and Francesc Conesa**[3]
[1]*Manipal Academy of Higher Education (MAHE), Manipal, India*
[2]*National Institute of Advanced Studies, Bengaluru, India*
[3]*Social Sciences, Heritage and Food (SOCIALPAT), IPNA, CSIC, Tenerife, Spain*
*E-mail: aishwaryam@nias.res.in**

Abstract: *Archaeological studies in Kachchh, Gujarat, continue to rely on legacy data sets created before the widespread use of GPS and standardised spatial recording, yet the quality of these data sets for modern spatial analysis has been poorly evaluated. This research assesses the legacy records of Mature Harappan archaeological sites in Eastern Kachchh, which are marked by variable reporting of coordinates, repeated site names and unclear cultural attributions, and assesses the potential of Remote Sensing and Geographic Information Systems (GIS), integrated with colonial Survey of India toposheets, to inform the re-evaluation of archaeological legacy data. The study adopted a methodological approach of cleaning and cross-checking published legacy datasets, spatial analyses using historical maps, CORONA imagery, multispectral satellite data, digital elevation models, and multi-season field surveys aided by GPS recording to reidentify and validate reported sites. The findings reveal that legacy coordinates exhibit significant spatial uncertainty, with an average error of about 4 km and a range of 1 to 16 km, underscoring the need to critically assess legacy spatial datasets. Although remote sensing and GIS have limited potential for primary site detection in Kachchh due to geomorphological variability, they are useful for site boundary delineation, landscape change reconstruction and contextualisation of confirmed sites. The research suggests that archaeological interpretations are best supported by integrating critically evaluated legacy data, field verification, and geospatial analysis, with technological tools that complement field surveys.*

Keywords: *Legacy data, Mature Harappan, Eastern Kachchh, Spatial uncertainty, Field-verified GIS*

Received: 24 July 2026
Revised: 30 August 2026
Accepted: 13 September 2026
Published: 30 September 2026

TO CITE THIS ARTICLE:

Aishwarya Prashant Mhaske & Francesc Conesa (2026). Beyond the Coordinates: Critical Approaches to Legacy Data Case Study of Kachchh. Ancient Asia, 17: 1, pp. 189-207. https://doi. org/10.47509/AA.2026. v17i01.11

Introduction

Legacy data in archaeology is the ever-expanding body of information produced by archaeologists and heritage managers over time, including previous surveys and archaeological excavations that predate the advent of digital recording. These data, stored in paper maps, field notes, printed reports, or non-standardised digital formats, can be challenging to incorporate into modern GIS and remote-sensing processes. Legacy data, as defined by Allison (2008), is "data from obsolete information systems" that need to be digitised and georeferenced for reuse. Despite their lack of consistency, accuracy and metadata, they are crucial for documenting archaeological research and reinterpretations of archaeological landscapes.

Archaeological surveys have been a crucial method for site discovery and documentation since the early days of archaeology in India, from descriptive site inventories to systematic, problem-based and data-driven surveys. Early surveys largely focused on site names and topography, rather than coordinates, and sites were frequently mentioned relative to local villages or landmarks (Sugandhi et al. 2015). In this study, legacy data refers specifically to published reports and records of archaeological explorations in Kachchh, the westernmost district of Gujarat state in India, which are the main data sources used.

Recent Harappan studies in South Asia have shown a renewed interest in integrating and reinterpreting legacy data. At the regional scale, Petrie and Lynam (2020) tested whether settlement maps of the Indus produced from surface surveys capture contemporaneous occupation and stability, while Green and Petrie (2018) tested post-urban settlement density using integrated survey data. Both studies made uncertainty explicit, categorising precision (high = GPS, medium = degrees/minutes, low = descriptive) and modelling it spatially using Geographic Information System (GIS). Subsequent authors created relational databases that retain information about each record's history, and Petrie and Lynam (2020) built on this by conducting simulations to test how assumptions of contemporaneity can inflate density estimates. These approaches prioritised transparency over certainty, providing means to separate certain from uncertain patterns. While these frameworks are highly successful for "big data" regional-scale analyses, they are less suited to small, geomorphologically diverse regions.

In eastern Kachchh, 33 Mature Harappan sites are reported in the legacy literature (Joshi et al. 1984; Joshi 1990a; Possehl 1999; Rajesh and Patel 2007; Shinde et al. 2011; Rajesh 2018; Prabhakar et al. 2023; Rajesh et al. 2025), though these records exhibit varying levels of spatial precision. Of these, 3 sites have been documented with precise geographic coordinates following the adoption of GPS-based field recording, while the remaining 30 constitute a legacy dataset characterised by coarse, incomplete, or descriptive locational information. This set of the remaining 30 legacy sites forms the basis of the present analysis. Such spatial inconsistencies pose significant challenges for site reidentification and for spatial analytical approaches such as clustering and network analysis, necessitating a critical re-evaluation of archival datasets.

This study critically examines the challenges of working with legacy data and evaluates the role of remote sensing and GIS, integrated with colonial-period Survey of India toposheets, in reassessing archaeological information for the Kachchh region. Focusing on Mature Harappan-period sites in eastern Kachchh (Fig. 1), which were only partially surveyed between 2015-16 (Rajesh 2016 *unpublished*), the study evaluates the extent to which remote sensing and GIS techniques can contribute to the reassessment of archaeological legacy data and site locations in the region.

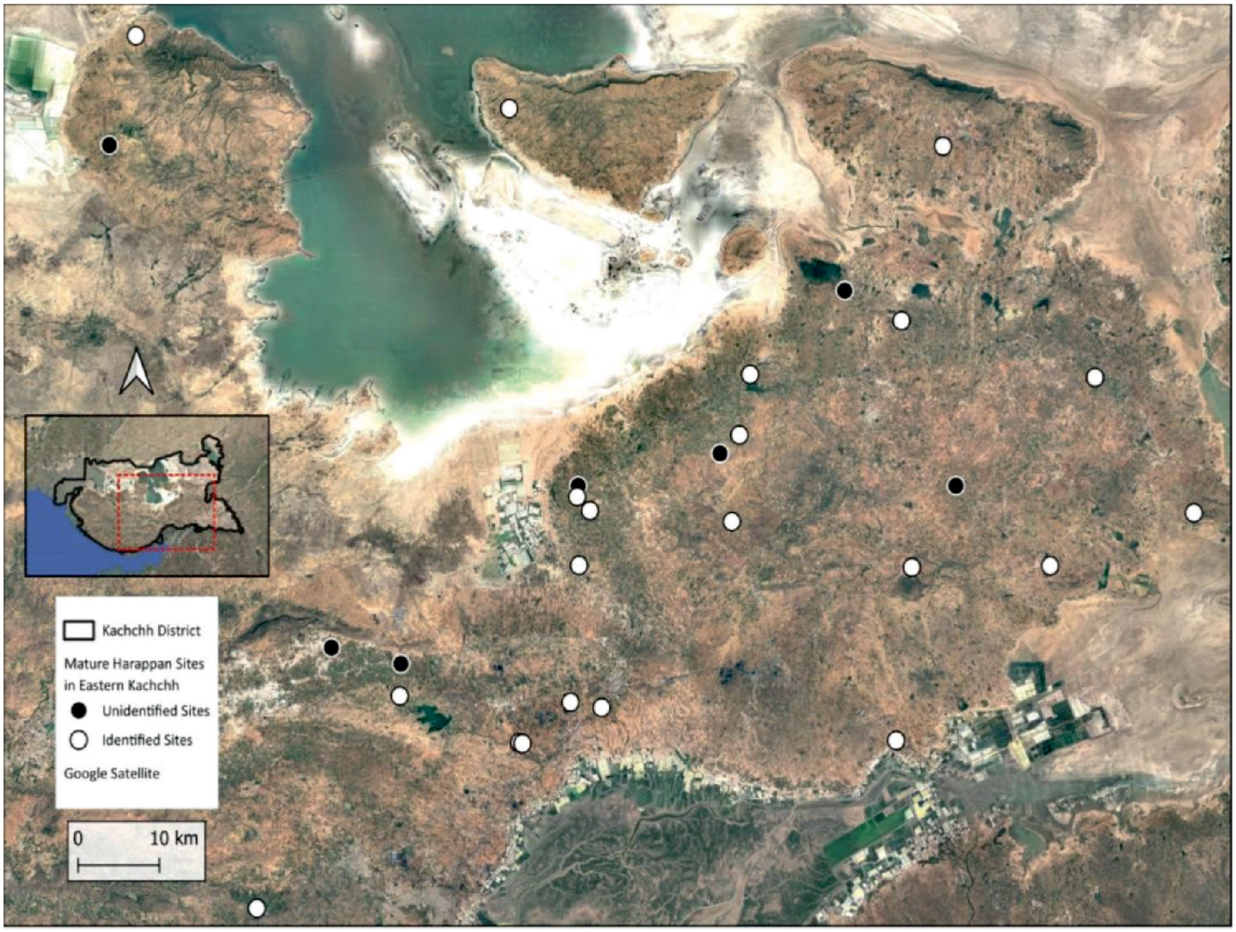

Figure 1: Distribution of Mature Harappan sites in Eastern Kachchh

Development of Archaeological Research in Kachchh

Early Explorations and Excavations

Archaeological investigations in Gujarat gained momentum after Indian independence, following the discovery of Harappan sites such as Lothal. The Archaeological Survey of India (ASI) and the Department of Archaeology, Government of Gujarat, led the earliest explorations in the Kachchh region. S.R. Rao, seeking to establish maritime connections between Saurashtra and Sindh, conducted the first archaeological surveys in Kachchh (Rao 1985). Rao's work reported sites such as Desalpur and Todia Timbo but did not include geographical coordinates (Rao 1985; IAR 1955-56), probably because he was unable to obtain access to the region's toposheets.

Expansion of Research

During the 1960s and 1970s, J.P. Joshi expanded Kachchh's archaeological research through a more problem-oriented and systematic survey strategy. Employing a village-to-village approach, he identified 16 Harappan sites, though coordinates were reported for only 8 of those sites (IAR 1964-65; 1965-66; 1967-68; Joshi et al. 1984). Excavations at Desalpur (Soundara, IAR 1963-64), Pabumath (IAR 1983-84) and Surkotada (Joshi 1990a, IAR 1970-71; 1971-72) followed, confirming the region's role in the land route as proposed by Joshi and in the wider Harappan cultural landscape. Parallel work by the Gujarat State Department of Archaeology added 7 more sites between 1960-61 and 1987-88, though the precision of coordinates remained inconsistent.

From the 1980s onwards, R.S. Bisht's systematic surveys to locate potential satellite sites around the urban centre of Dholavira marked a major methodological advance. His team identified 7 additional Harappan sites, providing coordinates for 4 (IAR 1984-85; 1986-87). Bisht also directed 13 seasons of excavation at Dholavira between 1989-90 and 2004-05 (Bisht 2021), transforming the understanding of urban planning and hydrological management in the Harappan context.

Methodological and Technological Advances

The 2008s marked a slow but significant transition in field and data-processing methods in Indian archaeology, with the growing use of geospatial and geophysical technologies. Global Positioning Systems (GPS) and total stations replaced previous plane-table mapping and descriptive locational recording, allowing for more precise site recording, excavation control and site reidentification of previously reported sites (IAR 2008-09; 2012-13). Meanwhile, non-invasive and spatial-explicit techniques increasingly supplemented excavation and survey, mirroring the broader shift in archaeological practices in India.

But remote sensing found its way into archaeologically relevant research in India much earlier, with satellite data being used as early as the 1980s to map palaeodrainage systems and regional landscape settings, such as the Saraswati river system (Yashpal et al. 1980). These initial uses were primarily palaeoenvironmental and exploratory, demonstrating the usefulness of satellite imagery for contextualising archaeological site distributions rather than mapping sites themselves. Since 2005, remote sensing has been increasingly coupled with GIS, enabling explicit archaeological investigations of settlement patterns, palaeochannels, sites, and landscape change at regional scales.

Subsequent research has shown the effectiveness of such work in India. Rajani and her collaborators have used multispectral imagery, digital terrain models, historical maps, and GIS to investigate a diverse range of archaeological settings, including Harappan settlement patterns along palaeochannels, medieval, historic urban and monastic landscapes, critically reflecting on the strengths and limitations of spatial data derived from remote sensing (Rajani and Rajawat 2011; Rajani 2016; Rajani and Kumar 2021; Pal and Rajani 2022; Mhaske and Rajani 2022; Mhaske 2026). Similar trends are found in the work of Conesa and colleagues, who have consistently used CORONA imagery, SAR, and multi-sensor remote sensing to map archaeological features, seasonal inundations and historic landscape changes in monsoonal semi-arid environments of western India, such as North Gujarat (Conesa et al. 2013, 2014, 2015; Orengo et al. 2020). At a regional scale, Orengo, Petrie and others have also demonstrated how multi-temporal satellite data and georeferenced historical maps can be integrated to map palaeo-channel networks and settlement landscapes in northwest India, placing archaeological sites in the long-term environmental and geomorphological context (Orengo and Petrie 2017; Petrie et al. 2019; Green et al. 2019; Gupta et al. 2024; Garcia-Molsosa et al. 2023; Conesa et al. 2023; Kour et al. 2026). Collectively, these studies demonstrate the theoretical and empirical validity of remote sensing and GIS-based archaeological approaches in South Asia.

Application in Kachchh and Outstanding Challenges

In Kachchh, geospatial methodological innovations have been used sparingly at major sites like Dholavira (Agrawal et al. 2018), Kanmer (Teramura et al. 2008; Kharakwal et al. 2012), and Shikarpur (Rajesh 2018). Multidisciplinary projects, such as the Harappan Archaeological Research in Kachchh (HARK), a project led by the University of Kerala and the Spanish National Research Council, continue to integrate excavation, regional survey, remote sensing, GIS, radiocarbon dating and palaeoenvironmental analysis. (Rajesh et al. 2025)

Despite these advances, archaeological studies in Kachchh continue to rely heavily on legacy site records created before the widespread adoption of GPS and systematic spatial recording. Although recent archaeological work has benefited from improved accuracy through the application of modern technologies, legacy data remains the backbone of regional analyses, creating challenges for spatial integration, site reidentification and comparative studies. These challenges provide the context for the following assessment of legacy data and geospatial approaches in Kachchh.

Legacy Data and Problems

Brief History of Legacy Data

The shift in coordinate reporting in Indian archaeology from descriptive village-based descriptions to GPS coordinates after 2008 sets the context for the problem in Kachchh. The majority of Harappan sites in the region were documented before the advent of GPS, using Survey of India toposheets or landmark descriptions. By contrast, sites reported after 2010 typically have GPS coordinates. Large-scale surveys by archaeologists such as S.R. Rao, J.P. Joshi, and R.S. Bisht, as well as the Department of Archaeology, Government of Gujarat, employed the most advanced methods available at the time. Early archaeological data are now difficult to locate due to imprecise descriptions, lack of coordinates, and diverse reporting standards. However, as Vidyarthi and Chauhan (2025) stress in their re-evaluation of Indian Palaeolithic sites, legacy data should not be discarded based on these shortcomings. Through critical evaluation, rigorous cross-checking, field verification, and geospatial technologies, these data can be converted from fragmented archival records into spatial databases. In this way, legacy data is not just a historical record, but a critical link between past survey practices and future archaeological investigations.

Legacy Data in Kachchh: Challenges and Inconsistencies

Archaeological data on Harappan sites in Kachchh is rich and diverse. J.P.Joshi et al. (1984) and Possehl (1999) were the first to compile Harappan sites in Kachchh. These are mostly from Indian Archaeological Review (IAR) volumes and journals (Purātattva, Man and Environment, etc). Subsequent compilations, such as Rajesh and Patel (2007), have reported 62 sites in Kachchh, while Shinde et al. (2011) have reported 53. In this study, only Mature Harappan sites were considered: 49 sites listed by Rajesh and Patel (2007) and 45 sites listed by Shinde et al. (2011). Only 34 and 30 sites are located in eastern Kachchh, respectively. These two datasets are significant compilations of previously published Harappan sites from previous research. As the authors acknowledge, these compilations unavoidably reflect the shortcomings of their legacy sources, including inconsistencies in locational accuracy, unclear locational descriptions, conflating site names, and varying cultural attributions.

Rajesh and Patel's (2007) dataset, drawn from IAR reports, dissertations and previous publications, contains fields for site name, district or river, latitude, longitude and references. But many records lack coordinates or full locational information; some use river basin names instead of district names. Of the 34 Mature Harappan sites in Kachchh, 28 have approximate coordinates, and 6 have none. Likewise, Shinde et al. (2011) offer additional metadata, but 23 out of 30 sites have coarse coordinates, and 7 lack locational data. Both data sets reflect limitations of previous sources, as the authors note at the start of the data sets.

To resolve inconsistencies in the legacy data, it was necessary to cross-check with IAR volumes, Joshi et al. (1984) and Possehl (1999) to build a coherent dataset. This exercise highlighted the following problems:

Duplicate Entries and Naming Variations: Some sites are recorded under multiple names or are inconsistently linked to one or the other village. For example, Sevakiya (IAR 1985-86) is given as

Bhachau in Rajesh and Patel (2007), while Shinde et al. (2011) list it both as Bhachau 2 and Sevakiya. Likewise, Kanmer is listed as Bakarkot and Kanmer in Shinde et al. (2011), following IAR (1985-86), which recorded both village and local names. Rajesh and Patel (2007) list Kotada Anjar as "Kotada: Kachchh", while previous sources (IAR 1965-66; Joshi et al. 1984) simply referred to Kotada Anjar. Rajesh and Patel (2007) also list Juni Kuran twice as Kotara, following the double naming conventions of IAR (1967-68).

These duplications, due to transliteration variations and changing naming practices, inflate site counts and obscure true settlement patterns.

Coordinate Discrepancies: Discrepancies in published coordinates are among the most significant challenges in the archaeological record of Kachchh. The site of Juni Kuran illustrates this problem clearly, as different sources assign substantially divergent locations to the same site, resulting in a spatial dispersion of its reported position across several tens of kilometres (Fig. 2; Table.1). A comparable issue is evident at Jhangar Anjar (also referred to as Jhangar), where published coordinates vary notably between sources, producing a spread of reported locations exceeding seventeen kilometres.

Table 1: Different Coordinates for Same Sites

Sites	*Coordinates*	*Sources*
Juni Kuran	23°27′00″N, 69°47′30″E	IAR (1967-68)
	24°00′00″N, 69°45′00″E	Joshi et al. (1984)
	23°27′00″N, 69°47′00″E	Rajesh and Patel (2007)
	23°58′00″N, 69°47′00″E	Shinde et al. (2011)
	23°19′10″N, 70°05′00″E	Rajesh and Patel (2007), Shinde et al. (2011), and IAR (1965-66)
Jhangar Anjar	23°18′00″N, 70°05′00″E	Joshi et al. (1984)
	23°10′00″N, 70°05′30″E	Joshi (1990)

Figure 2: Different locations of Juni Kuran from legacy datasets

Even minor variations, such as those for Juna Chopwada (IAR 1986-87: 23°16′00″N, 70°15′30″E; Rajesh and Patel 2007; Shinde et al. 2011: 23°16′00″N, 70°15′00″E), produce errors of 900m enough to misdirect field surveys in clustered landscapes.

In our dataset, the most pronounced discrepancy concerns Lakhsara I and II. In the published literature, including IAR (1986-87) and subsequent compilations, the reported coordinates 23°14′00″N, 70°41′00″E plot the sites near Shikarpur when visualised on geoportals. However, the associated descriptive information consistently links the sites to Moti Chirai village. The corrected longitudinal value (70°14′) from 70°41′ places the location 23°14′00″N, 70°14′00″E as Moti Chirai, suggesting that the discrepancy is probably due to a transcription or recording error. This case study demonstrates how small errors in field recording, data entry or publication can lead to large spatial offsets, with consequent impacts on the quality of compiled data sets (Fig. 3). Consequently, site coordinates were critically cross-checked against descriptive metadata and spatial visualisation, and only corrected when supported by multiple lines of evidence.

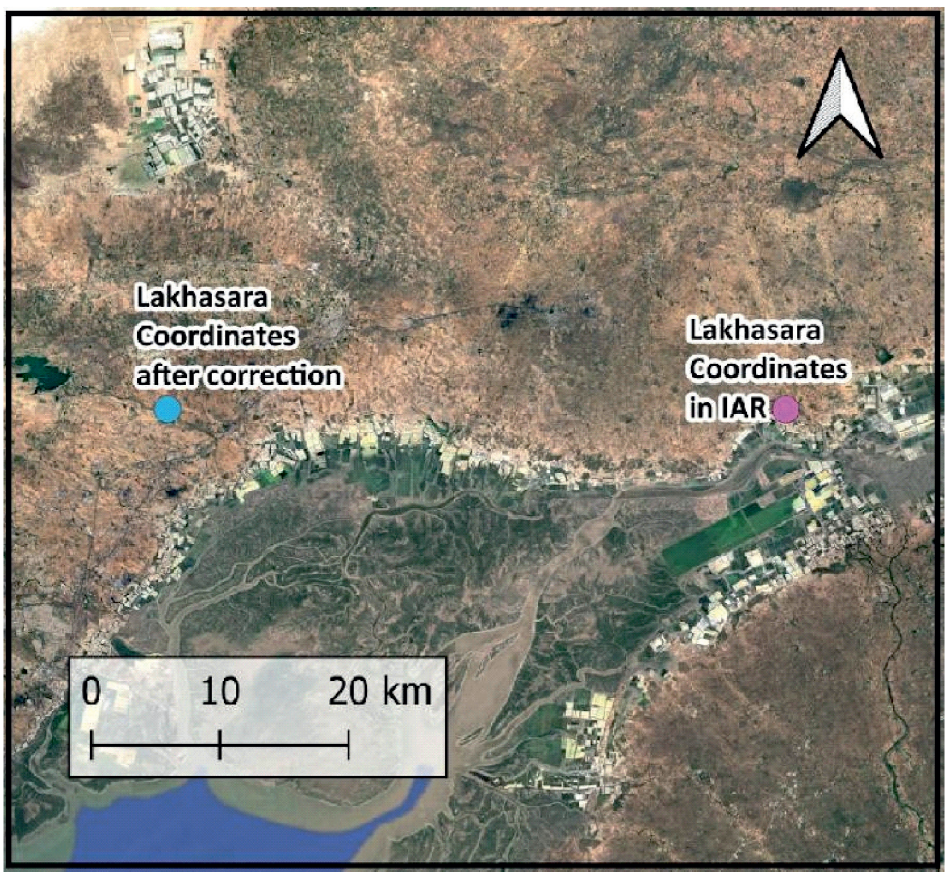

Figure 3: The misalignment of published coordinates and the corrected spatial position of Lakhsara I and II.

Such coordinate inconsistencies, ranging from a few hundred metres to several kilometres, highlight the unreliability of legacy data for direct spatial analysis.

Missing or reconstructed coordinates: Many early IAR entries lack coordinates altogether, for example, Khakhra Dera (IAR 1960-61), Surkotada (1964-65), Kanthkot (IAR 1967-68), Juni Kuran (IAR 1967-68), and Ramvav (IAR 1977-78). Joshi et al. (1984) attempted to fill these gaps through resurvey, creating one of the first relatively complete coordinate datasets for Kachchh. Later compilations, such as Rajesh and Patel (2007) and Shinde et al. (2011), relied heavily on Joshi's data, often reproducing his entries verbatim. This continuity, while useful, propagated earlier positional errors and compounded uncertainty across datasets.

Duplicate or Overlapping Site Records: There are instances where sites seem to be the same location with varying toponyms and coordinates. For instance, Khakhra Dera (23°34′00″N, 70°29′00″E) was recorded by J.M. Nanavati in 1960-61, while Kanthkot (23°29′00″N, 70°29′00″E) was documented by J.P. Joshi in 1967-68. While Khakhra Dera is 9.23 km north of Kanthkot on a map, field checking showed Kanthkot is located in the Khokhreswar Mahadev Temple, 11.48 km south of the coordinates recorded by Nanavati. Given the same locality and the linguistic proximity between "Khakhra" and "Khokhreswar", it is clear that they refer to the same archaeological site. These discrepancies, stemming from a lack of topological consistency, further inflate the number of reported sites and affect settlement pattern studies.

Conflicting cultural attributions: Apart from spatial inconsistencies, the legacy data also contain chronological inconsistencies, many of which appear to result from reusing previous classifications without fresh field investigations. For instance, Jhangar is classified as Mature Harappan by Rajesh and Patel (2007), Shinde et al. (2011), and the Surkotada report, but simply as "Harappan" in IAR (1965-66) and as "Post-Harappan" by Joshi et al. (1984). Likewise, Katasar is identified as Mature Harappan by Shinde et al. (2011) but as Late Harappan by Joshi et al. (1984), and Vaidwali Mohra is listed as both Mature and Late Harappan. Without new fieldwork, such legacy inconsistencies are perpetuated in compilations and complicate the development of coherent cultural and chronological models from compiled data.

Constructing a Clean Legacy Dataset for Kachchh

In light of these issues- duplicate entries, conflicting coordinates, and inconsistent classifications it was necessary to create a reference dataset. The IAR series was considered the most authoritative source (being the first official publication to resolve site descriptions), and Joshi et al. (1984) was used to fill in coordinates. Comparing the two sources enabled the identification of duplicates, the correction of locational inconsistencies, and the standardisation of village and taluka names. The result was 30 Mature Harappan sites, which formed the basis of preliminary field planning and verification. These 30 sites include 5 sites with no coordinate (see https://doi.org/10.5281/zenodo.18796737)

Methodological Challenges in Locating Archaeological Sites in Kachchh

The identification of archaeological sites in Kachchh is fraught with methodological problems, both because of the nature of existing data and the area's varied geomorphology. The majority of sites reported in previous surveys lack precise coordinates and are prone to error. This makes site identification difficult, particularly in an environment where natural features closely resemble anthropogenic ones.

The landscape of Kachchh is geomorphologically diverse, with salty plains, rocky outcrops, wind-blown dunes and palaeochannels (Thakkar 2017; Kar 2011). These features often exhibit topographic and spectral characteristics similar to archaeological mounds (Fig. 4), leading to a high number of potential anthropogenic soil and mound-like features (false positives) identified in remote sensing. Additionally, dynamic cultivation, sparse vegetation and sporadic farming exacerbate the challenge of separating archaeological mounds from natural and contemporary features. As a result, identifying Harappan sites in the region requires a multi-faceted approach involving legacy data analysis, focused remote sensing and ground validation.

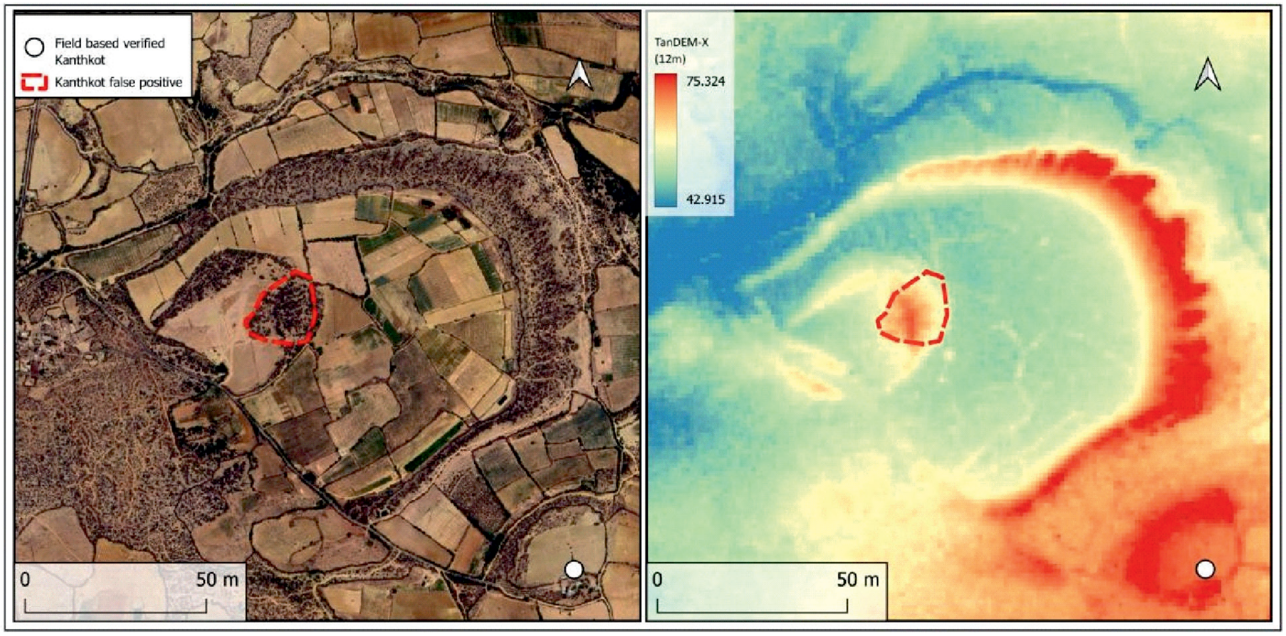

Figure 4: False positive for the site Kanthkot

Methodology

Remote Sensing and Map-Based Pre-Field Analysis

The objective of phase 1 of the study was to map the reported legacy sites and to validate their location. The coordinates of all sites in the legacy dataset were mapped using geospatial platforms, and buffer zones of 2 km and 5 km were drawn around the coordinates to account for errors ranging from a few hundred metres to 5 km due to the absence of seconds in the older data. These zones were systematically scanned in detail using high-resolution satellite basemaps, such as those available in Bhuvan and Google Earth geospatial platforms.

Well-known excavated sites such as Dholavira, Kanmer, and Shikarpur were used as reference sites to establish baseline photo-interpreted characteristics and spectral signatures of Harappan mounds, as these are among the few sites in Kachchh with precise GPS coordinates available from recent excavations. These spectral signatures serve as the Baseline for interpreting false-colour

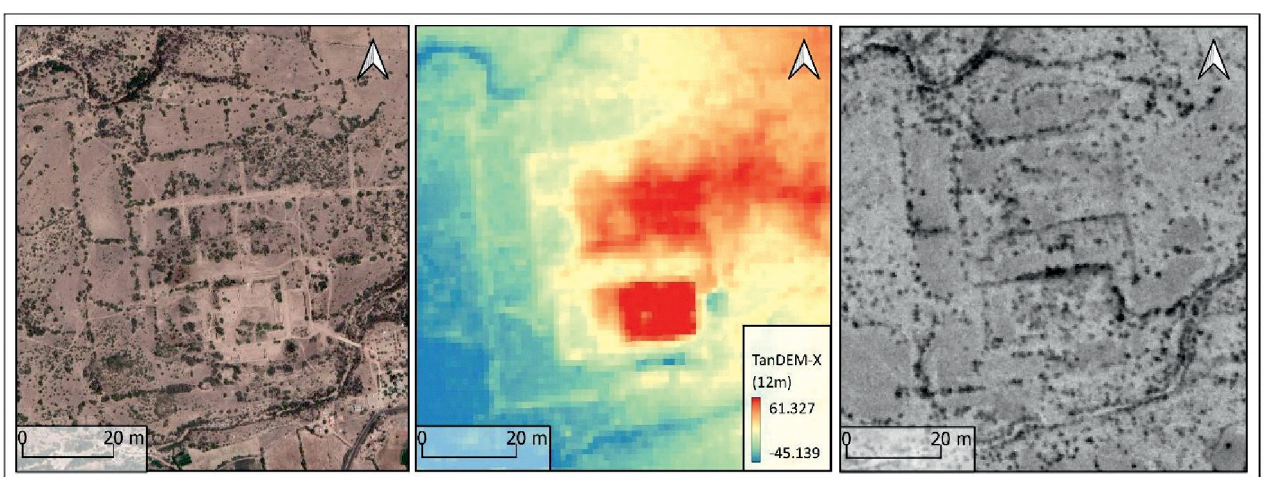

Figure 5: Dholavira as visualised in modern satellite imagery, TanDEM-X data and CORONA satellite imagery (left to right)

composite (FCC) images and multispectral indices. The dataset used in the analysis comprises LISS IV images (5.8m), CORONA historical satellite imagery (~ 2.7m), the TanDEM-X digital elevation model (12m), and multispectral indices discussed later. For example, Dholavira is clearly visible in satellite images, CORONA imagery, and TanDEM-X (Fig. 5). Kanmer is similarly identifiable, and Shikarpur is evident in Google Earth and TanDEM-X, though not distinct in CORONA imagery (Fig. 6). These three served as control examples for interpreting less precise legacy sites such as Juni Kuran, Surkotada, and Pabumath, where only coarse coordinates were available.

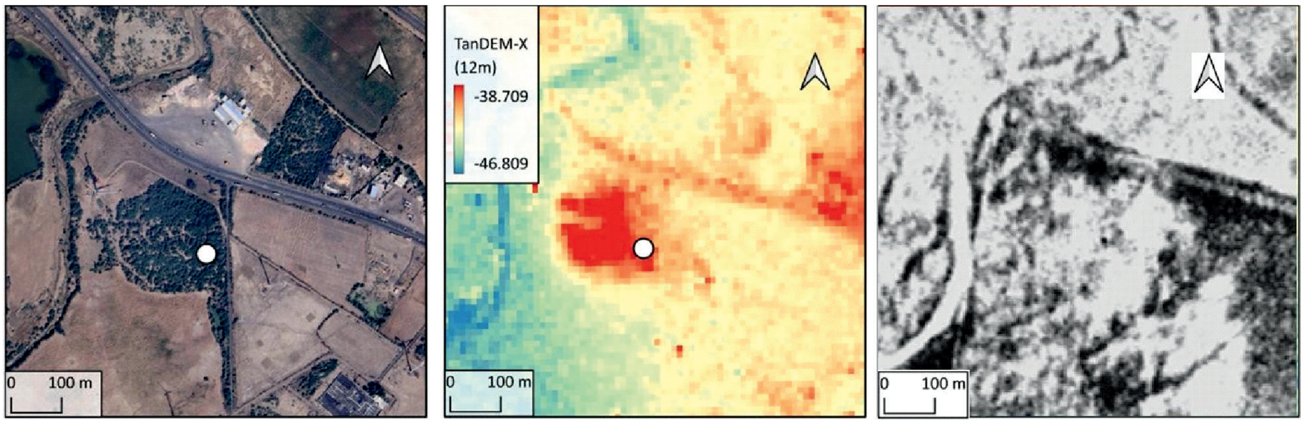

Figure 6: Shikarpur as visualised in modern satellite imagery, TanDEM-X data and CORONA satellite imagery (left to right)

To supplement satellite data, colonial-period Survey of India toposheets (1" to 1-mile scale) were incorporated. Originally produced for military and administrative mapping in the mid-19th century, these maps record villages, transport routes, and elevated features such as forts, mounds, and deserted or abandoned settlement locations (Petrie et al. 2025).

Mounds were often labelled with local terms such as khera (fields), tibba (dune or elevation), or kotada (fort ruins); there is a high correspondence between old settlements. Interestingly, abandoned settlements were marked with an "x," which proved useful for identifying potential archaeological remains.

Toposheets covering Kachchh (41A, 41E, and 41I) were obtained from Zenodo[i] for georeferencing in QGIS. For the mainland and island sheets, a first-order polynomial transformation was applied using 20-25 ground control points (GCPs). For the Rann and Banni plains, where fewer permanent features were available, a linear transformation with 10–12 GCPs was used (Fig. 7). These parameters were chosen after experimenting with multiple transformation settings, and the selected combinations produced the best spatial fit. Once georeferenced, the legacy coordinate buffers (2 km and 5 km) were overlaid, and each sheet was manually examined and photo-interpreted for labelled or "x"-marked sites, and a vector layer was generated.

Only two sites, Dholavira ("Kotada") (Petrie et al. 2025) and Juni Kuran ("Kotara Gadh"), were explicitly marked on the toposheets. Lodrani (Rajesh et al. 2025) was also noted. Since only three ancient mounds were labelled as "kotada", all "x"-marked deserted sites were digitised into a vector layer and imported into GeoTracker to guide ground verification during fieldwork.

Furthermore, multispectral image enhancement techniques such as False Colour Composites (FCC), Normalised Difference Vegetation Index (NDVI), and Soil Adjusted Vegetation Index (SAVI) were further used to identify sites. These image enhancement techniques were applied to assess their potential for identifying archaeological features and for delineating site extents.

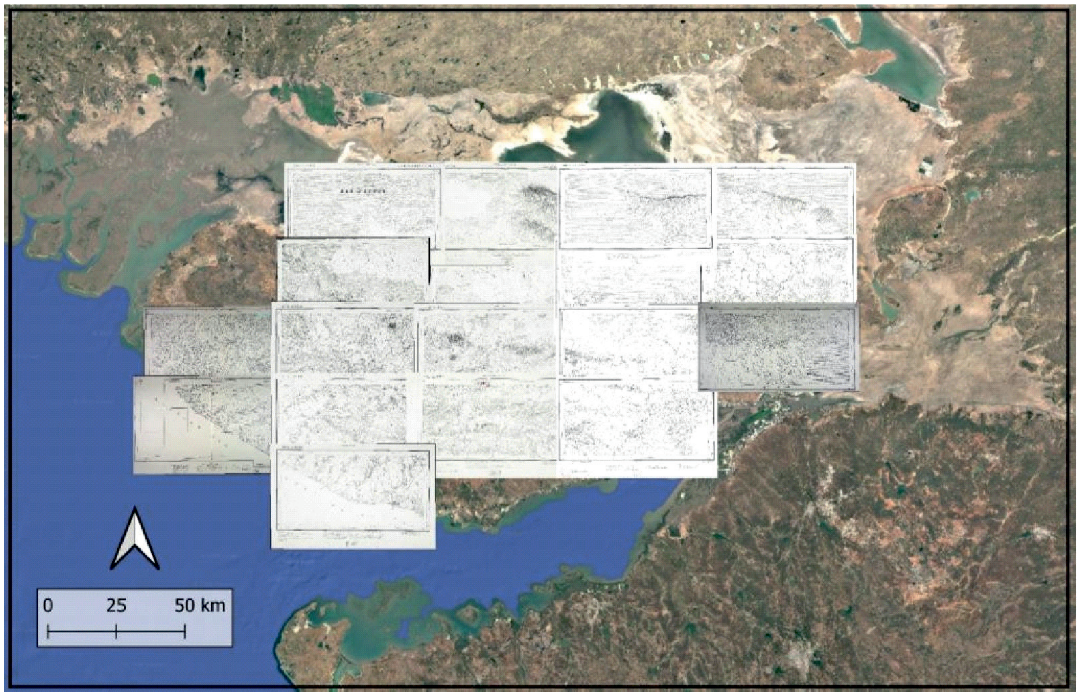

Figure 7: Georeferenced Survey of India toposheets from the British period.

Figure 8: Juna Chopadwa in false colour composite imagery, Google historical imagery (December 2014), and present Google satellite imagery (May 2023), from left to right.

Field Survey and Ground Verification

A systematic field survey was conducted in two seasons to reidentify legacy sites and validate earlier records. The survey prioritised "x"- marked locations from toposheets and villages within a 5 km buffer of legacy coordinates, as this range was found to encompass most probable site locations.

The first season of fieldwork focused on visiting "x" sites and a village-to-village survey. Pottery and other diagnostic artefacts were collected via random sampling, but pottery was the most common artefact found due to its prevalence and significance. In the second season, an attempt was made to verify sites previously reported in site gazetteers by Maharaja Sayajirao University (MUS) and the University of Kerala by Prof. Ajith Prasad and Dr S.V. Rajesh, respectively, to resolve inconsistencies in their cultural attributions and to confirm if they were legacy sites or not.

A total of 30 sites were identified, 25 with legacy coordinates and 5 without. 20 sites were successfully located: 10 new sites verified by the author, 8 sites previously verified by Prof. Ajith

Prasad, and two by Dr Francesc Conesa (personal communication). All sites were located using a Garmin GPS. The closest village, pottery spread, administrative information, land ownership, and site status were recorded for each site. Noted threats from cultivation, construction, and erosion were also documented for future monitoring.

Post-Field Remote Sensing Evaluation

Spatial Deviation Patterns in Identified Sites

Of the identified archaeological sites, 17 had legacy coordinates available for comparison with their corrected locations in order to understand the accuracy of their coordinates and potential spatial bias. The comparison of verified sites with their legacy inaccurate location showed a mean deviation of 3.96 km with a standard deviation of 3.70 km, suggesting a moderate level of variability in the accuracy of legacy coordinates. The smallest deviation was 0.93 km for Lakhsara I, which was a reasonably close match to its corrected position. Conversely, the maximum deviation was 16.54 km for Shikarpur, an outlier that significantly influenced the range of deviations. The median deviation was 3.16 km, implying that most sites were close to their corrected locations, with deviations typically less than 5 km (Fig. 9).

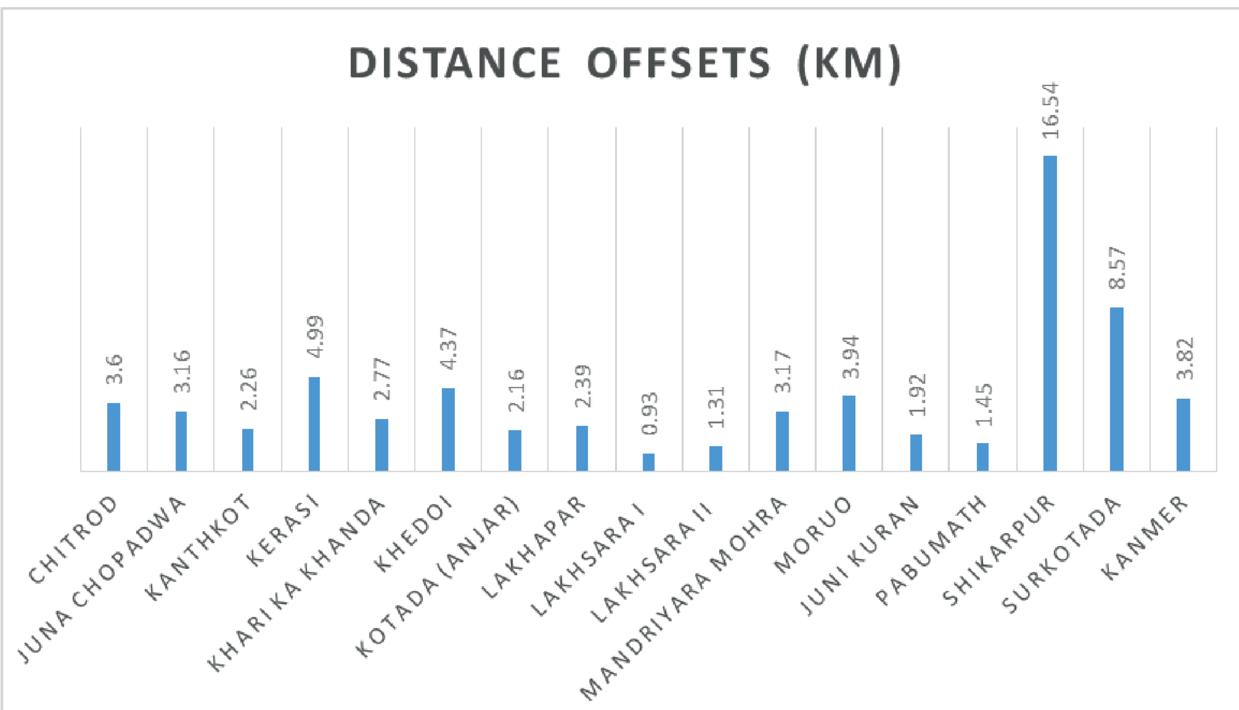

Figure 9: Histogram of spatial offsets between legacy and updated site coordinates.

The direction of deviations showed a pattern rather than a random distribution. The most common direction was northeast, followed by six sites (Chitrod, Juna Chopadwa, Lakhapar, Lakhsara I, Moruo, Shikarpur). Three sites each were oriented in the southwest (Kanthkot/Kharakadera, Kotada (Anjar), Juni Kuran Pabumath) and northwest (Kerasi, Khari ka Khanda, Khedoi). Two sites (Mandriya Mohra and Surkotada) were skewed towards the southeast, and one site each towards the east (Lakhsara II), south (Kanmer) and west (Pabumath).

The overall trend indicates that although the directions vary, there is a clear trend towards the northeast direction in many sites. This suggests a consistent spatial bias, likely due to mapping and/

or projection errors in previous surveys. The results indicate that most legacy coordinates fall within a 5 km range of their corrected locations, supporting the use of a 5 km buffer for future site searches.

Integrating Field Data with Satellite Imagery

This post-field analysis has shown that certain patterns have become clearer when using true coordinates. At Lakhasara, two localities were initially reported by Bisht and the site was later discovered in the field by Ajith Prasad. During the current survey, the two localities were visited, and based on the surface pottery and the distance between the sites, it was initially suggested that they could be part of a single mound, separated by the present road. This remained a question in the field due to a lack of evidence. But when the same area was examined in FCC compositions, a pattern was revealed that continued across the road, suggesting the two localities were part of the same archaeological mound, rather than separate sites (Fig. 10). Likewise, the pre-canal FCC imagery of Juna Chopwada enabled the boundaries of the site to be mapped before it was destroyed by modern development (Fig. 8). These cases demonstrate the value of integrating field observations with remote-sensing data to refine site boundaries and reconstruct landscape change.

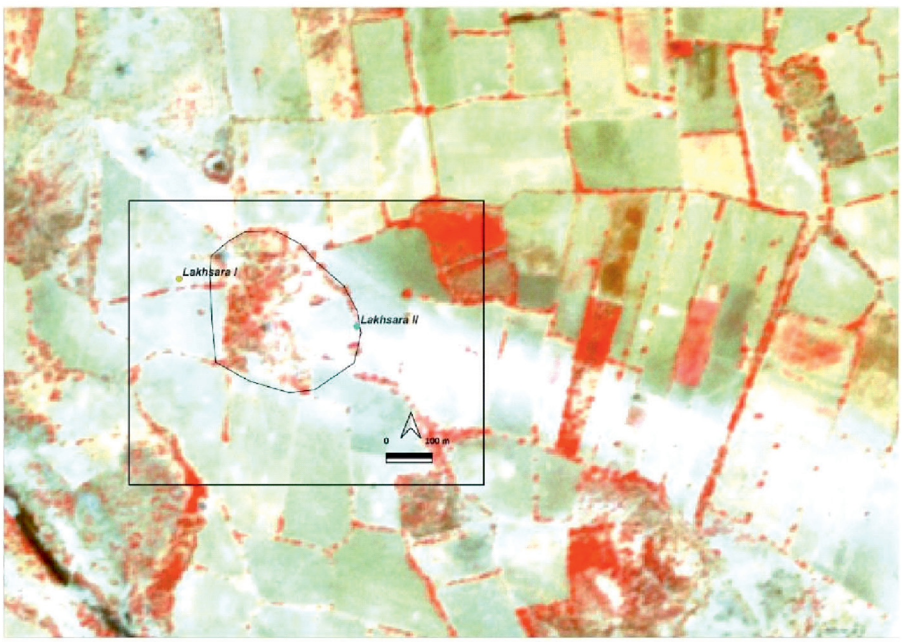

Figure 10: Full extent of Lakhsara I and II, represented as a single site in false colour composite (LISS IV 5.8m; acquired 07/2022)

Discussion: Evaluating Legacy Data, Remote Sensing, and Historical Maps

The combination of legacy datasets, remote sensing, historical maps and field verification offered essential insights into both the potential and challenges of archaeological discovery in Kachchh. The key issue was the uncertainty of legacy locations, with coordinate offsets ranging from a few hundred metres to several kilometres. Despite the application of 2 km and 5 km buffer zones, the uncertainty in legacy coordinates often resulted in locations falling on natural features such as ridges, dunes, and eroded knolls, whose spectral and topographic signatures are similar to those of archaeological mounds. Thus, the potential match between legacy sites and natural features may be an artifact of coordinate uncertainty, but it may also reflect the unique attributes of Harappan sites in Kachchh. For instance, whereas many Harappan sites in alluvial regions (such as Haryana, Cholistan, or Rajasthan) are composed of decomposed clay and silt, many Harappan sites in Kachchh are stone-based, resulting in different surface expressions and spectral signatures. Additionally, site reuse, including the reoccupation of archaeological sites under current settlements and their presence in alluvial and productive landscapes, may also affect their visibility and spectral responses.

In contrast, the application of this approach in Kachchh yielded limited results. The georeferenced toposheets of Kachchh (sheets 41A, 41E and 41I) only list three sites identified as Kotada - Dholavira, Juni Kuran and Lodrani - all of which are known as Harappan sites. The apparent scarcity of sites in Kachchh needs to be viewed against the backdrop of the early history of the survey. While the region was first surveyed in the mid-19th century by the Survey of India, much of the subsequent cartography, including the 1955 editions produced by the U.S. Army Map Service, was merely copied from these earlier 2-inch Survey of India maps rather than resurveyed. As a result, many of the "deserted" settlements probably represent medieval to early modern settlements and, in some instances, recurring pastoral or seasonal settlements rather than abandoned sites. The recent survey findings by Rajesh also show that many of these sites are from the Early Historic and Medieval periods. This indicates that the paucity of sites is perhaps not due to absence but rather an outcome of survey inheritance, settlement dynamics, and the challenges of recording ephemeral archaeological traces in an arid environment. A full survey of Kachchh was conducted likely after the 1990s, which also accounts for the paucity of archaeological sites on the older toposheets. Other sites marked with an “x” were confirmed to be abandoned villages, probably dating to after the 1819 earthquake, rather than archaeological mounds. So, while the "x" markers were successful in pinpointing sites of habitation, they did not mark Harappan sites in this instance.

However, the toposheets were useful for other purposes. They reliably mapped palaeochannels, drains and other topographic features, which were essential in understanding the palaeohydrology of the landscape. In Kachchh, where many ephemeral rivers have no names on contemporary maps and where local interviewees often did not know their names, the Survey of India sheets captured river systems that have otherwise been forgotten.

When the edited site vector layer was overlaid on the georeferenced toposheets, two sites, Pabumath and Kanmer (Fig. 11), were found to align with circular contours resembling mound-like features, and Shikarpur was noted as a deserted site, whereas Pabumath and Kanmer were not explicitly marked. This implies that the surveyors identified these as topographically distinct features (Petrie et al. 2025) but not as Kotada, the local term for fortified ruined settlements at the time of survey.

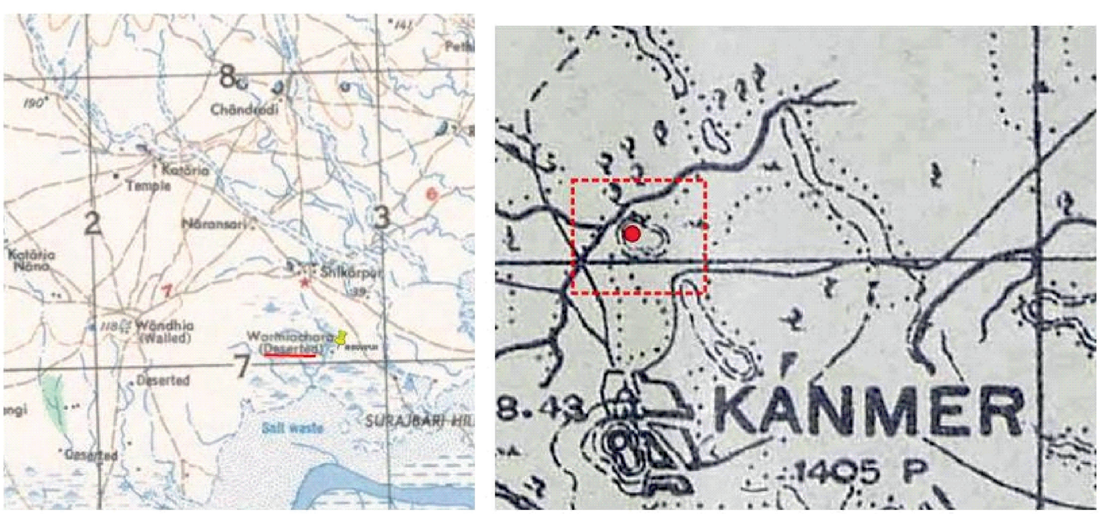

Figure 11: Shikarpur and Kanmer as recorded on toposheets.

In general, toposheets were an important archival resource for understanding landscape development, hydrological processes, and the contextual background of known archaeological sites. Their integration with contemporary geospatial applications contributes to broader landscape interpretation even where direct archaeological correlations are limited.

Image enhancements, which are widely used elsewhere to detect archaeological features using spectral signatures (Rajani and Kasturirangan 2014; Navalgund and Rajani 2017; Suganya and Rajani 2020; Pal and Rajani 2022; Rajani 2024), were unreliable for detecting mounds in Kachchh due to geomorphic and spectral ambiguity. The vegetation-based indices were found to be highly sensitive to environmental variability in the alluvial and semi-arid regions of eastern Kachchh. Spectral anomalies that were not associated with archaeological features often occurred as a result of soil moisture changes, seasonal sediment deposition, sparse vegetation cover and agricultural land-use practices, which led to false positives. Detection was most effective in non-cultivated or barren terrain where subsurface structural effects on vegetation stress were not obscured by irrigation or ploughing. When applied to independently verified sites, these indices were useful for delineating site extents and monitoring landscape change.

Comparative evaluation also found that previous reports of site discovery through remote-sensing techniques, including the discovery of three Harappan sites by Thakkar (2001), need to be re-evaluated. An example is at Nara, where Thakkar identified a 120-hectare area as a site. High-res satellite imagery and TanDEM-X re-examination of the same area showed that it is a natural geological formation (Fig. 12). Since there are no other known Harappan sites in Kachchh larger than 50 hectares (except Dholavira), this example highlights the importance of independent verification when interpreting remote-sensing results.

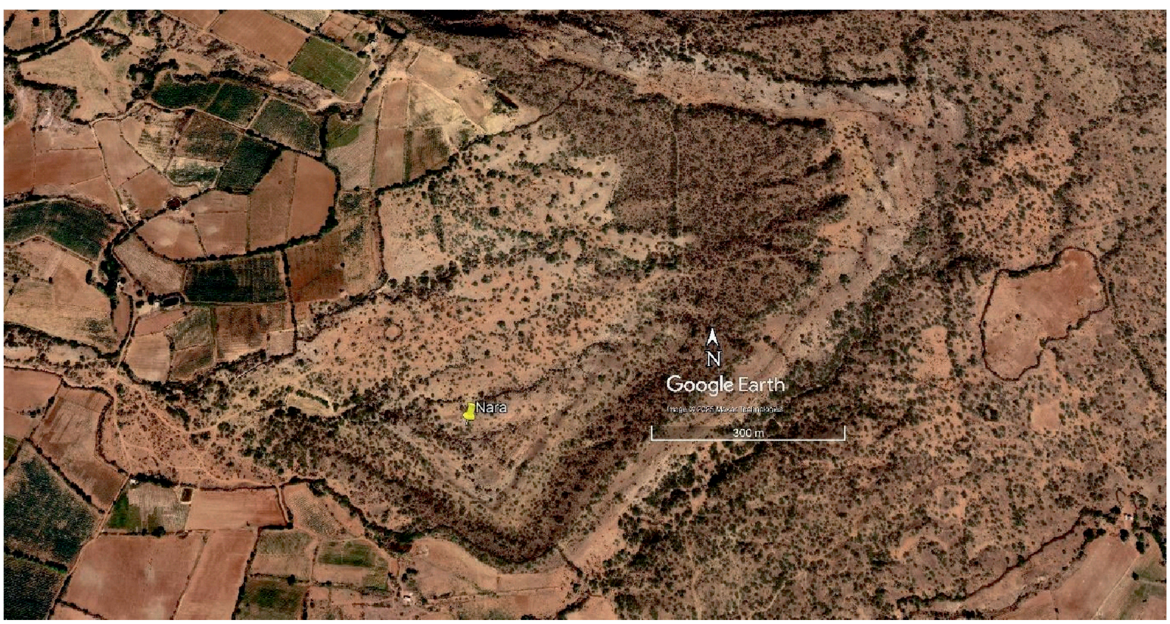

Figure 12: Extent of the Nara site as identified by Thakkar (2001)

Hector Orengo (Orengo and Petrie 2018; Orengo et al. 2020) have developed automated mound detection techniques that have proven successful in relatively homogeneous terrain like the Cholistan Desert. However, how these approaches can be transferred to Kachchh is not clear, as the region is characterised by a high degree of geomorphological complexity. Kachchh saline flats, ridges, and dunes produce many mound-like spectral and topographic signatures that may increase the likelihood of false positives. The generalizability of automated detection procedures in these contexts thus remains an unanswered question, rather than a proven limitation.

Finally, the results demonstrate the value of integrating legacy datasets, field observations, and geospatial analysis in the study of archaeological landscapes in Kachchh. When critically assessed and refined through a systematic survey, legacy records remain an important source of archaeological information. The combination of accurate GPS data, geomorphological knowledge, and satellite imagery enables a more robust reconstruction of site distribution and landscape dynamics.

Conclusion

This study critically examined the challenges of integrating legacy archaeological data with modern geospatial techniques in the geomorphologically complex landscape of Kachchh. The analysis demonstrates that while legacy datasets remain invaluable for reconstructing regional settlement patterns, their effective use depends on rigorous cross-verification, correction of positional errors, and systematic field validation. Positional inaccuracies, duplication of site names, and inconsistent cultural attributions limit the standalone analytical value of legacy records.

Remote sensing and GIS proved valuable for visualising and contextualising archaeological sites, delineating site extents, reconstructing landscape change, and supporting post-field analysis. The integration of field observations with geospatial data enabled a more robust interpretation of archaeological landscapes and improved the spatial reliability of legacy datasets.

This study also highlights the need for comprehensive and openly accessible archaeological databases. The cleaned and verified dataset produced in this study, archived through an open-access repository (https://doi.org/10.5281/zenodo.18796737), represents a step toward improving data transparency, reusability, and the long-term preservation of archaeological spatial information. More broadly, the study provides a framework for critically evaluating legacy datasets and integrating them with modern geospatial approaches in archaeologically and geomorphologically complex environments.

Acknowledgements

The authors gratefully acknowledge **Prof. M. B. Rajani** for her invaluable guidance, encouragement, and sustained academic support throughout the course of this research.

Aishwarya Prashant Mhaske gratefully acknowledges the **Indian Space Research Organisation (ISRO)** for funding her PhD research, of which this study forms a part, and the **National Institute of Advanced Studies (NIAS)** for providing institutional infrastructure, including computing facilities essential for the completion of this study.

Dr Francesc C Conesa acknowledges grant No. RYC2022-036700-I, funded by MCIN/AEI/10.13039/501100011033 and FSE+. This research is also part of project PID2023-151176NA-100, funded by MICIU/AEI/10.13039/501100011033 and FEDER, UE.

The authors sincerely thank **Mr Shivansh Pareek**, **Mr Saket Kumar**, and **Dr Samayita Banerjee** for critically evaluating earlier versions of the manuscript and for their valuable suggestions, which helped improve the paper's structure and clarity. The authors further extend their thanks to **Prof. Ajith Prasad** and **Dr S. V. Rajesh** for generously sharing research data that contributed significantly to this study.

Field assistance during surveys was provided by **Mr Prashant Somnath Mhaske**, **Mr Parmeshwar Danwate**, and **Mrs Megha Prashant Mhaske**, whose support is gratefully acknowledged.

The authors are deeply grateful to the local communities of **Kachchh** for their cooperation, hospitality, and invaluable local knowledge during fieldwork. Particular thanks are due to **Shamatbhai (Chitrod)**, **Baldev Singh (Jesada)**, **Khengarbhai (Kanthkot)**, **Khengarbhai (Gedi), Rameshbhai (Kota, Anjar)**, **Bharat Darji** and **Ramji Ahir (Samakhiyali)**, **Maheshbhai (Ramvav)**, **Ramjibhai** and **Dineshbhai (Ner)**, **Rameshbhai (Lodrani)**, **Shamjibhai (Chobari)**, **Mahesbhai**

(Kerasi) and **Jituba Jadeja (Khedoi)** for their assistance and support. The author also acknowledges **Mr Dhanpatbhai**, Archivist at **Prag Mahal, Bhuj**, for facilitating access to archival materials.

The authors apologise for any inadvertent omission of names and extend their sincere gratitude to all others who contributed to and supported the research and fieldwork in various capacities.

[i] (Brown, J. (2024). The "Old Survey of India Maps" Collection [Dataset]. Zenodo. https://doi.org/10.5281/zenodo.11661876 [last accessed 16/07/2024])

References

Agrawal, S., Majumder, M., Bisht, R.S. and Prashant, A. 2018. Archaeological studies at Dholavira using GPR. *Current Science,* 114: 879–887.

Allison, P.M. 2008. Dealing with legacy data: An introduction. *Internet Archaeology,* 24. DOI: https://doi.org/10.11141/ia.24.8

Bisht, R.S. 2021. Excavations at Dholavira (1989–90 to 2004–05). Draft report for comments. Unpublished manuscript. New Delhi: Archaeological Survey of India.

Conesa, F.C., Devanthéry, N., Balbo, A.L., Madella, M. and Ajithprasad, P. 2013. Identification of seasonally flooded areas in North Gujarat using radar satellite imagery: Implications for archaeology. *Heritage: Journal of Multidisciplinary Studies in Archaeology,* 1: 344–355.

Conesa, F.C., Devanthéry, N., Balbo, A.L., Madella, M. and Monserrat, O. 2014. Use of satellite SAR for understanding long-term human occupation dynamics in the monsoonal semi-arid plains of North Gujarat, India. Remote Sensing, 6(11): 11420–11443. DOI: https://doi.org/10.3390/rs61111420

Conesa, F.C., Madella, M., Galiatsatos, N., Balbo, A.L., Rajesh, S.V. and Ajithprasad, P. 2015. CORONA photographs in monsoonal semi-arid environments: Addressing archaeological surveys and historic landscape dynamics over North Gujarat, India. Archaeological Prospection, 22(2): 75–90. DOI: https://doi.org/10.1002/arp.1498

Conesa, F.C., Orengo, H.A., Lobo, A. and Petrie, C.A. 2023. An algorithm to detect endangered cultural heritage by agricultural expansion in drylands at a global scale. *Remote Sensing,* 15(1): 53. DOI: https://doi.org/10.3390/rs15010053

Deshpande, M.N. (ed.) 1974. Indian archaeology – A review 1970–71. New Delhi: Archaeological Survey of India.

Deshpande, M.N. (ed.) 1975. Indian archaeology – A review 1971–72. New Delhi: Archaeological Survey of India.

Garcia-Molsosa, A., Orengo, H.A. and Petrie, C.A. 2023. Reconstructing long-term settlement histories on complex alluvial floodplains by integrating historical map analysis and remote sensing. Heritage Science, 11: 1–27. DOI: https://doi.org/10.1186/s40494-023-00985-6

Ghosh, A. (ed.) 1956. Indian archaeology – A review 1955–56. New Delhi: Archaeological Survey of India.

Ghosh, A. (ed.) 1967. Indian archaeology – A review 1963–64. New Delhi: Archaeological Survey of India.

Ghosh, A. (ed.) 1969. Indian archaeology – A review 1964–65. New Delhi: Archaeological Survey of India.

Ghosh, A. (ed.) 1973. Indian archaeology – A review 1965–66. New Delhi: Archaeological Survey of India.

Ghosh, A. (ed.) 1996. Indian archaeology – A review 1960–61. New Delhi: Archaeological Survey of India.

Green, A.S. and Petrie, C.A. 2018. Landscapes of urbanization and de-urbanization: A large-scale approach to investigating the Indus Civilization's settlement distributions in northwest India. *Journal of Field Archaeology,* 43(4): 284–299. DOI: https://doi.org/10.1080/00934690.2018.1464332

Green, A.S., Orengo, H.A., Alam, A., Garcia-Molsosa, A., Green, L.M., Conesa, F. and Petrie, C.A. 2019. Re-discovering ancient landscapes: Archaeological survey of mound features from historical maps in northwest India. *Remote Sensing,* 11(18): 2089. DOI: https://doi.org/10.3390/rs11182089

Gupta, E., Prabhakar, V.N. and Jain, V. 2024. Sabarmati and its connection with the Harappan port Lothal and the Nal corridor: A study using multi-sensor data and cloud computing. *Journal of Archaeological Science,* 170: 106046. DOI: https://doi.org/10.1016/j.jas.2024.106046

Joshi, J.P., Bala, M. and Ram, J. 1984. The Indus Civilization: A reconsideration on the basis of distribution maps. In: Lal, B.B. and Gupta, S.P. (eds.) Frontiers of the Indus Civilization. New Delhi: Books & Books. pp. 511–530.

Joshi, J.P. 1990a. Excavations at Surkotada 1971–72 and exploration in Kutch. Memoirs of the Archaeological Survey of India No. 87. New Delhi: Archaeological Survey of India.

Joshi, J.P. (ed.) 1990b. Indian archaeology – A review 1985–86. New Delhi: Archaeological Survey of India.

Kar, A. 2011. Geomorphology of the arid lands of Kachchh and its importance in land resources planning. Landforms, Processes and Environment Management, 1: 1–21.

Kharakwal, J.S., Rawat, Y.S. and Osada, T. (eds.) 2012. Excavation at Kanmer: 2005–06 to 2008–09. Kyoto: Indus Project.

Kour, N., Garcia-Molsosa, A., Orengo, H.A. and Conesa, F. 2026. Mapping the past, preserving the future: Integrating remote sensing and geospatial data with local conservation efforts in Jammu, India: A case study of Biyan Tibba. In: Rajani, M.B. (ed.) Spatial Narratives of India's Heritage: Integrating Geospatial Analysis in the Humanities. Singapore: Springer Nature. pp. 179–200. DOI: https://doi.org/10.1007/978-981-95-0117-5_10

Lal, B.B. (ed.) 1968. Indian archaeology – A review 1967–68. New Delhi: Archaeological Survey of India.

Mhaske, A. and Rajani, M.B. 2022. Analysing topographical transformation of Bombay Islands and Bombay Fort using geospatial analysis and historical records. Proceedings of the Indian National Science Academy, 88(3): 345–356. DOI: https://doi.org/10.1007/s43538-022-00091-4

Mhaske, A.P. 2026. Kutch: A land ‘without a counterpart on the globe’—A perception from history. In: Rajani, M.B. (ed.) Spatial Narratives of India’s Heritage. Singapore: Springer. pp. 39–70. DOI: https://doi.org/10.1007/978-981-95-0117-5_3

Navalgund, R. and Rajani, M.B. 2017. The science behind archaeological signatures from space. *Current Science,* 113(10): 1859–1872.

Orengo, H.A. and Petrie, C.A. 2017. Large-scale, multi-temporal remote sensing of palaeo-river networks. *Remote Sensing,* 9(7): 735. DOI: https://doi.org/10.3390/rs9070735

Orengo, H.A. and Petrie, C.A. 2018. Multi-scale relief model (MSRM): A new algorithm for visualization of subtle topographic change. Earth Surface Processes and Landforms, 43(6): 1361–1369. DOI: https://doi.org/10.1002/esp.4317

Orengo, H.A., Conesa, F.C., Garcia-Molsosa, A., Lobo, A., Green, A.S., Madella, M. and Petrie, C.A. 2020. Automated detection of archaeological mounds using machine-learning classification of multisensor and multitemporal satellite data. Proceedings of the National Academy of Sciences, 117(31): 18240–18250. DOI: https://doi.org/10.1073/pnas.2005583117

Pal, G.K. and Rajani, M.B. 2022. Mapping archaeological remains of the 14th-century fort of Jahanpanah using geospatial analysis. In: Proceedings of the Satellite Workshops of ICVGIP 2021. Singapore: Springer. pp. 79–85. DOI: https://doi.org/10.1007/978-981-19-4136-8_6

Petrie, C.A., Orengo, H.A., Green, A.S., Walker, J.R., Garcia, A., Conesa, F. and Singh, R.N. 2019. Mapping archaeology while mapping an empire. *Geosciences,* 9(1): 11. DOI: https://doi.org/10.3390/geosciences9010011

Petrie, C.A. and Lynam, F. 2020. Revisiting settlement contemporaneity and exploring stability and instability. Journal of Field Archaeology, 45(1): 1–15. DOI: https://doi.org/10.1080/00934690.2019.1664848

Petrie, C.A., Jabbar, J.A., Abhayan, G.S., Alam, A., Berganzo-Besga, I., Campbell, R., Conesa, F.C., Durrani, M., Garcia-Molsosa, A. and Gerrits, P.J. 2025. Hidden in plain sight: The unrecognized contribution of the Survey of India in the documentation of ancient settlements in Pakistan and India. *Journal of Field Archaeology:* 107–128. DOI: https://doi.org/10.1080/00934690.2025.2572881

Possehl, G.L. 1999. Indus Age: The Beginnings. Philadelphia: University of Pennsylvania Press.

Prabhakar, V.N., Rai, S., Jain, V., Ray, J.S. and Bhushan, R. 2023. Evidence for prehistoric hunter-gatherer communities on Khadir Island, Great Rann of Kachchh. *Man and Environment,* 48(1): 5–14.

Rajani, M.B. and Rajawat, A.S. 2011. Potential of satellite-based sensors for studying archaeological site distribution. *Journal of Archaeological Science,* 38(9): 2010–2016. DOI: https://doi.org/10.1016/j.jas.2010.08.008

Rajani, M.B. and Kasturirangan, K. 2014. Multispectral remote sensing data analysis and application for detecting moats around medieval settlements in South India. *Journal of the Indian Society of Remote Sensing,* 42(3): 651–657. DOI: https://doi.org/10.1007/s12524-013-0346-4

Rajani, M.B. 2016. The expanse of archaeological remains at Nalanda. Archives of Asian Art, 66(1): 1–23. DOI: https://doi.org/10.1353/aaa.2016.0010

Rajani, M.B. and Kumar, V. 2021. Where was Odantapuri located? Resonance, 26(9): 1287–1304. DOI: https://doi.org/10.1007/s12045-021-1230-0

Rajani, M.B. 2024. Archaeological landscape of Thotlakonda and Bavikonda near Visakhapatnam, Andhra Pradesh: Insights from remote sensing and GIS analysis. *Current Science,* 127(10). DOI: https://doi.org/10.18520/cs/v127/i10/1180-1193

Rajesh, S.V. and Patel, A. 2007. A gazetteer of pre- and protohistoric sites in Gujarat. *Man and Environment,* 32: 61–136.

Rajesh, S.V. 2018. Indus archaeology in Gujarat. South Asian Archaeology Series, 4: 87–168.

Rajesh, S.V., Abhayan, G.S., Conesa, F., García-Granero, J.J., Gadekar, C. and Arun Kumar, K.S. 2025. Archaeological explorations at the Harappan site of Kotada in Lodrani, Bela Bet, Gujarat. *Man and Environment,* 49(1): 1–19.

Rao, N. (ed.) 1986. Indian archaeology – A review 1983–84. New Delhi: Archaeological Survey of India.

Rao, S.R. 1985. Maritime contacts of the Harappans. In: Lal, B.B. and Gupta, S.P. (eds.) Frontiers of the Indus Civilization. New Delhi: Books & Books. pp. 423–432.

Shinde, V., Deshpande, S.S. and Deshpande, S. 2011. Heritage Sites of Gujarat: A Gazetteer. New Delhi: Aryan Books International.

Sugandhi, N., Raczek, T.P., Shirvalkar, P., Brummeler, C.K. and Pandey, L. 2015. Methods and problems in the site census approach. Heritage: *Journal of Multidisciplinary Studies in Archaeology,* 3: 163–179.

Suganya, K. and Rajani, M.B. 2020. Riverfront gardens and city walls of Mughal Agra: A study of their locations, extent and subsequent transformations using remote sensing and GIS. South Asian Studies, 36(2): 139–165. DOI: https://doi.org/10.1080/02666030.2020.1721119

Teramura, H., Kondo, Y., Uno, T. and Sakai, H. 2008. Archaeology with GIS in the Indus Project. In: Linguistics, Archaeology and the Human Past. Kyoto. pp. 45–101.

Tewari, R. (ed.) 2015a. Indian archaeology – A review 2008–09. New Delhi: Archaeological Survey of India.

Tewari, R. (ed.) 2015b. Indian archaeology – A review 2012–13. New Delhi: Archaeological Survey of India.

Thakkar, M.G. 2017. Geomorphological Field Guidebook on the Kachchh Peninsula. Allahabad: Indian Institute of Geomorphologists.

Thakkar, P.S. 2001. Locating potential archaeological sites in Gujarat using satellite data. NNRMS Bulletin, 26. Bangalore: Department of Space, Government of India.

Thapar, B.K. (ed.) 1980. Indian archaeology – A review 1977–78. New Delhi: Archaeological Survey of India.

Tripathi, R.C. (ed.) 1987. Indian archaeology – A review 1984–85. New Delhi: Archaeological Survey of India.

Vidyarthi, V. and Chauhan, P. 2025. Mapping the Indian Palaeolithic. *Journal of Computer Applications in Archaeology,* 8(1). DOI: https://doi.org/10.5334/jcaa.148

Yashpal, Sahai, B., Sood, R.K. and Agarwal, D.P. 1980. Remote sensing of the ‘lost’ Saraswati River. Proceedings of the Indian Academy of Sciences (Earth and Planetary Sciences), 89(3): 317–331.