MINA | Map Indian Archaeology
Opening post-colonial archaeological research in the Indian context through Web-based geovisualisation

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Introduction

Map Indian Archeology (MINA) is a Web-based open map platform. It is also an invitation to open conversation on and collaborate in Indian archaeology by asking questions about unknown patterns and relationships, promote the development of digital geospatial tools, and encourage greater engagement with critical cartography. The map platform is not a definitive statement on Indian archaeology. Rather, the latter is an opening for critical digital archaeological research in the Indian context.

We build upon Shanmugapriya and Menon's observation that Indian humanities scholars (including archaeologists) have growing interests in digital methods, tools and pedagogy.[1] We take seriously their assessment that digital initiatives in the Indian context do not easily engage with critical forms of inquiry and in building a community of digital scholars. Bergmann and Lally's prompt on what would geospatial technologies "adequate to the theoretical commitments of the critical social sciences and theoretical humanities look like" inspires us to consider how best archaeologists might engage in a dialogue with these lines of thought.[2] Equally important to these concerns is the "materiality of virtual geographies",[3] that highlights a situated relationship between humans and technology in terms of 'where' the virtual is located.

Menon and Shanmugapriya remark that digital humanists face structural inequalities, whether in building 'inclusive and diverse' (e.g. multilingual) databases to digital infrastructures including an active research environment to the "lack of access to digital tools" as a result of prohibitive licensing fees for commercial software, and limited awareness and confidence in using open source tools.[4] Most crucially, these views shift focus from the accumulation of data to developing robust digital tools and technologies for meaningful processing of information and training the next generation of digital scholars in the Global South. Concerns about power such as who governs digital heritage, who processes and analyzes 'data' for knowledge generation, for what purpose and who narrates are central in post-colonial studies[5] and offer a guide toward anti-colonial digital research and training in archaeology.

The geographer Trevor Harris has remarked that the geospatial web can "empower communities of amateurs, students and experts" in contributing to archaeological inquiry in "ways that differ markedly from traditionally conceived GIS and digital mapping approaches".[6] In this context, Harris envisions an emergent community of "spatially enabled citizen sensors" who could potentially fill in the "no-data-no-geography" gap in archaeology, which in turn would challenge "traditional hallmarks" of standards, metadata and authenticity in archaeological spatial information. However, the critical geographer Mordechai Haklay has asserted that 'neogeography' or Web-based geographic information does not necessarily enable democratization of knowledge making, but can do so when scholars take into account the social and political dimensions of technology and data governance practices.[7] Issues of ownership of digital heritage are of particular import when performing research in transnational contexts that were subject to European colonialism and that continue to challenge colonial practices in archaeology and heritage studies in a globalized world. In this context, some heritage scholars[8] have adopted concepts of 'counter mapping' based on the principles that "heritage is everywhere; heritage is for everyone and that we are all heritage experts".[9] Counter mapping draws from recognition that maps have served as tools of administration for state (or corporate) control of terrestrial, marine and air space, and because of this situation, ethnic and linguistic minorities and Indigenous peoples can employ these instruments to assert their rights towards formally challenging state planning and conservation policy.[10] Decolonial scholarship critiques and 'de-links' from European canons, drawing instead from theorists[11] located in the 'margins' or Global South to highlight both body-politics (who) and geo-politics (where from) in knowledge generation.[12] Recent efforts in 'decolonizing the map' re-center Indigenous interests, knowledges, and epistemologies in the field of cartography[13], bringing into focus praxis guided by Indigenous data sovereignty principles.[14] Global Indigenous data governance principles are based on awareness that colonial practices privileged non-Indigenous scholars in collecting Indigenous knowledge and cultural heritage, information that was subsequently misused or brought harm to the community, experiences that Black and racialized peoples in former European colonies can certainly relate to.

Stobiecka for example has suggested that digital archaeology has been used to "avoid the politics and ethics" in the field of heritage studies.[15] Through the case of the digital 3D copy of the Syrian Arch of Septimius Serverus or "Arch of Triumph", she challenges the idea of world heritage and suggests that the replica and its placement in various locations around the world reflects a "neo-colonial form of oppression". These issues are compounded when scholars realized that the Institute of Digital Archaeology, which had created the replica, had not offered information on the technology, the individuals involved in making the replica, the funding agencies that sponsored the project, and that the organization had "copyrighted the replica of the arch".[16] For Stobiecka, this scenario presents a 'digital Other' that is created by Western agendas and that enables heritage to be owned and controlled by Western organizations. Nevertheless, Stobiecka does not explicitly examine the role of state-oriented institutions and universities in digital heritage, and there remains considerable scope to address anti-colonial methods in digital scholarship.

Archaeologists routinely employ geospatial tools and technologies such as geographic information systems (GIS), Differential Global Positioning Systems (an advanced form of GPS), remotely sensed products such as Lidar, as well as maps and map-forms. With these intellectual interests, there is great potential for geographic visualisationvisualisation in the field of archaeology.[17] Maps are typically examined within the communication model in which information is transmitted in a unidirectional way from specialists to non-specialists. In the representational approach, visualisations promote exploration and encourage (specialist and non-specialist) questions about unknown patterns and spatial relationships in complex data.[18] They harness human cognition for processing information and generate new understandings and insights.[19] The focus shifts to facilitating dynamic interaction that enables spatial understanding of complex phenomena, and examining why these representations acquire meaning.[20] Yet, spatial relationships are not the only associations that structure archaeological data. Relational, temporal and thematic components in archaeological information are equally interesting to archaeologists[21] and they seek to elucidate patterns and relationships in archaeological data through a range of 'sensory visualisation'[22] including sound[23] and smell.[24] For instance, Mlekuz argues that an acoustic map itself is archaeological evidence and a way to know the world, whereas Eve explores 'navigation by nose' through an experiment that deploys odours into the landscape before, during and after a battle (based on the Battle of Waterloo).

In this piece, we offer an overview of MINA | Map Indian Archaeology as a 'proof-of-concept' to promote exploration and questions about unknown spatial patterns and relationships in Indian archaeology. We outline how and why we made the platform, which sources we chose, and we discuss challenges and opportunities for further investigation. We created the map platform using the open source library Leaflet and associated libraries. The entire code base for the platform is available on GitHub for examination and re-use. This public nature of the project is crucial as it encourages students and scholars in engaging with Indian archaeology in new ways, which in turn can enhance intellectual interest in and nuanced understandings of digital methods and technologies. As we suggest at the beginning of this article, MINA is not a definitive authority on Indian archaeology. Rather, it seeks to open intellectual and social space for digital archaeological research in the Indian context.

Through MINA, we explore and examine the Archaeological Survey of India (henceforth, the Survey)'s English-language publication, *Indian Archaeology – a Review* (*Review* for short).[25] The Survey is India's national department for archaeology and heritage management. The *Review* is the only periodical that offers unparalleled chronological coverage on archaeology in post-colonial India. Digitized forms of the volumes are available under the *Right to Information Act, 2005*.[26] The first volume of the *Review* was published in 1953, not long after Indian independence from the British Crown in 1947. Sixty-one volumes (1953 through to 2013) are available however, our current focus is on the first seven years of this periodical (1953-1960). This period is prior to the use of radiocarbon dating in the Indian context, which offers insights into the range of dating techniques Indian archaeologists utilized in their analysis and interpretation of archaeological data. Each edited compilation consists of several sections, including 'excavations and explorations' that inventories archaeological activities carried out during a calendar year throughout the Indian Republic. We begin with a brief overview of how Web-based platforms in archaeology with a focus on the Indian context, and the development of MINA and sources of archaeological information. In the final section, we discuss opportunities for research and training in digital geospatial methods.

Web-based Platforms in Archaeology

Growing numbers of archaeologists utilize Web-based platforms, particularly in publishing and communication of scholarship,[27] collaboration,[28] citizen science,[29] networked or linked data,[30] as well as archaeological geospatial information[31] and digital storytelling.[32]

In this context, ESRI's StoryMap, a commercial 'off-the-shelf' product is typically characterized as "superior", based on its ease of use (e.g. no knowledge of coding), compatibility with other ESRI software products, web platform support and functionality the enable importation of different kinds of archaeological information (e.g. 2D and 3D images, text, and location information).[33] Typically, such efforts emphasize the communication of archaeological information to a range of audiences and efficacy in public outreach. More fundamentally, they maintain the conventional role of an archaeologist as a consumer of digital geospatial products.

Archaeologists increasingly advocate for transparency in information transformation and processing through use of scripted code and code sharing.[34] Until recently, archaeologists relied on off-the-shelf commercial software for data collection, processing, and analysis of archaeological data. Termed point-and-click or 'black box' technologies, these tools obscure the underlying algorithms, code and bias that enable automated transformation and processing of information.[35] In cases where proprietary software are utilized, archaeologists do not adequately question what happens with the data and how and why they are transformed as they are, and ultimately miss opportunities to evaluate the product or result of that computational process. As Dennis argues, the issue of opaqueness remains pertinent when archaeologists utilize open-source software with external libraries because the archaeologist might not have extensive understanding of the underlying transformations and processes to explain it to a student, for example, or to offer insight into how these transformations affect subsequent analysis and interpretation.[36] For Dennis, these failings are ethical issues embedded in digital archaeological research. Moreover, understandings of technical workflows themselves will not address biases in archaeological research. How can we begin to address these concerns in Indian archaeology?

Bhuvan is a Web-based platform for the Indian Space Research Organization (ISRO) that was released in stable form in 2015. The platform facilitates sharing of select satellite imagery across India, as well as central government data such as census information, schools, urban survey, monuments as well as disaster management, flood and environmental information. The imagery serves as a base map for all other thematic layers. The Survey's inventory of heritage sites and monuments is available as a thematic layer on the platform and this information is not available for download, linking or re-purposing outside of Bhuvan.[37] Each heritage monument on the thematic layer is represented with a triangle icon, however, at present, no other information about the monument itself is available. Protected areas and boundaries for each monument are visualized as lines. Four 'case studies' including Tipu Palace, Srirangapatna, Devanahalli and Golgumbaz are available, with geometric features or 'footprints' for each heritage place. Detailed information on the data on heritage layer and their digitization is not available.

The National Mission on Monuments and Antiquities (NMMA) is another central government-sponsored website focused on Indian heritage. The interface has a searchable feature with a location display. Users can select heritage sites based on text search parameters that include geography (e.g., state), dynasty, cultural affiliation and designation as world heritage. Individual sites have associated images and descriptions. Like the heritage layer in Bhuvan, information on the NMMA interface is not available to download or re-purpose and there is limited discussion on the process of transforming analog information to digital forms. Rather, both platforms are designed to offer heritage information to the public in a unidirectional manner, much like a static printed periodical. The platforms therefore reflect and amplify state-oriented views of Indian heritage, which in turn can silence the voices of ethnic and linguistic minorities in India.

Web publishing of archaeological and heritage sites is not exclusive to state-oriented institutions. Between 2005 and 2010, a team of scholars from the French Institute of Pondicherry, Tamil University (Tamil Nadu), Mahatma Gandhi University (Kerala), Mangalore University (Karnataka), and Central University of Hyderabad (Andhra Pradesh) developed the Historical Atlas of South India.[38] The digital historical atlas offered a computational database of 7000 archaeological and historical sites, along with roughly 10,000 images linked to individual sites.[39] Although the project was limited in geographic scope to southern India, it covered a considerable range in chronology from 'prehistoric' (3000 BCE) times to 1600 CE. Most importantly, the project was amongst the first Web-based platforms developed to share archaeological information in the Indian context. We discuss how greater engagement with geo-visual methods can enhance the range and scope of digital archaeological research. Maps in Indian archaeology, for example, are primarily used as communication devices yet, when they are examined from the lens of knowledge making, we bring them into focus as sources of spatial information, and shift attention to how and why they are effective in specific contexts, and what kinds of interpretations are privileged. This reorientation can open intellectual space for archaeologists to collaborate with scholars from critical geography, cognitive science, anthropology, history, computer science and the history of science. These efforts, in turn, can create opportunities for research and training in digital methods.

We propose a shift from scholarly efforts in collecting, managing, structuring and documenting data to developing visualisation tools appropriate for archaeological data. Greater efforts in this geo-visual research can offer students and scholars opportunities to learn by doing and enhance their familiarity with the transformation and processing of digital archaeological information. Such critical research can deepen our understanding of the Indian past.

At the same time, greater efforts are needed to address structural inequalities in digital scholarship. For example, we cannot repeat colonial practices that saw Indian labour pour into collecting archaeological data and building archaeological spatial databases, only to see access to these databases controlled exclusively through and by institutions in the Global North. In these scenarios, Indian students and scholars typically do not have opportunities to build their digital skills. Rather, we seek a more equitable partnership between institutions that acknowledges that digital infrastructures are more readily available in the Global North, such that this situation offers a chance for training in digital methods toward building a transnational community of scholars. These efforts, in turn, can support anti-colonial methods in Indian archaeology. In the next section, we discuss MINA's development and the availability of its code and data for scholarly examination and re-use.

Opening the MINA Platform

One of the authors (Gupta) began building the platform as part of the Michigan State University Digital Archaeology Institute. The aim was to create an interactive Web map to explore and navigate different aspects of Indian archaeology through information published in the *Review* volumes and enable linkages to these data with other sources such as digital newspapers and digital archaeological collections. These efforts were scaled down based on available time and resources. The result was a visualisation of archaeological investigations carried out in India from 1953 to 1960.

The project draws upon Livingstone's affirmation that science is 'placed' in geographic and social space and is part of culture.[40] Examining specific places where archaeologists carried out fieldwork at particular moments offers an innovative method of historical inquiry to explore and elucidate how knowledge is weaved with power and space, which is a critical factor in understanding change and continuity in archaeological practices.[41] Each 'place' represents archaeological fieldwork in a community, each with situated narrative that challenged conventional ideas about the Indian past.[42] This framework reorients attention to the highly structured nature of social groups, of which archaeologists are a part, on the values and beliefs of researchers, the methods, tools and techniques they employ, and the respective influences of competing traditions in archaeological research and national styles of science. In the next subsections, we discuss three main components to the platform, namely, geocoding archaeological investigations, building the map with Leaflet and documenting the process and source code in a public repository on GitHub.

Geocoding Archaeological Investigations

Gupta examined reports from 1953 to 1960 for archaeological investigations. Optical Character Recognition was minimally used in this phase of the project. There are limited 'dictionaries' and databases for (1) place names in 1950s India; (2) archaeologists' names; and (3) university and research institutions in India. Building a dictionary to automate text mining was beyond the scope of this project. From the selected volumes, Gupta manually recorded 2273 investigations, along with geographical information such as place name (usually a village name, sometimes archaeological site name), the district (an administrative division), and state (a sub-national administrative division). In addition to geography, we included the year of investigation, the type of investigation (exploration or excavation), and where available, the broad culture-historical period as reported. These metadata information included investigating institution and any collaborators, the archaeological team or department and where available, the names of archaeologists involved in fieldwork.

Most records did not have associated geographical coordinates (e.g., latitude and longitude). We noticed place names with multiple spellings, and districts that no longer exist. Place names, districts and states change names and geometries. For example, in 2014, there were 676 districts, 29 states and 7 Union territories, whereas at the time of writing (2021), 718 districts are recognized. Local villages, towns, districts, and states are often reorganized, completely or partially absorbed into others, and renamed. These social and political phenomena are important to consider when utilizing a geocoding service. A geocoder built with place names in 2020 does not necessarily recogniseprevious and alternate referents, and thus would result in potentially erroneous or inaccurate geographical coordinates. For example, in the 1950s, "Bombay" was a state (as well as a city and district), and it was subsequently reorganized to create the state of "Maharashtra". A geocoder that allows heterogeneity in geographical referents would be ideal in the Indian context.

We also recorded named periods as reported in the volumes. We considered how archaeologists had associated material culture to a culture-historical period and whether the classifications were based on pottery, stone, metal or bone tools or other artifacts. Was radiocarbon analysis utilized for dating recovered material? Much of this information is not made explicit or available in the reports. Additionally, we recognized that there were different ways to describe a 'thing'. For example, a cromlech is different from a cairn, but the criteria were not made explicit in the *Review*. Therefore, our encoding of thematic information required significant interpretation of the reports. We recognized that tags might be a way to address the range of descriptive terms for the next phase of the project. In addition to texts, the reports have maps, drawings and images, which we have not yet examined in this phase of the project.

To geocode Indian archaeological investigations without reported geographical coordinates, we used Chieko Maene's automated geocoder, Geopy.[43] Geopy calls APIs from ArcGIS and Google, reads a list of place names and associates them with geographical coordinates. The script creates a new file with the resulting geocoded list. The script returns coordinates for each place name, as well as what the location refers to, such as the 'building name', 'street address', point of interest, and administrative unit. For 10% of the records, we manually searched for geographical coordinates and correlated them with descriptive information or maps in the reports. This subset served as a control sample and enabled us to examine data quality issues in terms of the spatial, temporal and thematic transformations of archaeological information. For example, how often did the automated geocoder return an identifiable archaeological site or community? Because our data consist of places named in the 1950s, many records did not geocode well (see Figure 1). In Figure 1, we demonstrate one of the challenges in geocoding, where contemporary place names give us inaccurate coordinates for our 1950s place names. We further determined that the automated coordinates were accurate to roughly 1 degree or roughly 100 kilometers. Our automation introduced additional imperfections into the process, which in turn impact upon analysis and interpretation.

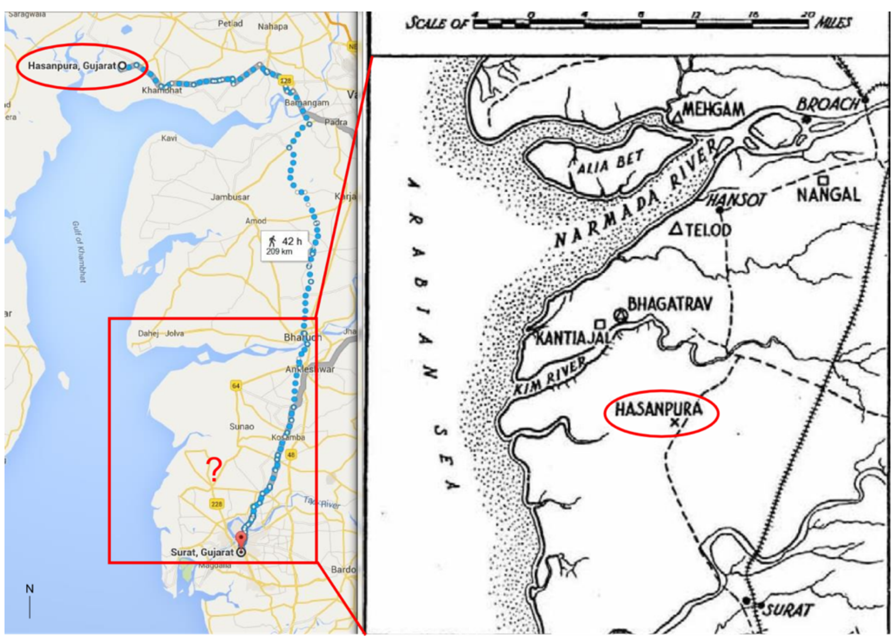

Figure 1.

We were concerned about the misuse of highly accurate location information on archaeological sites, particularly as we intended to host the data on a public GitHub repository. However, because of the significant spatial error associated with geocoded coordinates, we decided that publishing the data would not bring additional harm to an archaeological site such as damage because of looting.

GitHub Repository for MINA

Our data and code are available on GitHub. Making the code available on a public sharing platform is part of our project ethos. We recognise that practices that promote proprietary, 'black box' techniques do not support deeper understanding of data transformation and processing in archaeology. In this scenario, activities invariably focus on the sequence of automated commands or buttons to generate a result, efforts that do not create opportunities to understand why and how particular results are produced the way they are. By making the code for MINA available, we seek to build and expand upon efforts that bring the transformation of data into focus. We recognise that the learning curve for these tools is steeper when compared with point-and-click software. Yet by using these tools, breaking them apart, and putting them back together, we can enable undergraduate and graduate students in becoming familiarized with these digital geospatial tools, with versioning practices and create opportunities for them to gain confidence in digital method and practice.

We further committed to using GitHub for hosting MINA because of the availability of free Web hosting services for public accounts. Here, we acknowledge that the cloud platform is based in the Global North and owned by Microsoft Corporation. In keeping with this platform, we have not addressed colonial data governance practices and the 'materiality of virtual technologies'. As Shanmugapriya and Menon remark, structural inequities persist in all aspects of digital scholarship. We hope to develop a partnership with an Indian institution that can provide hosting services soon, as well as training workshops.[44]

Leaflet for Web Map Platform

We used the open-source JavaScript library Leaflet which enables mobile-friendly maps. Leaflet includes several plugins that add features such as markers and clustering which we implemented in the platform. We utilized four particular libraries, namely, L.tileLayer, Omnivore, L.markerClusters and L.heatLayer.

The L.tileLayer library enables us to pull and display satellite imagery tiles from Mapbox. Omnivore is a library that pulls data from the CSV and parses location data as visual markers on a base map. Once implemented, all 2273 archaeological investigations were visible on the map with a default marker for each investigation (Figure 2). Each marker has a pop-up that presents basic descriptive information including place name, the year of investigation, state in which the investigation took place, the investigating institution and the precision of the geocoding process.

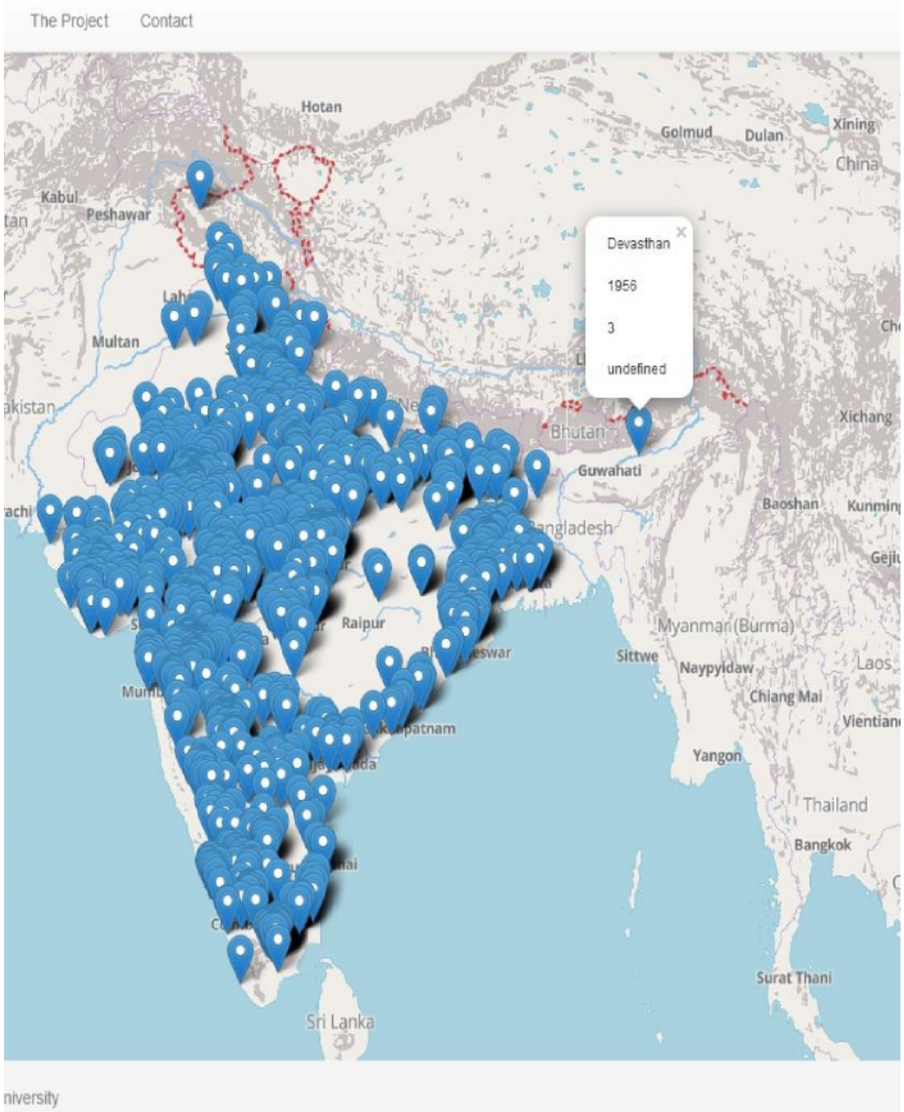

Figure 2.

Visualizing all 2000+ investigations carried a heavy visual load, and we were unable to discern spatial patterns. We made the decision to use a grouping or clustering library, L.markerClusters, which significantly reduced visual load and improved user interaction with the Web map (Figure 3). In this phase, we utilized the default options in each library to demonstrate what is possible and gain an understanding of challenges and opportunities in their use. For example, we implemented the L. heatLayer library to produce a heat map of the density of investigations (Figure 4). Each visualisation can be employed to raise questions about the clustering algorithm and spatial reasoning.

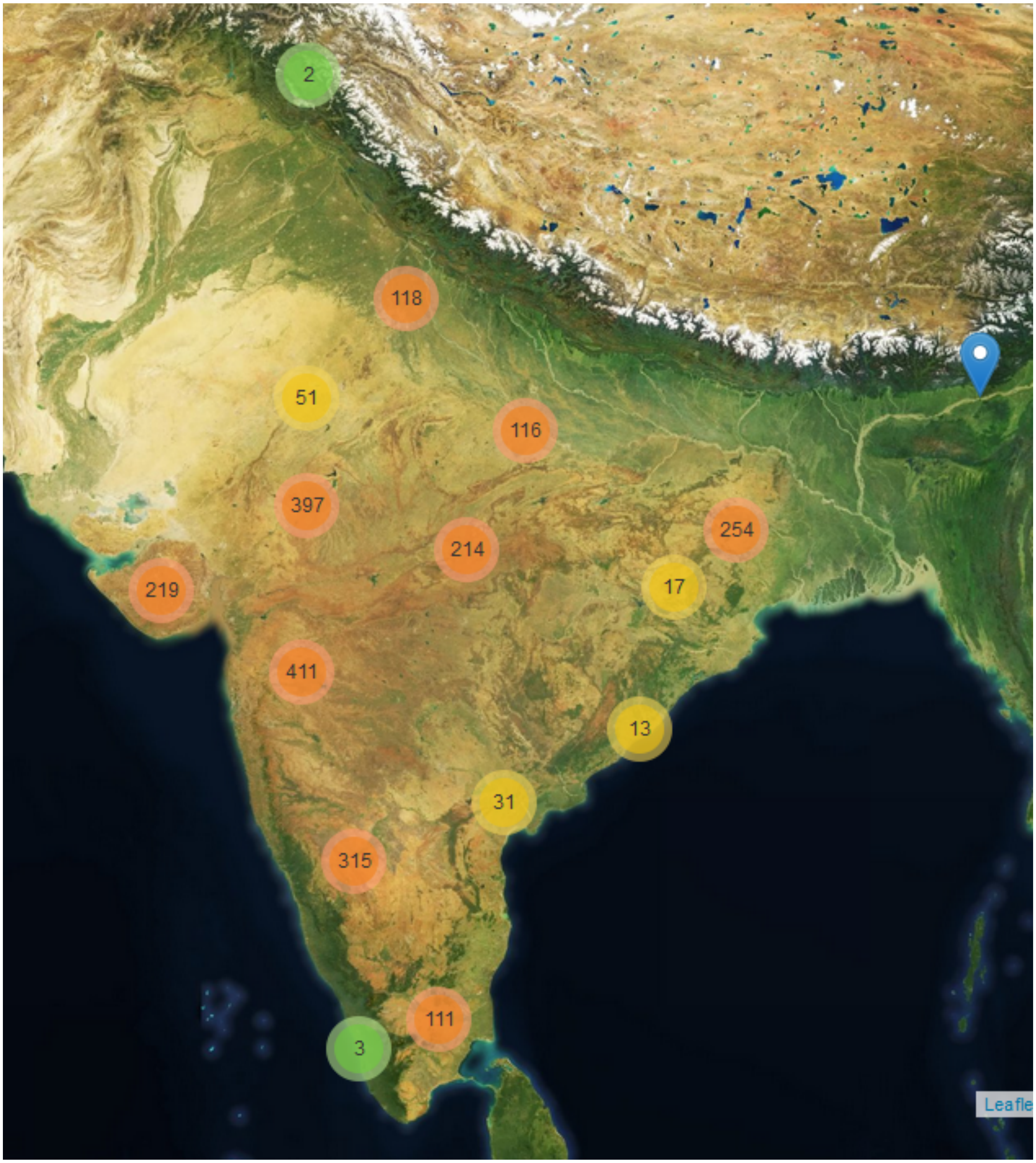

Figure 3.

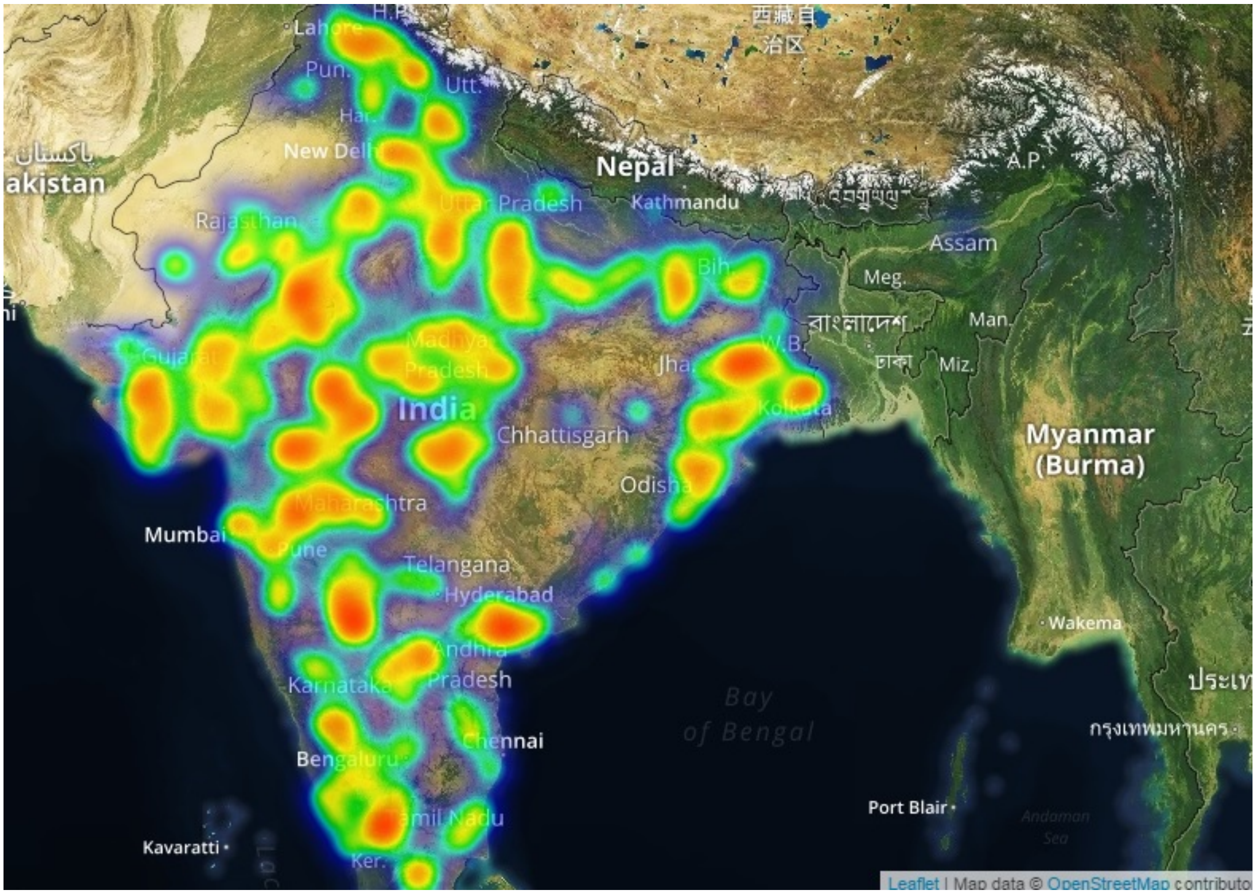

Figure 4.

Conclusions

In this piece, we unpack the map platform, MINA | Map Indian Archaeology to open conversation on intellectual interests and concerns of Indian archaeologists and digital humanities scholars when it comes to geospatial information and digital tools and technologies. We propose ways to facilitate critical digital archaeological research in the Indian context through explicit discussion of power in the governance of digital heritage, by asking who processes 'data' for knowledge generation, where from, and toward what end, and who narrates. We deliberately draw attention to these issues to provide intellectual space for further critical forms of inquiry such as data governance principles, and to encourage building of a community of digital scholars in the Indian context.

We discuss in detail existing Web-based map platforms that showcase Indian heritage and describe our efforts in exploring the Survey's *Indian Archaeology – a Review*. The English-language periodical offers an opportunity to examine methods, tools and technologies that Indian archaeologists employed in the analysis and interpretation of archaeological data prior to the use of radiocarbon dating in the Indian context. We provide an outline of the development of the map platform through GitHub and Leaflet and offer insights into challenges and opportunities when working with historical data. Finally, we suggest that greater attention to issues of power, knowledge making, and data governance can create intellectual space for novel digital archaeological research as well as opportunities for advanced training in digital and geospatial method and practice.

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