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Historical Landscape of Sistan in Iran and Afghanistan: EAMENA Dataset for Assessing Environmental Impact on Cultural Heritage

DATA PAPER

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ABSTRACT

This dataset is an exported subset of the Endangered Archaeology in the Middle East and North Africa (EAMENA) database. It includes archaeological and cultural heritage places, such as ancient settlements, historical structures, traditional villages, and irrigation systems within the central areas of the historical landscape of Sistan (سیستان), located in eastern Iran and southwestern Afghanistan. The data was gathered by the visual inspection of 16,875 km^2 of open-access satellite imagery accessible on Google Earth covering the period from 2001 to 2022, utilising the EAMENA methodology for archaeological and condition assessment. It is stored in the EAMENA web-based open-access database, hosted by the University of Oxford. The primary objective of compiling this dataset is to evaluate the impact of recent climate and environmental changes, as well as other disturbance factors, such as agriculture, building and development, and infrastructure, on the cultural heritage places of this historical region.

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KEYWORDS:
Sistan; Iran; Afghanistan; Archaeology; Cultural heritage; Remote sensing; Open access; Climate change

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(1) OVERVIEW

CONTEXT

In this paper, we present an open-access dataset to facilitate and empower research on threats to cultural heritage places within the central areas of the historical landscape of Sistan (سیستان), in Iran and Afghanistan. This historical landscape is facing severe environmental and climatic changes, resulting in prolonged droughts leading to the drying up of wetlands, the intense wind and sandstorms known as the "120-day wind", and other forms of disturbances. These changes not only make life challenging for its inhabitants but also have highly adverse effects on all forms of cultural heritage.

Identifying and assessing anthropogenic and natural risks to archaeological and cultural heritage sites and landscapes are crucial steps in managing these places. This process is essential for researchers and heritage managers alike in planning, prioritising, and mitigating the aforementioned risks, which encompass challenges ranging from climate change to urban and agricultural development [1]. Applying the FAIR principles[1], which provide aspirational guidelines in data management [2] —utilising unique resource identifiers (Findable), enabling open access (Accessible), ensuring ontology compliance (Interoperable)—makes cultural heritage data shareable (Reusable), facilitating collaboration, enabling large-scale analysis, and aiding informed decision-making.

Created by the Endangered Archaeology in the Middle East and North Africa (EAMENA) project and deposited in its online geoweb database, this dataset delivers remote sensing data to enable cultural heritage assessment across the historical region of Sistan. Sharing cultural heritage data across modern national boundaries illuminates past contexts and serves as a powerful reminder of the intertwined and diverse tapestry of human cultures. Furthermore, it highlights that exploring and safeguarding this shared heritage strengthens our understanding of our global history and heritage [3].

With coverage initially focused on central areas of Sistan, the dataset establishes a methodology and baseline that can be expanded through future surveys into eastern Sistan parts of Afghanistan and additional undocumented areas in Iran.

The extensive historical Sistan region spans eastern Iran and southwestern Afghanistan, situated just northwest of the Pakistan border (Figure 1). Located in an arid region and considered to be one of the most active dust sources in West Asia [4, 5], Sistan shapes a basin with a 482-metre average elevation above sea level [6]. The basin's water supply is sourced from rivers originating in Afghanistan's Central Highlands, including the Helmand (هلمند/هیرمند), Khash (خاش), Harut (هاروت) and Farah (فراه). This region contains a distinctive wetlands system with three major shallow lakes (Hamun-i Puzak, Hamun-i Saberi, and Hamun-i Helmand) (هامون پوزک، هامون صابری، هامون هلمند), smaller lakes and marshes, and vast reed beds. The lowest point where waters ultimately converge is Afghanistan's Gawd-i Zareh (گود زره) depression [6]. Formed based on wet/dry seasonal fluctuations, the Hamun wetlands

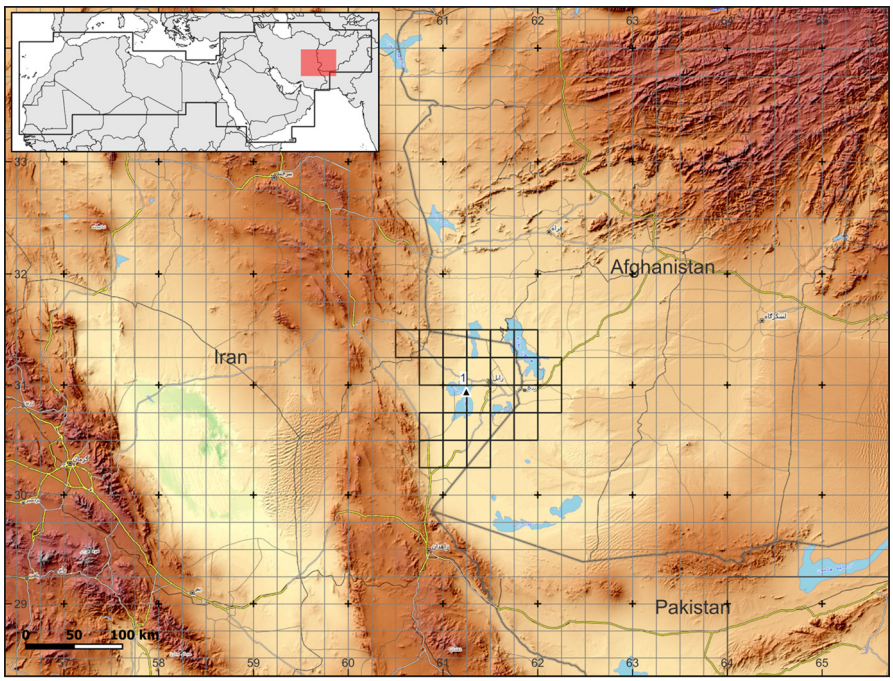

Figure 1 Location of the Sistan dataset grid squares (bolded black) in the eastern part of the EAMENA project's geographical scope, crossing the Iran-Afghanistan border. The city of Zabol (زابل) and the Khawdja Mountain (labelled "1") are in the grid centre. Grey grids represent general EAMENA grid squares (0.25 degrees in longitude and latitude), not included in the Sistan dataset. Inset: The EAMENA project's geographical scope (from Afghanistan to Mauritania) and the Sistan dataset area (red box). Basemap: https://opentopomap.org/.

are fragmented and interconnected, creating an oasis that has sustained local communities for generations. The lone topographic prominence is Iran's Kuh-i Khawdja (Khawdja Mountain) 609, (کوه خواجه) metres above sea level, situated between Hamun-i Puzak and Gawd-i Zareh [6].

With archaeological evidence from the Bronze Age through the medieval Islamic eras, Sistan's history dates back over 5,000 years [7, 8]. Bronze and Iron Age settlements discovered in Afghanistan's Lower Helmand Valley were examined in the 1970s by the Smithsonian Institution and Afghan Directorate of Archaeology and Historic Preservation collaboration [9]. On the Iranian side, the World Heritage Site of Shahr-i-Sokhta (شهر سوخته), which dates back to c. 3200 BCE, provides early evidence for a complex society [10]. Extensively studied sites range from the Dahaneh Gholaman (دهانه غلامان) Achaemenid provincial capital [11, 12] to the sacred, pilgrimage-associated Kuh-i Khawdja precinct, with its early and late Sasanian-era construction phases [13]. During the medieval period, settlements like old Zahedan (Zahedan Kohneh, زاهدان کهنه) thrived [14].

Historical records are provided by Persian and Arabic texts from the Middle Ages, supplemented by 19th and early 20th century accounts by European explorers including Rawlinson, McMahon and Tate [15]. The later research projects have been led by many scholars and institutions – Aurel Stein, Walter Fairservis, Marc Abramiuk, Ernest Herzfeld, the French DAFA (Délégation archéologique française en Afghanistan – French Archaeological Delegation in Afghanistan), Maurizio Tosi directing the Italian IsMEO initiative, S.M. Sajjadi's Shahr-i-Sokhta excavations, the Smithsonian-Afghan Institute Helmand Project, the Afghan Heritage Mapping Project at Chicago's Oriental Institute, and Iranian experts like R. Mehrafarin, S. Roustaei, and A. Moqaddam [15].

The Iran-Afghanistan border bisects the interconnected Hamun wetlands system, complicating management as over 90% of the wetlands and their primary water sources lie within Afghanistan [16, 17]. Recent decades have brought extensive changes, with the United Nations Environment Programme (UNEP) data showing 99% of Afghanistan's Sistan wetland has completely desiccated [16]. Landsat images confirm the Hamun Lakes severely dried up between 1976–2021, losing most surface area (Figure 2). Modaresi Rad *et al.* [17] detail the Hamun Lakes' shrinking and intermittent drying since the 2000s, attributing this to over-cultivation and excessive upstream water withdrawal in the Helmand Basin that generated sand storms along the border. Beyond escalated agricultural demand, the last decade saw Iran divert water from the Helmand River to support its urban and agricultural development, further stressing the system [18].

The "120-day wind" which prevails from mid-May to mid-September, causes major dust emissions as it erodes the dried Hamun wetland sediment [19, 20]. Halting human activity through disrupted visibility and sand dune mobility, this wind annually erodes structures across both traditional villages and cultural heritage sites.

Rising temperatures from climate change impact precipitation and snowpack in upstream areas and will likely further reduce a critical water source, exacerbating natural drought cycles [17]. Moreover, the lack of state security due to prolonged instability and conflict in Afghanistan, insufficient infrastructure maintenance, and Afghanistan-Iran water disputes over the Helmand Basin challenge sustainable water management despite the region's interconnected hydrology [17].

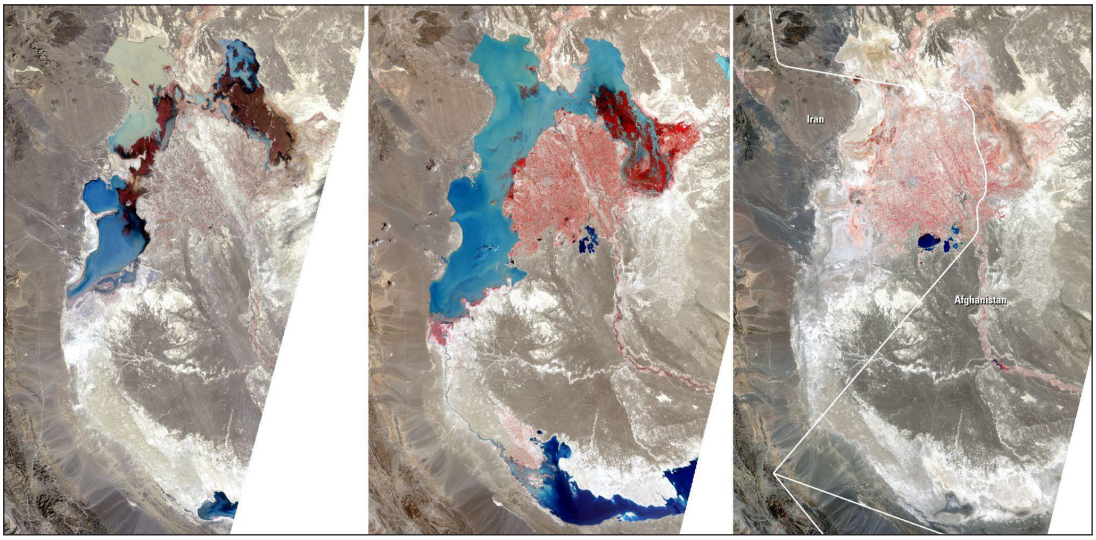

Figure 2 From left to right: Hamun Lake in November 1976, June 1998, and July 2021. Images respectively from Landsat 2, Landsat 5, and Landsat 8.

Source: USGS. https://eros.usgs.gov/media-gallery/earthshot/lake-hamoun-iran-and-afghanistan (Accessed 2023-11-30).

In the absence of prior online resources aligning with FAIR principles for Sistan, our dataset provides foundational visibility. The data allows us to document detectable events that have impacted heritage places due to human or natural forces (disturbances) and identify factors that make these places vulnerable to potential future disturbances across Sistan's historical landscape. This enables researchers and heritage managers to examine the threats facing heritage places, which is particularly crucial in light of escalating environmental and climatic impacts that have critically altered regional water management. With cultural heritage spanning ancient sites, traditional settlements, and irrigation systems like qanats/kareez (underground water canals), our remote sensing survey and analysis establishes a methodology to assess climate change repercussions on this diverse cultural heritage.

The production of this paper has also been undertaken using a workflow designed to streamline publication pipelines for the vast EAMENA regional database (see the Reuse potential section). The EAMENA project, led by Oxford University in partnership with the universities of Durham and Leicester and funded by Arcadia since 2015, uses satellite imagery to rapidly record and make available information about archaeological sites and landscapes. It currently gathers over 370,000 records from the Middle Eastern and North African countries in its database. As EAMENA's first such data paper effort, this dataset models effective accessibility enhancements to this expansive heritage inventory. Beyond identifying threats to Sistan's heritage, it pioneers pathways for researchers to exploit the EAMENA database's contents.

SPATIAL COVERAGE

The spatial coverage pertains to the surveyed EAMENA grid squares, as detailed in the methods section, whether heritage places have been found within them or not. It covers 16,875 km^2 with these boundaries:

Northern boundary: + 31.5
Southern boundary: + 30
Eastern boundary: + 62.5
Western boundary: – 60.5

The geographic centre of the dataset is the Iranian city of Zabol (زابل).

TEMPORAL COVERAGE

Heritage places identified and assessed belong to the Southern Iran Chalcolithic (5000–2900 BCE, n = 1); Southern Iran Bronze Age (2900 – 1000 BCE, n = 1), Iran Iron Age (1400 – 330 BCE, n = 1); Levant, Mesopotamia, Iran and Northern Arabia Classical/Pre-Islamic (330 BCE – 640 CE, n = 6); Iran Islamic (640–1900 CE, n = 703); MENA Contemporary Islamic (1900–2023 CE, n = 10) and unknown periods (n = 944). Each of these periods is an entry in the time gazetteer PeriodO[2] created by the 'University of Oxford and University of Southampton. EAMENA Database. 2021' authority.[3] PeriodO (http://perio.do) provides standardised definitions for cultural historical periods, which improves the reusability and interoperability of linked open data (LOD).

(2) METHODS

STEPS

Data collection and the establishment of the dataset followed the EAMENA project methodology for the investigation and documentation of endangered archaeological resources in the Middle East and North Africa region [21]. EAMENA relies primarily on freely accessible remote sensing data from satellite imagery on Google Earth, collected over time from providers and platforms, such as CNES/Airbus and Landsat/Copernicus, as well as published information, records, and surveys. Satellite imagery has proven to be a useful and efficient survey method, especially for surveying vast, arid landscapes and areas with limited ground access. Bibliographic references, along with other related information such as images, are recorded as Information Resources in the database where they are utilised. They can be retrieved using the unique identifier of the heritage place.

Within the framework of EAMENA, the entire geographical scope of the project (from Afghanistan to Mauritania) is subdivided into grid squares, each measuring 0.25 degrees in longitude and latitude, which corresponds to approximately 25 × 27 kilometres, depending on the location (Figure 1). The EAMENA grid system approach allows systematic scanning by visual inspection of satellite images of each square within the study area, which encompasses a portion of historical Sistan, by dedicated researchers and project collaborators listed in the dataset (field "Assessment Investigator – Actor"), Zenodo dataset metadata as "Data collectors", and here below in the Dataset Creators section. During this thorough examination, heritage places, including archaeological sites, historical settlements, and traditional villages, were manually identified and documented from pre-existing sources or recognised via visual inspection. By comparing satellite images over time (using Google Earth's time slider between 2001 and 2022), any disturbances or recent changes affecting these heritage places were pinpointed and recorded.

All data was recorded in the EAMENA database (database.eamena.org), which incorporates multiple resource models to record heritage places and built heritage components, information resources such as bibliographic data, and the detailed condition assessments. The EAMENA database (version 4) is an online geospatial database deployed on Arches (version

7.3), an open-source software platform developed by the Getty Conservation Institute and the World Monuments Fund.

Arches serves as a semantic web-based purpose-built platform for cultural heritage management. It is based on CIDOC-CRM, the Conceptual Reference Model for cultural heritage information [2]. An Arches resource model is a structured data model designed for the Arches Platform. It encompasses the data structure (the entity-relationship model) and also includes the interface for entering data (forms) and generating reports for each resource model.[4] The graph structure of the database allows the recording of multiple interpretations for the same resource at the field level. For example, a heritage place can have two different geometries (a point for its geometric centre and a polygon for its perimeter or a line for its path) or different archaeological interpretations with different levels of confidence made by two or more contributors.

The database incorporates controlled vocabulary. Glossaries are rooted in resources like FISH (Forum on Information Standards in Heritage) and Getty AAT (Art and Architecture Thesaurus). These vocabularies have been adapted and expanded to align with the particular needs of the EAMENA project [22]. For example, the EAMENA 'Heritage Place Type' could take the value 'Archaeological Site', which is a direct match with the AAT term 'Archaeological site' (aat:300000810). Other AAT and FISH terms have been adapted but are still structured data (see: https://eamena.org/advanced-use#rm-hp-fields).

Heritage places are central to the EAMENA project. For readability reasons—since heritage places are detailed through 98 different fields—their resource model and field descriptions are presented as HTML widgets on the project's website, accessible respectively at https://eamena.org/advanced-use#rm-hp-erd and https://eamena.org/advanced-use#rm-hp-fields).

For the Sistan dataset, we have adhered to the minimum data standards (MDS) defined by the EAMENA project, as detailed below in Figure 3. This standard for data entry was agreed to ensure that different EAMENA teams, volunteers, and trainees were all recording sites to a standard threshold. This was established as an internal QA measure as the number of individuals entering data had grown, and they were now based in multiple institutions. The standard was agreed by team members in a project-wide consultation. The EAMENA MDS is a proposed level of data recording that consists of an enhanced record of a heritage place. The MDS captures metadata, i.e., Assessment Summary (Assessment Investigator, Assessment Type, Assessment

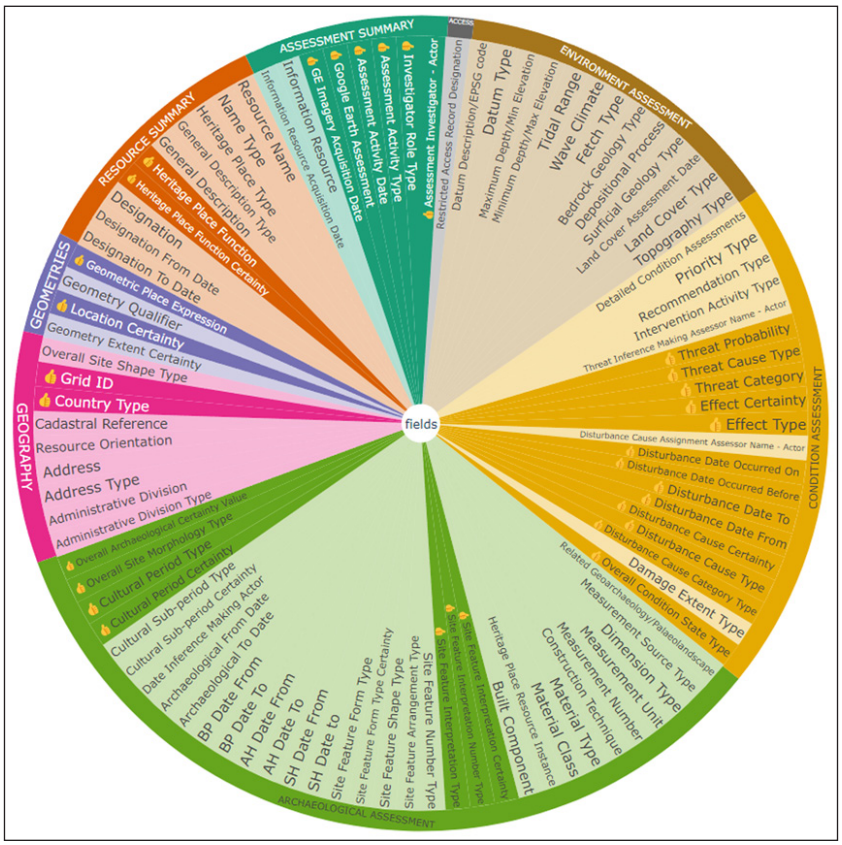

Figure 3 Snapshot of the EAMENA Heritage fields (n = 98) with the Minimum Data Standards (MDS) fields highlighted in darker colours with thumbs up. In cases where supplementary information beyond the minimum standards was available, such as the Heritage Place Type, it has been duly documented. The JavaScript interactive version of this pie chart is hosted on EAMENA's website (https://eamena.org/advanced-use#rm-hp-mds) and GitHub (https://github.com/eamena-project).

Activity Date, Google Earth Assessment, Google Earth Imagery Acquisition Date), as well as minimum data for enhancing Resource Summary, Geometries, Geography, Archaeological Assessment, and Condition Assessment. It ensures that data is enhanced to a level that permits a meaningful archaeological and condition assessment of heritage places in a standardised manner and adheres to sustainable reuse and citation.

The Heritage Places resource model is publicly available (https://github.com/achp-project/prj-eamena-marea/tree/main/resource_models) and is currently mapped with sibling projects using Arches (MASHA, MAPSS, MarEA, etc.). Together, these projects cover a part of the cultural heritage in the Global South, enabling the creation of standardised data, and data querying.

QUALITY CONTROL

Given the potential for significant uncertainties in archaeological data, particularly when acquired through remote sensing, the database is structured to enable the recording of multiple interpretations for each data field. Additionally, the system allows for the documentation of the level of certainty associated with each assessment, which spans from "Definite" and "High" to "Medium," "Low," "Negligible," and "Not Applicable" (used when a related field is marked as "Unknown").

A significant portion of the validation process is integrated directly into the database during data entry. This includes checks for missing mandatory fields and error detection mechanisms such as data type verification and compliance with controlled vocabularies. The Arches-based system supports data correction by providing online error notifications. Utilising the same validation protocols and error alerts, large datasets can be imported through a bulk upload process using an Excel spreadsheet, known as the Bulk Upload (BU) form. This lightweight, standalone file is designed for easy sharing, allowing experienced users to review each form before uploading it to the database. Equipped with native Excel capabilities for filtering, sorting, and aggregating, the BU form enhances data editing. It includes user-friendly drop-down menus that mirror the database's controlled vocabularies and extensive glossaries with definitions for each term, supplemented by examples of Heritage Place data for reference. For the Sistan dataset, all BU forms have been reviewed by the first author of this paper. The EAMENA project has developed both the bulk upload procedure and the EAMENA interface bulk uploader, an Arches-compliant plugin.

CONSTRAINTS

Since this dataset was primarily assembled through remote sensing and the analysis of Google Earth imagery, determining the cultural periods of the sites was often challenging. In some cases, architectural evidence, structural parallels between heritage places, and an examination of certain surveys and published reports, including [15], led to the identification of the Islamic periods as the most probable period for these sites. Nonetheless, this does not exclude the possibility of the presence of additional cultural strata at these locations.

(3) DATASET DESCRIPTION

The dataset comprises 1,641 heritage places (with 1,668 geometries, i.e. points, lines, polygons), 21 grid squares having heritage places, and 4 grid squares surveyed where we identified no heritage places. All Heritage Places have a central point as their primary geometry, but some, especially qanats, also include lines to depict their paths (Figure 4). Following the structure of the database, each heritage place can be recorded across approximately a hundred different fields. These fields cover various aspects, including the location (coordinates, administrative division, country, etc.), archaeological assessment (absolute date, cultural period, construction material, etc.), structured menus for the description of threats and disturbances, satellite imagery and resources used for its assessment, and details about the assessor and date of the assessment, among others (see the fields' descriptions https://eamena.org/advanced-use#rm-hp-fields).

Heritage places are located in Afghanistan (n = 1088) and Iran (n = 580) between the cross-border provinces of Sistan and Baluchestan (n = 580), Nimruz (Afghanistan, n = 540) and Farah (Afghanistan, n = 48).

OBJECT NAME

Heritage Places are recorded under the "Sistan: part 1. Heritage Places" Zenodo deposit; assessed Grid Squares are recorded under the "Sistan: part 1. Grid Squares" Zenodo deposit. The dataset has been divided according to EAMENA resource models, specifically into Heritage Places and Grid Squares. The two repositories both pertain to Part 1 of the Sistan survey. As mentioned in the context section, this dataset primarily focuses on the central areas of Sistan, but it can be expanded through future surveys to include the eastern parts of Sistan in Afghanistan and additional undocumented areas in Iran.

DATA TYPE

Primary data, secondary data, processed data, interpretation of data

FORMAT NAMES AND VERSIONS

GeoJSON

CREATION DATES

2021-05-21 to 2023-11-03

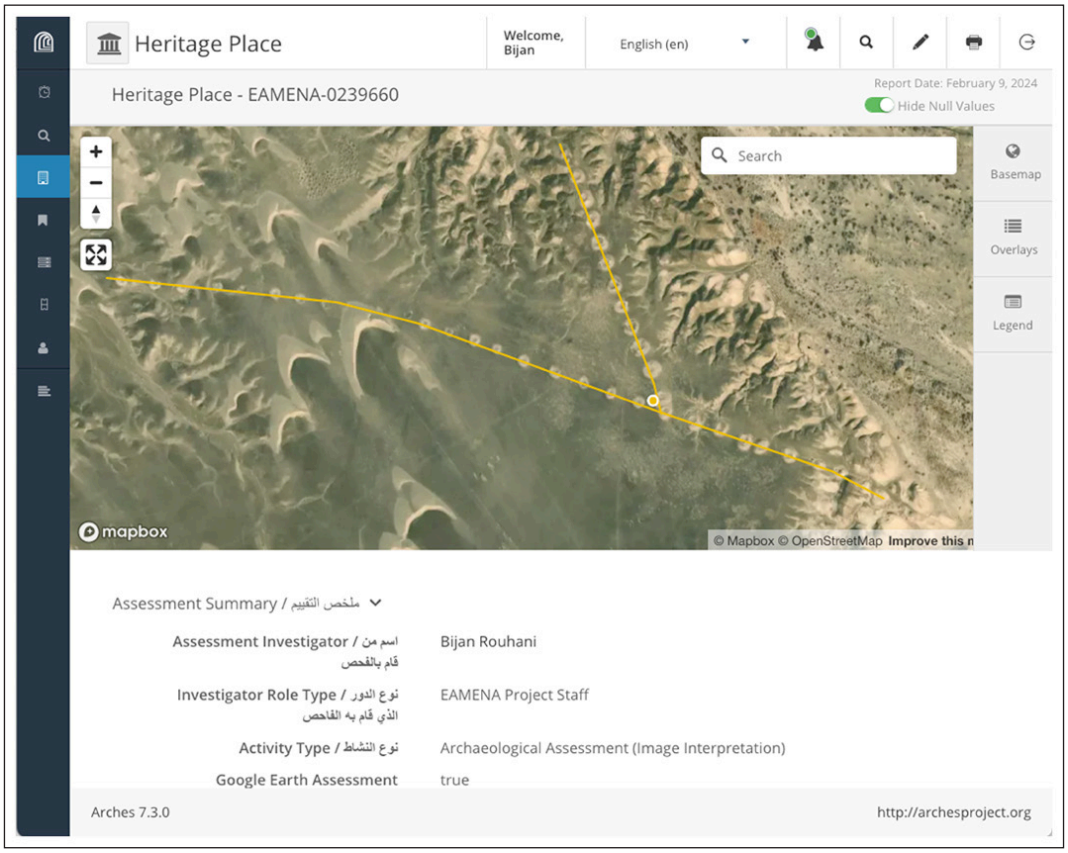

Figure 4 Screenshot of the upper section of the EAMENA-0239660 Heritage Place report in the Arches-based database at eamena.org, displaying three geometries: a point and two lines. The line geometry can be utilised to show the path of a heritage place, like the branches of a qanat system in this example.

DATASET CREATORS

Data collection and the establishment of the dataset have been spearheaded by Bijan Rouhani, Senior Researcher of the EAMENA project at the School of Archaeology, University of Oxford. Additionally, Danlei Zhou, Liberty Hinze, Yasaman Nabati Mazloumi, and Rachel Smith have contributed to data collection and site recording as part of their volunteer work and student placement with the EAMENA project. Thomas Huet, Researcher and Database Manager at EAMENA, has played a key role in designing IT.

LANGUAGE

English

LICENSE

As part of the database.eamena.org, the Sistan dataset is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4).

REPOSITORY LOCATION

Zenodo's community 'eamena' (https://zenodo.org/communities/eamena) with this DOI: https://doi.org/10.5281/zenodo.10375902 and https://doi.org/10.5281/zenodo.10376132

PUBLICATION DATE

The dataset was published on the 14/12/2023.

(4) REUSE POTENTIAL

The release of this dataset aims primarily to enhance its reusability, with the intention of sharing it with local archaeologists and researchers to support further research and preservation efforts for endangered sites. As outlined in the context section of this paper, Sistan is a historical landscape with wetlands situated between Iran and Afghanistan, profoundly affected by environmental changes and other factors such as agriculture and development. In Afghanistan, decades of conflict and instability have significantly undermined cultural heritage management, while in Iran, the Sistan region stands out as one of the most deprived and impoverished areas. Moreover, the absence of open-access cultural heritage databases for Sistan, which would document the shared disturbance factors on both sides of the border, presents a significant challenge to the management, preservation, and research of this cultural heritage that they share (Figure 5). Although this dataset was compiled by a project outside of Iran and Afghanistan using remote sensing methods, its dissemination could serve as a model for heritage management specialists in both countries. Identifying the most significant disturbance factors and prioritising sites at the highest risk for protection could be among the potential applications of this dataset.

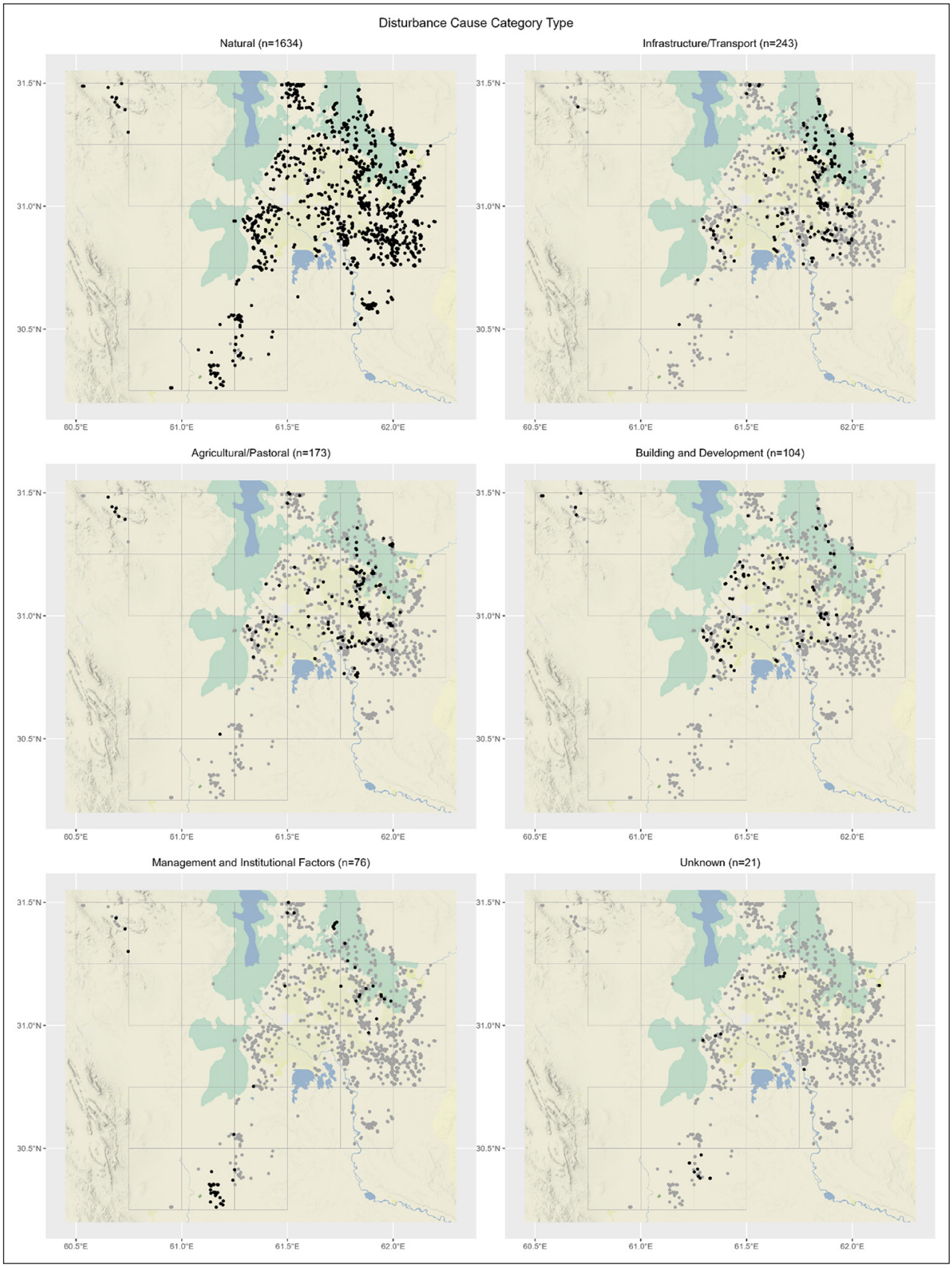

Figure 5 The main disturbance factors impacting Sistan's heritage places, with their number of occurrences. Multiple disturbance factors can simultaneously affect a heritage place.

As an example of a particular heritage place that requires further heritage protection and management, EAMENA-0192343 (also known as Haji Bazz Khalesi House, عمارت حاجی بز خالصی) is located in Zabol (Sistan and Baluchestan province). This traditional house from the Late Islamic period (1400–1900 CE) faces several threats,

including natural factors (water and/or wind action, and vegetation) which have led to erosion, building and development (construction), and management and institutional factors.

This dataset can also be utilised for teaching students the documentation of disturbance factors in fragile historical environments and the application of structured databases and assessment methodologies, such as the EAMENA method.

The reuse potential of the Sistan dataset encompasses both ethical and technical considerations.

From an ethical perspective, applying remote sensing techniques for collecting archaeological data in the MENA region and reusing datasets established by non-local institutions and projects may raise some ethical questions. EAMENA has been advocating a humanitarian approach based on widely accepted humanitarian goals such as impartiality and accountability, fostering community empowerment and sustainability. An overarching theme is the concept of "do no harm" [23].

While there are questions and concerns about disclosing the geographical locations of historical sites and the potential risk of looting, it has been ensured that the data does not contain sensitive information concerning Sistan. Several highly significant historical sites in the Sistan region are among those recognised, and their spatial information is already accessible. Additionally, this dataset documents other sites, such as traditional villages, agricultural and field systems, and irrigation canals, which are not typically targeted by looters.

From a technical perspective, the Sistan dataset, heritage places resource model and grids are housed under Zenodo's community 'eamena' (https://zenodo.org/communities/eamena). Zenodo is OAI-PMH[5] compliant and the Sistan dataset metadata (licence CC 0) can be harvested through the Zenodo API (https://zenodo.org/oai2d) or directly online. Reuse of the dataset can be done by running R functions (https://github.com/eamena-project/eamenaR) for its statistical analysis, mostly on GeoJSON files such as the Sistan dataset, and Python functions for the database backend management (https://github.com/eamena-project/eamena-functions). In both cases, documentation is provided on https://github.com/eamena-project. The eamenaR package enables users to analyse typological, spatial, and temporal data, manage datasets, and compute basic statistics. Functions include data import from GeoJSON files, generation of static and interactive graphs and maps, and adherence to FAIR principles for data accessibility and reuse. It supports collaboration and facilitates the integration of EAMENA data into broader research frameworks.

A version of the current dataset exists in the EAMENA database (database.eamena.org), where it will continue to undergo possible improvements through assessments of ongoing and future threats and disturbances, among other factors. The current published dataset, identified with a DOI, ensure that cultural heritage actors could refer to it and share it unambiguously. The EAMENA database is an open-access platform built on open-source software (Arches), featuring a web-geospatial semantic graph structure. This allows resources to be accessed via UUID/URL, significantly enhancing both its accessibility and interoperability. Moreover, the EAMENA project provides technical documentation on data entry, data search and data analysis (MOOCs,[6] YouTube tutorials, digital handbooks,[7] etc.). The Sistan dataset is available for download from the database in various formats, such as GeoJSON, CSV and shapefile by anyone with Contributor permissions or higher.[8]

To enable the publication of datasets from the EAMENA database, detailed guidance and IT workflow on posting an EAMENA dataset on Zenodo ('eamena' community) have been created. The 'citation-generator' workflow, currently available as a Jupyter notebook on EAMENA's GitHub and mirrored on Google Colab is being developed into an EAMENA database plugin.[9] It is scheduled for release this year and will subsequently be integrated into the Arches software.

NOTES

1 https://www.go-fair.org/fair-principles/ (accessed 2023-12-13).

2 Respectively: http://n2t.net/ark:/99152/p0m64tdqdhw, http://n2t.net/ark:/99152/p0m64tdsqhp, http://n2t.net/ark:/99152/p0m64tdq2q4, http://n2t.net/ark:/99152/p0m64tdf9bv, http://n2t.net/ark:/99152/p0m64tdvsp5 and http://n2t.net/ark:/99152/p0m64tdvprx.

3 http://n2t.net/ark:/99152/p0m64td.

4 https://www.archesproject.org/arm-wg-documentation/.

5 https://www.openarchives.org/pmh/.

6 MOOC 1: https://eamena.org/mooc-1-endangered-archaeology-using-remote-sensing-to-protect-cultural-heritage and MOOC 2: https://eamena.org/mooc2-advanced-archaeological-remote-sensing-site-prospection-landscape-archaeology-and-heritage-pro.

7 https://eamena.org/cpf-training.

8 https://eamena.org/open-access-policy.

9 https://colab.research.google.com/github/eamena-project/eamena-arches-dev/blob/main/dev/citations/citation_generator.ipynb.

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endangered cultural heritage, protect endangered ecosystems, and promote access to knowledge.

COMPETING INTERESTS

The authors have no competing interests to declare.

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