Joseph C. Miller Memorial Lecture Series

12

eds. Abdelkader Al Ghouz, Jeannine Bischoff, Sarah Dusend

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Mapping Conflict during the Era of the Slave Trade: Metadata Schema for a Spatial Statistical Model and Digital Archive of Enforced Migrations in Pre-Colonial Africa

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Mapping Conflict during the Era of the Slave Trade: Metadata Schema for a Spatial Statistical Model and Digital Archive of Enforced Migrations in Pre-Colonial Africa[1]

New directions in mapping highly uncertain migratory patterns in Africa is at the intersection of history, GIScience, spatial statistics, and computer science. To calculate probabilities of inland African origins of enslaved people, an initial experiment focused on a single quadrant of West Africa in what is now associated with southwestern Nigeria, Benin, and parts of Togo. This study examines the historical period surrounding the collapse of the kingdom of Oyo and departure of an estimated 121,000 people from the Bight of Benin to Brazil, Cuba, and Sierra Leone between 1817 and 1836. *Yoruba Diaspora: A Cartographically Based Interactive Digital Archive* showcases methods, initial sample data, and temporal maps which toggle annually. Data points link into collections of a digital archive to provide direct access to historical sources from which data are compiled.[2] By compiling conflict data, the hypothesis is that instances of inland conflict were prime locations for enslavement and forced migration. Yoruba speakers absorbed into transcontinental and transoceanic slave trades are a case in point. This investigation was initially conceived in consideration of broader geographic and temporal periods to trace migratory patterns within West Africa during the era of

1 I would like to acknowledge the support from the Andrew W. Mellon Foundation New Directions Fellowship (grant number: N–2006–08535) and the University of Colorado (CU) Boulder, which have graciously supported the development of Africa Historical GIS. I would also like to acknowledge Donna Axel and Andrew Chiacchierini for helping to draft funding applications.

2 Ben Brumfield and Sara Brumfield (www.brumfieldlabs.com), along with Vachan Aswathanarayana (M.A. Computer Science, University of Colorado Boulder) coded and mounted a system in Omeka-S which displayed a series of twenty-one annual maps as static images on an image carousel illustrating Oyo's collapse. Additionally, an interface was coded to tag image co-ordinates and input links to additional pages. To access code, see https://github.com/SlaveryImages/docker-omeka-s-iiif.

the Atlantic slave trade, and the Yoruba data provide a good case to test the model.[3]

Designed as a cartographically based interactive digital archive, Africa Historical GIS (AHGIS) is intended to operate on a temporal axis. Users can toggle through changing landscapes of intra-African conflict aligned with digital representations of slave ship departures. Spatial data points, including ships, link into caches of historical data, digital resources, and multimedia, such as digitized archival materials, recordings of music, dance, or religious ceremonies, genealogical lists, as well as 3D objects and environments (Figure 1 and 2). This forthcoming digital humanities project is being published using open-source applications, such as R Studio and QGIS. At the University of Colorado (CU) Boulder, spatial statistical modelling is being designed in collaboration with Eric Vance, director of the Laboratory of Interdisciplinary Statistical Analysis, while workflows and archiving in consultation with Thea Lindquist, director of the Center for Research Data and Digital Scholarship, also at CU Boulder.[4] At the outset of this project, data and materials will be hosted through the Regenerated Identity (RegID) content management system, which Kartikay Chadha has developed at Walk With Web Inc. (www.walkwithweb.org). Other linkable digital humanities publications focused on migrations in Africa and the African Diaspora, which can be layered into a AHGIS platform, are also being built at Walk With Web Inc.[5]

3 Henry B. Lovejoy, dir., *Yoruba Diaspora: A Cartographically Based Interactive Digital Archive*, http://yorubadiaspora.org; Henry B. Lovejoy, "Mapping Uncertainty: The Collapse of Oyo and the Trans-Atlantic Slave Trade, 1816–1836," *Journal of Global Slavery* 4/2 (2019): 127–161; Henry B. Lovejoy, "Re-Drawing Historical Maps of the Bight of Benin Hinterland, c. 1780," *Canadian Journal of African Studies* 47/3 (2013): 443–463.

4 Data curation workflows are being supported by Inna Kouper (Indiana University), Thea Lindquist (University of Colorado, Boulder), as well as Jonathan Petters and Andrea Ogier, (Virginia Tech) for their Institute of Museum and Library Services grant, "Extending Data Curation to Interdisciplinary and Highly Collaborative Research" (LG–246400–OLS–20).

5 See www.walkwithweb.org for a full list of digital humanities publications and projects.

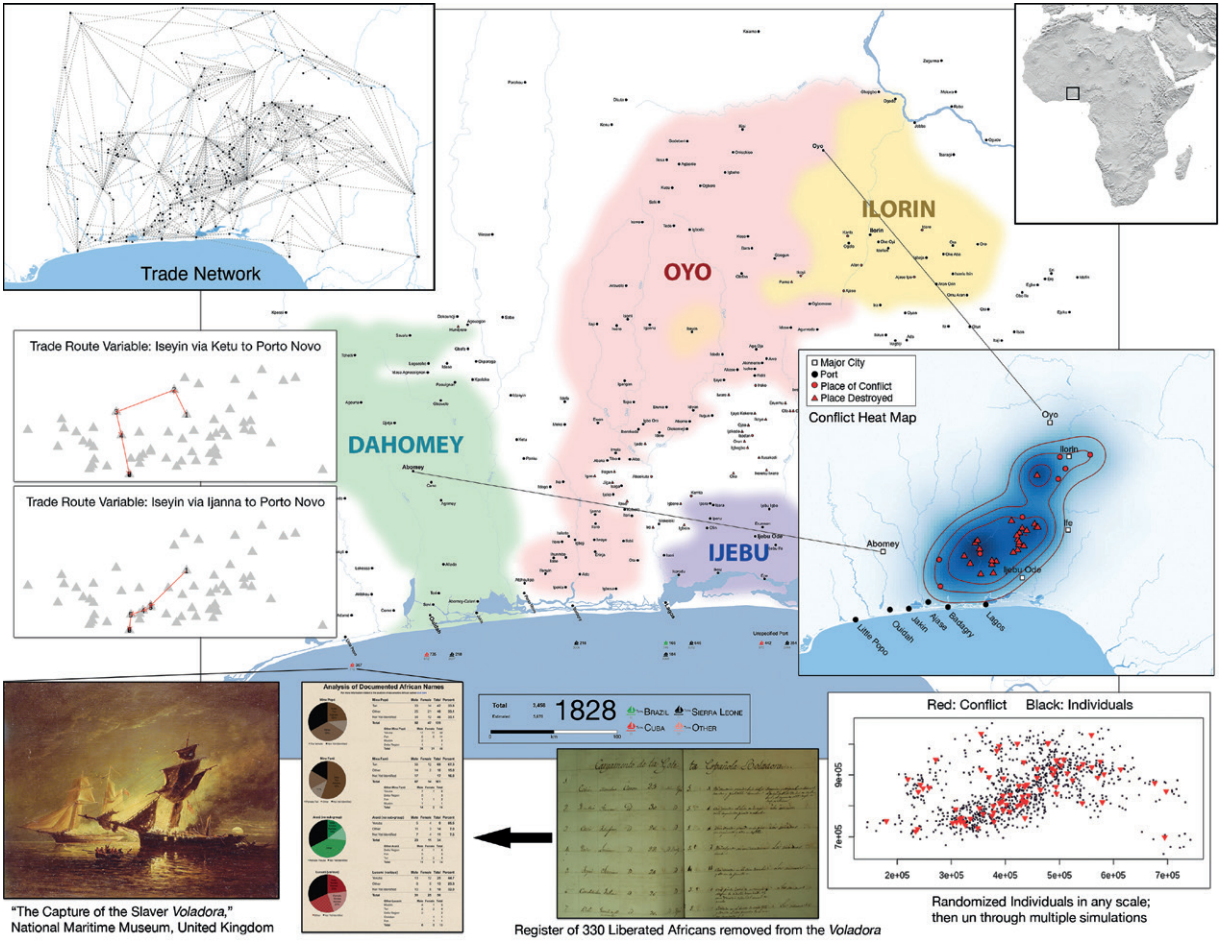

Figure 1: Infographic Showing Intra-African Conflict and Registers of People on Slave Ships Leaving the Bight of Benin in 1828

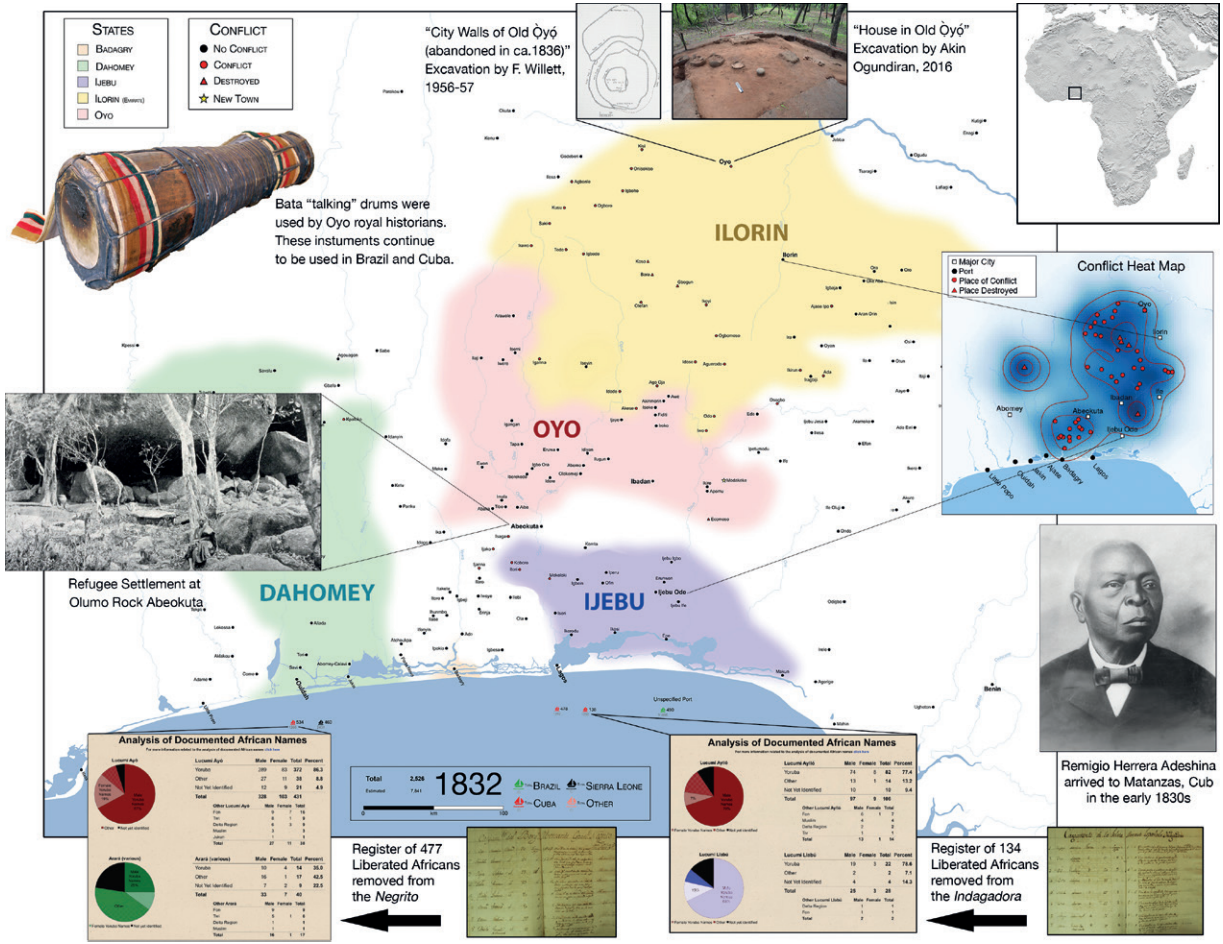

Figure 2: Infographic Showing Intra-African Conflict and Registers of People on Slave Ships Leaving the Bight of Benin in 1832

The ethics of generating new data for this type of project requires special attention, and most importantly, input from African scholars and universities. Before data collection can begin, however, a metadata schema is needed, and the ones presented in the appendices herein have involved consultations with scholars in African diaspora history, applied mathematics, archaeology, computer science, economic history, geography, information science, libraries, and software engineering.[6] Publishing metadata schema is a necessary part of the workflow, especially as humanities scholarship evolves beyond traditional print publications and into digital spaces using datasets that are oftentimes created and shared through linked open data ontologies and linked open data resources, such as the *World Historical Gazetteer* or *Getty Thesaurus of Geographic Names*.[7] Data collection will be a laborious process, which will be achieved systematically using a regionalization of the continent outlined in Figure 3.[8]

Preliminary results to estimate conditional probabilities of African origins have determined a pressing need to generate more data for an improved mapping platform. In future considerations of mapping the entire continent, deciding what data will be targeted has required theoretical conceptualizations before data collection begins. Variables required for spatial modelling pre-colonial migratory patterns revolve around different places whereby instances of intra-African conflict occurred over different periods of time. It also involves plotting slave

6 During the development of the metadata schema presented herein, I would like to acknowledge the discussions surrounding AHGIS metadata I had with Suzanne Blier, Kartikay Chadha, Shiva Darian, Toyin Falola, James Fenske, Karl Grossner, Anne Kelly Knowles, Inna Kouper, Thea Lindquist, Paul Lovejoy, Patrick Manning, Ruth Mostern, Akin Ogundiran, Eric Vance, Jonathan Ward and Warren Whatley.

7 Ruth Mostern, dir., *World Historical Gazetteer*, www.worldhistory.pitt.edu; The Getty Research Institute, *Getty Thesaurus of Geographic Names*, www.getty.edu/research/tools/vocabularies/tgn/.

8 Henry B. Lovejoy, Paul E. Lovejoy, Walter Hawthorne, Edward A. Alpers, Mariana Candido, Matthew S. Hopper, Ghislaine Lydon, Colleen Kriger, and John Thornton, "Defining Regions of Pre-Colonial Africa: A Controlled Vocabulary for Linking Open-Source Data for Digital History Projects," *History in Africa: Digital Humanities Special Issue* 48 (2021): 1–26; Henry B. Lovejoy, Paul E. Lovejoy, Walter Hawthorne, Edward A. Alpers, Mariana Candido, and Matthew S. Hopper, "Redefining African Regions for Linking Open-Source Data," *History in Africa* 46 (2019): 5–36.

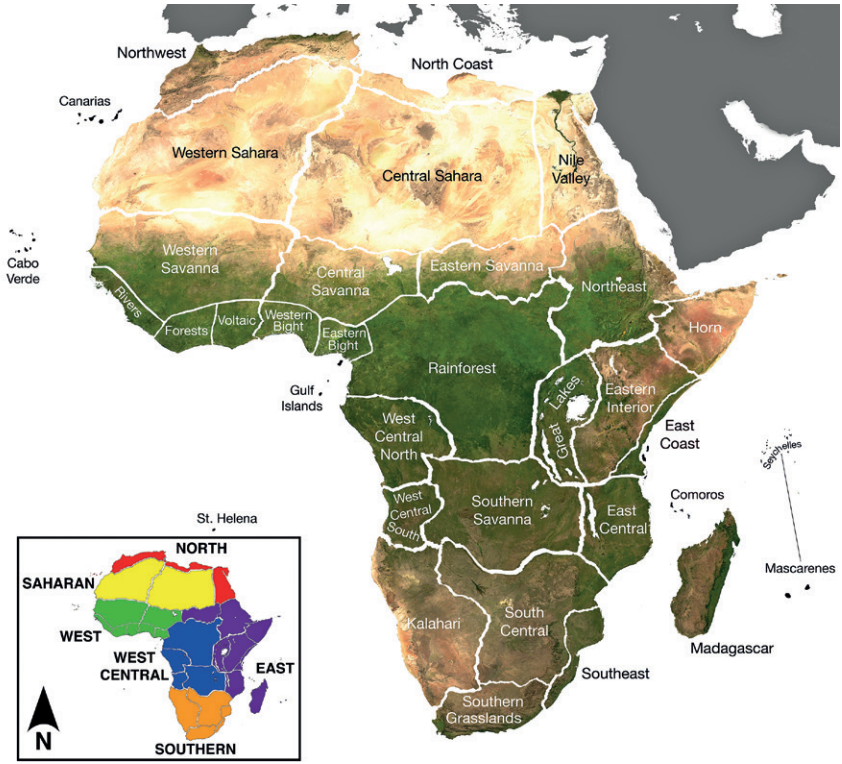

Figure 3: African Regions

ship departures alongside the shifting constellations of conflict.[9] Applying spatial statistical formulas to these data will then help identify more clearly when and where enslaved people likely came from inland, and when and where they went in diaspora.[10] Illustrating migratory patterns on maps will also inform patterns for people who did not board

9 The animated map of the slave trade in this article inspired AHGIS. Andrew Kahn, and Jamelle Bouie, "The Slave Trade in Two Minutes," *Slate Magazine*, 25.06.2015, http://www.slate.com.

10 Ashton Wiens, Henry B. Lovejoy, Zachary Mullen, and Eric Vance, "A Modelling Strategy to Estimate Conditional Probabilities of African Origins: The Collapse of the Oyo Empire and the Transatlantic Slave Trade, 1817–1836," *Journal of the Royal Statistical Society: Series A "Statistics in Society"* [forthcoming].

slave ships and who travelled inland as refugees or enslaved. While slave ship data currently exist in digital formats through *Voyages: The Trans-Atlantic Slave Trade Database* and *Liberated Africans*,[11] instances of intra-African conflict on a place-by-place basis need to be curated, which is the aim of AHGIS.

As with many data-driven digital history publications, deciding what information to collect beforehand is a methodological problem. For this project, it must be emphasized that the data will be highly categorical and sparse, since so much detail of pre-colonial African history is missing due to the dearth of written records relative to other highly populated regions of the world. At the pre-publication stage, data collection involves foresight to predict what data are available and what will be needed in the future. Providing a rationale for such decisions is best practice. Metadata schemas constitute theoretical frameworks that underpin the usability of systems, retrievability of data for analysis, effectiveness of visualization designs, and replicability, which is a minimum condition for a scientific finding to be believable and informative. According to a U.S. National Science Foundation (NSF) sub-committee, replicability refers "to the ability of a researcher to duplicate the results of a prior study using the same materials as were used by the original investigator. That is, a second researcher might use the same raw data to build the same analysis files and implement the same statistical analysis in an attempt to yield the same results."[12]

This paper presents metadata schemas for spatial, conflict, and population data that will be collected for AHGIS. Metadata documentation explains the variables to be extracted from primary sources, as well as the structure of data for analysis. The schema is a specification that represents the data model and provides "a clearly defined set of infor-

11 Alex Boruki, Daniel B. Domingues da Silva, Paul Gardullo, Allen Tullos, Abby Wolf, and Karin Wulf, dirs., *Voyages: The Trans-Atlantic Slave Trade Database*, www.slavevoyages.org; Henry B. Lovejoy, dir., *Liberated Africans*, www.liberatedafricans.org.

12 Kenneth Bollen, John T. Cacioppo, Robert Kaplan, Jon Krosnick, and James L. Olds, *Social, Behavioral, and Economic Sciences Perspectives on Robust and Reliable Science* (Arlington: National Science Foundation, 2015), 3.

mational items with clearly defined relationships."[13] The creation of the AHGIS metadata schema has involved attempts at pre-determining potential outcomes, such as which variables will function with software, tools, and applications for data analysis and visualizations. In addition to the schema, sustainability plans have also been considered, especially for how data will be collected, stored, accessed, and maintained so that others may reuse, retest, and filter data in meaningful ways. This formal conceptualization of the AHGIS domain also considers "the future potential of integrations with other ontologies," especially via the semantic web.[14]

Published metadata schema are a timestamp for web-developmental processes surrounding digital humanities publications.[15] This article contains three metadata schemas for AHGIS, which are presented in three appendices. They reflect the different but inter-related spatial categories for place, conflict, and population. Despite rigorous efforts, they are subject to change depending on project developments and improved linkages. For feasibility, this project scope centres on Africa in the nineteenth century, but development certainly takes into consideration the entire continent and for earlier or later periods. Metadata schemas are highly theoretical, and their methods and explanations are often shared across other disciplines and projects involving digital humanities research. For example, the AHGIS metadata schema presented herein draws upon and overlaps with other historical GIS publications and projects, such as those focused on the displacement of enslaved people, depopulation of indigenous groups, Jewish diaspora, genocide, and other displacements of refugees due to conflict, natural disasters, or disease.

13 Julia Flanders, and Fotis Jannidis, "Data Modeling in a Digital Humanities Context: An Introduction," in Julia Flanders, and Fotis Jannidis, eds., *The Shape of Data in the Digital Humanities: Modeling Texts and Text-based Resources* (London: Routledge, 2018), 4.

14 Oyvind Eide, and Christian-Emil Smith Ore, "Ontologies and Data Modeling," in Julia Flanders and Fotis Jannidis, eds., *The Shape of Data in the Digital Humanities: Modeling Texts and Text-based Resources* (London: Routledge, 2018), 175.

15 Publishing DH project benchmarks, such as metadata schema, help inform tenure and promotion review. See also Henry B. Lovejoy, "Who Did What When? Acknowledging Collaborative Contributions in Digital History Projects," *Esclavages & Post-Esclavages* 3 (2020): 1–21.

Metadata Schema and Best Practices

Before variables and values of AHGIS metadata schema are explained, it is integral to establish what data, metadata, and metadata schemas are and what they do. Questions initiated at the start of new digital humanities publications mostly revolve around feasibility, or the balance between what is possible and what is not. Developing a metadata schema facilitates this process because it is a computational outline of functionality and scientific outputs. Metadata schemas have other practical purposes, too. Defining project data improves communication among humanists, data scientists, and software engineers, who develop project-specific vocabularies to increase efficiency and accuracy. They also allow humans and machines to better understand each other, which promotes improved interoperability between data and the validity of outputs further along the project's lifespan.

Metadata has different meanings in different networks and across fields. Some people use the term synonymously with data, others use it to refer to machine readable information. In general terms, metadata may describe a variety of electronic resources or refer to a description of a resource applied to any type of digital or non-digital object, including textual and non-textual media. According to the National Information Standards Organization (NISO), metadata is "structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource." It is often defined as "data about data," or "information about information."[16]

NISO has categorized at least three main types of metadata: descriptive, structured, and administrative. Accordingly,

> Descriptive metadata describes a resource for purposes such as discovery and identification. It can include elements such as title, abstract, author, and keywords. Structural metadata indicates how compound objects are put together, for example, how pages are ordered to form

16 National Information Standards Organization (NISO), *Understanding Metadata* (Bethesda: NISO Press, 2004), 1.

> chapters. Administrative metadata provides information to help manage a resource, such as when and how it was created, file type and other technical information, and who can access it. There are several subsets of administrative data [such as] rights management metadata, which deals with intellectual property rights, [or] reservation metadata, which contains information needed to archive and preserve a resource.[17]

Creators of metadata and metadata schema make decisions about what information should be collected, stored, accessed, and maintained over the course of a project, especially as new or more data is expected to be inputted or generated over time. Interdisciplinary collaborations expediate the process because oftentimes the production of new metadata can be automated. For example, RegID automatically records administrative data, that is the names and dates of researcher inputs, which relates to best practices iterated in "Collaborators' Bill of Rights."[18]

Building metadata schema for curating new historical data requires specialized knowledge of the sources from which data will derive. It must also consider digital systems in which those data will be applied, accessed, and hosted. In 2016, Mark D. Wilkinson and several other scientists published the *FAIR Guiding Principles for Scientific Data Management and Stewardship* to improve infrastructure to support the reuse of scientific data. FAIR, or Findability, Accessibility, Interoperability, and Reuse of digital assets, is a set of guidelines that emphasize machine-actionability, or the capacity of computational systems to find, access, interoperate, and reuse data with minimal or no human intervention. These scholars argue that good data management "is the key conduit

17 NISO, *Understanding Metadata* (Bethesda: NISO Press, 2004), 1.

18 Christina Boyles, Anne Cong-Huyen, Carrie Johnston, Jim McGrath, and Amanda Phillips, "Precarious Labor and the Digital Humanities," *American Quarterly* 70/3 (2018): 693–700; Tanya Clement, et al., "Collaborators' Bill of Rights," *Off the Tracks: Laying New Lines for Digital Humanities Scholars*, http://mcpress.media-commons.org/offthetracks/part-one-models-for-collaboration-career-paths-acquiring-institutional-support-and-transformation-in-the-field/a-collaboration/collaborators%E2%80%99-bill-of-rights/; Haley Di Pressi, Stephanie Gorman, Miriam Posner, Raphael Sasayama, and Tori Schmitt, "A Student Collaborators' Bill of Rights," *HumTech Blog, Los Angeles, Center for Digital Humanities*, 08.06.2015, https://humtech.ucla.edu/news/a-student-collaborators-bill-of-rights/.

leading to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse by the community after the data publication process."[19]

Developing metadata schemas at the outset is a necessary "first step" to facilitate the future discovery of relevant information, organize digital resources, provide digital identifications, and support the archiving and preservation of digital media. Metadata is therefore essential to ensure resources will be sustainable and made accessible in the future. Structured metadata schema improves functionality because they are elements of information designed for a specific purpose in digital humanities research. According to NISO, the semantics of a metadata schema are "the definition or meaning of the elements themselves," that is "the values given to metadata elements."[20] Metadata schemas describe the choices made to define elements, their semantics, and optionally, rules for how values must be formulated within an organized arrangement of words and phrases. Controlled vocabularies are used to index content, and to retrieve content through browsing or searching, which facilitate identifying semantic triples, or RDF triples, for linked open data connectivity.

It is more prudent to define terms, controlled vocabularies, and semantics in advance of data collection. The remainder of this article explains the rationale for three interrelated sets of data to be collected surrounding places, instances of conflicts, and population. The three appendices outline the foundational metadata schema for AHGIS. As digital humanities publications can evolve, the following explanations may be subject to change, especially as they adapt to evolving technologies, increased categorizations, and refined spatial statistical modelling.

19 Mark Wilkinson, et al., "The FAIR Guiding Principles for Scientific Data Management and Stewardship," *Scientific Data* 3/160018 (2016): 1; Mark Wilkinson, "Fair Principles," *GO FAIR*, www.go-fair.org/fair-principles/.

20 NISO, *Understanding Metadata* (Bethesda: NISO Press, 2004), 2.

Metadata Schema 1: Places in Pre-Colonial Africa

Compared to other heavily populated regions of the world, historical sub-Saharan Africa lacks reliable historical maps. Of course, indigenous populations have understood their natural surroundings in their own terms for thousands of years, but they did not necessarily produce maps according to Euro-centric methods, standards, or scale. The relative dearth of contemporary maps of the African mainland has profoundly affected our understanding of when and where people came from in pre-colonial Africa; and where they went, especially in relation to transcontinental and transoceanic slave trades in the pre-colonial period. Scholars have attempted to fill this cartographic void with a myriad of historical maps scattered across the historiography, but these maps are fragmented into spatial quadrants relative to the scope of a given study. As *Yoruba-Diaspora.org* demonstrates, scattered spatial data in relation to conflict exist throughout the historiography and these data can be collated into datasets capable of producing statistic models that illustrate migratory patterns over time.

The metadata schema in the first appendix describes the place-orientated data designed to integrate into global spatial repositories. These datasets are relatively straight forward and implement geographic hierarchies for data organization, linkages, analysis, and cartographic representations. Per the recommendations of members of the *World Historical Gazetteer* and *Getty Thesaurus of Geographic Names*, the first value to be collected is a toponym, or the most common name attached to a place or location. This value is required, along with X and Y decimal coordinates, which can be obtained through various open-source web services with a database of coordinates systems used in maps worldwide, such as www.epsg.io/map. AHGIS will operate on the WGS84, which is maintained by the United States National Geospatial-Intelligence Agency.

Once spatial data are plotted, it is possible to automatically assign an ID number to a place name and coordinates. Sometimes human settlements have multiple names in multiple languages. There is opportunity to enter alternative placenames, which is an optional value. Alternative place names refer to the name of a place as it is less commonly known

or spelled, such as Oyo in Yoruba (most common) versus Katunga in Hausa (less common); or Lagos in Portuguese (most common) and Eko in Yoruba (less common). In addition, many African places have multiple spellings, i.e., Whydah compared with Ouidah; or Ketu and Ketou. The number of alternative place names generally depends on the place in question, how the place might have been referred to in historical sources or phonetic spelling across various European languages.

It is worthwhile to identify the certainty or uncertainty of the historical locations of places.[21] In many circumstances, pre-colonial African places no longer exist on modern-day maps because they were destroyed, never re-built, or relocated elsewhere. Otherwise, smaller towns were incorporated into larger cities due to urbanization. In the historiography, scholars often provide relative locations on published maps of places that no longer exist today *apropos* their location to known places which continue to thrive. "Certain" locations indicate a place that either exists on modern-day maps today or can be corroborated with archaeological evidence involving precise geo-locations. "Uncertain" places reflect data that are approximated relative to other places, do not exist on modern-day maps, or have not been excavated by archaeologists. These two categories will facilitate data analysis and verification of outputs, while being able to identify and improve upon imprecise locations, especially if more spatial data become available.

With place name(s), coordinates and the certainty of locations tagged, it is now possible to locate human settlements within two separate geographic hierarchies, both of which start with the continent of Africa. The first geographic hierarchy facilitates linkages with the *World*

21 Classifying place data as "certain" or "uncertain" draws upon metadata schema from the *Holocaust Ghettos Project*, which uses three classifiers: unknown (no data available), uncertain (ambiguous data usually quantified with "probably," "most likely," "maybe," etc.), and certain (factual data). Anne Kelly Knowles, Justice Hillebrand, Paul B. Jaskot, and Anika Walke, "Integrative, Interdisciplinary Database Design for the Spatial Humanities: The Case of the Holocaust Ghettos Project," *International Journal of Humanities and Arts Computing* 14/1–2 (2020): 64–80; Justice Hillebrand in consultation with Anne Kelly Knowles, Paul B. Jaskot, Anika Walke, and Eve Duffy, "Appendix A: Basic Attributes Table Instructions for Data Entry Holocaust Ghettos Project;" and "Appendix B: Physical Characteristics - Spatial Table Instructions for Data Entry," *Holocaust Ghettos Project*, 29 Oct. 2019.

Historical Gazetteer and *Getty Thesaurus of Geographic Names* by entering where a given place is located within a modern-day African country, and then within a state, province, or department. Locating historical places within in modern-day terms helps researchers, students, and the public locate historical places more easily. For AHGIS, these data will likely not be displayed since the historical context bears little resemblance to present-day countries. For this reason, the second geographic hierarchy relates to an updated regionalization for Africa which several African historians designed as a controlled vocabulary for improved linkages among a wide range of open-source data repositories focused on Africa and the African Diaspora (Figure 3).

The final two variables to be collected for this place schema relate to sources and notes about a given location in the AHGIS place dataset. In consideration of places that have existed for centuries and will continue to exist into the future, documenting sources is not required. Making source data optional increases the speed of data entry since researchers will not always need to input bibliographic references at this stage of the process but is an option to cite obscure references. Additionally, place for more detailed notes is provided, especially for more obscure geographic references, locations, spellings, and interpretations.

Metadata Schema 2: Conflict in Pre-Colonial Africa

Once spatial data about a place are recorded, it is possible to assign a chronology of conflict events that occurred at each place as written about or mapped in the historiography. Primary and secondary sources, whether written or oral, contain spatial data involving descriptions of conflict as historical events, such as warfare or slave raiding. In many circumstances, historical conflicts resulted in the enslavement of different people, some of whom remained in Africa, others who left the continent on slave ships, and many who were killed or died from lack of food. Generating a list of known African cities, towns, and villages – and noting when conflict may have occurred at those places in specific years or periods – can result in a clearer understanding of the direction

and flow of internal African enforced migrations. The second appendix is for event-based, conflict data. This information provides the basis from which to develop spatial statistical models on a conflict-by-conflict basis connected to specific places. To operate on a temporal axis, the conflict data must include a date range, or start and end dates, while keeping track of the certainty of that information. Year is mandatory, while month and day are optional and generally sparser, although they could reflect seasonal changes as conflict mostly occurred in the dry season, not during the rains.[22] Generally, the difference between "certain" and "uncertain" dates relates to ones explicitly documented in primary sources and those approximated by historians in the secondary literature, or more generally, they refer to "circa" a given date. Each spatial datapoint may have as few as zero conflicts or as many as needed.

Beyond start and end dates, a categorical conflict scale differentiates between type of conflict. It includes five variables: 0 – for no conflict; 1 – for a minor conflict or slave raiding; 2 – for major conflict not resulting in the destruction of a place; 3 – major conflict resulting in the destruction or abandonment of a place; and 4 – foundation of a new place, whether a place was destroyed and rebuilt at the same location, or the inhabitants relocated elsewhere. This simple scale is integral to spatial statistical modelling and for calculating conditional probabilities of inland origins with the best available information. It is subjective and determined by the person inputting data based on a deep understanding and reading of the historiography. The process involves comparing conflict and how the conflict is described in the historiography.

22 The temporality of AHGIS will account for wet and dry seasons, which have remained roughly the same despite climate change. Factoring in seasonal changes relates to conflict because most conflict, and hence migratory patterns, intensified during the dry season as moats dried up, rivers were easier to cross, and moving armies or caravans of people was much easier. These seasonal fluctuations suggest how AHGIS base maps will have to approximate the ebb and flow of inland bodies of water, lagoons, and rivers as they swell and shrink over the course of a twelve-month period. Seasons undoubtedly affect the time and distance it would take to move people toward the coast, as well as the departure of slave ships, which sought to fill their hulls with as many as people as possible. Figuring out time and distance is possible during different seasons is possible, especially using global estimates of travel times, whether by boat, walking, or riding horses. It is also possible to evaluate travel times documented in narratives of enslaved Africans who described their slave routes sometimes in detail.

To help justify the classification of conflicts according a rudimentary 5-part scale, optional data will also be collected for the names or titles of specific conflicts, if referred to as such in the historiography. In addition, bibliographic references from primary or secondary sources provide users with resources to double check data. Multiple references for a single conflict may exist, especially if the chronology of the conflict is debated or spans several years. Symbology will be used to show differences in degrees of conflict. If a place is founded or destroyed at a certain date, that place cannot exist before and after, respectively – causing a location to appear or disappear on the map. Symbology changes to reflect periods with or without conflict. Topology of places, instances of conflict, and the people who resided at them are adapting techniques to increase inclusivity.[23] For clarification, if needed, there is also an additional notes field to record other details.

Since conflict at any given location usually involved groups of people fighting against one another, it is possible to record high levels of detail about the people involved in conflict events. In this phase of the scheme, it is worth trying to capture who were the primary political affiliations and alliances occupying a given place at an instance of conflict, as well as the names and titles of key local rulers, allegiances, alliances, and military leaders. People-orientated data provide more insight about the scale of the conflicts, especially as well-known leaders, who can have digital identities, often commanded armies that conquered or defended more than one place. As people were taken from one place and moved to another, collecting this information will improve historical modelling to understand ethnolinguistic compositions of inland migratory patterns over space and time. In due course, spatial data points may also host complex genealogical trees, such as king lists, councils, military leaders, religious leaders, locations of wards, as well as other famous merchants and enslaved people.

23 Levi Westerveld and Anne Kelley Knowles, "Loosening the Grid: Topology as the Basis for a More Inclusive GIS," *International Journal of Geographical Information Science* (2020): 1–21; Levi Westerveld and Anne Kelley Knowles, "I Was There," in Brooke E Marston, et al., *Atlas of Design*, vol. 5 (Golden Valley: North American Cartographic Information Society, 2020): 62–65.

Likewise, it is possible to identify characteristics about attacking groups, such as political affiliations, alliances, and leadership and whether ventures are organized by the state or political leaders or whether those doing the attacking were ad hoc groups of men, gangs, age-grade associations, or simple bandits. Other optional information can be inputted for observed or estimated army sizes as an integer or range, as well as a controlled vocabulary to take note of infantry, cavalry, archers, firearms, armour, musicians, and usages of boats. In time, attacking armies can be associated with other locations from which military campaigns initially began, or indeed if an invading army conquers a place, only to have it retaken by the original inhabitants. In terms of feasibility, the devil is in the details for inputting data about the people associated with each place. Linked open data may provide part of the solution as connections are made between related and relevant resources, which will likely be integrated over the long term.

Unlike the place metadata, sources or providing bibliographic references for these conflict data is a required value. There is also a place to input additional notes, which is optional.

Metadata Schema 3: Place Size in Pre-Colonial Africa

The final appendix helps organize population sizes for specific places, including by introducing a controlled vocabulary to classify human settlements by types. These highly uncertain data stem from a lack of reliable historical population counts for the continent in the entire pre-colonial period. Nonetheless, population estimates are sometimes based on observations in primary sources, which are problematic; or provided in the secondary literature based on comparison of one place to another, or indeed, through archaeological analyses of the sizes of human settlements before their abandonment.

The first information in this data sub-series to be collected is a date or date range, which is associated with the description of a type of place, which is a controlled vocabulary consisting of six variables: 1) City represents a large and important place, such as capitals or major

trading towns of major states, which usually have many wards and defensive fortifications, such as walls; 2) Town refers to a medium and important place, perhaps a major trading town, a capital of a province, which often contain with several wards and mud walls; 3) Village is a small and less important place, not a major trading town, but can have wards and fortifications. It is default classification, if place type is unknown or not described in the historiography; 4) Hamlet refers to an even smaller community usually formed around a family compound, although multiple families might reside together; 5) Outpost is a camp or military station used to organize troops for defence, slave raiding, or staging conflict; 6) Feature refers to human settlements that form at recognizable natural places such as a hill, rock, or bodies of water. Assigning types to a period can help to visualize differences in sizes of places in the African interior.

While the above controlled vocabulary of a settlement hierarchy is simplistic in design, it is based on how scholars refer to pre-colonial places in the secondary literature. Using this place type can be misleading especially because populations vary, and some cities may have been smaller than some large towns. Moreover, the position in a settlement hierarchy implies status, which may have implications when evaluating human migrations, which is not clearly determined in advance. In many circumstances, scholars did not necessarily consider the places they discussed in this format or for these reasons. However, it is worth trying to document a place to show its relative growth and decline as it was described.

Another variable worth consider relates to walled cities and towns. Many places in pre-colonial Africa can be easily categorized as whether they had large defensive walls and a moat, compared to those that did not. Lengthy discussions with archaeologists and historians revealed that this was an important category since it not only denotes the defensive significance of a human settlement. Since most human settlements use wall-like structures, these structures can be flagged using a check box with two variables: mud walls and fencing. Since most human settlements would have erected some defence measures, or “fencing,” this category denotes less developed human settlements, rather than a place

"without walls." If it is not known whether a place had walls or not, fencing will automatically become the default option.

A second spatial data category worth tagging is whether a location was described as a major port or place of trade. The choice will be provided between two variables: port, that is a major place of trade on a significant body of water on the coast or inland, including oceans, lagoons, lakes, or rivers; and trade centres along trade routes not on a body of water, such as those in the Sahara. For example, ports of the trans-Atlantic slave trade are worth highlighting. However, these coastal places were not the only major centres of trade. There were equally significant markets on inland lakes, lagoon, and rivers, which have existed for centuries. Otherwise, there were other markets not on bodies of water. In consideration that conflict disrupts and alters trade routes, identifying key inland ports and trade centres will enable improvements to spatial statistical modelling.

Beyond default sources and notes required to document this information, there will also be an option to enter in population estimates and their certainties. Sometimes first-hand observers made observations about the size of places, which in other circumstances scholars compare to nearby places of the same size. These estimates are far and few between but also worth identifying at the place or particular year that the estimate was described and documented.

Conclusion

Based on historical accounts, archaeological and bio-archaeological evidence, instances of enslavement usually followed violent acts of warfare, raiding or kidnapping. Curating new data for thousands of inland African places, and identifying periods of conflict at those places, will enable a powerful visualization of a major theme in modern history – the role of slavery and the demography of African migrations in global context. By collating and plotting geo-political data on a temporal axis using GIS technologies and R Shiny App, mathematical formulas have already been applied to predict locations of original enslavement and subsequent

migrations to other destinations within Africa or toward the coast. These data can be linked into caches of digitized collections of primary sources and other multimedia using open-source content management systems, such as RegId.

This meta-critical project appeals to a wide range of scholarship in history, literary studies, geography, anthropology, ethnomusicology, archaeology, sociology, political science, economic history, applied mathematics, computer science and genealogy. Scholars across these disciplines will benefit by accessing extensive open-source biographic historical data and collections, which are interactively connected to places plotted on animated maps illustrating shifting patterns of conflict in pre-colonial Africa over time. These data should interest economic historians who explore intra-African conflicts and the suppression of the slave trade in relation to land, labour, and capital.[24] It will also impact genome projects related to African migrations, including the recently published results of genetic analyses of the African diaspora in the Americas.[25] The development of historical GIS applications and visualizations will facilitate the dissemination of new knowledge because maps can be designed that are easily comprehensible for teaching K-12, college students and the public about the heritage of forced global migrations.

The project helps fulfil the mandate of the United Nations in recognizing an International Decade for People of African Descent (2015–2024) and the aims of the UNESCO *Slave Route Project: Resistance, Heritage, Liberty* in overcoming obstacles in mutual understanding, reconciliation, and cooperation among diverse peoples. Using maps and data for 12.5

24 James Fenske, "Land Abundance and Economic Institutions: Egba Land and Slavery, 1830–1914," *Economic History Review* 65, 2 (2012), 527–555; James Fenske, and Namrata Kala, "1807: Economic Shocks, Conflict and the Slave Trade," *Journal of Development Economics* 126 (2017): 66–76; Nathan Nunn, "The Long-Term Effects of Africa's Slave Trades," *The Quarterly Journal of Economics* 13367 (2008): 139–176; Sandra Sequeira, Nathan Nunn, and Nancy Qian, "Migrants and the Making of America: The Short- and Long-Run Effects of Immigration during the Age of Mass Migration." *CEPR Discussion Papers* (2017): 1–49.

25 Steven J. Micheletti, Kasia Bryc, Samantha G. Ancona Esselmann, William A. Freyman, Meghan E. Moreno. G. David Poznik, and Anjali J. Shastri, "Genetic Consequences of the Transatlantic Slave Trade in the Americas," *Journal of Human Genetics* 107 (2020): 1–13.

million people involved in the trans-Atlantic trade between 1500 and 1867, we will be able to piece together forced population movements from specific places inland to slave ships at the coast. Knowing more about how and why people moved within Africa and when and where they went in diaspora will provide new knowledge that enlightens Africans, their descendants and indeed everyone about ancestry and heritage, while informing individual, organizational and national policy decisions that address responses to systemic racism. AHGIS will also have the potential to inform data from human genome projects, such as 23andme.com, ancestry.com and familysearch.org.

Appendix 1: Metadata Schema for Places in Pre-Colonial Africa

ID	Required or Optional	Value	Input Prompt	Data Cat	Data Type	Definition and Description	Example
1	Required	toponym	Place Name	Place	Text	Label or name given to a place as it is most known.	Oyo, Lagos, etc.
2	Required	x_coordinate	X Coordinate or Longitude	Place	Decimal Coordinate	GIS coordinate for x or longitude. Collect data in **EPSG:4326 (WGS84)** coordinate system. Recommended website to look up coordinates: https://epsg.io/map	5.026637; or -7.826048
3	Required	y_coordinate	Y Coordinate or Latitude	Place	Decimal Coordinate	GIS coordinate for y or latitude. Collect data in **EPSG:4326 (WGS84)** coordinate system. Recommended website to look up coordinates: https://epsg.io/map	8.236362; or -12.456987
4	Required	place_ID	Place ID	Place	URI	Self-generating URI equals "toponym" + "x_coordinate" and "y_coordinate." One alphanumeric URI prefixed with ADMAPS.	ADMAPS0000001
5	Optional	toponym_ secondary	Alternative Place Name	Place	Text	Label or name given to a place as is less commonly known, perhaps in another language. There may be differences in the spelling of a place due to English, French, Portuguese, etc. spellings. Variations in spelling, can include original spelling derived from primary sources. Separate multiple entries with a semi colon.	Katunga; Eko; etc.
6	Required	location_cert	Location Certainty	Place	Check box	When coordinates are entered, choice between two variables: **Certain** - The place still exists on modern maps; or the place specifically relates to archaeological excavations. **Uncertain** - Approximate location of a place relative to other places, but not present on modern maps or archaeology.	Certain, Uncertain

7	Required	country	Location of Place in Modern Country	Place	Dropdown List	Country list, easier if dropdown is autofill. Required for linking with Getty Thesaurus of Geographic Names.	Niger, Benin, etc.
8	Required	state_prov_dept	State, Province, or Department in Modern Country	Place	Dropdown List	State, Province, or Department of modern country. Required for linking with Getty Thesaurus of Geographic Names.	Oyo, Delta, etc.
9	Required	region	Historical Region	Place	Dropdown List	Choice of a sub-region as defined in Lovejoy, Lovejoy, et al, "Defining African Regions" (2021).	Western Bight, Central Savanna, Voltaic, etc.
10	Optional	place_source	Unidentified Place Source	Source	Text	Not all places need a source because the place existed in the past for centuries and continues to exist today. Cite only obscure places and references, which do not have extensive histories. Separate multiple entries with a semi colon.	Samuel Johnson, *The History of the Yorubas from the Earliest Times to the Beginning of the British Protectorate* (London: Routledge& Sons Limited, 1921), 75.
11	Optional	place_notes	Place Notes	Source	Text	Option to add additional notes about a place.	For example, the location of an obscure place might require clarification on coordinate selection, or the spelling of the name, etc.

Appendix 2: Metadata Schema for Instances of Conflict in Pre-Colonial Africa

ID	Required or Optional	Value	Input Prompt	Data Cat	Data Type	Definition and Description	Example
1	Optional	start_ date	Start Date	Event	Date	**YYYY-MM-DD** format. Earliest possible date when place was engaged in conflict. Year is mandatory, while month and day are optional. Consideration of wet and dry season. Dry season = December to April. Wet season = May to November. Most conflict and most migration intensified during dry season because moats dried up, rivers were easier to cross and moving armies and caravans was easier. Based on this logic, there should be a feature to show approximate start days and months on approximate start of dry season in December (12-01) and ending April (04-30). This value is optional because some places were not involved in conflict over the period of study but should be represented on a map.	1817-12-01
2	Required, if conflict start date known	start_cert	Start Date Certainty	Event	Check box	When start date is entered, there is a choice between two variables: **Certain** - is conflict start date documented in primary sources to a specific year, month, or day. **Uncertain** - is conflict start date approximated or circa to a specific year in secondary sources.	Certain, Uncertain
3	Required, if conflict start date known	end_date	End Date	Event	Date	**YYYY-MM-DD** format. Latest possible date place was engaged in conflict. Year is mandatory, while month and day are optional. Consideration of wet and dry season. Dry season = December to April. Wet season = May to November. Most conflict and most migration intensified during dry season because moats dried up, rivers were easier to cross and moving armies and caravans was easier. Based on this logic, there should be a feature to show approximate start days and months on approximate start of dry season in December (12-01) and ending April (04-30). This value is required once start date is completed.	1818-04-30

4	Required, if conflict start date known	end_cert	End Date Certainty	Event	Check box	When end date is entered, there is a choice between two variables: **Certain** - is conflict start date documented in primary sources to a specific day, including month and day. **Uncertain** - is conflict start date approximated to a specific year.	Certain, Uncertain
5	Required, if conflict start date known	conflict_ scale	Conflict Scale	Event	Dropdown List	When all names, coordinates and dates are entered, there is choice between five variables relative to type of conflict: **0** - No conflict **1** - Slave raiding or minor conflict **2** - Major conflict not resulting in destruction of place **3** - Major conflict resulting in destruction or abandonment of place **4** - Foundation of new place	0, 1, 2, 3, or 4
6	Optional	conflict_ name	Conflict Name	Event	Text	Specific name in primary or secondary sources associated with conflict, war, or battle, if known.	Erunmu War, Owu War, Battle at Owiwi Creek, etc.
7	Required, if conflict start date known	conflict_ source	Conflict Source	Source	Text	Bibliographic reference from either primary or secondary source from where the conflict is documented. Separate multiple sources with a semi-colon.	Samuel Johnson, *The History of the Yorubas from the Earliest Times to the Beginning of the British Protectorate* (London: Routledge& Sons Limited, 1921), 75; Samuel Johnson, *The History of the Yorubas from the Earliest Times to the Beginning of the British Protectorate* (London: Routledge & Sons Limited, 1921), 75.
8	Optional	conflict_ note	Conflict Note	Source	Text	Any additional notes about the conflict of a place, such as differences or discrepancies in when it might have occurred. Enter specific quotes, if needed.	For example, there is difference of opinion in the start and end dates of the Owu war. The place_notes can help clarify how different scholars have a different periodization.

ID	Required or Optional	Value	Input Prompt	Data Cat	Data Type	Definition and Description	Example
9	Optional	local_ people	People(s) Residing at Place at Start of Conflict	People	Text	Input political affiliations of key group(s) occupying a given place, if more than one group at a place, separate with a semi colon.	Oyo; Sokoto; Nupe; Ilorin; Ijebu; Dahomey; etc.
10	Optional	local_ leaders	Name(s) and Title(s) of Local Leader(s) during Conflict	People	Text	Input names of local leaders, councils, military officials, etc. of a conflict at a place as documented in primary or secondary sources. Place title in brackets, and separate multiple entries with a semi colon.	Abiodun (Alafin); Afonja (Are Ona Kakanfo); Muhammed Bello (Sultan); etc.
11	Optional	local_ army_ size	Local Army Size	People	Integer	Provide number for size of a military unit defending a place, if known. Indicate ranges with a dash.	10, 100, 1000-2000, etc.
12	Optional	local_ army_ unit	Local Army Units	People	Select all that apply	Select all that apply: Infantry Cavalry Archers Firearms Armor Musicians Boats	Infantry, cavalry, etc.
13	Required, if local_people known	local_cert	People(s) Residing at Place Certainty	People	Check box	When local people data is entered, there is a choice between two variables: **Certain** - is documented in primary sources. **Uncertain** - is approximated or assumed in secondary sources.	Certain, Uncertain
14	Optional	attack_ group	Attacking Group	People	Text	Provide the main political affiliation(s) of the group attacking the place. If alliances of groups, separate with a semi colon.	Oyo; Sokoto; Nupe; Ilorin; Ijebu; Dahomey; etc.

15	Optional	attack_ leaders	Name(s) and Title(s) of Leader(s) Attacking a Place	People	Text	Input names of local leaders, councils, military officials, etc. of a conflict at a place as documented in primary or secondary sources. Place title in brackets, and separate multiple entries with a semi colon.	Abiodun (Alafin); Afonja (Are Ona Kakanfo); Muhammed Bello (Sultan); etc.
16	Optional	army_ size	Attacking Army Size	People	Integer	Provide number for size of a military unit attacking a place, if known. Indicate ranges with a dash.	10, 100, 1000-2000, etc.
17	Optional	attack_ army_ unit	Attacking Army Units	People	Select all that apply	Select all that apply: Infantry Cavalry Archers Firearms Armor Musicians Boats	Infantry, cavalry, etc.
18	Required, if army size known	attack_ cert	Attacking Army Certainty	People	Check box	When attacking army data is entered, there is a choice between two variables: **Certain** - is documented in primary sources. **Uncertain** - is approximated or assumed.	Certain, Uncertain
19	Required, if army size known	army_ source	People Source	Source	Text	Bibliographic reference from either primary or secondary source. Separate multiple sources with a semi-colon.	Samuel Johnson, *The History of the Yorubas from the Earliest Times to the Beginning of the British Protectorate* (London: Routledge & Sons Limited, 1921), 75; Samuel Johnson, *The History of the Yorubas from the Earliest Times to the Beginning of the British Protectorate* (London: Routledge & Sons Limited, 1921), 75.
20	Optional	army_ note	People Note	Source	Text	Any additional notes about the attacking army, unit, or slave raiding. Enter specific quotes, if needed.	Additional descriptions

Appendix 3: Metadata Schema for Place Sizes in Pre-Colonial Africa

ID	Required or Optional	Value	Input Prompt	Data Cat	Data Type	Definition and Description	Example
1	Required	place_year	Population Year	Event	Date	YYYY-MM-DD that population referred to, month and day may be optional	1824, 1845, etc.
2	Required	place_type	Place Type	Place	Dropdown List	Type of place at time of conflict into six variables, if unknown classify as village: **City** - a large and important place, such as capitals or major trading towns of major states, which usually have many wards and defensive walls. **Town** - A medium and important place, perhaps a major trading town, a capital of a province, which often contain with several wards and mud walls. **Village** - A small and less important place, not a major trading town, but can have wards and walls. Default classification, if unknown. **Hamlet** - A smaller community usually around a single-family compound, although multiple communities reside together. **Outpost** - A camp or military outpost used to organize troops for defence, slave raiding, and staging conflict. Examples include, Eko, ribat, etc. **Feature** - A recognizable geographic feature such as a hill, rock, confluence of bodies of water, etc.	City, Town, Village, Hamlet, Port, Outpost, or Feature
3	Required	walls	Walls	Place	Check Box	Indicate whether a place has walls based on two variables: **Mud Wall** - If the place had substantial defensive walls with a moat and thorny bushes. Usually associated with city or town place types. **Fence** - Fencing that does not have strong defensive properties but demonstrates settlement. If walls are not known, fence is default option.	Walls, Fence

4	Required	port	Port or Major Centre of Trade	Place	Check Box	Choice between two variables related to whether the place was a port or major centre of trade. **Port** - A major place of trade on a significant body of water on the coast or inland, including oceans, lagoons, lakes, or rivers. **Trade Centre** - Along trade routes not on a body of water.	Examples include, Ouidah, Rabba, Meko, Salaga, etc.
5	Optional	pop	Population	Place	Integer	Population size relative to specific dates. May also appear as a range.	1000, 10000, 100000, etc.; or 5000-10000
6	Required, if population known	pop_cert	Population Certainty	Place	Dropdown List	When population is entered at specific dates, choice between two variables. This variable must consider changing population sizes of places between dry and rainy season, where place populations increased during the dry season and decreased during the wet season: **Estimate** - was population approximated in a primary source or through archaeological excavations. **Assumption** - is population approximated, assumed, or associated with another place in secondary sources.	Estimate, Assumption
7	Required, if population known	pop_source	Population Source	Source	Text	Bibliographic reference from either primary or secondary source from where the population estimation is documented. Separate multiple entries with a semi colon.	Samuel Johnson, *The History of the Yorubas from the Earliest Times to the Beginning of the British Protectorate* (London: Routledge & Sons Limited, 1921), 75; Samuel Johnson, *The History of the Yorubas from the Earliest Times to the Beginning of the British Protectorate* (London: Routledge & Sons Limited, 1921), 75.
8	Optional	pop_notes	Population Notes	Source	Text	Any additional notes about a place, such as differences or discrepancies in population. Enter specific quotes, if needed.	In a hypothetical example, scholar x claims, “Ishogbo is about the same size as Ketu.” scholar y claims Ketu had a population of about 10,000 people; therefore, it is assumed Ishogbo had a population of 10,000 people.

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Labelled a crime against humanity by the United Nations in 2011, the slave trade and its legacy of bondage unfortunately continue to shape modern society through racism, discrimination, and unconscious bias. For those who were silenced, and for their descendants, there is little reconciliation. Without knowing their individual stories – where they came from, where they were taken – this part of human history remains a generalized story of mass atrocity, lacking details about the experiences of enslaved human beings. While historians have amassed data for over 12.5 million people involved in the Atlantic slave trade between 1500 and 1867, we have not been able to piece together enforced population movements from specific African places inland to slave ships at the coast. By applying methods from GIScience and spatial statistics, it is possible to learn about global migrations resulting from slavery *within* pre-colonial Africa. By extracting spatial data from primary and secondary sources, it is possible to design a spatial data repository and digital archive of pre-colonial African places with instances of conflict to operate on a temporal scale with Geographic Information Systems (GIS).

THE AUTHOR

Henry Lovejoy is an Assistant Professor and Director of the Digital Slavery Research Lab at the University of Colorado at Boulder. His book, *Prieto: Yorùbá Kingship in Colonial Cuba during the Age of Revolutions*, won the Chief Delano Book Prize for Yorùbá Studies. He is also co-editor of *Liberated Africans and the Abolition of the Slave Trade, 1807–1896*. He also sits on the board of directors for the Black American West Museum & Heritage Centre in Five Points, Denver.