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Short Communication: Geographical Insights in Brief

Unlocking the Research Potential of Early Modern Dutch Maps

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Abstract: Working from the GLOBALISE project, we have enhanced access to over 5,000 Dutch maps from the seventeenth and eighteenth centuries, renowned for their geographic and historical significance. We have laid the groundwork for enriching these maps with annotations and metadata following the International Image Interoperability Framework (IIIF) standards, directly linked to their digital representations from the collection-holding institutions. This approach ensures a FAIR framework for sharing research results and fosters collaborative annotation. We enriched the maps with georeferencing annotations and employed automated tools to extract toponyms and geographic features, enabling large-scale analysis. These annotations open new pathways for exploring understudied historical regions, such as early modern Kerala, and assessing Dutch colonial influence globally. By publishing our data early, we aim to encourage further collaborative refinements, allowing a wider scholarly community to improve and build upon this work. This approach highlights the potential of combining historical cartography with computational tools to empower large-scale geographic and historical research.

Keywords: Historical Cartography; Geographic Information Systems (GIS); Spatial Analysis; IIIF Framework; Annotation; Colonial History

Highlights:

- Dataset of over 5,000 early modern Dutch maps, accessible for collaborative annotation.
- Automated tools used to extract geographic features, toponyms, and cartographic symbols from maps.
- New opportunities for large-scale analysis of early modern topographies and Dutch colonial influence.

1. Introduction

Early modern Dutch cartographers are renowned for producing detailed and accurate maps of the world as they knew it. Rich in geographical information, these maps depicted new lands and sea routes, playing a crucial role in trade development and the rise of the Netherlands as a colonial power (Sutton, 2015; Zandvliet, 1998). Key sponsors and facilitators of these cartographic practices were the Dutch East India Company (VOC) and, to a lesser extent, the West India Company (WIC). The VOC established a robust system for creating, collecting, and expanding cartographic knowledge, employing teams of cartographers in Europe and Asia. At its height in the eighteenth century, the mapmaking office in Batavia (Jakarta) employed 25-30 staff, producing around 3,000 sea and land maps of VOC territories in Asia and the Cape of Good Hope. Many were sent to the Netherlands, informing renowned mapmakers like Willem Jansz Blaeu (Guleij, 2016).

These maps are invaluable historical documents, offering insights into topographies of Asian and African regions, and geographical knowledge and exploratory efforts of the early modern era. They also provide information on how trading companies like the VOC and WIC influenced vast regions in the Global South by establishing strongholds, renaming geographic features, and exploiting lands for agricultural production. Despite their significance, these maps remain underutilized for large-scale computational analysis. Challenges include variations in accuracy, scale, and purpose, which complicate their systematic study. Additionally, the maps are dispersed across various institutions, such as the National Archives of the Netherlands and the Leiden University Library.

Fortunately, an increasing number of institutions now provide access to their map collections via the IIIF image API[1], which makes it easier to view materials from multiple collections through a single interface. Ideally, they would also offer IIIF Collections and Manifests following the IIIF Presentation API specifications[2], incorporating relevant metadata and enabling researchers to annotate toponyms, cartographic details, and geographic features directly on the map image provided by the library or archival institution. This would foster FAIR data-sharing practices and enable interactive exploration and visualization of annotations.

[1] https://iiif.io/api/image/3.0/
[2] https://iiif.io/api/presentation/3.0/

Since IIIF Manifests are not yet widely available for these collections, the GLOBALISE project[3]—which is developing an advanced research infrastructure for the VOC archives (Petram & van Rossum, 2022)—has taken the initiative to create them for a substantial collection of early modern maps of the Dutch colonial territories and regions where they were active. We have made these manifests, including annotations generated through automated methods, accessible on Zenodo to facilitate research into the histories, geographies and topographies of these areas, with regular updates planned until at least the conclusion of the GLOBALISE project in late 2026. Eventually, we hope that collection-holding institutions, as the authoritative providers of canonical representations of maps and metadata, will publish such manifests through their infrastructures themselves, after which we can easily transpose our enrichments to these representations. Doing so would ensure the sustainability and accessibility of this cartographic heritage while promoting collaboration and ongoing data enrichment in an interoperable and reusable format.

2. Context and Literature Review

Early modern Dutch cartographic material has long captivated scholars, who have examined it from various perspectives. Studies have explored the practices and networks of Dutch mapmakers (Schilder, 1976; van Netten, 2014), the knowledge exchange between cartographic traditions (Storms et al., 2018), and the pivotal role of maps in trade, territorial exploitation, and colonial expansion (Sutton, 2015; Zandvliet, 1998). Comprehensive bibliographies and facsimile editions have cataloged these maps and atlases, offering detailed descriptions and perspectives into their historical contexts (Koeman, 1967; van der Krogt, 1997; van Diessen et al., 2006; Brommer, 2011).

While this literature offers valuable historical and interpretive insights, it remains disconnected from the digital representations of the maps themselves. Meanwhile, advances in digital map-processing technologies have created opportunities to take enrichment a step further by analyzing historical maps and enhancing them with meaningful annotations. Since the 1980s, researchers at the intersection of computer science, geography, and cartography have developed methods to extract geographic features from scanned map images and integrate them into GIS models (Chiang et al., 2014, 2019). Recent studies have advanced processing older materials, training bespoke models for uniform corpora (e.g. Gobbi et al., 2019; Jiao et al., 2020; Lenc et al., 2023). Other approaches, such as those by Uhl & Duan (2021) and O'Hara et al. (2024), have experimented with training convolutional neural networks (CNNs) on modern data and applying them to historical map series to analyze ecological changes and human settlement patterns. Despite this progress, early modern Dutch cartographic materials, particularly those linked to the colonial and non-western world, remain largely unprocessed using computational methods.

Chiang et al. (2020) attribute the underutilization of historical maps in computational contexts to disciplinary silos, where users of scanned maps and developers of map-processing technologies rarely collaborate. This applies to early modern Dutch maps, compounded by a third silo: content providers. While institutions increasingly offer high-resolution images of historical maps, often via IIIF, they have yet to fully address researchers' needs. In fields like medieval manuscript studies, platforms have emerged that provide not only high-resolution images but also tools for annotating and sharing these annotations. Examples include the *Florentine Codex* platform by the Getty Institute[4] and *Mandragore* of the Bibliothèque Nationale de France[5] (Jacquemard, 2022; Moreux, 2021). These platforms significantly enhance research accessibility and foster collaborative exploration, setting a benchmark for cartographic collections.

IIIF presents itself as a transformative solution for bridging silos in map research. It enables the aggregation of traditional metadata, annotations, and digital representations of maps into a unified, interoperable framework. For early modern Dutch maps, this could unlock their potential for large-scale computational analysis while ensuring that annotations and metadata are linked to their canonical digital representations. In this way, IIIF offers a path toward overcoming disciplinary boundaries, addressing the needs of researchers, and advancing the study of Dutch colonial cartography and our reconceptualization of early modern geographies.

3. Materials and Methods

To enhance the research potential of early modern Dutch maps, we have focused on collections from the National Archives of the Netherlands relevant to the GLOBALISE project. Specifically, we targeted the Leupe collection of maps of non-European regions (4.VEL and 4.VELH, 1584-1813[6]), preparing them for the addition of annotations and enriched metadata. This collection, compiled by nineteenth-century archivist P.A. Leupe, includes manuscript and printed maps from the VOC archives and companies active in the Caribbean and South America. The Leupe maps are accessible through the National Archives' IIIF Image API, which provides access to zoomable, high-resolution images. Though the National Archives hold a significant collection, many other archives, such as the Leiden University Library and the Allard Pierson Museum (Amsterdam), also house relevant maps. We aim to incorporate their collections as well in the near future.

To enable enrichments and annotations on the maps, we converted the Leupe collection into IIIF Collections and Manifests following the specifications of the IIIF Presentation API. We utilized the archive's Encoded Archival Description (EAD) and METS files to mirror the archival hierarchy and added metadata such as titles and creation dates. Recognizing that the Leupe collection contains outdated or biased descriptions from the nineteenth century, we also linked each map to the Atlas of Mutual Heritage[7] for updated descriptions when available (van Wissen et al., 2023).

We subsequently also started annotating the maps. Our enrichments are organized into three layers, each focusing on different aspects. The first layer adds IIIF Georeference Extension annotations, which link historical maps to a modern world map. This bridges the historical and contemporary representations of the area on the map. We drew on data from an earlier crowdsourcing initiative for this step and used the Allmaps tool[8] for complementary work. In the second layer, we extracted named places from the maps. Using the text spotter model integrated in the Alan Turing Institute's MapReader pipeline (Wood et al., 2024; Xie et al., 2024), we automatically extracted and transcribed over 1.2 million textual snippets (mostly toponyms) from around 5,000 images. Finally, the third layer focuses on map symbols that represent geological, human habitation or colonial features. For this, we applied Meta's SAM 2 zero-shot segmentation model[9] to identify symbols—like a flag marking settlements or

[3] https://globalise.huygens.knaw.nl/
[4] https://florentinecodex.getty.edu/
[5] https://mandragore.bnf.fr/
[6] https://www.nationaalarchief.nl/onderzoeken/archief/4.VEL; https://www.nationaalarchief.nl/onderzoeken/archief/4.VELH
[7] https://www.atlasofmutualheritage.nl/
[8] https://allmaps.org/
[9] https://ai.meta.com/sam2/

trees indicating plantations. We manually classified a sample of extracted features to train a classification model. Definitions for these classes will be provided using a controlled vocabulary, linked to the Getty Institute's Art and Architectural Thesaurus (AAT)[10] and other relevant external resources where applicable. This layer provides insight into world geographies as encountered in Dutch maps, the Dutch colonial worldview and its evolution in the early modern period. We aggregated all enrichments, along with the image metadata into a single IIIF Manifest following the Web Annotation standard[11], allowing to view and analyze each annotation layer independently or in combination. The annotation layers are also available for separate download, allowing for offline analysis.

These experiments will continue, in alignment with and contributing to the MapReader project, with plans to add further enrichments to the dataset. For example, we expect that the results of place name extraction can be further improved if we apply a specific Handwritten Text Recognition (HTR) model trained on early modern Dutch handwriting. We will use the open-source HTR software Loghi for this.[12] Additionally, we aim to integrate the extracted toponyms into the places dataset developed in GLOBALISE, linking them through Linked Open Data to facilitate richer contextualization and understanding of these locations.[13] Below, we highlight two areas where we plan to further explore the enriched map material in relation to other archival sources.

4. Use Cases

4.1. Remarrying Maps to Text and Reconceptualizing Histories of Early Modern Kerala

Information from maps and textual archives complement each other, and their combination can unlock new insights into underexplored historical regions like early modern Kerala (India). This region was strategically important to the VOC, which maintained a presence there from 1663 to 1795. The Company's archives contain rich textual descriptions that enhance our understanding of Kerala's geography and politics. The VOC also produced over thirty detailed maps of Kerala, now part of the Leupe collection. These maps depict coastlines, mountains, and use recognizable symbols to mark key locations such as fortresses, churches, temples, and kingdom boundaries. Together with the archives, they form one of the most extensive yet under-utilized sources of place-related information for early modern Kerala. Although maps like the Roz-Nama indicate the presence of an indigenous map-making tradition (Schwartenberg, 1992), they lack the scope and detail of the VOC maps.

Our integrated approach, implemented in the *Necessary Reunions* project, starting in 2025, combines automatically extracted data from both maps and textual archives, offering a deeper understanding of the region. Maps and texts are especially valuable when paired, as visualizations often clarify location details that written descriptions cannot fully convey. For example, a 1736 document describes VOC territorial control in Cochin but only the 'situation map of Cochin' from the same period, which shows a moat, provides a clear indication of the territorial boundaries (Figure 1).[14] Textual descriptions of the extent of kingdoms can similarly be synthesized with visualizations of the size of kingdoms on maps. Using Linked Data, we will link annotations directly to the digital representations of the Kerala maps and add links to textual materials and reference data made available by the GLOBALISE project. This effort will contribute to envisioning the political landscape of early modern Kerala, which is unexplored territory in the history of the region.

4.2. Measuring the Impact of Dutch Colonialism

European colonial domination in the Global South, which began in the early modern era, has had lasting effects on culture, migration, land use, and economics. But how extensive are these impacts? While historical studies based on written sources provide insights into where and how long colonial powers exerted influence, maps offer a valuable complement. For instance, Kusumaningrum et al. (2021) showed that river courses on maps could identify Dutch sand mining activity in South-West Sulawesi. Maps also provide information on, for example, the extent of tin mines, another quantitative indicator of colonial rule.

Our goal is to assess the depth of Dutch colonial influence in the early modern period by extracting and analyzing consistent visible features on historical maps, such as agricultural land (e.g., sugar and cotton plantations, see Figure 2 for an example) and building locations. Using our approach of georeferencing and annotation of visible features, we can easily overlay maps from different periods, revealing the extent of colonial presence across Dutch-influenced regions through time. Annotations linked to these maps, such as details of plantations and colonial infrastructure, will be displayed with metadata and brief descriptions. This will allow us to create interactive maps for different sub-periods, providing a dynamic visual representation of colonial control. We recently applied for funding to further explore this approach, which will also enable us to analyze correlations between historical colonial influence and modern developments.

5. Discussion

Our dataset is a work in progress. The decision to publish it at this stage reflects the collaborative potential of the IIIF approach, which allows for the ongoing annotation and enhancement of the early modern Dutch historical map collection by a broader community of scholars. This framework not only facilitates shared access but also supports the continuous improvement of the dataset as more users contribute to its development.

As outlined in the methods, the use of automatic text extraction and georeferencing tools has allowed us to process a large collection of maps. However, we acknowledge that the quality of our annotation layers is lower than that of manually annotated maps or maps for which bespoke models have been trained. For instance, our extraction of toponyms and geographic features via text spotter and segmentation models that were not specifically trained for the materials introduces some degree of noise. Yet, this reflects a trade-off we consciously made, prioritizing the ability to analyze a vast collection of over 5,000 maps, rather than focusing on a smaller, meticulously curated set of high-precision data.

[10] https://www.getty.edu/research/tools/vocabularies/aat/
[11] https://www.w3.org/TR/annotation-model/
[12] https://github.com/knaw-huc/loghi
[13] The GLOBALISE places dataset focuses on providing the geographical coordinates, place type, and name and spelling variation information of places mentioned in the VOC archives. Versions of this dataset will be published over the next two years on https://datasets.iisg.amsterdam/dataverse/globalise.
[14] Copy of the Council Resolutions in Cochin, Wednesday, August 29, 1736.NL-HaNA, VOC, inv. no. 2378, scan no. 950, transcription GLOBALISE project (https://globalise.huygens.knaw.nl/), March 2024.

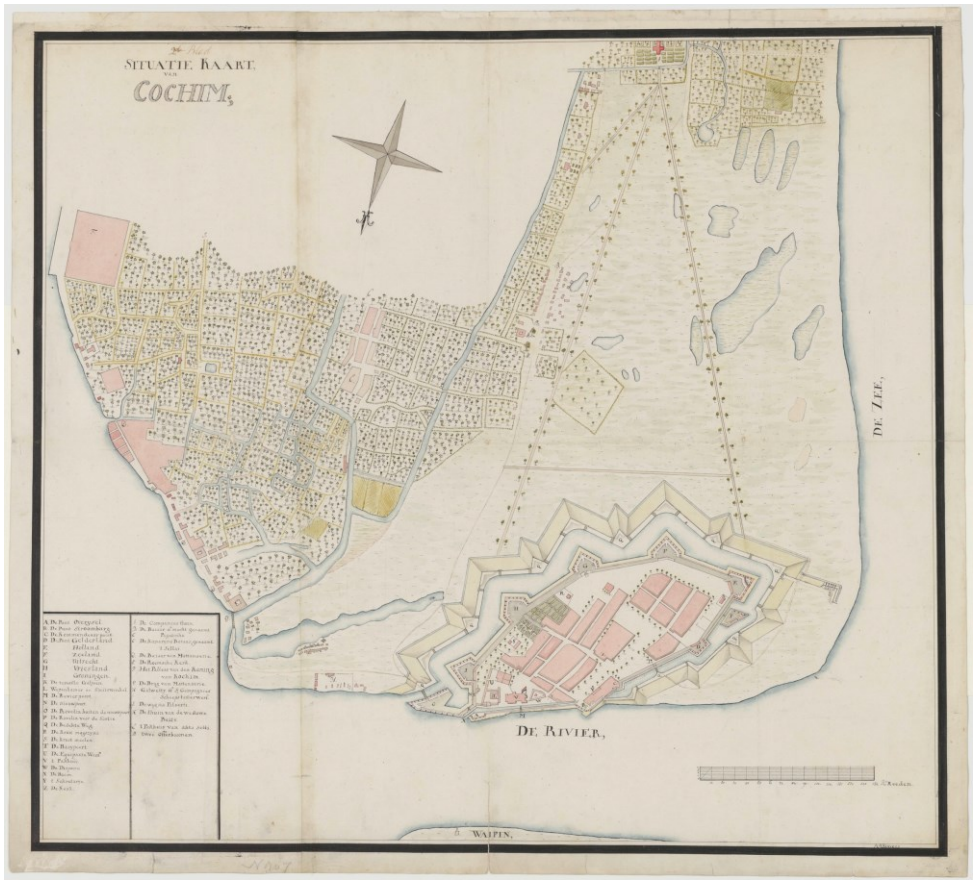

Figure 1. Map of Cochin, 18th century. Source: NL-HaNA, 4.VEL, inv. no. 907, http://hdl.handle.net/10648/1ee0e682-3223-4a6a-90fd-c05536198d5c. License: CC0

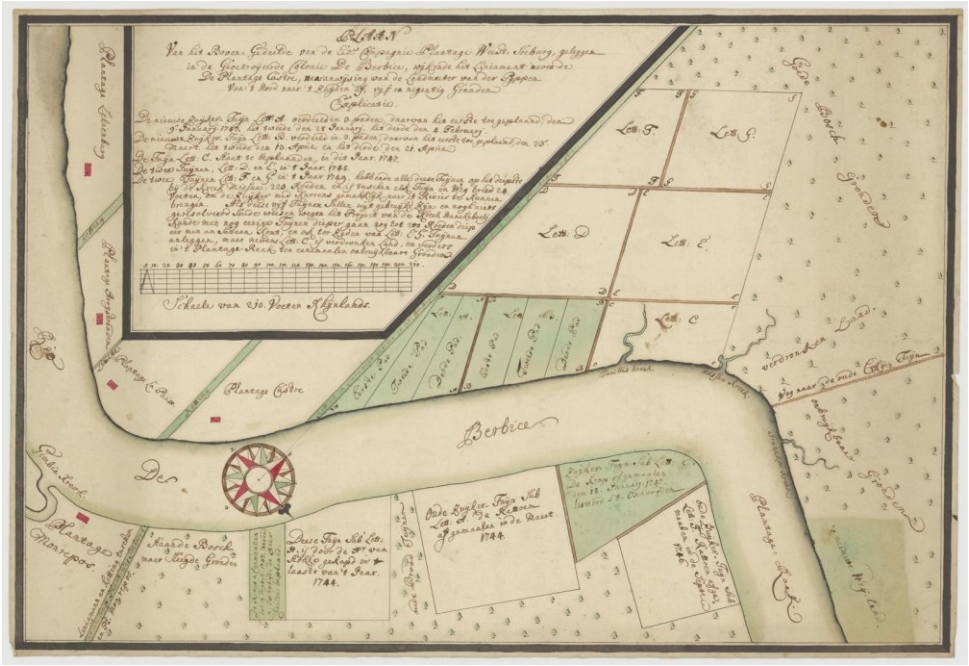

Figure 2. Map of a part of the plantation West-Soeburg in the Berbice colony in modern Guyana, 1747. It clearly depicts plots of land designated for sugar cane and cotton cultivation. Source: NL-HaNA, 4.VEL, inv. no. 1592, http://hdl.handle.net/10648/7ce85993-302c-4ab0-b89b-335895e19a59. License: CC0.

This trade-off is particularly justified by the potential for large-scale historical and geographical insights that emerge from examining this broader collection. For instance, the integration of map data with textual archives offers novel opportunities for understanding historical topographies as is the case with early modern Kerala, for which the VOC's maps and records are immensely rich but underexplored sources. Additionally, the insights about the depth of colonial influence that can be gained from maps, combined with contemporary datasets, allow for a more comprehensive understanding of Dutch colonial impact, especially in areas like land use and settlement patterns.

In conclusion, while our annotation layers may lack the precision of bespoke models, the sheer volume of data generated by automated methods and made available in an interoperable way significantly enhances the research potential of historical maps, paving the way for further exploration. We anticipate that as more archives adopt the IIIF Presentation API and as further enrichments are added, the quality of both the data and its analysis will continue to improve. Our publication of this dataset aims to initiate this process of collaborative refinement, providing a foundation for ongoing research that can incorporate both larger datasets and more specialized, precise models in the future.

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Contribution statement: Leon van Wissen conceptualized the processing and annotation of maps based on the IIIF Presentation API specifications, initiated a data workshop that highlighted the immense value of early modern Dutch maps, and developed the dataset. Together with Manjusha Kuruppath, he also made significant contributions to this article, which was primarily authored by Lodewijk Petram.

Data Availability Statement: The scanned maps are freely available under a CC-0 license from the National Archives of the Netherlands via their website. The IIIF Collections and Manifests generated by GLOBALISE are hosted by the project, with a copy, including the scripts used to generate them, available as a data dump on Zenodo under a CC-BY-4.0 license: https://doi.org/10.5281/zenodo.13860149. This data dump also includes a copy of the project's GitHub repository, which contains scripts and data related to various enrichment processes: https://github.com/globalise-huygens/maps.

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