

Uralic Historical Atlas (URHIA): Interactive Web App for Spatial Data

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Abstract

In this paper, we present an interactive web mapping service designed to display spatial historical data for both scientific and general audiences. The service, Uralic Historical Atlas (URHIA), was developed using user-centered design framework with Uralic linguistics researchers as the primary end-users. The platform is based on GeoNode, a local spatial data infrastructure supported by the University of Turku. Originally focused on Uralic language datasets, the platform has since been expanded to serve as other data collections as well. For example, we introduce the Archaeological Artefact Atlas as a developing case study. This paper outlines the technical solutions behind URHIA and highlights how it enhances research accessibility and usability for a broad audience.

Keywords

Uralic language speaker areas, spatial analysis, GIS, Archaeological artefact database of Finland, user-centered design

1. Introduction

The University of Turku has a 15-year tradition of interdisciplinary collaboration among geographers, biologists, linguists, and archaeologists to study the human past and the evolution of the Uralic language family (also known as the Finno-Ugric family)^{1,2,3}. This research has resulted in the compilation of various databases, including spatial datasets, on human diversity in Finland and Northern Eurasia, which are made available under an Open Access license. Although these data collections are freely available, as detailed in Vesakoski et al. (this volume), we recognize that not all users are proficient with computational tools, which may limit their ability to fully utilize the data. To enhance the accessibility and usability of these data collections for both researchers and the general public, we created the Uralic Historical Atlas (URHIA)⁴, an interactive spatial data platform. URHIA is built on GeoNode (by GeoSolutions), which forms the foundation of the University of Turku's spatial data infrastructure⁵. Here, we detail the technical solutions employed to apply this platform for the Archaeological Artefact Database of Finland (AADA). A description of the user-centered design framework used during the first phase of URHIA's development, focusing on the cartographic database of Uralic language speaker areas, has been provided elsewhere (Roose et al. 2021). As part of this process, the study reviewed 12 spatial data platforms related to human-history research, focusing on low-cost, collaborative, and interactive map functionalities. Platforms were analyzed across 20 characteristics, including organizational purpose, thematic content, and design features.

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¹ <https://bedlan.net/>

² <https://sites.utu.fi/urko/>

³ <https://humandiversity.fi>

⁴ <https://urhia.fi>

⁵ <http://geonode.utu.fi>

⁶ <https://sites.utu.fi/urhia/aada/>

Through collaborative teamwork and a commitment to user-centered design, URHIA has evolved into a dynamic tool that addresses diverse research needs. This mapping service features the Uralic Language Atlas and the Archaeological Artefact Atlas of Finland, underscoring the commitment to scientific FAIR principles (Findable, Accessible, Interoperable, and Reusable).

2. Thematic spatial datasets and URHIA spatial data platform development

We are actively developing the URHIA platform to dynamically visualize various thematic spatial datasets, extending beyond what typical data repositories can offer. This platform serves as an interactive data showroom, allowing users to explore and engage with information from multiple data collections in an immersive way.

Currently, the platform showcases the Uralic Language Atlas (Fig. 1a), which maps Uralic language speaker areas and the newly launched Archaeological Artefact Atlas (Fig. 1b), an interactive version of the Archaeological Artefact Database of Finland (AADA). The Uralic Language Atlas is based on a comprehensive Geographical Database of the Uralic Languages developed by Rantanen et al. (2022), which maps both historical and contemporary distributions of Uralic languages. This unique polygon dataset was created by integrating expert knowledge with digitized maps from the literature. The Archaeological Artefact Atlas, in turn, is based on extensive dataset compiled by Pesonen et al. (2024). The dataset publication includes approximately 38,000 individual artefacts and 10,000 pottery type identifications, spanning from the Early Mesolithic to the end of the Iron Age in Finland (c. 8900 calBC–1300/1500 calAD). The development of AADA was a monumental effort, with archaeologists systematically visiting museum archives and documenting artefacts between 2013 and 2020.

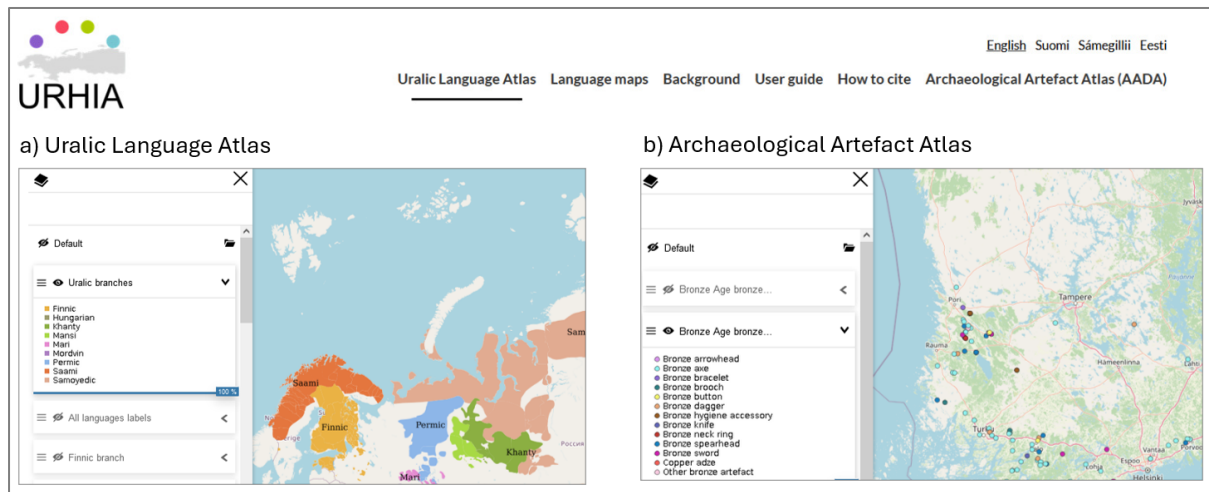


Figure 1: Example of the URHIA web app window: a) Uralic Language Atlas⁴ showing language branches, b) Archaeological Artefact Atlas⁶ displaying Bronze Age artefacts in Finland.

2.1. Technical decisions in initiating URHIA

The initial development of the URHIA platform (URKO project 2020-2022) followed a user-centered design process (Roose et al., 2021), which led to the creation of the Uralic Language Atlas. For the platform's technical foundation, we chose GeoNode (version 2.0), an open-source geospatial platform that is Copyright 2018 Open Source Geospatial Foundation (OSGeo). This decision was influenced by the support provided by the University of Turku, which simplified infrastructure setup, maintenance, and ensured long-term sustainability. In 2023, the platform was upgraded to GeoNode version 4.0, with GeoServer 2.23 as the application server. This update introduced more advanced front-end tools that would improve URHIA's functionality in the next development steps.

GeoNode's open-source nature allowed for flexible modifications tailored to URHIA's specific needs, while its lack of licensing fees was a significant advantage for an academic project working

within a limited budget. Additionally, GeoNode offers built-in tools for data management, making the integration of data, metadata, and map visualizations more streamlined and efficient. The platform's user-friendly interface makes it accessible to both expert and general users, aligning with URHIA's goal of serving researchers as well as the public.

A key strength of GeoNode is its scalability, allowing the platform to grow by incorporating new datasets and functionalities without requiring significant overhauls. However, extensive customization beyond its default features demands technical expertise, which can be time-consuming and may require external support for teams with limited resources. GeoNode, like any web-based platform, also has potential security vulnerabilities, so implementing security best practices and regular updates is crucial.

While GeoNode is relatively easy to use, creating a seamless and intuitive experience for non-expert users still requires significant customization. Ensuring the platform to be fully accessible to a lay audience proved to be more resource-intensive and demanding than initially anticipated.

2.2. Technical decisions in developing Archaeological Artefact Atlas

The atlas aims to provide data and present artefact distributions on a map according to user requests, offering a spatio-temporal context for comparing artefacts across different time periods and regions. Developing the Archaeological Artefact Atlas of Finland within the URHIA spatial data platform posed unique challenges due to the specific needs of archaeological data. One major challenge was related to the spatial overlap of artefact finds. Typically, several artefacts have been discovered at a single excavation site, making it difficult to display all of them on a single map. To address this issue, URHIA incorporates custom functionalities that allow users to filter and subset large datasets based on specific attributes. This ensures that the data is presented in a meaningful way without overwhelming users with dense clusters of overlapping points (Figure 2).



Figure 2: A visualization of how the archaeological finds can be filtered and classified based on the artefact attributes and how overlapping finds can be shown as clusters in the Archaeological Artefact Atlas of Finland.

Another challenge was managing datasets with negative dates, particularly representing periods before 0 BC. GeoNode, like many other GIS platforms, typically uses positive integers to represent dates, which can lead to issues when working with ancient time periods. To resolve this, we implemented a temporal dataset using thematic time layers, such as the Bronze Age layer (e.g., Figure 1b). These layers allowed us to separate and display archaeological data from different historical periods. The key improvement goal for the next development step is to enhance the temporal filtering, which is to incorporate database query based on specified time period e.g. with a timeline slider, also available within GeoNode's current frontend.

Another development currently in progress is the integration of photographs of artefacts (Moilanen et al., 2023) directly into the map, which will enrich the spatial data with visual context. Once implemented, these images will be displayed in pop-out windows on the platform, as illustrated in Figure 3. This feature aims to allow users to engage with the archaeological data more intuitively, offering a more immersive exploration of artefacts in their geographical locations.

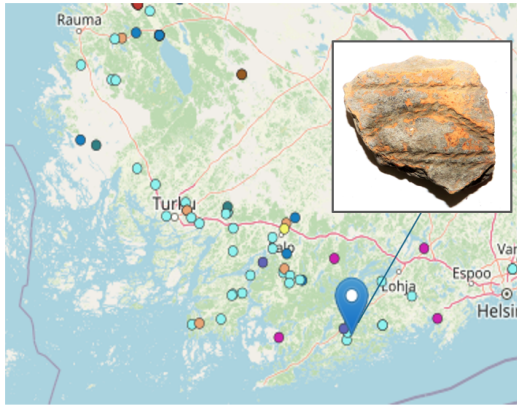


Figure 3: Sketch of a pop-out window of the Archaeological Artefact Atlas of Finland for archaeological artefact photographs.

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