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Research Article

A Geospatial Approach to Modelling Social, Religious and Political Shifts in History

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Abstract: The present paper introduces the project RELIC (Modelling Religiopolitics. The Imperium Christianum via its Commoners), conducted at the University of Vienna, and the Natural History Museum Vienna, funded by the European Research Council, highlighting the main potential in research and describing the project's methodology. RELIC proposes a complex, comparative analysis and contextualisation of archaeological and historical remains of the rural population living on the eastern fringes of the later Holy Roman Empire during the Ottonian and Salian periods (10th -12th c.), exploring the influences of centres and networks of secular and ecclesiastical lords, of the natural environment, and of the economic infrastructure. Investigating this often-overlooked segment of the population and its hitherto unexplored or neglected role allows us to study how (top-level) changes in political and ecclesiastical organisations can be reflected in the evidence concerning the lower levels of society and of the local church network, how different strategies worked in different political settings, and what role local initiatives/agencies could have played in religious and political shifts. The archaeology of Christianisation frequently focuses on one crucial aspect, i.e. the division of pagan and Christian elements, based predominantly on cemetery types and some aspects of the material culture. The spatial contextualization of burial customs and material remains, particularly through comparative and large-scale analysis, has the potential to reveal new narratives about the pagan-Christian transition and the phenomenon of transitional cemeteries.

Keywords: Christianisation; OpenAtlas; GIS; Central Eastern Europe; Medieval Europe

Highlights:

- RELIC explores Christianisation through geospatial, historical and archaeological data.
- Spatial patterns of church networks reveal political-religious dynamics.
- The OpenAtlas framework enables digital analysis of historical and spatial data.

1. Introduction

This paper addresses how the Christianisation of rural East-Central Europe unfolded during the 10th–12th centuries. By combining geospatial methodologies with historical narratives, it explores the role of rural populations in shaping ecclesiastical networks and adapting to political changes. The study seeks to answer how spatial patterns reflect religious transformation and how local contexts influenced these processes. This research fills a gap by focusing on underrepresented rural networks within the broader framework of medieval state formation.

Carefully interlaced actions of secular and religious leaders are a timeless and worldwide phenomenon observed throughout history as well as today, as transmitting political narratives by the Church to the general public has always been a highly effective way of indirectly building political support. Processes such as Christianisation, frequently tied to "the making of Europe" (Bartlett 2015), are particularly pertinent to current societal contexts. Narratives of state formation and the foundations of Christian kingdoms—often emphasising shared beginnings and a common Christian heritage—are particularly relevant to modern political narratives, especially in the states of present-day Central-Eastern Europe. But what do we actually know about this process as a regional phenomenon from the perspective of the general population? How was Christianisation received, and how did it truly unfold in rural areas where most of the population lived? These are difficult questions to answer. There are contrasting and sometimes conflicting historical and archaeological perspectives. Historians often interpret individual (princely) conversions and the institutionalisation of Christianity at higher levels with certainty, while material evidence suggests that the process at lower levels was not always a purely religious act but often a political one—more of a gradual adaptation than a single event.

The dramatic changes in the political and ecclesiastical landscape after the first millennium in present-day Central Europe led to the significant expansion of the Ottonian, later known as the Holy Roman Empire. This expansion followed the principles of the *Imperium Christianum*, an idea introduced by Charlemagne and consciously revived by Emperor Otto I and his predecessors. This model influenced the emerging Slav and Magyar kingdoms on the Empire's eastern peripheries.

Narratives of Christianisation have largely been constructed from written accounts and the foundations of the highest Church institutions, focusing on the secular and ecclesiastical elite. The primary objective of the project RELIC is to undertake a comparative investigation of the Christianisation processes in East-Central Europe using novel approaches and methodologies. The study focuses on the rural population, their churches, and cemeteries and contextualises them in a regional and international comparison. The proposed research will incorporate an interdisciplinary examination of the Christianisation of commoners and the development of the early rural church network. This will include a comparative analysis of archaeological and historical evidence, employing digital methods to analyse large-scale data. The state-of-the-art in this field allows for a synthetic approach and a comparative assessment of regional data on Christianisation narratives. By applying the OpenAtlas framework to the data, we will create a comprehensive analytical database, which will enable the evaluation of the lower levels of the ecclesiastical network and local Christianisation processes.

The project focuses on regions including Silesia, Lesser Poland, Bohemia, Hungary, and the territories of Carinthia and the Bishopric of Salzburg. These regions are geographically and historically interconnected; the implementation of institutionalised Christianity played a crucial role in securing and expanding the Ottonian Empire's supremacy. Similar processes were observed in Poland, Bohemia, and Hungary. Initial efforts at Christianisation in these territories were primarily directed from the Bishopric of Salzburg. However, modern state borders and language barriers have significantly impacted the research of this region, often resulting in isolated narratives.

Our project proposes a novel approach to studying Christianisation on multiple spatial scales. Firstly, instead of concentrating on the upper echelons of society and extensively studied historical evidence, the focus will be on predominantly unpublished and unutilised archaeological data archives from the most informative sites concerning the Christianisation of commoners. On a macro level, the site locations of rural churches and field cemeteries can be contextualised concerning each other and the networks of secular and ecclesiastical power centres, such as the seats of the king, lords, and ecclesiastical dignitaries. Secondly, spatial relations of these sites will be supplemented with inter- and intra-site level analyses of material evidence from well-researched and published sites, including burial customs, liturgical objects, and grave accessories. The results of the archaeological analysis will be compared and contrasted with historical evidence and existing narratives on conversion and Christianisation.

2. Literature Review

To contextualise the process and the proposed approach, the following section will provide a brief overview of the thoroughly reconstructed historical events of the Christianisation of the Germanic, Slavic and Hungarian populations and review the most essential historical and archaeological literature connected to it.

Despite the presence of Christian communities in the territory of the Late Roman Empire, the Eastern Alps region lacked uniform continuity in Christian practices, particularly in religious infrastructure. During the sixth and seventh centuries, the ethnic landscape of Bavaria and Carinthia was reshaped by remaining populations and immigrating Germanic- and Slavic-speaking groups, resulting in different histories of Christianisation for these areas.

In Bavaria, Christian tradition remained strong, supported by Christian dukes in the sixth century and various missions in the seventh century. However, organising a stable, multi-level church network and the institutionalisation of Christianity were linked to the re-establishment of the bishoprics of Salzburg and Passau around the mid to late eighth century (Wood 2001; Winckler 2018; Winckler 2019). In contrast, Carantania's Christianisation began with the conversion of the Slavic elites in the mid-eighth century as part of their alliance with the Bavarian dukes, seeking protection from the Avar threat (Fazioli 2015). Various forms of Christianity emerged in parts of Carantania (Glaser 2012), with the process documented in the text of the Conversio Bagoariorum et Carantanorum, written around 870 to legitimise Salzburg's claim over Carinthia and Lower Pannonia (Wolfram 1995; Wolfram 2012; Eichert 2010).

The archbishopric of Salzburg became the centre for Christianising missions in Carantania, Moravia, and Pannonia (Reindel 1964). The implementation of institutionalised Christianity often coincided with Frankish expansion, underscoring the influence of secular political powers (Koller 1972). Missionary work and colonisation proceeded simultaneously, with dioceses such as Regensburg and Freising also receiving lands. Local churches and monastic institutions began to appear in the late eighth to early ninth centuries north of the Karawanks, whereas similar developments south of the Drava River occurred later due to less active involvement from the Patriarchate of Aquileia (Bratož 1990). Local Christian elites often established their seats in reused Roman-era manors where churches (Hofkapelle) were also built (Lehner 2013). However, conflicts with the Moravians and Magyar raids disrupted ecclesiastical networks, halting development in these territories for half a century following the battle of Pressburg in 907 (Nowotny 2012).

Christianisation processes in neighbouring countries exhibited both similarities and differences. The Moravian princes, led by Mojmír, were baptised in 831 by the bishop of Passau, followed by the Bohemian princes in 845. Géza, the prince of Hungary from the Árpádian dynasty, was baptised in the late tenth century. These conversions were politically motivated, aiming for peace with the Frankish (or Ottonian) Empire. The baptism of Bohemian and Moravian princes had minimal immediate effects on their subjects, with continuous pagan practices observed in the Moravian centre, Mikulčice, until the arrival of missionaries Constantine and Methodius in the 860s. Using the Slavic language and liturgy, these missionaries catalysed the conversion of the Moravian population. Svatopluk, the ruler of Moravia, made several attempts to establish an independent Church of Great Moravia, though this organisation never achieved stability and was later destroyed by Hungarian attacks in 907 (Sommer et al. 2007).

Bohemia, however, persisted. In 873, Prince Bořivoj, the first Přemysl ruler, was baptised by Svatopluk. Although Bohemian churches were initially under the bishopric of Methodius, a more organised church system emerged in Central Bohemia under Spytihněv I (889–915). By 895, the Bohemian Church fell under the jurisdiction of the bishopric of Regensburg. The full implementation of institutionalised Christianity and the establishment of a church network were primarily achieved by Boleslav I (c. 935–972), with the founding of the bishoprics of Prague and Olomouc delayed until 973 due to the need for permissions from Regensburg and the Emperor. The first archbishopric was not established until 1344, reflecting the Church's long-dependent status (Sommer et al. 2007, Štefan 2022, Kalhous & Šrámek 2024, Štefan 2024).

The Christianisation of Poland is equally complex, with Mieszko's baptism in 966 traditionally marked as the starting point. However, archaeological evidence suggests that effective, institutionalised Christianisation occurred during the reign of his son, Bolesław the Brave (992–1025), who established the archbishopric of Gniezno in 1000 and the dioceses of Wrocław and Kraków, and thus implemented institutionalised Christianisation in Lesser Poland and Silesia (Bukowska 2012; Urbańczyk 2019, Urbańczyk 2024). The inclusion of the entire country in the Christian network was a separate and complex process, which, unfortunately, exceeds the limits of both the project and the present study.

It is evident from the historical overview that there are similarities and differences in the Christianisation processes across the region. Although various elements of these processes have been studied in detail, there are no comprehensive studies of rural churches and their geospatial relationships to ecclesiastical and secular centres, nor synthetic studies focusing on the Christianisation of the rural population as such. References to the local church network, the smallest yet most fundamental unit of the ecclesiastical system, are seldom found. As a result, theories regarding the development of the Church as an institution often lack direct evidence and reconstructions, with major narratives of Christianisation overlooking the part of the Church system that directly represented the majority of society. The local churches were in direct contact with the masses of commoners, whose conversion was crucial for providing income to the Church and forming the "body" of the Christian community. Regulations concerning the collection of tithes—an essential income element for local churches and bishops—appear as early as the 9th century in the Carolingian Empire (Eldevik 2003). In Hungary, for instance, the introduction of tithes, along with detailed secular legislation concerning the equipping of churches for masses, appears in 11th-century law collections (Bak 2000), indicating the integration of the local population into the Church and highlighting the importance of the lower ecclesiastical network from the early stages of the newly Christianised state. The collective and cumulative role of rural communities (the majority of society) and the local church network was to maintain and stabilise this system in the long term, supporting state power and the "new order" both politically and economically. However, little concrete information remains available on this aspect.

While archaeology has introduced new directions in researching Christianisation from Late Antiquity to the High Middle Ages, it mainly focused on material culture, burial customs, and religious identity transformations. Moreover, archaeological research is often segmented in time and space, highlighting further the need for a comprehensive approach to understanding religious transformations and identities within broader political, social, and economic contexts (Thomas et al. 2017, 328–29; see also Hadley 2007; Hoggett 2007). RELIC aims to address gaps in our understanding by examining the spatial-hierarchical elements of Christianisation models, such as the relationships between churches and fortifications, proprietary churches, investigating the politically driven, top-down nature of Christianisation, its role in state and alliance formation, and contrast it to locally developed, bottom-up Christianisation processes.

The study of cultural landscapes as layered entities has been a growing focus in historical geography, often collating and mapping cultural heritage sites to reveal how layers of civilisation superimpose to create complex historical landscapes. While it is not possible to give a complete overview of this topic here, some examples on the narrower field are highlighted here to underline the potential of spatial approaches to religiopolitical changes in medieval times. Klimanova and Kolbowsky (2017) exemplify this approach in their analysis of cultural palimpsests in the Mediterranean Basin. Their work employs GIS-based mapping to uncover how successive civilisations shaped the physical and cultural landscape, focusing on integrating religious and secular elements over time. By identifying spatial patterns of religious structures and settlements, they demonstrate how interactions between natural environments and human activities created enduring layers of cultural transformation. Similarly, Pleterski's (2024) work exemplifies this approach by focusing on the interplay between burial sites, settlement structures, and geomorphology in the Eastern Alps, particularly about the processes of Slavicisation and Christianisation. His micro-regional analysis demonstrates how spatial data, combined with historical narratives, can illuminate the strategic placement of burial sites and their evolving relationships with ecclesiastical power centres. Although in another setting and with a slightly different methodology, Triplett (2017) also demonstrates how advanced GIS tools can visualise overlapping spheres of influence and the strategic positioning of fortifications along religious frontiers. This work highlights how spatial analysis, including viewshed and cost-distance methods, can elucidate patterns of territorial control and surveillance in contested regions. Finally, in one of RELIC's preliminary studies, Vargha (2022) emphasises the importance of spatial analysis in contextualising Christianisation within Hungary's medieval rural church networks. Combining archaeological evidence, material culture, and geospatial tools, provides a multi-scalar framework for understanding how local church networks were integrated into broader religious and political structures, offering an innovative approach to regional transformations during the 11th and 12th centuries. These studies underscore the value of spatial analysis in understanding long-term transformations shaped by interactions between natural environments and human societies. By focusing on burial sites and ecclesiastical networks, RELIC extends this line of research, capturing not only the physical layers of transformation but also the socio-political dynamics that underpin them. This layered perspective situates RELIC within a broader academic discourse on the role of landscapes as archives of cultural and religious change.

3. Materials & Methods

The RELIC project distinguishes itself from similar initiatives, such as the Corpus Architecturae Religiosae Europeae (CARE) project and the Early Christian Churches and Landscapes (ECCLES) project. While projects like CARE focus on cataloguing and documenting early Christian architectural sites (Brogiolo & Jurković, 2012), and ECCLES explores the spatial and cultural contexts of early Christian churches (https://earlychristianchurchesandlandscapes.wordpress.com), RELIC approaches Christianisation comprehensively, collating data from archival sources to well-published sites and integrates geospatial analysis and advanced data management tools to uncover patterns of religious transformation at broader spatial and temporal scales. By reviewing, organising, and analysing diverse datasets, RELIC provides a systematic framework that captures the interplay of local, regional, and political influences in the Christianisation of East-Central Europe, offering new avenues for comparative and cross-disciplinary studies.

RELIC collects data on the above-mentioned entities. This, on a general level, includes churches, monasteries, fortifications, rural and urban settlements, cemeteries, and the latter includes all relevant information on various levels and in multiple layers down to burials and single artefacts.

In order to deal with such a complex and diverse pool of information, the team utilises the open-source software OpenAtlas (https://openatlas.eu, see also: Watzinger 2019) for data acquisition and data management. It has been developed by a team from the Natural History Museum Vienna (NHMW) and the Austrian Centre for Digital Humanities and Cultural Heritage (ACDH-CH) of the Austrian Academy of Sciences for more than ten years now.

It stores its data not in a relational data model but rather in a network of nodes and links (entity–relationship model, Fig. 1). Each node represents an entity relevant to the project, and each link is a connection between two nodes. This allows for connecting datasets within their own domains (e.g. archaeology) and into further domains (e.g. archival sources). One example would be a church that is surrounded by a churchyard cemetery from the 10th century but also shows architectural features of the pre-Romanesque era and is mentioned in written sources with respective actors and events involved. While each entity is treated with its specific and discipline-relevant information, these interdisciplinary connections can also be mapped in the database system, which in turn allows for querying any kind of network between our sources. So almost any thinkable question can be asked of the system. One example would be to list all churches that show features of pre-Romanesque architecture,

have been excavated and do not show burials before the 10th century but field cemeteries within a perimeter of 10km and were in the property of the Salzburg bishopric.

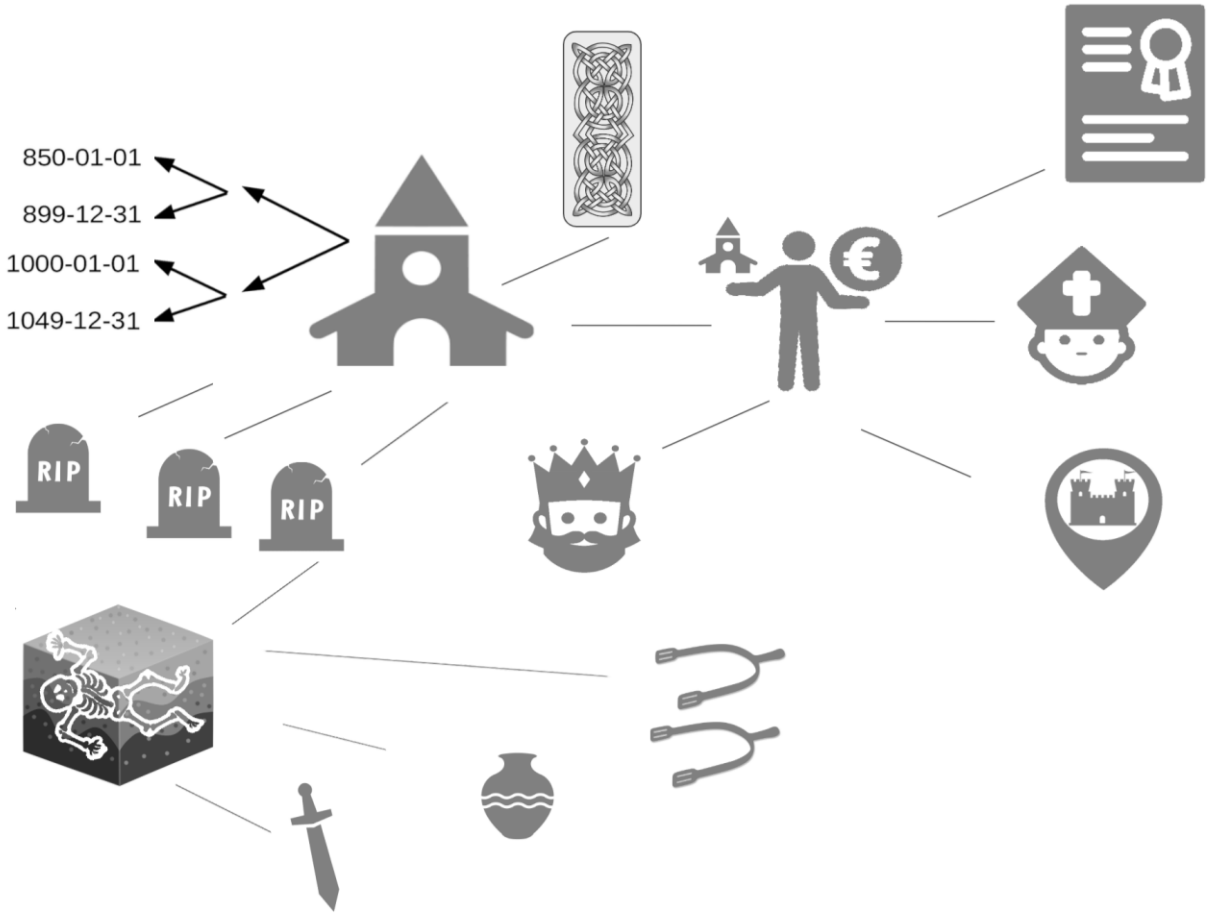

Figure 1. Visualisation of connections between various RELIC entities. Each symbol stands for one CIDOC-CRM entity. Image: (c) S. Eichert

In OpenAtlas, each entity is a node of a specific CIDOC CRM class linked to other nodes through properties defined by CIDOC CRM. This is primarily managed using two tables in a PostgreSQL/PostGIS database: one for entities and another for links.

Table 1. "Entities"

id	class	name	description
1	E18 "physical thing"	Cemetery A	Early medieval cemetery near Vienna
2	E53 "place"	Location of "1"	Location of cemetery A
3	E55 "type"	Cemetery	Site where human remains are intentionally buried
4	E31 "document"	Eichert 2010	Printed Publication of Cemetery A

Table 2. "Links"

domain id	property	Range id
1	P2	3
1	P53	2
4	P67	1

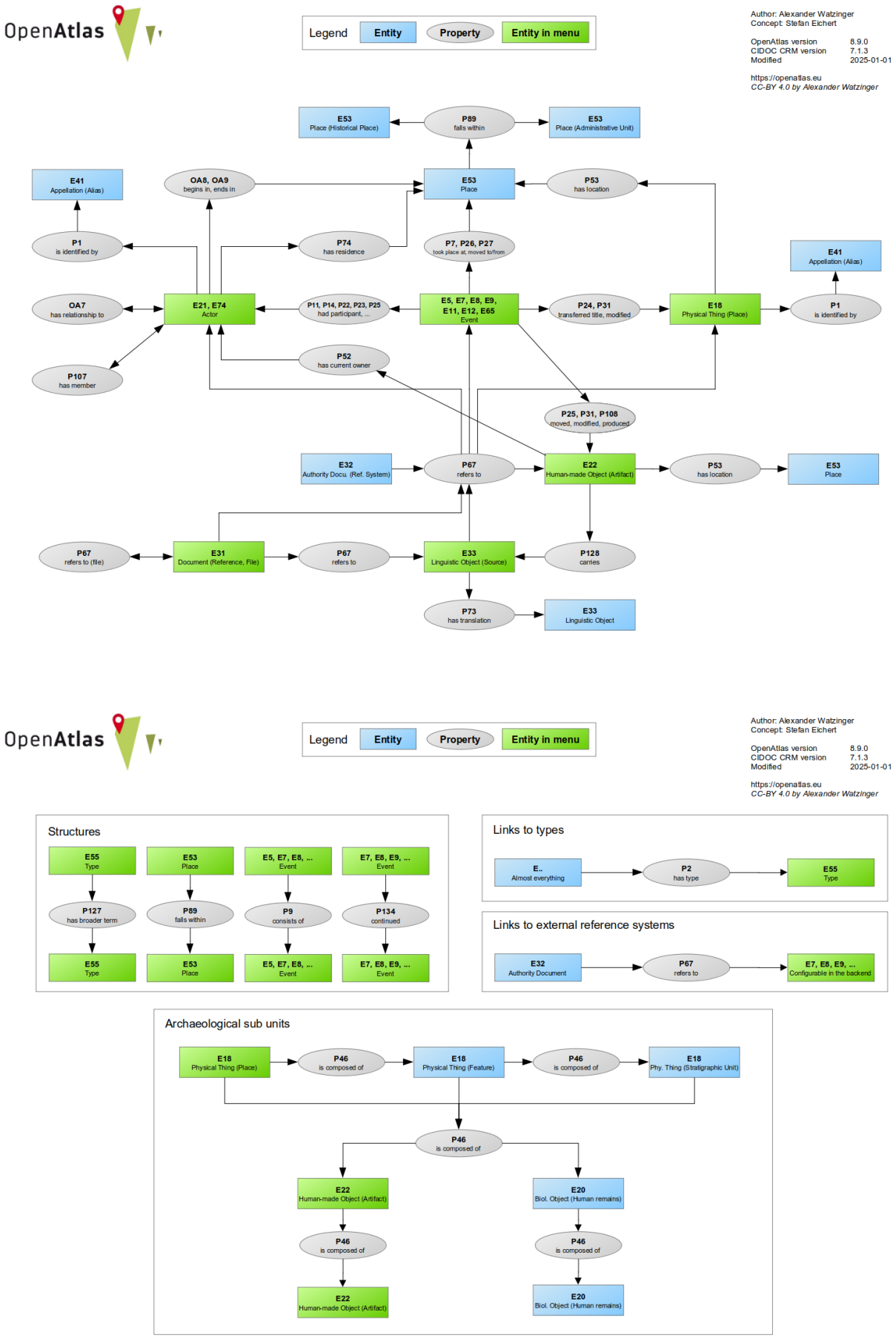

Figure 2. Mapping of CIDOC CRM entities in OpenAtlas. Image: (CC-BY 4.0) Alexander Watzinger

The "name" and "description" columns can further be resolved using P1 (has identifier) or P3 (has note).

Physical objects like excavation sites, graves, or burials are classified as E18 (physical object), while finds are classified as E22 (human-made object). Their hierarchy (site - grave - burial/skeleton - find) is defined by P46 (is composed of). Terminology is linked via E55 (type) and P2 (has type), organised hierarchically using P127 (has broader/narrower term). Each entity has a primary functional type, defining its role in the hierarchy (burial site - grave - burial - find).

Furthermore, each entity can be associated with multiple other types to "tag" them with typological or other attributes. Specific values can also be recorded to define these attributes precisely. For example, linking a find entity with a material entity and a certain percentage:

"Brooch A" (E22) has type (P2) "Copper" (E55) with a value of 80% "Brooch A" (E22) has type (P2) "Tin" (E55) with a value of 20%

By using such type entities, various domain-specific thesauri can be integrated as well. The hierarchical structure of the types allows for very detailed "tags," but they do not have to be.

These type-trees can individually be tailored to the needs of the project. Also, existing SKOS model based controlled vocabularies can be imported. Every type of entry can also be referenced with a corresponding entry from an existing reference system. This can, for example, be an identifier (along with a resolver URL) from a controlled vocabulary such as Getty AAT, WHO ICD, or Wikidata in order to make the information interoperable and more comprehensible.

To record the temporal attributes of certain entities (Eichert et al. 2016), OpenAtlas uses timestamps and/or timespans. Similar to the GeoJSON-T format (https://github.com/kgeographer/geojson-t), each physical entity can have a timespan for the beginning and end of its lifespan in addition to its spatial extent. In most archaeological contexts, this represents the temporal range within which archaeologists would date the respective object. For example, a certain type of artefact, such as an enamelled disc brooch, might first appear in the second half of the 9th century and be found in graves until the first half of the 11th century. In this case, four temporal nodes would be linked to the physical entity of the brooch:

- earliest begin: 850-01-01
- latest begin: 899-12-31
- earliest end: 1000-01-01
- latest end: 1049-12-31

Spatial quality is addressed in a similar manner (Eichert et al. 2016). When the exact spatial extent or shape of a physical object is known, such as the boundaries of an excavation area, this information is documented precisely. If the exact extent is not known, an area can be defined within which the physical object's location is guaranteed to fall. The larger this defined area, the lower the precision, and vice versa. To represent this within the CIDOC CRM framework, OpenAtlas connects an entity of class E53 (Place) with an entity of class E55 (Type) — either “shape” or “area” — using property P2 (has type). Additionally, it derives an entity of class E94 (Space Primitive) from the PostGIS geometry linked to the place through property P168 (place is defined by). Currently, polygons, points and line strings are supported.

This way data is digitally stored in a clear and well-documented manner, allowing for transfer and communication with other data sources. This approach differs slightly from other mappings, such as those by Masur et al. (2014) or Doerr et al. (2017), primarily because it does not use specialised concepts like CRMarchaeo or CRMsci, nor does it employ deeper subclasses. However, it still follows the same overall framework and extends it by an additional level, distinguishing between the stratigraphic unit and the feature containing it. Ontology experts could later define the classes more specifically to achieve greater classification precision, while OpenAtlas focuses on ensuring the highest possible level of certainty.

This technical and conceptual setup has successfully been used for various projects and RELIC can also build upon previous results. The project "Eastern Alps Revisited" (Austrian Academy of Sciences and University of Vienna) (Diesenberger et al. 2020) collected data on the Eastern Alps region.

Another project, "Frontier, Contact Zone or No Man’s Land?" (University of Vienna, Austria and Masaryk University, Brno, Czechia) (Eichert et al. 2019), focused on the Austrian/Moravian border region.

The "Digitising Patterns of Power" project (Austrian Academy of Sciences) (Popović et al. 2019) expanded the dataset to include additional sites from Austria and Czechia.

Since 2019, additional data from Bohemia has been incorporated as part of the “MEDCEM - Medieval Cemeteries at the Periphery of the Carolingian World” project, carried out by the Archaeological Institute of the Czech Academy of Sciences (https://thanados.net/about/medcem).

Currently, the "THANADOS" project (The Anthropological and Archaeological Database of Sepultures) is ongoing (https://thanados.net), (Austrian Academy of Sciences and Natural History Museum Vienna) (Eichert 2021). It began in June 2019 and is now long-term established at the Natural History Museum Vienna and continuously developed further.

Therefore, the RELIC project can build upon an already existing conceptual and technical framework and reuse the data from the above-mentioned projects. Besides, the data pool will be enriched with new data from the regions under study.

To disseminate the data, the existing public web application of THANADOS will be adapted and expanded to handle "non-burial" data. The application utilises Python and Flask on the server side, and HTML5, JavaScript, and CSS on the client side, leveraging common open-source web technologies. Data is retrieved from the database via the application, transferred to the browser in JSON or GeoJSON format, and then visualised on the client side according to the context.

The framework Bootstrap (currently version 5.x) has been employed for a responsive interface. Each location or entity has its own landing page with a persistent URL for unique identification and access. Metadata is embedded in the HTML source, and a FAIR Data Object Assessment Metrics evaluation (https://www.f-uji.net/) currently indicates a FAIR level of "moderate" with over 50%.

These landing pages provide comprehensive information on each entity, including links to related entities. A full catalogue of all linked entities can also be displayed. If a site has a defined location, an interactive map is available showing spatially documented graves, buildings, and findings, with each feature represented as GIS geometry. This is implemented using the JavaScript library "Leaflet.js", which supports various GIS functionalities and query options for mapping, visualisation, and spatial analysis directly within the browser at the intra-site level.

Additionally, a dashboard for each site visualises key statistical data using diagrams and plots, created with open-source JavaScript libraries "charts.js" and "D3.js". Inter-site comparisons can be made through interactive charts, and global searches allow for queries combining any search criteria to explore the entire dataset. Results are presented in tabular form and on a map.

All data can be downloaded in CSV, GeoJSON, and image formats. All generated results and information are made available as open data under the Creative Commons Attribution International 4.0 license. Where third-party or differently licensed data is used, it is clearly marked, such as images or drawings from original publications. Alongside the landing page URL, the actual authors are always credited, referencing the authors

of the original publications from which the content was digitised, thereby aiding in the dissemination of their results and increasing their bibliometric impact.

4. Results

As a result, the RELIC project presents a pioneering approach to studying Christianisation in East-Central Europe, with a particular emphasis on the rural population and the lower ecclesiastical network. By addressing previously neglected aspects of Christianisation, such as the geospatial relationships between rural churches and power centres, and through a comparative analysis of burial customs and material culture, the project offers new perspectives on the religious and political transformations of the region. The integration of historical and archaeological data, combined with the advanced digital methodologies provided by the OpenAtlas framework, enables large-scale spatial and comparative analyses that shed light on the complex dynamics of Christianisation.

One of the most notable features of RELIC is its adaptability as a research model. The interdisciplinary approach—employing digital mapping, geospatial analysis, and data synthesis—can be applied to other research themes within history and archaeology, making it a versatile tool for exploring various historical processes, from state formation to religious diffusion. This model's flexibility allows for comparative studies across different regions and periods, broadening its potential impact on future research.

Furthermore, the open-access database created through RELIC will serve as a valuable resource for researchers beyond the project itself. By making data on churches, burial sites, and artefacts accessible to the wider academic community, the project ensures that its findings can be used for further studies, facilitating cross-disciplinary research and fostering new insights into the Christianisation process and other historical phenomena.

Pilot studies and research projects already applied these principles and methodologies, successfully reconstructing the development of the lower ecclesiastical network in eleventh and twelfth-century Hungary, Bohemia and Moravia, demonstrating the potential of the proposed methodology (Vargha 2022, Vargha et al. 2024, LA WEAVE REPLICO). These studies have shown that regional characteristics and large-scale organisational aspects can be detected through site-level examination of local church networks, highlighting the groundbreaking potential for such comparative examinations. Supplemented by the in-depth study of material remains—such as the physical characteristics of churches, burial customs, grave goods, and the distribution and characteristics of liturgical objects—this research could contribute significantly to the study of Christianisation and state formation. A synthetic and qualitative analysis of well-researched sites embedded within the spatial study of church networks represents a novel approach. The archaeology of Christianisation often focuses on the division of pagan and Christian elements, based predominantly on cemetery types and certain aspects of material culture. However, the spatial contextualisation of burial customs and material remains, especially their comparative and large-scale analysis, has the potential to reveal new narratives about the pagan-Christian transition and the phenomenon of transitional cemeteries.

This is where one of the key areas where RELIC is expected to provide significant insights lies: the study of transitional cemeteries, which serve as critical markers of the Christianisation process. Transitional cemeteries, by definition, are burial sites that reflect the shift from field cemeteries - burial sites without churches, where the religious identity of the buried individuals is ambiguous - to those associated with the Christian church. These sites often represent a tangible overlap between two cultural and religious frameworks, where older traditions persisted alongside the gradual adoption of Christian practices. They frequently exhibit unique features, such as churches constructed atop or near existing cemeteries, and evidence of evolving burial customs, including changes in grave goods and the alignment of graves with Christian norms (Fig. 3).

Earlier research on transitional cemeteries has highlighted their importance in understanding the Christianisation of rural communities, primarily focusing on site-level analyses. Studies have identified key patterns, such as the construction of churches directly over pre-existing cemeteries, and have explored shifts in burial customs, including the gradual reduction in grave goods and the changing spatial organisation of burial sites (Vargha 2022, 59-70, Čechura 2024). However, these studies often remain constrained by limited datasets, inconsistent chronological frameworks, and a lack of comparative regional analysis. RELIC addresses these limitations by integrating geospatial and archaeological data to enable nuanced comparisons of burial customs and grave furnishings across multiple sites and regions. Furthermore, RELIC's ability to combine spatial clustering with precise chronological analysis offers new perspectives on the tempo of religious transformation, revealing variations not only between regions but also within smaller localities.

By situating transitional cemeteries within a larger framework, RELIC demonstrates the interconnectedness of local burial practices and the overarching structures of Christianisation. The project's comprehensive approach highlights how these sites reflect not just the physical remnants of religious transformation but also the socio-political dynamics that shaped them. This broader perspective reveals that the Christianisation of East-Central Europe was not a monolithic or uniform process but a complex interplay of local adaptation and centralised directives. Through its innovative integration of geospatial tools and diverse datasets, RELIC provides the means to revisit and reinterpret transitional cemeteries as part of a wider network, offering a more nuanced understanding of this transformative period in European history.

5. Discussion

With the help of the discussed digital, Open-Atlas based framework, and the holistic approach towards published historical, archaeological, and archival archaeological data, the project will also explore the interplay between missionary activities and the establishment of monastic and local church foundations, as well as the actual local church networks and their connections to power structures. Additionally, it seeks to determine whether historically observed differences in the Christianisation of the region—such as the Church's independence from the Empire, local Christian traditions, and the continuous influence of Byzantine Christianity—are reflected in the geospatial patterns of local church networks and their relations to power centres. Through creating spatial models, the project will approximate how the Christianisation of the majority population in various regions advanced the Church's power and stabilised the elite. Spatial modelling provides an approximation of how Christianisation contributed to strengthening Church authority and stabilising the elite (Vargha 2022, Vargha et al. 2024).

The geographical framework of this project is particularly relevant for centre-periphery investigations. Unlike historical narratives, archaeological evidence reveals the fine-scale regional diversities of Christianisation by studying local materials from frontier regions and ambiguities reflected in the material culture, especially in funerary contexts. This is especially relevant for transitional cemeteries, which provide tangible evidence of the gradual replacement of pagan burial customs with Christian practices. By focusing on rural areas and using archaeological data from field cemeteries, settlements, and ecclesiastical centres, the project highlights the diversity of paths to Christianisation across the region. Archaeology, particularly archival archaeological materials, can provide a vast amount of diverse data. Although only a fraction of the rural

churches have been archaeologically investigated and thoroughly researched as monuments, basic attributes such as location, dating, and physical characteristics can be retrieved from existing databases and various publications. Additionally, the church network can be contextualised into the physical and infrastructural landscape, the latter also including other site types, such as field cemeteries, centres of secular and ecclesiastical power, and settlements. While the archaeological study of individual sites does not always offer much on its own, combining site-based study results in a "Big Data" composition allows for a deep comparative geospatial and statistical analysis about local centres and landscapes.

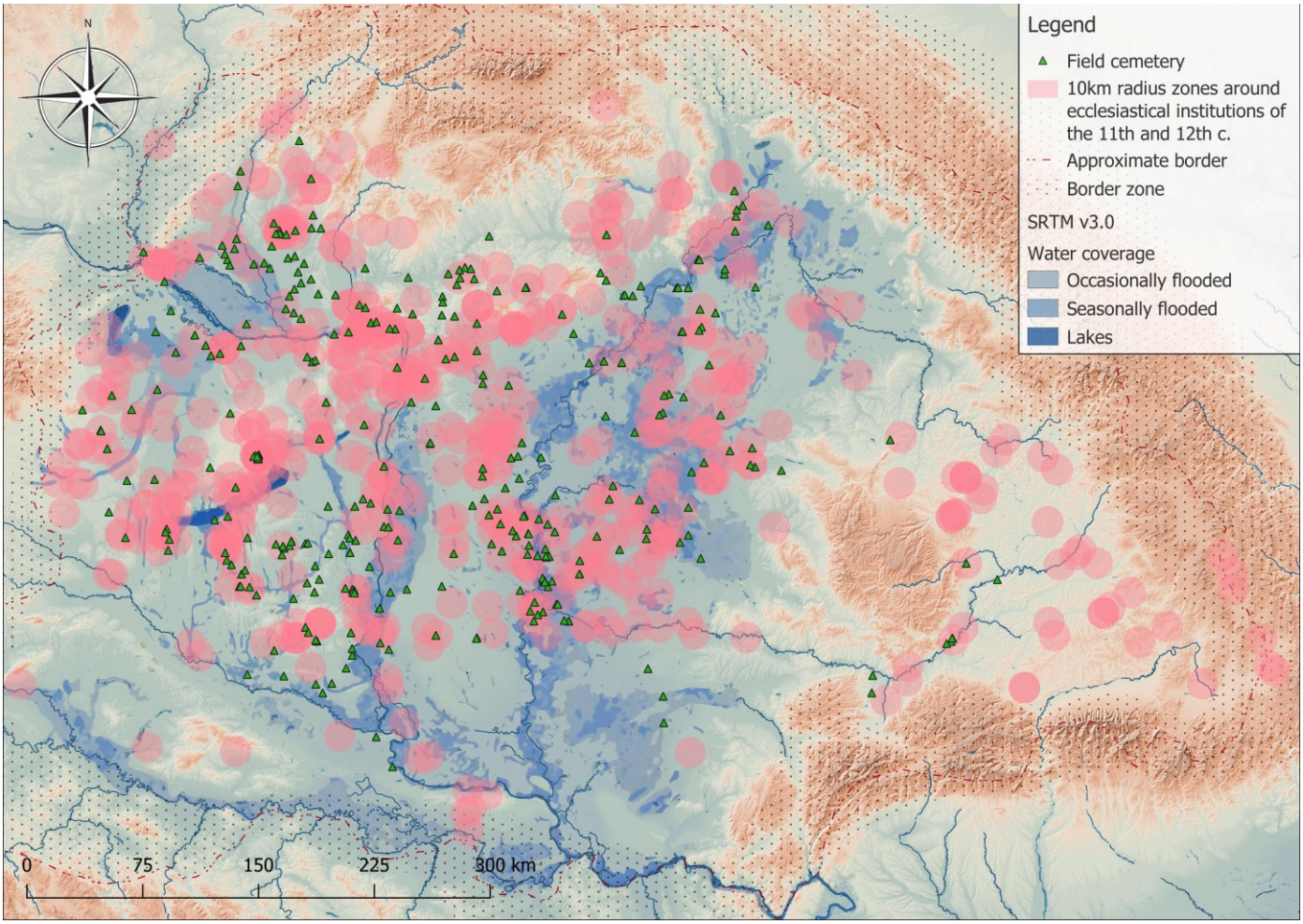

Figure 3. The distribution of field cemeteries in comparison to 10km radius buffer zones around the 11th and 12th century churches in Hungary. Image: (c) M. Vargha

The spatial analysis will consider secular and ecclesiastical power centres, examining their distribution patterns and relationships. This will include proximity, network, and site catchment analyses, as well as hot-spot analysis and machine-learning-based time series clustering (Vargha 2022; Štular et al. 2022). Incorporating qualitative data derived from well-researched sites enriches this analysis, offering a more nuanced understanding of the tangible and intangible aspects of Christianisation. Artefacts, burial customs, and site organisation reflect the interplay between local agencies and centralised religious directives. The transition from field cemeteries to churchyards, for instance, illustrates how Christian burial practices gradually replaced earlier traditions. This transformation not only signifies a religious shift but also reflects broader socio-political changes as local communities were incorporated into ecclesiastical networks. Similarly, clustering patterns of the earliest churches reveal how religious centres were strategically positioned in relation to power structures, offering insights into the interactions between rural societies and elites during this transformative period.

Interpreting the spatial patterns of the rural church network can help identify whether the expansion process was top-down or organically developed, reflect on its chronological background, and illuminate the interactions between rural societies and the elite in realising this major religious and political shift. One of the significant contributions of this research lies in its ability to address long-debated questions about the Christianisation process. For example, the clustered distribution of the earliest churches provides evidence for both centralised planning by ecclesiastical authorities and grassroots initiatives by local communities. This dual perspective challenges traditional narratives that depict Christianisation as either entirely elite-driven or solely a regional phenomenon. Instead, the findings suggest a complex interplay of top-down and bottom-up processes, shaped by local traditions, geographic factors, and the influence of neighbouring Christian polities. Another critical contribution is the project's ability to analyse regional differences and similarities across the Christianisation landscape. By comparing geospatial patterns in burial customs, church networks, and the spatial organisation of secular and ecclesiastical centres, the project reveals how cultural, political, and environmental factors influenced the pace and character of Christianisation. These regional variations underscore the importance of integrating local data into broader historical narratives, offering a more comprehensive understanding of how religious and political transformations unfolded in East-Central Europe.

Finally, the ability to contextualise archaeological and historical data within the broader infrastructural and physical landscape strengthens the project's contribution to both historical geography and digital humanities. By situating local church networks within their broader spatial and social contexts, this research not only advances our understanding of Christianisation but also provides a replicable framework for studying other historical transformations. The integration of material evidence, archival data, and advanced spatial modelling offers a new lens through which to examine the dynamic relationships between power, religion, and society in medieval Europe.

6. Conclusions

This study highlights the potential of integrating geospatial analysis, historical research, and archaeological data to explore the Christianisation of rural East-Central Europe during the 10th to 12th centuries. The RELIC project offers a comprehensive approach to understanding the dynamics of religious and political transformations in this critical period by focusing on underrepresented rural populations and their ecclesiastical networks.

The innovative methodologies employed in RELIC, particularly using the OpenAtlas framework and GIS-based tools, enable large-scale comparative analyses that were previously unattainable. These tools allow researchers to uncover nuanced patterns in the spatial organisation of rural churches, burial customs, and their relationship with secular and ecclesiastical power centres. Such insights provide a clearer understanding of how local and regional variations influenced the trajectory of Christianisation, demonstrating the interplay between top-down directives and bottom-up adaptations.

By addressing the limitations of previous site-specific studies, the project situates the rural church networks within broader historical and spatial contexts. This approach reveals the socio-political complexities of Christianisation, challenging the monolithic narratives that have dominated historical discourse. The findings underscore that Christianisation was a multifaceted process shaped by regional diversity, local agencies, and the overarching influence of ecclesiastical and political powers.

Moreover, the interdisciplinary methodology of RELIC provides a replicable framework for examining other historical processes, offering tools for broader applications in the fields of digital humanities and historical geography. By making its findings accessible through open data platforms, RELIC fosters collaboration and invites further exploration into the intersections of religion, politics, and society.

In summary, the RELIC project not only advances our understanding of the Christianisation process in East-Central Europe but also establishes a foundation for future studies to explore the interconnectedness of local traditions, regional dynamics, and overarching political structures. This comprehensive perspective opens new pathways for research and enriches the broader discourse on medieval religious and political history.

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Data Availability Statement: OpenAtlas is an open-source database software developed especially to acquire, edit and manage research data from various fields of humanities like history, archaeology and cultural heritage as well as related scientific data (THANADOS is a Digital Humanities web portal for archaeologically and anthropologically investigated burials and their digital dissemination. It is a platform for hosting any thematically relevant datasets that the authors want to offer as Open Data in a standardised form (https://thanados.net/) under Creative Commons Attribution Licences.

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