Digital Humanities Solutions for pan-European Numismatic and Archaeological Heritage Based on Linked Open Data

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Abstract

This paper discusses current challenges in archaeological cultural heritage data management and presents the interdisciplinary research project DigiNUMA. The project investigates solutions in data harmonisation and dissemination of pan-European cultural heritage through an interdisciplinary and cross-sectoral project in Digital Humanities, semantic computing, participatory heritage, museum collections management and archaeological/numismatic studies. Using Finnish and English numismatic data as a test case, DigiNUMA creates ontological infrastructure and a proof-of-concept data model for finely-grained Linked Open Data (LOD) harmonisation across national and international databases for cultural heritage data, and tests it through a broad suite of Digital Humanities analyses.

Keywords

Linked Open Data, archaeological and numismatic cultural heritage, data harmonisation, museum collections management, ontologies

1. Introduction

DigiNUMA: Digital Solutions for European Numismatic Heritage[1] is a currently ongoing research project at the University of Helsinki and Aalto University, Finland, funded by the Jenny and Antti Wihuri Foundation. It engages with the following challenges and opportunities created by the digitisation of society: (a) The need for digital solutions in archaeological cultural heritage management stemming from the vastly increased amount of information generated

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[1]Project homepage: https://seco.cs.aalto.fi/projects/diginuma

by the public, specifically the growing number of archaeological finds recovered by metal-detectorists and other public finders in European countries; (b) The pan-European need to develop an internationally operable and harmonised LOD infrastructure for using cultural heritage data from different countries in research; (c) Increasing the accessibility (democratisation) of cultural heritage data among different audiences, including outside the archaeological and scientific community.

In response to these needs DigiNUMA proposes: (a) To produce new ontological infrastructure for recording public finds data in Finland, with specific reference to international cultural heritage data harmonisation; (b) To test and interpret the data through Digital Humanities analyses; (c) To develop a proof-of-concept pilot for a data and public access heritage service demonstrator CoinSampo (RahaSampo in Finnish), based on the Sampo model [1], with built-in apps for creating data analysis and visualisations, as a model for disseminating archaeological cultural heritage data within an international context. The project collaborates with other pan-European LOD data harmonisation projects, especially ARIADNEplus[2] (all archaeological data [2]) and nomisma.org[3] (specifically numismatic data [3]), and ties in well with the aims and objectives of the European Public Finds Recording Network (EPFRN).[4] The larger research context the project engages in is therefore the study of the potential offered by data harmonisation strategies in developing digital heritage services.

2. Project Background

As outlined above, DigiNUMA responds to a set of new large-scale needs in cultural heritage management, research and dissemination. The previous decade has witnessed a proliferation in the number of archaeological finds being made by the public across Europe, mainly through hobby metal-detecting. This is especially so in several north-west European countries where this activity is permitted (with restrictions), but also in places where it is prohibited. Because of this, public finds recording schemes have been established, or are being developed, in many countries including Finland (FindSampo[5]), England and Wales (the Portable Antiquities Scheme at the British Museum, PAS[6]), Denmark (Digitale Metaldetektorfund, DIME[7]), the Netherlands (Portable Antiquities of the Netherlands, PAN[8]), Belgium (MEDEA[9]), as well as Estonia and the Czech Republic [4, 5, 6, 7, 8]. Besides reaching out to the public to record the finds they make, which in some cases is mandatory,[10] these Schemes inform the public of the laws and guidelines related to metal-detecting and other public searching[11] (especially encouraging responsible

[2] https://ariadne-infrastructure.eu

[3] http://nomisma.org

[4] https://www2.helsinki.fi/en/networks/european-public-finds-recording-network

[5] https://loytosampo.fi/fi/

[6] https://finds.org.uk

[7] https://www.metaldetektorfund.dk

[8] https://portable-antiquities.nl

[9] https://vondsten.be

[10] According to Finnish law all finds older than 100 years must be reported: Antiquities Act 295/1963 https://www.finlex.fi/fi/laki/ajantasa/1963/19630295#a295-1963

[11] See for England and Wales: https://finds.org.uk/documents/file/Code-2017.pdf and for Finland https://www.museovirasto.fi/uploads/Arkisto-ja-kokoelmapalvelut/Julkaisut/muinaisjaannokset-ja-metallinetsin-2017.pdf

behaviour), and assist law enforcement in response to illegal metal-detecting, damage to historic monuments, and the failure to report certain categories of finds [9].

This public finds data is of great value to archaeology (e.g. [10]). Crucially, by maintaining online platforms that present key data about these finds (archaeological descriptions, weights and measurements, images, findspot information, etc) these public finds recording schemes, and other heritage institutions managing finds records, have created a significant and growing reservoir of cultural heritage data that can be equally used by professionals as well as by members of the public (including detectorists) interested in archaeology. For responsible metal-detectorists – in particular those who have a serious or avocational relationship with the activity and might be described as 'citizen science archaeologists' – these digital services play a central role in advancing the democratisation of archaeological science [11, 12]. Indeed, it is clear that the public have a thirst for archaeological knowledge and it is important that archaeologists – especially in the context of public funding – quench that thirst.

The specific data service models, however, have invariably been unique to each country or even inter-regionally,[12] and with limited interoperability. The processes of recording are often linked to specific institutional contexts and are not internationally uniform. Different databases possess different field structures and field contents, and exact matches between archaeological object terms arising from different scholarly traditions may be difficult to reach. The exploitation of frequently underused legacy archaeological collections and dataset resources is further hindered by the requirement to master complex specialist statistical software for conducting analysis. This highlights a need for new research into a digital infrastructure that enables sharing of cultural heritage data, facilitating its management among heritage professionals and making it available to wider and more diverse audiences.

DigiNUMA will contribute to advancing social good by exploring pathways to make digitised archaeological heritage more accessible to multiple communities. The diverse user-audiences DigiNUMA will serve include heritage professionals and management, amateur numismatists, academic scholars, metal-detectorists and other public finders. The model heritage data service demonstrator can equally be used for educational purposes in schools and universities. This project thereby aims to contribute to the broader conversation about how recent digital transformations have affected knowledge creation and exchanges between actors and stake-holders in the field of cultural heritage, with a particular emphasis on coin finds.

3. Data

The material studied by DigiNUMA is located in a broader context of small archaeological metalwork finds – such as coins, dress accessories and domestic items – and the participatory heritage activity by which they have been largely recovered. Legal conditions and professional attitudes towards the metal-detecting hobby vary across Europe [4]. But, notwithstanding many issues related to resourcing, challenges in dealing with the increasing numbers of reported finds and safeguarding vulnerable archaeology [10], there is increasing attention paid to the added value of a permissive approach in terms of scientific knowledge, cultural heritage management

[12]See Historic Environment Records in England https://historicengland.org.uk/advice/technical-advice/information-management/hers

and the societal impact of public participation. In those countries where finds recording schemes exist there has been an unprecedented increase in 'big data' and public engagement with archaeology [5, 13, 14]. The longest running of the European public finds schemes, the PAS, contains over 1 million records containing over 1,6 million items reported in England and Wales since 1997 [7]. In Finland the absolute numbers are smaller but their relative growth since metal-detecting became popular in the mid-2010s is significant; between 2000–2010 there were some 400 finds made by the public recorded to the Muinaiskalupäiväkirja,[13] the diarization system of the FHA's archaeological collections; the Ilppari[14] public finds reporting service of the FHA received reports of over 14,000 new finds or finds collections between its launch in February 2019 and November 2020.

To study the management and transnational dissemination of this data, DigiNUMA is developing an infrastructure for transnational cultural heritage data based on ontologies extracted from the classifications and typologies used to describe archaeological artefacts. As a case study, the project targets coin finds obtained from Finnish and English digital archives, because: (a) Coins are by far the most numerous object-type reported by the members of the public to the national finds reporting schemes (e.g., [15, 16]); (b) Coins are of great interest to most metal detectorists and other finders as easily recognisable historical objects, which in significant part accounts for this positive bias [17, 16] (c) There is a strong basis in numismatic scholarship for new data exploration and ontological work (e.g. in England [18] and in Finland [19, 20]), as well as the ontological foundation provided in Finland by MAO/TAO[15] and internationally through nomisma.org); (d) The data is often precise in terms of its dating and place of manufacture, making it suitable for Digital Humanities analysis; (e) Coins move around across borders, recording and reflecting historical exchanges that are relevant to wider European audiences.

DigiNUMA will draw upon a considerable amount of existing but understudied numismatic data maintained by the Finnish National Museum Coin Cabinet and the FHA, much of which has never been analysed by Digital Humanities methods. The most important Finnish databases are the Coin Cabinet's database of over 8300 metal-detected single coin finds from the Iron Age to the Early Modern Period, and the database of numismatic objects from the FHA's MuseumPlus collections management system including the Coin Cabinet's collection of Viking Age coins (mostly from hoards). The Viking Age collections contain approximately 4000 German and 1000 Anglo-Saxon (early English) coins, and 2000 Islamic dirhams minted from the eight century onwards. Internationally, DigiNUMA will employ English early medieval coin data from the PAS at the British Museum (c. 6000 coins).

Coins from AD c. 800 – c. 1150 (the Viking Age in north-western Europe, or in Finland the Late Iron Age) will be targeted for specific assessment, as many of these coin types and their later imitations are encountered in a broad geographic area spanning from England through the Baltic region to Finland, and further to eastern Europe and western Asia, enhancing the relevance of the research results within an international context. In Iron Age Finland, as in many other parts of northern Europe, coins were used as bullion and valued by their weight (in silver) rather than denomination. Consequently the coins used came in many types. During the

[13] https://www.kyppi.fi/palveluikkuna/kmloyto

[14] https://www.kyppi.fi/palveluikkuna/ilmoitus/edit/asp/enk_default.aspx

[15] https://finto.fi/maotao/en

Viking Age coin circulation was indeed particularly international, creating socio-economic links between countries in Europe and beyond. This underlines the necessity to bring numismatic data together from transnational sources to better appreciate world-historical large-scale patterns in economic growth, travel and monetisation [21].

These perspectives can be naturally extended to all archaeological data, and as has been demonstrated, metal-detected finds enable new levels in understanding material culture diffusion internationally in early medieval northern Europe [22]. Furthermore, the interconnected nature of the Viking Age makes it an excellent testing ground for studies of connectivity, based on novel LOD applications [23]. Using the large and complex data from the British Museum alongside the Finnish material assures that the created data service model can be applied across nation-states.

4. CoinSampo Application and Data Service

Finnish institutions have been early adopters in making cultural heritage data services available online. Principal among these is the FHA, which has historic environment data for over 50,000 archaeological monuments.[16] The online finds reporting service Ilppari, launched in 2019, specifically targets the needs of archaeological citizen science. The Academy of Finland funded consortium project 'Finnish Archaeological Finds Recording Linked Open Database' (SuALT, 2017–2021) developed a framework for data sharing with the metal-detected finds data collected by the FHA, and was launched as a public online database and portal FindSampo[17] (Löytösampo) in late 2021 [24, 25].

Technologically, DigiNUMA is based on this tested pre-existing data service model. Over more than ten years the Aalto University Semantic Computing Research Group has developed the 'Sampo' model and series of LOD services and semantic portals [1]. FindSampo is one of the most recent examples, but other Sampo portals such as CultureSampo, Booksampo, WarSampo, and BiographySampo have had in total millions of end users on the Web.[18] CoinSampo will build upon and expand this existing framework and experience. The data service will be based on an RDF[19] triple store that can be freely queried using the SPARQL[20] query language. This service can be directly used for researching the data. The portal will be a single page web application based on the Sampo model and Sampo-UI[21] framework [26], and using the data service through SPARQL queries.

The portal will also offer an easy way to download the data in CSV format, and tools for searching, browsing, and data analysis. The data analysis tools aim to be easy to use so that they would not only be accessible to professional researchers, but also to hobbyists. As an example using sample data by the FHA, Fig. 1 shows how a user wishing to investigate Finnish Late Iron Age coin (Finnish: *raha*) finds distributions can use a faceted search to filter out finds of interest and then compute and visualize a kernel density surface analysis – or a 'heat map' – of findspots. This immediately reveals the high concentration of early finds in the south-western

[16] https://www.kyppi.fi/palveluikkuna/mjreki

[17] The portal online: https://findsampo.fi; project homepage: https://seco.cs.aalto.fi/projects/sualt/

[18] https://seco.cs.aalto.fi/applications/sampo

[19] https://www.w3.org/RDF

[20] https://www.w3.org/TR/rdf-sparql-query

[21] https://seco.cs.aalto.fi/tools/sampo-ui

province of Häme, reflecting known historical settlement patterns. A further investigation using the statistical tools in the Pie/Bar Chart app shows that over 99 percent of the coins are made of silver, which is in line with the bullion economy of the period.

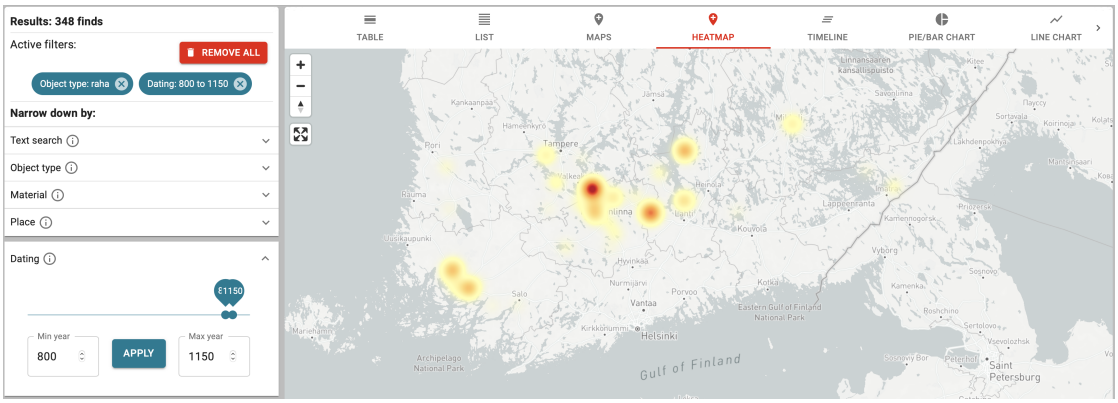

Figure 1: A test map of using CoinSampo for data analysis and exploration.

Though subject to future work, the integration of the Finnish numismatic data into the international numismatic LOD cloud can be effectuated through the nomisma.org paradigm. The required ontology and concepts are currently being developed at a European level by the nomisma.org Medieval Working Group and the DARIAH-EU Digital Numismatics Working Group, in both of which DigiNUMA is involved. This will also facilitate integration of coin find data into the ARIADNEplus portal, the pipeline for which is currently being updated in close cooperation with nomisma.org. Not limited to data from a single numismatic collection, DigiNUMA also aims to develop the CoinSampo application so that any dataset conforming to the nomisma.org model (including several that are already freely available online at nomisma.org) could be disseminated, investigated and analysed using it [27].

5. Discussion

The core mission of the DigiNUMA project is to research the possibilities for fine-grained national and transnational interoperability for archaeological and historical data arriving from disparate institutional sources, and making it available for broad audiences. Despite promising developments in digital cultural heritage, the demand for operational infrastructure to combine databases nationally and internationally has not yet been met. Its need is widely recognised: ARIADNEplus is presently developing a data alignment methodology for combining diverse national archaeological databases, but given how data is recorded it will necessarily operate at the topmost coarse-grained classification level (e.g. records are identified only by broad type category such as a “coin”, a “brooch”, or a “sword”). Alignment of low-level classifications (sub-types, etc) remains a significant problem [28], not least as items may be classified differently in a variety of national and cultural contexts. In order to enable full interoperability of legacy datasets, a data model that identifies, captures and encodes critical facets of information must be developed. Hence our the focus is on coin data, where general parameters of defining items

are less diverse than among most object types.

The comparison between the Finnish and English coin datasets will represent a new direction in the use of semantic web technologies and Digital Humanities approaches in analysis and in national collections management. It explores and enhances possibilities created by mass digitisation, such as the recent pilot project to digitise and photograph the Finnish Coin Cabinet collection of early medieval English coins in 2021; the digitisation of the collections is an ongoing long-term concern for the FHA. DigiNUMA aims to inform these efforts, desired long-term goals of which include the linking of the collections management systems used by the authorities to open platforms such as CoinSampo and the recently launched FindSampo.

LOD and semantic research will facilitate collections management in providing linked up-to-date data on the coins, the typological definitions of which are seldom absolute and might change through new finds. Combining data on coin finds in the Baltic Sea region, or indeed Northern Europe, would greatly facilitate new wide-ranging work of similarities and differences in the spread of coin types. Through its data-driven approach DigiNUMA will facilitate new research on coin production and circulation at a large historical scale among societies and regions of very different levels of development of a monetised and bullion economy; the application of such methods are now opening new potential in, for example, understanding travel networks or long-term economic change at different geographic scales [16].

Furthermore, it is recognised that illegal trade in archaeological artefacts is an international problem, and that illegal metal-detecting contributes to it [9] [29]. It is difficult to monitor this traffic, especially when objects (e.g. coins) are sold across borders on websites such as eBay.com. Digital solutions to support schemes in tackling the problem, such as the partnership between eBay and the PAS,[22] are required. The model for heritage data service developed by this project can be used in the future to identify and provenance illicit artefacts by creating a vast, freely accessible and easily operable reference catalogue including object imagery for professionals involved in heritage crime law enforcement, thereby helping to protect material culture from black market operators.

Finally, and importantly, DigiNUMA responds to the pressure to open up new possibilities in the fields of archaeology and citizen science participation in cultural heritage and extending the possibilities for learning and researching archaeology to broader international audiences. The mass of new data that has emerged in the recent years, and continues to emerge owing to metal-detecting, has set new requirements for public accessible heritage platforms and tools. Definitions of coin typologies found in old museum catalogues are often outdated and might derive from publications made in the nineteenth century, and here citizen science-led information provided by amateurs (especially avocational detectorists) can also be of great help, as the small number of museum professionals working at collections seldom have the resources to extensively examine all the available material. The societal implications of engaging with a citizen science-led approach reach beyond scientific knowledge acquisition: for example, among many practitioners metal-detecting ties into local identities in the countryside with associated benefits related to community and individual well-being [13], including mental well-being during the COVID-19 pandemic (e.g. BBC report 02.01.2021[23]). More broadly, access

[22] https://finds.org.uk/treasure/advice/schemeandebay

[23] https://www.bbc.com/news/av/uk-wales-55506661

to cultural heritage is enshrined in the Faro Convention[24] as a human right; arguably, this can be interpreted within a cross-national context. By building public accessible infrastructure that embraces historical material culture not just as a national phenomenon but as transnational heritage, these participatory and international approaches to cultural heritage counter narratives empowering exclusion and discrimination.

References

[1] E. Hyvönen, Digital humanities on the Semantic Web: Sampo model and portal series, Semantic Web – Interoperability, Usability, Applicability (2021). Submitted.

[2] J. Richards, F. Niccolucci (Eds.), The Ariadne Impact, Archaeolingua, Budapest, 2019.

[3] K. Tolle, D. Wigg-Wolf, Improving data quality by rules: A numismatic example, in: Digital Archaeologies, Material Worlds (Past and Present), Proc. of the 45rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology, 2020, pp. 193–201.

[4] P. Deckers, M. Lewis, S. Thomas (Eds.), Aspects of Non-professional Metal Detecting in Europe, De Gruyter, 2016. Topical Issue of Open Archaeology.

[5] A. Dobat, T. Christiansen, M. Jessen, M. Henriksen, P. Jensen, The Dime project background, status and future perspectives of a user driven recording scheme for metal detector finds as an example of participatory heritage, Danish Journal of Archaeology 8 (2019) 1–15.

[6] T. Kurisoo, R. Ramme, M. Smirnova, Discoveries made by the users of searching devices and the public in 2019 and the new Heritage Conservation Act, Arheoloogised Välitööd Eestis. Archaeological Fieldword in Estonia 2019 (2020) 263–287.

[7] M. Lewis, The Portable Antiquities Scheme Annual Report 2020, British Museum, London, 2021.

[8] A. Wessman, S. Thomas, V. Rohiola, Digital archaeology and citizen science: Introducing the goals of FindSampo and the SuALT project, SKAS 1 (2019) 2–17.

[9] A. Daubney, L. Nicholas, Detecting heritage crime(s). What we know about illicit metal detecting in England and Wales, International Journal of Cultural Property 26 (2019) 139–165.

[10] M. Lewis, A detectorist's utopia? Archaeology and metal-detecting in England and Wales, Open Archaeology 2 (2016) 126–139.

[11] A. Wessman, S. Thomas, V. Rohiola, J. Kuitunen, E. Ikkala, J. Tuominen, E. Koho, M. Hyvönen, A citizen science approach to archaeology: Finnish archaeological finds recording linked open database (SuALT), in: Proc of the Digital Humanities in the Nordic Countries 4th Conference (DHN 2019), 2019.

[12] A. Wessman, E. Oksanen, Metal-detecting data as citizen science archaeology, in: P. Halinen, V. Heyd, K. Mannermaa (Eds.), Odes to Mika. Festschrift for Professor Mika Lavento on the occasion of his 60th birthday, The Archaeological Society of Finland, 2022, pp. 293–302.

[13] A. Dobat, S. Wood, B. Jensen, S. Schmidt, A. Dobat., "I now look forward to the future, by finding things from our past…" Exploring the potential of metal detector archaeology as a

[24] https://www.coe.int/en/web/culture-and-heritage/faro-convention

source of well-being and happiness for British Armed Forces veterans with mental health impairments., International Journal of Heritage Studies 26 (2020) 370–386.
[14] V. Immonen, J. Kinnunen, Metal detecting as a social formation: A longitudinal survey study from Finland, Journal of Social Archaeology 20 (2020) 313–334.
[15] K. Leahy, M. Lewis, Finds Identified: Portable Antiquities Scheme, Greenlight Publishing, Witham, 2018.
[16] E. Oksanen, M. Lewis, Medieval commercial sites as seen through Portable Antiquities Scheme data, Antiquaries Journal 100 (2020) 1–32.
[17] K. Robbins, Understanding the Impact of Sampling Bias Data Recorded by the Portable Antiquities Scheme, Ph.D. thesis, University of Southampton, 2012.
[18] R. Naismith, Medieval European coinage with a catalogue of the coins in the Fitzwilliam Museum, Cambridge, vol. 8: Britain and Ireland c. 400–1066, Cambridge University Press, Cambridge, 2017.
[19] F. Ehrnsten, Pengar för gemene man? Det medeltida myntbruket i Finland, Suomen keskiajan arkeologinen seura, Helsinki, 2019.
[20] T. Talvio, Coins and coin finds in Finland AD 800–1200, Suomen muinaismuistoyhdistys, Helsinki, 2002.
[21] P. Nightingale, The evolution of weight-standards and the creation of new monetary and commercial links in northern Europe from the tenth to the twelfth century, The Economic History Review 38 (1985) 196–201.
[22] P. Deckers, S. Croix, S. M. Sindbæk, Assembling the full cast: Ritual performance, gender transgression and iconographic innovation in viking-age ribe, Medieval Archaeology 65 (2021) 30–65.
[23] E. Hyvönen, Publishing and using cultural heritage linked data on the semantic web, Morgan & Claypool, Palo Alto, CA, 2012. doi:10.2200/S00452ED1V01Y201210WBE003.
[24] E. Hyvönen, H. Rantala, E. Ikkala, M. Koho, J. Tuominen, B. Anafi, S. Thomas, A. Wessman, E. Oksanen, V. Rohiola, J. Kuitunen, M. Ryyppö, Citizen science archaeological finds on the Semantic Web: The FindSampo framework, Antiquity 95 (2021) 1–7.
[25] H. Rantala, E. Ikkala, M. Koho, J. Tuominen, V. Rohiola, E. Hyvönen, Using FindSampo linked open data service and portal for spatio-temporal data analysis of archaeological finds in digital humanities, in: Proc. of the Digital Humanities in the Nordic Countries (DHN 2021), CEUR Workshop Proceedings, 2021. URL: http://ceur-ws.org/Vol-2980/paper330.pdf.
[26] E. Ikkala, E. Hyvönen, H. Rantala, M. Koho, Sampo-UI: A full stack JavaScript framework for developing semantic portal user interfaces, Semantic Web – Interoperability, Usability, Applicability 13 (2022) 69–84. doi:10.3233/SW-210428.
[27] H. Ranta, E. Oksanen, E. Hyvönen, Harmonizing and using numismatic linked data in digital humanities research and application development: Case diginuma, in: The Semantic Web. ESWC 2022, Springer-Verlag, 2022. URL: https://seco.cs.aalto.fi/publications/2022/rantala-et-al-harmonizing-2022.pdf, accepted.
[28] N. Reynolds, F. Riede, House of cards: cultural taxonomy and the study of the European Upper Palaeolithic, Antiquity 93 (2019) 1350–1358.
[29] S. Hardy, Black archaeology in eastern Europe: Metal detecting, illicit trafficking of cultural objects, and "legal nihilism" in Belarus, Poland, Russia, and Ukraine, Public Archaeology 15 (2016) 214–237.