CoalHeritage: Visualising and Promoting Europe’s Coal Mining Heritage

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Abstract: Heritage and culture tourism involve features that commemorate a valued past. Mining heritage tourism allows visitors to experience the past, guided by former mining landscapes and engaging interactively with material artifacts. This paper introduces the CoalHeritage European project, focusing on the promotion of coal mining heritage through the production and design of the European Visual Map Journal (EVMJ). The EVMJ is a user-friendly, web-based, interactive storytelling platform that supports the transfer of industrial and geoheritage from former coal mining areas. It aims to collect and disseminate heritage assets from post-mining coal areas, informing stakeholders and promoting these sites as tourist destinations. To further enhance public awareness, several ESRI StoryMaps web apps are being created to highlight specific features of each case study across Europe. The aim of this work is to introduce coal mining heritage as a new term, present the coal heritage platform and its importance for disseminating coal heritage aspects to the public, describe the methodology used for its design, and provide a brief overview of its evolving content.

Keywords: GIS; WebGIS; story map; CoalHeritage; Europe; mining heritage; coal transition

1. Introduction

Climate change and the need to reduce CO2 emissions have led to the development of strategies for the decarbonisation of the energy sector by the European Union (EU), aiming for reductions of at least 53% by 2030 and 93% by 2050, rendering inevitable the transition out of coal for coal-intensive countries and regions [1]. With the imminent closure of the coal mines arises the issue of the management of the mine assets, such as buildings and equipment (movable and immovable), as well as the valorisation of the geological aspect of these mining areas. Although this can be a very challenging task, it can also be viewed
as an opportunity to showcase the importance of these mining/industrial sites (as well as already-closed mines that have not been valorised yet), by converting them and promoting them as sites of natural and cultural heritage, and, in particular, geoheritage and coal mining/industrial heritage, respectively. The engagement of the stakeholders (including the general public) is also key to the success of the conversion.

Mining is an industrial activity linked to the human activities. Consequently, the heritage linked to this activity is a type of cultural heritage that refers to both surface and underground human elements related to mining, which have historical, cultural, or social value. Even if mining heritage is not part of geological heritage because mines are not natural and the result of geological processes, the extracted mineral resources, including coal, are abiotic elements of natural origin resulting from the Earth’s history. Consequently, geological heritage may have a close relationship with industrial heritage and, thus, with mining heritage. Geological heritage, or geoheritage, is a fundamental part of natural heritage. According to the International Association for the Conservation of Geological Heritage (ProGEO), an affiliated organisation of the IUGS (International Union of Geological Sciences) and a member of the IUCN (International Union for the Conservation of Nature), geological heritage can be defined as “the special places and objects that have a key role in understanding of the history of the Earth—its rocks, minerals and fossils, and landscapes. Geoheritage is an applied scientific discipline which focuses on unique, special and representative geosites, supporting science of geology and its place in modern culture” [2]. Geological heritage linked to mining heritage could be outcrops showing coal-bearing formations and collections of fossils, rocks, and ores. Many European countries have inventoried or are currently inventorying their geoheritage, applying accurate methodologies [2–7].

According to the International Committee for the Conservation of the Industrial Heritage (TICCIH), “the industrial heritage consists of the remains of industrial culture which are of historical, technological, social, architectural or scientific value. These remains consist of buildings and machinery, workshops, mills and factories, mines and sites for processing and refining, warehouses and stores, places where energy is generated, transmitted and used, transport and all its infrastructure, as well as places used for social activities related to industry such as housing, religious worship or education” [8]. The mining industry combines the exploitation and management of natural sources (raw materials, energy sources) resulting from the Earth’s history and transforms them into products that contribute to everyday life and culture. Industrial facilities, such as buildings and towns built as a result of industrial activity in an area, are part of the cultural/industrial heritage. Moreover, intangible assets are also included in the mining heritage of a region: the technical knowledge, the working life, and, of course, the social and cultural aspects of the operation of an industrial site and its effect on the local communities and wider regions over the years, hence its historical and social value [9].

The primary drivers of success for any region hinge on the establishment of favourable social and economic conditions. The mining industry, spanning all stages of technological extraction and processing, exerts a substantial impact on the environment. Notably, industrial heritage tourism can play a constructive role in both preserving and enhancing the environment. The growth of this tourism sector has catalysed public sector investments in urban areas and the reclamation of contaminated and abandoned land in former industrial zones.

Coal mining heritage is a very typical example of industrial/geological heritage with a profound effect on a local, regional, and national level. Through the concept of mining heritage, large numbers of the remains of mining activities can and have been converted into tourist attractions, leading to the economic growth of the local communities. In order to ensure the conservation and promotion of such former mining sites, a number of mines and factories are even included in the UNESCO World Heritage List [10]. For any mining site/region to be characterised as heritage, it is essential that its authenticity and integrity are assessed. The valorisation of the assets of a mining site is an integral part of the procedure of its declaration as heritage, which follows the creation of an inventory
of those assets and is followed by the creation of reclamation, protection, conservation, and management plans. Additionally, other European projects such as the “MineHeritage: Historical Mining Tracing and Learning from Ancient Materials and Mining Technology” and “Mineral Intelligence for Europe—Mintell4EU” projects address similar issues in an effort to disseminate the importance of mining heritage through historic periods [11,12] and provides a comparative context for our work.

This paper aims to promote the conservation of selected coal mining heritage in Europe. The project includes many mining heritage aspects such as legislation, funding, management, conservation, and promotion. All of these aspects, along with the candidate heritage sites that the project aims to promote, will be visualised in a web-interactive platform, the European Visual Map Journal (EVMJ). The EVMJ will be developed using a web-based storytelling platform. In recent years, storytelling has become crucial for web-based Geographic Information System (GIS) platforms, offering a dynamic way to convey complex data and spatial relationships in an engaging way. It enhances learning and material retention by transforming traditional communication methods with digital interactive maps. Story maps have emerged as innovative tools for narrating about places or topics, integrating multimedia, web maps, and text to foster audience engagement [13–17].

This paper presents the implementation of story mapping technology in the development of an interactive, user-friendly WebGIS platform [18] (https://storymaps.arcgis.com/collections/987904b97d664cedb2ea4c161fb0f31e, accessed on 12 July 2024). Interactive information about coal mining heritage is presented on the platform through different themes and categories of interest. The aim is to help visitors from all backgrounds to explore coal mining heritage using a variety of 2D and 3D representations. The platform’s content is hosted on a cloud database related to the coal mining heritage assets in the partner countries: Greece, Poland, Slovenia, Germany, and France. Finally, the EVMJ will serve both as an inventory and as a dissemination tool for the promotion of coal mining heritage.

2. Overview of CoalHeritage’s Approach

The objectives of this work are structured into a coherent plan to address and promote coal mining heritage across Europe, including a thorough analysis of the current state of coal mining heritage that establishes the groundwork for strategic transitions. This involves assessing legislative frameworks, stakeholder awareness, and the potential for declaring sites as national heritage. An inventory of mine assets will also be compiled, adhering to international data standards. This inventory supports the creation of a European Visual Map Journal (EVMJ) to visually represent coal heritage sites, integrating informative texts and geospatial data into an interactive platform. Finally, efforts to promote and protect mining heritage will engage stakeholders and the public, fostering an appreciation for industrial heritage through thematic presentations, workshops, and collaborations with other networks, aiming to influence policy at various levels.

Recognising the significant dependency on coal, the project aims to highlight the repurposed mining sites into cultural heritage venues, thus providing new opportunities for the most affected communities, including mine workers, through sectors like tourism. This work identifies the urgent need to manage post-mining landscapes, tackle unemployment through retraining, and promote coal mining’s role in regional development. This can be achieved by fostering an interregional network, promoting industrial heritage, and aiming for the sustainable economic growth and preservation of coal mining’s tangible and intangible assets, aligning with EU Green Deal objectives. In summary, the European-funded CoalHeritage project adopts a comprehensive four-phase approach to delve into the various aspects of coal mining heritage across Europe, starting with an analysis of the current situation to understand the state of coal mining, including strategies, criteria for heritage designation, and stakeholder awareness. Following this, the development of a European Visual Map Journal (EVMJ) synthesises these insights into a geodatabase and web-interactive maps, featuring multimedia content, spatial data, and narratives. The final
stage focuses on engaging stakeholders and disseminating the project’s findings, involving national and local authorities, industries, and the public to ensure the project’s success and sustainable impact (Figure 1).

![Figure 1. CoalHeritage workplan.](image)

2.1. Pilot Case Studies

CoalHeritage focuses on supporting coal regions within the European Union and elsewhere that are either in the process of phasing out coal use or are approaching the final phase of coal mining activities. These areas are linked to the coal industry and face significant challenges due to their long-term dependence on coal and carbon-intensive practices for economic growth. For the production and design of the European Visual Map Journal (EVMJ), CoalHeritage selected study regions from a preliminary pool of potential coal regions/sites across participating countries, based on selected criteria that were defined during the project. Furthermore, the CoalHeritage platform, at the initial stage, presented and analysed different coal heritage sites across five European countries and specifically in Greece, Poland, Germany, Slovenia, and France, illustrating a wide range of various coal heritage phases. In the following sections, a brief description is provided for each country.

2.1.1. Greece

Greece hosts a plethora of lignite deposits, many of which have been exploited in the past and some of which are still being mined today. Lignite in Greece has been mined mainly for power production since the 19th century, with a peak in the 1950s. Lignite has been mined both in open-pit and in underground mines. The coal phase-out has brought the closure of many lignite mines in the last few years. The CoalHeritage project showcased the most important lignite mines in Greece, both historical and active, undergoing transition.

Aliveri lignite mines: The Aliveri mines are located on the western coast of the central part of Evia Island. The first (underground) mine opened in 1896 and operations ceased in 1988, including both underground and surface mining. The Aliveri mines are the most important historical lignite mines in Greece for several reasons. They hosted the first thermoelectric power plant in the country, which ensured energy security for the whole of Greece for many years since its opening in the early 1950s; moreover, they were the first mines to be operated by the then newly formed Public Power Corporation (PPC) [19].
Today, one of the remaining surface mines in Aliveri (Figure 2) is the Apokalypsi open-pit mine, now an open-pit lake. A number of buildings and a plethora of equipment, both movable and immovable (e.g., railways), have also survived, some of which are exhibited in an exhibition centre housed in the former technical school for the mine workers [20].

Figure 2. Remaining mining facilities in Aliveri: Prinias mining facilities (top); the exhibition centre of Agios Loukas, at the site of the old technical school (bottom left); Apokalypsi pit lake (bottom right) [20].

Kymi lignite mines (Figure 3): Kymi is also located in the central part of Evia Island, on the east coast. The underground lignite mines of Kymi started operating in 1833 and ceased operation entirely by the Second World War. Today, a few of the mine entrances survive, as well as a few buildings, railway lines, and part of an aerial line, and are partially preserved [21].

Figure 3. Remains of the Engi mining facilities (left) and the aerial line where lignite was transported to the port of Paralia in Kymi (right) [21].

Peristeri lignite mines: The underground Peristeri lignite mines were located in Athens and operated from 1936 to 1956, with the 1950s being the peak of production. Today, no mine entrances are preserved due to the intense urbanisation of the area. A park has been created on the site of the former lignite mines, featuring an outdoor theatre [22].

Kalogreza lignite mines: The two underground lignite mines of Kalogreza, an area located in the northern part of Athens, operated from 1935 to 1957, providing lignite of very high quality for the electrification of Athens at the time. Today, a part of one of the last constructed loading towers still remains in Kalogreza (Figure 4).
Megalopolis Lignite Centre: Megalopolis Lignite Centre is in central Peloponnese, in the Megalopolis lignite basin. Four mines have operated in total in the Megalopolis Lignite Centre. The first mine to start operating was Thoknia (now closed), in 1969. The other mines of Megalopolis are Choremi, Marathoussa (opened in 1991, now a pit lake), and Kyparissia (opened in 1990, now also a pit lake), all of which fed the thermal power plants. The main machines used for mining were bucket wheel excavators [19].

Lignite Centre of Western Macedonia (LCWM): The Lignite Centre of Western Macedonia, located in northern Greece, was the largest and most important Greek lignite mining area of recent decades. Thus, the first large-scale mining operations in Ptolemais lignite basin commenced in 1956, following the foundation of the Ptolemais Lignite Mines Mineral and Industrial S.A. (LIPTOL). The first open-pit lignite mine and the first power plant of the area (10 MW) started operating in 1957 [23]. LIPTOL was acquired by PPC in 1959. Lignite mining was achieved via continuous excavation–transport–disposal, using bucket wheel excavators, conveyor belts, and stockpilers [19]. The Ptolemaida mining area consists of the Main Field mine (closed), Kardia (closed in 2021), Mavropigi mine, and South Field mine [24]. The Amyntaio mining area consists of the Amyntaio mine (closed in 2020), Lakkia mine (closed in 2021), and Anargyroi mine (closed in 2010) [25].

2.1.2. Poland

Poland is in a period of transition related to changing approaches to energy. There are still 28 hard coal (20 active, and 8 in closure) and 5 lignite mining plants in Poland. The following areas can be distinguished: the Lower Silesian Mining Basin (there is currently no more mining in this area), the Upper Silesian Mining Region (there are both active and closed underground coal mines in this area), and the Lublin Coal Basin (includes active mines). According to the established coal mine closure plan, the last mine is scheduled to close in 2049. A good example of heritage protection is “Zabrze—a complex of historic coal mines”. The complex has borne witness to the development of mining in Upper Silesia since the late 18th century. The complex consists of three historically related buildings, as described below.

Królowa Luiza Mine (Queen Luiza Mine): A fragment of the underground sections and sidewalk 510, forming part of the Wilhelm adit of the Królowa Luiza coal mine, are the oldest preserved coal workings in Poland.

Główna Kluczowa Sztolnia Dziedziczna (Main Key Hereditary Adit): This is an adit that has been drilled since the 18th century and served transport and drainage functions. It is the continent’s longest engineering object related to coal mining. It is characterised by
a very good state of preservation. It includes an authentic roadway lining and historical traces of excavation and mining. It provides an opportunity to learn about the methods of transporting coal in the first half of the 19th century.

Guido Mine: This mine was founded in the 19th century and is an example of a private mine. Decks named 170 and 320 have been made available for tourist travel and are among the deepest underground historical tourist routes of their kind. These routes showcase original machinery from the post-war period, and visitors can also become acquainted with the technological lines operating in the mine.

In addition, the complex includes above-ground facilities related to the mine infrastructure such as shaft towers and buildings. The whole complex is managed by The Museum of Coal Mining in Zabrze, which is one of the organisations promoting mining values and culture related to coal heritage.

2.1.3. Slovenia

The SAŠA region has a rich mining history spanning nearly 150 years (Figure 5), prominently featuring the Velenje Coal Mine, which remains integral to the region’s socio-economic fabric. The Šaleška Valley (Salek Valley), home to the largest Slovenian coal deposit, also hosts significant electricity generation facilities, notably in Šoštanj (Sostanj), contributing about 30% of Slovenia’s electricity. Slovenia’s lignite and brown coal reserves total 1244 million tonnes, with Velenje holding 346 million tonnes.

The region’s dependency on coal is pronounced, despite a shift towards closure and restructuring, illustrated by the gradual phase-out of coal mining in Zasavje, culminating in the closure of the Trbovlje-Hrastnik coal mine in 2013. The Velenje Coal Mine Group’s strategic projects aim to transition to a carbon-free society, generate new high-value jobs, and reduce dependency on coal.

The region encompasses ten municipalities, with varying socio-economic and environmental impacts anticipated during the transition. The Coal Mining Museum of Slovenia, located in Velenje, offers a historical perspective on the mining industry, featuring exhibits such as the Škale shaft and Dominion machine (Figure 6), and provides an interactive experience reflecting the miners’ work.

In addition to Velenje, the Zagorje Mining Museum and Urbanščica Black Coal Mine preserves the mining heritage, showcasing the evolution of mining techniques and equipment. These museums highlight the cultural and historical significance of coal mining in Slovenia, emphasising the importance of preserving this legacy as the region transitions away from coal.

2.1.4. France

France experienced coal mining activity for three centuries, with a gradual decline in recent decades and final closure in 2004. As far as possible, the French State has supported the conversion of the mining regions, whose most famous are Nord-Pas-de-Calais and Lorraine, located in northern and eastern France, respectively [26,27]. The conversion was a necessity to ensure their economic survival, and a policy to preserve mining heritage has developed in both regions, especially at the Wendel Mine Complex (WMC) and the Lewarde Mining History Centre (LMHC) [28–30].

The WMC (Figure 7), one of the largest and most complete complexes of coal mining buildings in Europe, offers leisure-time and cultural activities for visitors who can discover the miner’s museum, cycle paths, and walking trails, and enjoy a large number of activities such as visits to mining towns. The museum invites visitors to discover the history of coal mining in Lorraine while revealing the place occupied by miners. In a modern and attractive presentation, objects, models, and multimedia resources immerse visitors in the history of coal, the daily life of the miners and their families, and the social policies of mining companies. The WMC also aims to conserve and highlight collections (nearly 2000 objects and machines), publications, and temporary exhibitions.
Figure 5. (a) Queen Luiza Mine, a part at the ground level. Photo: FLYING FOTO. (b) Queen Luiza Mine, a mining rail in a former training adit at 43 Sienkiewicza Street. Photo: Agata Mucha (NID). (c) Main Key Hereditary Adit, southern adit. Photo: Łukasz Zawada, ze zbiorów MGW. (d) Main Key Hereditary Adit, a section at the Carnall shaft—the so-called crystal section. Photo: Łukasz Zawada, ze zbiorów MGW. (e) Guido Mine, ground part. Photo: FLYING FOTO. (f) Guido Mine, southern side of the pit of the Kolejowy shaft with mine carts at the level of 320 m. Photo: E. Caban. (g) Guido Mine, chamber of the central hydraulic system at the level of 320 m, mechanised wall with a roadheader KGS-245. Photo: Jerzy Koenigshaus, ze zbiorów MGW. (h) Guido Mine, research chamber no. 1 at the level of 320 m, view from the longwall. Photo: Agnieszka Wróblewska. Zabrze—a complex of historic coal mines (source: https://zabytek.pl/en/obiekty/zabrze-zespólowy-kopalnii-wegla-kamiennego, accessed on 12 July 2024).
Nestled in the UNESCO World Heritage Nord-Pas-de-Calais Mining Basin (https://wch.unesco.org/en/list/1360, accessed on 12 July 2024), the LMHC (chm-lewarde.com/fr, accessed on 12 July 2024) comprises expansive industrial structures. Since 1984, the centre has aimed to preserve and display the mining culture, ensuring that the forthcoming generations gain insights into this 300-year mining history. The LMHC (Figure 8) holds a collection of 15,000 objects representing the mining techniques, ethnology with representations of the miners’ daily lives, and geology with significant petrographic and palaeontological collections. The centre also aims to raise public awareness of energy issues and improve our understanding of the current challenges about future energy sources.

2.1.5. Germany

Due to the collapse of the coal, steel, and related industries in the Ruhr area from the end of the 1950s, the region witnessed sharp industrial decline and rising unemployment. By the 1990s, about two-thirds of the coal, steel, and related industry jobs were lost. This resulted in socio-economic problems; hence, the regional industry was in need of sustainable restructuring and transition. Converting former coal mining and industrial sites for new economic activities poses challenges due to remnants of prior use like soil and water pollution, mining shafts, and outdated infrastructure, requiring substantial investments in site conversion. Over the last three decades, urban renewal initiatives have encouraged socio-economic transition in old industrialised locations, promoting new forms of urban tourism and converting closed factories into heritage sites to enhance destination attractiveness and foster entrepreneurial activities in tourism and services. The Ruhr Regional Association (RVR) has been playing a pivotal role in coordinating efforts, fostering collaboration among municipalities since 1920. The RVR has facilitated transformations

Figure 6. (a) The Škale (Scale) shaft: cave lift at the Coal Mining Museum of Slovenia. (b) The Dominion Mine Skip. (c) Mine roadway with chain conveyer. Source: Mining Muzeum Zagorje. (d) Pesje Coal Crushing and Processing Plant (DIK). Source: Personal archive of Premogovnik Velenje d.o.o.
in the Ruhr area, repurposing former industrial sites into cultural and leisure hubs. The Industrial Heritage Trail, a project of the RVR from 1999 onwards and part of the European Route of Industrial Heritage, is one of the transformation strategies for the region, linking tourist attractions related to the industrial heritage in the Ruhr area in Germany. Over a distance of 400 km, the tourist-themed route connects the most important and tourist-attractive industrial monuments in the Ruhr area; it consists of a network of industrial heritage sites and enables a visualisation of the history of coal mining, steel production, and industrialisation in the Ruhr area. The route network provides visitors with a unique heritage of the Ruhr metropolis to explore, including the Ruhr area’s only UNESCO World Heritage Site, Zollverein in Essen, and 27 anchor points, locations with particular historical significance and tourist appeal. In addition, 17 panoramas, 13 settlements, and numerous themed routes are part of the Industrial Heritage route. These sites include former coal mines, steel mills, museums, and other industrial landmarks, and they are connected by a system of signage and information to create a comprehensive experience for visitors (Figure 9) interested in the region’s industrial history.

Figure 7. The Wendel Mine Complex (WMC) in the Lorraine region, France. (a) A view of some of buildings of the WMC including the Wendel 2 head frame. (b) Recent building where mine galleries with machineries and tools for different mining periods in Lorraine are reconstructed. (c) Miners’ clothing hanging room, nicknamed the “room of the hanged”. (d) Setting up of a coal cutter to show the most recent coal extraction technique in Lorraine up to 2004. (e) Coal ore block (1 m length of anthracite) and (f) coal ore and Carboniferous sandstone/conglomerate drilling cores, shown as part of a geoheritage exhibition. (Courtesy picture: N. Charles—BRGM.)
The selection for the ESRI ecosystem provides a variety of ready-to-use applications based on open-source technology, along with a novel story map capabilities [31].

Regarding geospatial datasets, they were reprojected into the WGS 1984 Web Mercator (auxiliary sphere) projection and stored within an ArcGIS Pro v. 3.1 software geodatabase. The selection for the ESRI ecosystem provides a variety of ready-to-use applications based on open-source technology, along with a novel story map capabilities [31].

ArcGIS StoryMaps [32–34] provides a user-friendly interface and can be easily visited using a personal computer or mobile device; it combines a unique design and additional features. Due to the complex information that needs to be depicted, 6 sections were created for each CoalHeritage country. The following diagram (Figure 10) outlines a schematic

Figure 8. The Lewarde Mining History Centre (LMHC) in Nord-Pas-de-Calais (France), included in the UNESCO World Heritage site of “Nord-Pas de Calais Mining Basin” since 2012. (a) General overview of the LMHC site with the two head frames of the Delloye pit. (b) Machineries formerly used in the coal mine. (c) Lamps of the miners in the lamp shop. (d) Fossil of *Pecopteris* frond as part of the paleontological collection of the LMHC, and considered geoheritage. (e) and (f) Reconstruction of a mine gallery to show the development of mining techniques throughout history. Courtesy pictures: N. Charles—BRGM.

2.2. WebGIS Platform

In order to create the currently under-development EVMJ, different categories of datasets have been integrated, utilising various open-source portals such as Open Street Map (OSM) basemap, geographical boundaries, and building footprints, including texts from bibliographic references, topographic maps, and other 3D coal mining facility cards. In addition, extensive data collection is being carried out for each site, with representative photos and videos, to enhance the existing coal mining heritage and available knowledge. Regarding geospatial datasets, they were reprojected into the WGS 1984 Web Mercator (auxiliary sphere) projection and stored within an ArcGIS Pro v. 3.1 software geodatabase. The selection for the ESRI ecosystem provides a variety of ready-to-use applications based on open-source technology, along with a novel story map capabilities [31].
workflow for handling and presenting geographic data within a GIS framework, employing a suite of ESRI tools. A collection of various forms of available information, including vector and raster data, descriptive narratives, and tabular datasets, is implemented. Following collection, the data are organised into a geodatabase with ArcGIS Pro v. 3.1, ensuring it is standardised or homogenised for consistent use. It is then uploaded to a cloud platform, enabling the creation and sharing of web maps, scenes, and applications. The subsequent phase involves transforming the organised data into engaging and interactive story maps with ArcGIS StoryMaps apps, enhancing the data with narrative and context. Finally, the ESRI StoryMap Collection feature is selected, which is a powerful tool that allows users to organise and present a series of related StoryMaps in a single, cohesive interface. This feature is particularly useful for projects that cover multiple themes, locations, or events and require a structured way to navigate through the different CoalHeritage countries.

Figure 9. Map of the industrial heritage trail “Route der Industriekultur” in the Ruhr region of Germany (modified from Route der Industriekultur, 2023, K).

Figure 10. Schematic workflow of the developed EVMJ.
3. Preliminary Results

The European Visual Map Journal (EVMJ)

The developed EVMJ, which is available at the following link (https://storymaps.arcgis.com/collections/987904b97d664cedb2ea4c161fb0f31e, accessed on 12 July 2024), incorporates data regarding the coal heritage and geographical characteristics of each country along with its coal mining history, as well as the different stories and phases of coal mining evolution, status, and best practices. The EVMJ is equipped with various tools designed to enhance the visualisation and interaction with 3D models related to coal mining heritage. These tools provide a deeper understanding of spatial relationships and real-world dimensions within the historical and present contexts of mining sites. Key tools include precise measurement tools for assessing the scale and spatial relationships between different elements in the 3D model, interactive viewing options that enable users to explore 3D models from various angles and perspectives, and export and sharing functionalities to disseminate knowledge and promote coal mining heritage. Tools such as measurement tools have been added to better understand the dimensions of the preserved equipment in the real world in order to enhance the learning experience and support education. This WebGIS platform provides narrative text on the abovementioned topics enriched with 2D web maps, 3D buildings, and facility cards, as well as multimedia content like photos, videos, and hyperlinks. One of the important elements of the EVMJ are 3D models of selected objects, machines, and devices related to coal heritage. In particular, 3D models are developed based on photos of real objects using the photogrammetry method. Photorealistic models created in this way, apart from their presentation on a visual map, can also be used as teaching aids in modern forms of education using multimedia presentation techniques or Extended Reality (XR) techniques. The ongoing illustrated thematic maps and 3D facility cards used in the developed platform are initially processed in ArcGIS Pro v3.2, and the selected settings for user interaction with each web map/scene—such as zoom levels, pop-up functionalities, and the initial viewpoint—are configured in both the online platform and the StoryMap builder. Additionally, to effectively showcase the information, various StoryMaps have been incorporated into the main one, offering a detailed exploration of the analysed topics as described in the following text. Under the current development phase of the platform, the information has been organised in seven sections: (a) an overview of the CoalHeritage project, (b) insights into Germany, focusing on the Ewald Colliery and Zollverein Coal Mine Industrial Complex, (c) insights into Greece, with a focus on the Aliveri lignite basin and the Western Macedonia Lignite Centre, (d) insights into France, showcasing initiatives in regions like Nord-Pas-de-Calais and Lorraine, including the Wendel Mine Complex (WMC) and the Lewarde Mining History Centre (LMHC), (e) insights into Poland, highlighting the Experimental Mine Barbara, (f) insights into Slovenia, featuring the unique Šalek Valley, and (g) exploring 3D models of CoalHeritage assets. By organising the platform in this way and implementing these tools, the EVMJ aims to provide a comprehensive, engaging, and educational resource for users to explore and understand the rich coal mining heritage of Europe.

The first top tab (Figure 11), “CoalHeritage at a Glance”, gives information about the CoalHeritage project’s objectives related to managing and repurposing former coal mining regions across Europe as sites of cultural and industrial heritage. The project addresses the challenges posed by the EU’s decarbonisation goals and the transition away from coal, aiming to preserve the historical significance of mining sites through conservation and promotion. Notable sites include Colliery Ewald and Colliery Zollverein in Germany, Aliveri mine and Western Macedonia region in Greece, Parc Explor Wendel and the Mining History Centre in France, Experimental Mine Barbara in Poland, and Šalek Valley (Salek Valley) in Slovenia.
In the second tab (Figure 12), an overview of two significant coal heritage sites in Germany are provided: Colliery Ewald and Colliery Zollverein. Colliery Ewald, located in Herten, Ruhr area, operated from 1871 to 2000. Post-closure, it underwent a transformation, preserving structures like the Malakow Tower and Shaft 2, and repurposing the site for trade, logistics, and events such as RevuePalast Ruhr and MotorWorld. Colliery Zollverein, a UNESCO World Heritage site, was the largest coal mine and coking plant in Europe until 1986. It now serves as a cultural and creative hub, with notable sites like the Grand Hall Zollverein and Design Zentrum, emphasising its architectural and historical significance. The Zollverein Foundation manages the preservation and redevelopment of the site, promoting its industrial heritage.

The third tab (Figure 13) contains information about two lignite mining regions in Greece: Aliveri and Western Macedonia. The Aliveri lignite basin, known since ancient times, saw initial underground mining attempts in 1896, with significant operations commencing in the 1950s. Mining transitioned from underground to surface methods before ceasing in the 1990s. The area has since been repurposed for cultural uses. In Western Macedonia, the extensive lignite deposits in the Ptolemaida, Amyntaio, and Florina regions have been central to Greece’s industrialisation. Starting significant operations in 1939, the region’s mines and power plants have played a crucial role, with significant mergers and operational shifts occurring up to 2020. The document highlights the historical and ongoing transformation of these mining regions, emphasising their cultural and industrial heritage. A web map shows their spatial distribution using Imagery as a basemap (from ESRI’s basic
gallery maps). Users have the ability to choose a location to see additional information and to explore a timeline with historical photos from the mining era of Aliveri’s facilities and mining history.

Figure 12. Examples from the EVMJ: the geographical location of Ewald Colliery in the Ruhr region of Germany, with a satellite ESRI basemap on the left showcasing 3D building footprints and labels of surrounding structures.

Figure 13. Examples from the EVMJ: the geographical location of Aliveri lignite basin, with a satellite ESRI basemap on the left showcasing 3D building footprints and labels of surrounding structures.
The fourth tab (Figure 14) describes the transformation of coal mining sites in France, focusing on regions like Nord-Pas-de-Calais, Lorraine, and Auvergne-Rhône-Alpes. Due to the decline of the coal industry, these regions have been reconverted for various uses. Nord-Pas-de-Calais has invested in renewable energy, with wind farms creating new jobs. Lorraine’s Moselle coal basin has become a tech park for high-tech industries. Auvergne-Rhône-Alpes has transformed mining sites into tourist attractions. Environmental rehabilitation has also been a priority, with former mining sites converted into natural parks. The document highlights notable projects like the Wendel Miner Museum in Lorraine, the Cité des Électriciens in Bruay-la-Buissière, and the Mining History Centre in Lewarde, showcasing efforts to preserve and repurpose mining heritage for cultural, economic, and environmental benefits.

Narrative text refers to each path separately, describing its route and giving information about the most characteristic features of it. A web map, using OpenStreetMap (from ESRI’s basic gallery maps) as a basemap, shows their location. Users can choose a path on the map to see representative photos.

The fifth tab (Figure 15) describes the Experimental Mine Barbara in Poland, a crucial partner in the CoalHeritage project. Established in 1925, the mine is part of the Central Mining Institute—National Research Institute and serves as a prominent example of repurposing former coal mine facilities. The mine has two underground levels at 30 m and 46 m, where it conducts significant research on mining safety, including testing new machinery, dust explosions, and methane explosions. After World War II, it became central to improving mine safety, and today, it remains the only underground coal mine laboratory in Europe. It provides extensive experimental testing capabilities for various configurations, supporting innovative research in mining safety, environmental protection, and potentially cybersecurity. Narrative text describes each one along with points of interest during its route, and a web map shows their location on the OpenStreetMap basemap (from ESRI’s basic gallery maps). Users can select a trail to see representative photos.

![Image](image.jpg)

**Figure 14.** Examples from the EVMJ: the geographical location of the Mining History Centre (France), with a satellite ESRI basemap on the left showcasing 3D building footprints and labels of surrounding structures.
EXTENSIVE lignite mining caused ground subsidence, resulting in several villages sinking partially or completely underwater. These lakes now serve as a reminder of the past communities, with underwater remnants of buildings such as homes, schools, inns, and churches. A section of the story map highlights ongoing changes in the valley due to continuous mining, the interest in these submerged sites, and efforts by the Coal Mining Museum of Slovenia in Velenje to organise virtual dives for visitors to explore these hidden underwater worlds, preserving the history beneath the lakes’ serene surfaces.

**Figure 15.** Examples from the EVMJ: Historical image of the Experimental Mine Barbara (Poland), accompanied by narrative text.

**Figure 16.** Examples from the EVMJ: Terrain of Šalek Valley (Salek Valley) in the past (left) and today (right). The user can apply the swipe widget to compare the two images in the platform.
Finally, the seventh tab (Figure 17), Explore 3D Models of CoalHeritage Assets, discusses the use of the European Visual Map Journal (EVMJ) platform to showcase 3D models of historical coal machinery in real-world locations in Poland. The platform provides tools for precise measurement, interactive viewing, and contextual visualisation, enhancing the understanding of the spatial relationships and dimensions of mining equipment and sites. The document highlights the first chain coal cutting machine introduced in England in 1853 and the coal steam engine from the “Pstrowski” Coal Mine in Zabrze-Biskupice, emphasising their historical significance and technological advancements. This initiative, funded by the Research Fund for Coal and Steel, aims to preserve and educate about coal mining heritage through advanced visualisation techniques.

![Figure 17](image_url)

**Figure 17.** Examples from the EVMJ: The geographical location of a coal cutting machine, with a satellite ESRI basemap on the left showcasing 3D building footprints and labels of surrounding structures.

### 4. Discussion

In the modern era, which is characterised by rapid technological advancements and evolving socio-economic landscapes, the transition of coal heritage sites into new sites of industrial and cultural significance becomes pivotal. This era demands innovative approaches to repurpose these historical sites, integrating them into the contemporary fabric of society while preserving their historical essence. Coal heritage sites, transitioning into modern industrial and touristic sites, embody the rich industrial history that powered economic and social development. These sites, once centres of coal production, are evolving into cultural and educational landmarks. This transition should not only preserve the tangible infrastructure and geological assets (e.g., fossils, minerals, rocks, ores), but also the intangible heritage, including the stories, traditions, and experiences of those connected to the coal mining industry. Transforming these sites into places of heritage ensures that future generations can learn from and appreciate the historical significance of coal mining in shaping communities and countries.

Storytelling platforms are powerful tools that allow for an integrated visualisation and arrangement of all of the depicted information regarding a study area, especially when the information belongs to various scientific domains. Maps, text, and multimedia content are very useful for effective dissemination and stakeholder engagement, as they utilise the visual aspect of the information. StoryMaps applications are, by definition, interactive and allow users to visualise the content from different perspectives. Their narrative nature transforms data into information and, subsequently, knowledge. The European Visual Map Journal (EVMJ) showcases coal heritage areas from five countries and 3D models of coal machinery in real-world locations within the boundaries of Poland, which serves as an
excellent example to highlight the possibilities for machine location and scale. The selected uploaded models are placed on the map with true coordinates in Poland. By placing the historical 3D model on these specific locations within the EVMJ map, it provides a contextual visualisation of their historical operation. The models are scaled appropriately to match the geographical and environmental context of the map. For instance, the 3D model of Frederick Hurda’s first chain coal-cutting machine, located in Poland and used widely in English and German mines in the 19th century, is depicted at a real scale, providing a realistic sense of size and space. This scale helps in understanding the physical dimensions of the machine relative to the surrounding area, such as adjacent buildings or infrastructure. This placement not only enriches the map with historical context, but also enhances user interaction by allowing them to explore how such machinery was an integral part of the coal mining landscape. It also aids educational purposes by providing a tangible connection to the past techniques and technologies used in coal mining, emphasised through interactive and scaled representations.

The European Visual Map Journal (EVMJ) platform is equipped with various tools designed to enhance the visualisation and interaction with 3D models related to coal mining heritage. These tools aim to provide a deeper understanding of the spatial relationships and dimensions within the historical and present contexts of mining sites. One of the standout features of the EVMJ is the capability to perform precise measurements directly within the 3D environment. This tool allows users to measure distances and heights in 3D models, which is very important for assessing the scale and spatial relationships between different elements in the 3D model. Whether it is determining the height of a coal-cutting machine or the distance between two historical sites, these tools provide essential data for practical planning (such as developing coal heritage routes). The platform supports interactive viewing options, enabling users to explore 3D models from various angles and perspectives. Users can rotate, zoom, and pan across different models, offering a comprehensive view that helps in understanding the detailed features and mechanics of mining equipment. The platform also facilitates the export and sharing of findings and models. Users can share the 3D model to support the dissemination of knowledge and the promotion of coal mining heritage.

5. Conclusions

In summary, the abovementioned tools make the EVMJ a robust platform for the exploration and presentation of coal mining heritage in an interactive and educational manner, supporting a wide range of users from researchers and educators to general enthusiasts. The integration of these tools into the 3D models not only makes the learning experience more engaging, but also enhances the understanding of historical and geographical data. By employing these advanced tools and technologies, the European Visual Map Journal (EVMJ) seeks to create an immersive and educational platform that promotes the understanding and appreciation of coal mining heritage. This comprehensive approach supports the project’s goals of preserving cultural heritage, fostering tourism, and contributing to the economic and social development of the regions involved. In addition, the platform highlights the urgent need for the preservation of coal heritage sites. By showcasing these sites’ historical, cultural, and geological significance through advanced visualisation tools, the European Visual Map Journal (EVMJ) underscores the importance of preserving these sites for future generations. This urgency is driven by the rapid transition away from coal in many regions, making it crucial to document and protect these sites before they deteriorate or are repurposed.

The methodology applied in the CoalHeritage project and in the ongoing EVMJ tries to incorporate feedback from a wide range of stakeholders from countries with intense coal mining history in terms of coal heritage due to the rapid energy transition status in many parts of Europe. However, ongoing evaluation and adaptation are necessary to address the dynamic nature of coal heritage preservation and presentation. Continuous refinement
based on user feedback and technological advancements will be crucial in maintaining the project’s aims and effectiveness in terms of the development coal mining heritage network.


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Conflicts of Interest: Authors Tadeja Jegrišnik and Matjaž Kamenik were employed by the company Premogovnik Velenje d.o.o. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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