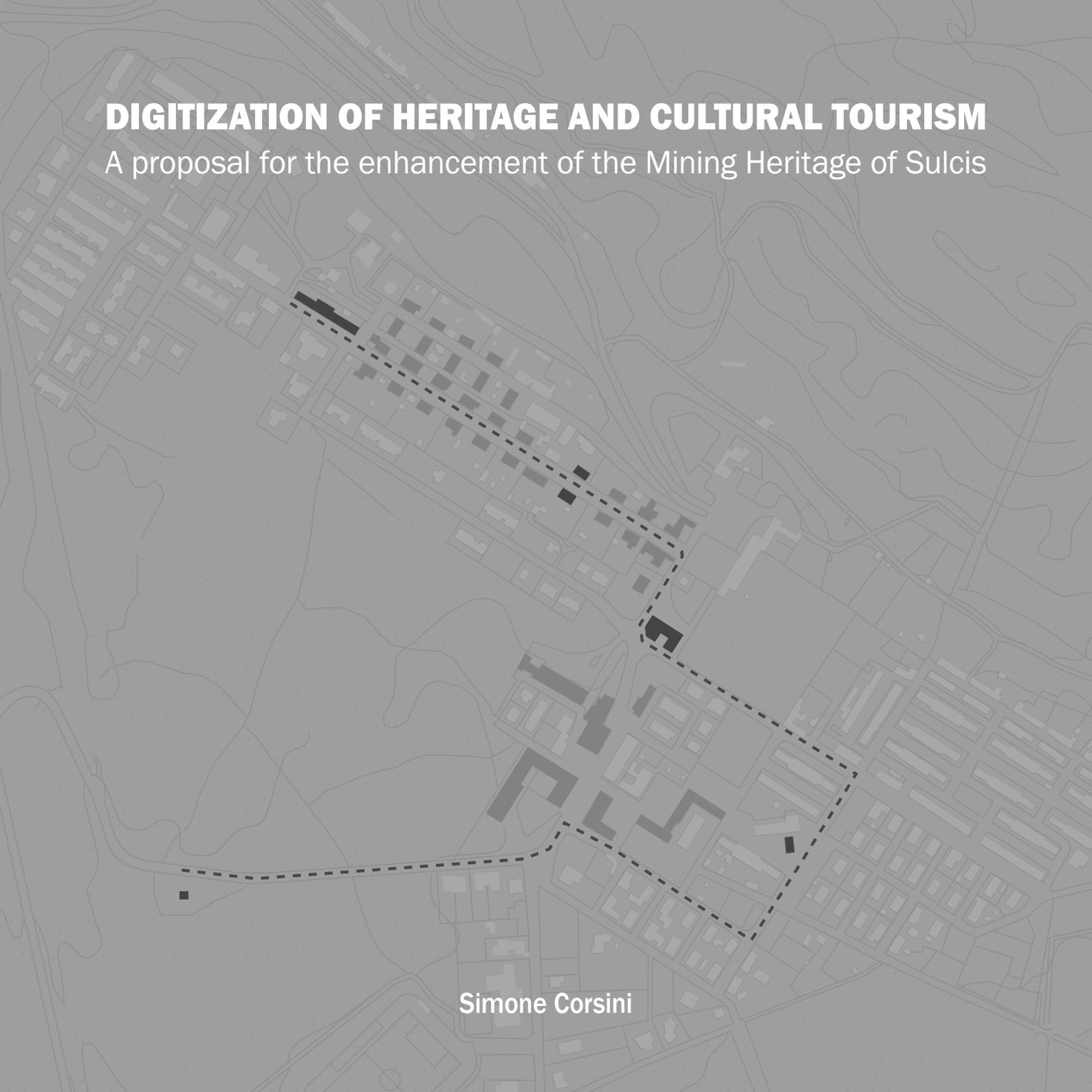


DIGITIZATION OF HERITAGE AND CULTURAL TOURISM

A proposal for the enhancement of the Mining Heritage of Sulcis



Simone Corsini



**Politecnico
di Torino**

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DIGITIZATION OF HERITAGE AND CULTURAL TOURISM

**A proposal for the enhancement
of the Mining Heritage of Sulcis**

Supervisor:
Manuela Mattone

Co-supervisor:
Fulvio Rinaudo

Candidate:
Simone Corsini

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Abstract

This thesis deals with the theme of the enhancement of mining sites, referring in particular to those present in the Sulcis coal basin in Southern Sardinia (Italy), with the inclusion of not yet rehabilitated objects and sites in the cultural-tourist offer, through the improvement of existing itineraries. The contents of the research are divided into topics that cover the state of the heritage, the promotion of cultural routes, and a focus on the case study of the Bacu Abis Mine, and try to analyze and present a series of key points on which to base a proposal for the enhancement of the mining heritage of Sulcis.

In the introductory analysis it is described an overview of the scenarios that stakeholders have faced trying to address the problems arising from de-industrialization in international contexts. The closure of mining sites has led to the depopulation of parts of the territory, which has caused negative economic and social impacts, leaving mining legacies under increasing neglect. The enhancement of industrial heritage can have a social and economic impact on the territories if considered as a driver for sustainable development and a potential opportunity for local growth.

From this perspective, cultural tourism can be seen as a way to support the development of industrial areas, providing accessibility to the heritage and contributing to its preservation. The promotion of itineraries is intended to diversify the tourist flows towards more sustainable solutions for the mining regions, creating networks exploiting the cultural and natural attractions that the territory offers.

The analysis carried out is useful for defining a proposal for the integration of a route in the cultural itinerary of *Cammino Minerario di Santa Barbara*, dedicated to the history of the Bacu Abis Mine, as a result of the process of digitization of its mining heritage, to be included in the tourist experience through the use of augmented reality, aimed at better sharing, understanding, and enjoyment of the heritage.

1. MINING HERITAGE: FROM ABANDONMENT TO ENHANCEMENT

The introductory analysis is an attempt to summarize the current state of the coal mining industry, useful for describing an overview of the scenarios that local organizations and authorities have faced in international contexts, and trying to address the problems arising from de-industrialization.

Starting from the present and past activity of the mining industry at a global level, the closure of sites where it has already occurred and where it has not yet occurred, and the critical aspects related to the effects that the closure has caused, this chapter aims to provide a general overview of the state of the mining heritage. Globally, the end of extraction industries has led to the depopulation of parts of the territories which has caused negative economic and social impacts, leaving the mining legacies under increasing neglect by local governances, which has led to the total disuse and decay of the production sites.

Mining heritage, and more generally industrial heritage, can represent a driver of sustainable development in rural areas, often far from inhabited centers or hard to reach, through processes of inclusion of those abandoned and not yet recovered facilities in a system of sites of cultural, historical and landscape interest, interconnected in a network. In some cases, the adaptive reuse of architecture can represent one of the main solutions, and indicates the process of defining a new intended use for buildings complexes, to prevent their neglect and consequent state of degradation, and guarantee continuity of use based on the adaptation of the structure to new activities. Alternatively, the enhancement of such facilities more easily dictated by a renewed accessibility of the site, even before a reuse intervention is carried out, is a faster and less invasive type of intervention.

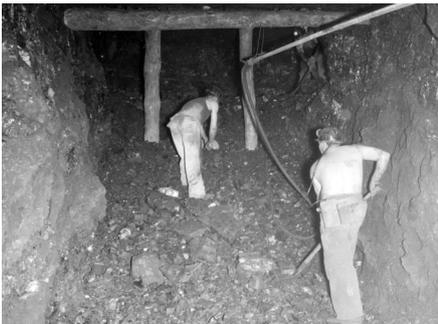
In this chapter, some case studies are mentioned, comparable in terms of function, historical memory, and architectural types, although belonging to different contexts, which thanks to enhancement processes have had a successful social and economic impact on their territories.

1.1 CURRENT STATE OF THE COAL INDUSTRY AND CRITICAL ISSUES

Mining heritage includes sites, structures, machinery, and documents related to the past mining activity, in contexts in which it has marked the history and the culture of the place. When historical and cultural assets are associated with certain objects, we are referring to a set of goods that have had such an impact on the territory that they are testimonies of traditions built over time with identity values for a community or a place.

« Heritage is our legacy from the past, what we live with today, and what we pass on to future generations »¹

In the case of mines, they are testimonies of a process of technological evolution that has changed both the structure of the communities with new migratory phenomena and the morphology of the territories, with iconic and characteristic elements of the landscape. The latter mainly derive from typological characteristics and from the equipment and structures necessary for the extraction and processing of minerals, located on the ground (extraction towers and building complexes) or underground (wells and tunnels). There are two main mining methods, open-pit and underground, chosen depending on the type of deposit, the size, and the quality of the mineral. The two procedures differ not only in the type of excavation (the first involves extracting from the surface, while the second requires the construction of wells and tunnels) but also in the way the landscape is modified. Another distinction is by type of mineral extracted, the largest productions regard metallic minerals such as gold, iron, and copper, or non-metallic minerals such as salt, limestone, or coal, among others. To provide examples similar to the Sardinian context, the main focus of the research, the following dissertation is particularly related to the coal production sites.



◀ Images 1 and 2

Underground gallery of the Great Mine of Serbariu (Italy) in 1938 (left), and Bacu Abis open-pit mine (Italy) in the second half of the 19th century (right).

Sources: *Archivio del Centro Italiano della Cultura del Carbone*; *Biblioteca comunale di Serbariu, sezione di storia locale*.

¹ UNESCO World Heritage. Source: <https://www.unesco.org/en/world-heritage> (Accessed: May 2024).

1.1.1 Coal mining overview

In the last decades of the 20th century, due to the excessive soil exploitation and uncontrolled modification of the land, several documents were drawn up at an international level, aimed at a more responsible and controlled management of the environment. One of the most relevant is the *Brundtland Report (Our Common Future)*², published in 1987 by WCED World Commission on Environment and Development, which introduces the topic of “sustainable development”. This denomination identifies a progress capable of meeting the needs of current generations, without compromising future generations. The *Report* deals with the topic of sustainability on a large scale, not only focusing on industry, but highlighting various types of issues related to global population growth, food security, diversity of species and ecosystems, and sustainable energy sources.

Today, the closure of coal mines represents an important step towards the transition to cleaner and renewable energy sources. The *European Green Deal*³ marked the coal phase-out as a key factor in meeting the 2030 climate targets and arriving at climate neutrality by 2050, and in 2020 the European Union created a fund to support the energy transition⁴.

To introduce the state of the coal industry, its setting and its activity, a current overview of production and consumption in Europe and worldwide is presented.

Global coal use is increasing: more than 2% in 2023⁵. According to the report *IEA (International Energy Agency) Coal Market Update*⁶, by 2040 coal will continue to be the largest source of electricity worldwide, stressing the importance of developing cleaner and more efficient technologies to mitigate environmental impacts.

Coal has been used as a fuel since ancient times, but it became a primary energy source starting from the Industrial Revolution between the 18th and 19th centuries. There are various types of classification of the mineral, based on chemical-physical characteristics, origin, and stratigraphy. Usually, reference is made to two categories, differentiated according to the degree of maturity and the calorific value, or the amount of energy obtainable from the combustion of a unit quantity of fuel: lignite (carbon content of approximately 70%) and anthracite (carbon content of 90%), also called “brown coal” and “hard coal”.

2 *Brundtland Report*. Source: <https://www.sciencedirect.com/topics/social-sciences/brundtland-report> (Accessed: May 2024).

3 *European Green Deal*. Source: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_it (Accessed: June 2024).

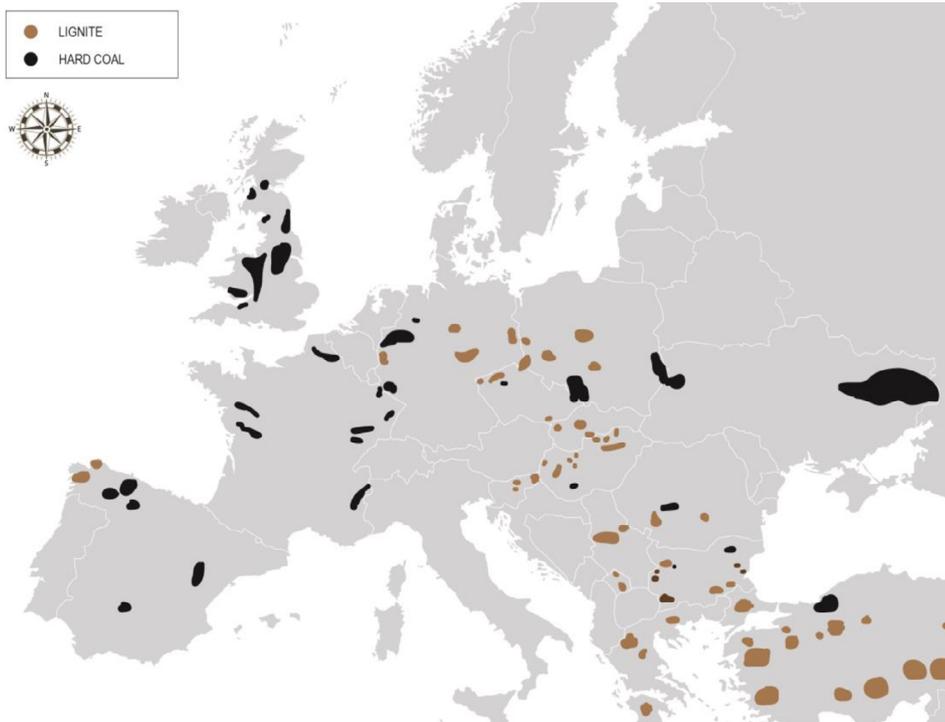
4 *EU support for coal regions*, European Court of Auditors Special Report. 2022.

5 *Boom and Bust Coal 2024*, annual survey of the global coal fleet by Global Energy Monitor and partners.

6 *Coal Market Update report*. Source: <https://www.iea.org/reports/coal-market-update-july-2023> (Accessed: June 2024).

The largest deposits (about 60% of the world's coal reserves) are located in Asia and North America, and the largest producers and consumers of coal are China, India, and the United States, followed by Indonesia, Australia, and Russia.

There are several coal basins in Europe, the largest of which are in the central and northern countries, such as the Ruhr Coalfield in Germany, or the Silesian Coal Basin in Poland. Other important deposits are located in Spain (Asturian Mining Basins), UK (Black Country), France (Nord-Pas de Calais), Ukraine (Donetsk Region), followed by smaller deposits in Belgium, the Netherlands, the Czech Republic, Slovakia, Bulgaria, and Italy.



◀ Image 3

European coal basins location.

Source: *Coal mining closure and circular economy*. 2022.

Already in the 17th and 18th centuries, Central and Eastern Europe became important centers of production, and with the Industrial Revolution, the growing demand for fuels led to an intensification of the exploitation of deposits.

In Germany, large-scale production of hard coal began in the 18th century and increased significantly in the 19th century, particularly in the Ruhr area (Western Germany), while the production of brown coal developed particularly in the 20th century in Lusatia

(Eastern Germany) with the first large-scale opencast surface mines⁷. In the Silesian Basin (Poland), coal, zinc, and lead have been extracted since the Industrial Revolution. Coal has been the most significant mined mineral in terms of quantity, and its extraction has amounted to over 70% after the Second World War. Currently, with 27 active mines, it is the highest-producing area in Europe⁸.

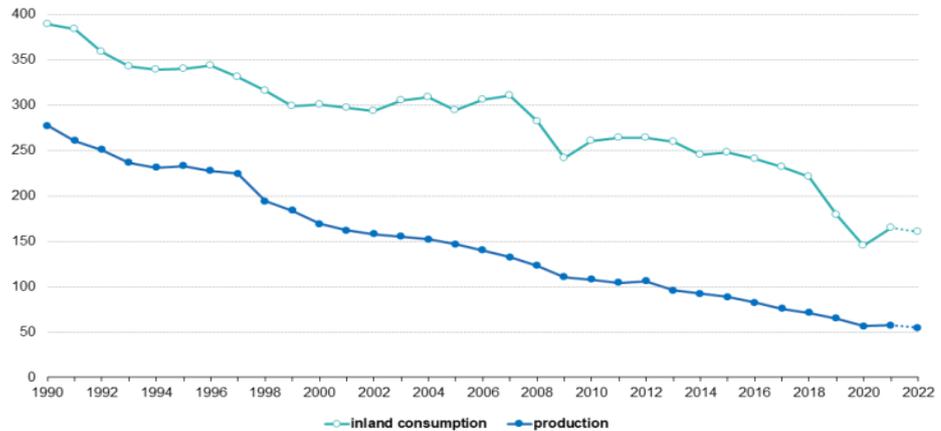
Generally, brown coal production and consumption have had a similar trend from 1990 to today, alternating ups and downs. Although there are still several European countries among the most important producers and consumers in the world (such as Germany, with 11 lignite mines still active, which has announced its exit from coal by 2038), generally there has been a decrease in both in its extraction and use: the 2022 consumption of brown coal in the EU is estimated at 294 million tonnes, 21% less than in 2018⁹.

Hard coal has a noticeable import dependency (59.6% in 2021): in 2021, Russia supplied more than half (53.6 %) of the EU's hard coal imports, followed by Australia (17.5 %) and the United States (15.7 %). This is due to the fact that the only European countries that still produce it, Poland and the Czech Republic, have reduced its extraction since 2012 (-33% in Poland and -84% in the Czech Republic), while consumption has decreased slower¹⁰.

► Image 4

Inland consumption and production of hard coal, EU, 1990-2022 (million tonnes).

Source: Eurostat (nrg_cb_sff), (nrg_cb_sffm): https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Coal_production_and_consumption_statistics

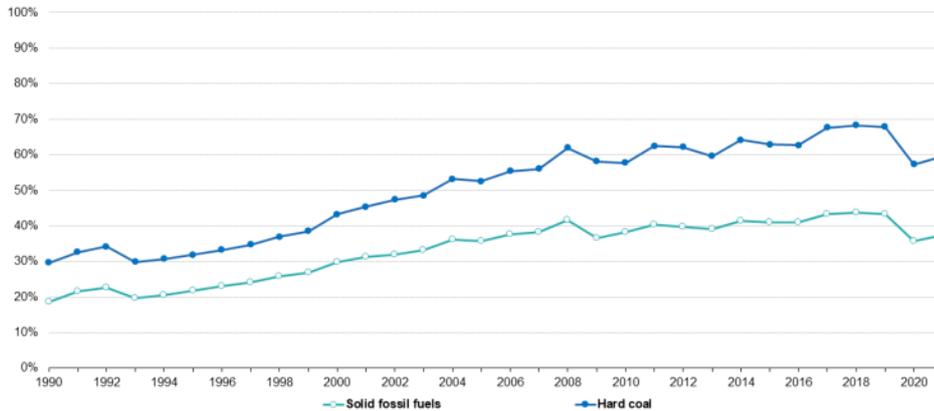


7 Krümmelbein J., Bens O., Raab T., Naeth M.A. *A history of lignite coal mining and reclamation practices in Lusatia, eastern Germany*. 2012.

8 Dulias R. *The Impact of Mining on the Landscape*. Chapter: A Brief History of Mining in the Upper Silesian Coal Basin, p. 31-49. 2016.

9 *Coal production and consumption statistics* report, Eurostat, 2023. Source: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Coal_production_and_consumption_statistics (Accessed: June 2024).

10 *Coal production and consumption statistics* report, Eurostat, 2023. Source: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Coal_production_and_consumption_statistics (Accessed: June 2024).

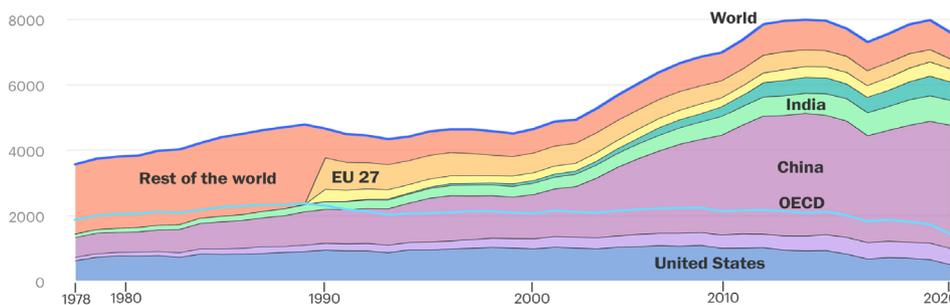


◀ Image 5

Import dependency for solid fossil fuels and hard coal, EU, 1990-2021.

Source: Eurostat (nrg_bal_c): https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Coal_production_and_consumption_statistics

Italy ended the production of coal in 2018 with the closure of the last active site, the mine of Monte Sinni, located southwest of the city of Gonnese, in Southern Sardinia. It is placed in the only hard coal deposit of the country (there is a presence of brown coal in some small areas of Tuscany and Umbria), the Sulcis coal basin. This closure marked the end of an industrial activity that began in 1853. The overall picture (Image 6) shows that worldwide coal extraction and consumption is decreasing in Western countries, while it is increasing in Asian countries, with China in first place: 49% of world production in 2020. The same trend is shown by sites such as Global Coal Mine Tracker (GCMT), a worldwide data set of mines created by Global Energy Monitor that provides detailed information as capacity, production, and emissions (the most recent release of this data was in April 2024 and it included data on 70 countries)¹¹, documenting how the recent mine re-development in Asia is creating hundreds of new sources of emissions. In this regard, on a large scale, it is clear that coal production is not an equal and constant process in terms of quantity nor common to all countries.



◀ Image 6

World total coal production, 1971-2020 (million tonnes).

Source: <https://www.iea.org/data-and-statistics/charts/world-total-coal-production-1971-2020>

¹¹ Global Coal Mine Tracker dataset. Source: <https://globalenergymonitor.org/projects/global-coal-mine-tracker/> (Accessed: June 2024).

1.1.2 Impacts of mine closures

The closure of coal mines has been a gradual process and there has not been a precise date for all mines, in Europe it occurred mainly during the 20th century, mostly because of the exhaustion of some deposits or because of competition from other countries.

By focusing on territories where closures have already occurred or are in progress, it is possible to describe the effects it has brought on communities and contexts.

« *Shrinking mining cities, once prosperous settlements servicing a mining site or a system of mining sites, are characterized by long-term population and / or economic decline. Many of these towns experience periods of growth and shrinkage, mirroring the ebbs and flows of international mineral markets which determine the fortunes of the dominant mining corporation upon which each of these towns heavily depends* »¹²

The effects of the closures are of different nature and affect different categories, a number of factors can contribute to the negative consequences from a social and economic perspective. These include institutional and governance matters, inadequate structures and strategic planning, financial issues, and the lack or scarcity of resources. In the *Socio Economic Aspects of Mine Closure and Sustainable Development* report¹³ by the Centre for Sustainability in Mining and Industry (CSMI) of the COALTECH Research Association, it is highlighted the importance of integrating the closure plan into the mine life cycle. Often, in the contexts mentioned before, this planning only began once the decision to close had been made (or never occurred), leading to a series of critical side effects.

The first and more explicit impact is on the communities that depend directly on mining work: loss of jobs, labor shifts, and economic and social difficulties for the communities that depend on mining activity. Often, the opening of a mine is followed by an immigration phenomenon for which the families of workers, arriving from other cities or regions, have created new communities in the territories.

A case in point is that of Carbonia (Italy), a city founded in 1938 together with the coal mine of Serbariu, for the need to provide housing for the families of miners. Although the city was initially supposed to host about 12,000 inhabitants, immigration intensified as a workforce was needed, and the number of houses did not satisfy the growing

¹² Martinez-Fernandez C., Chung-Tong Wu, Schatz L., Taira N., Vargas-Hernández J. *The Shrinking Mining City: Urban Dynamics and Contested Territory*. International Journal of Urban and Regional Research, p. 213-225. 2012.

¹³ *Socio Economic Aspects of Mine Closure and Sustainable Development* report. Source: <https://coaltech.co.za/wp-content/uploads/2019/10/Task-7.8.5-Socio-Economic-Aspects-of-Mine-Closure-Literature-Overview-Report-1-2010.pdf> (Accessed: June 2024).

number of workers who reached the city, so an expansion plan was carried out from 1939 to 1940, years in which the population exceeded 17,000 inhabitants, of which about 12,000 workers (20% migrating from other regions). The city was in continuous evolution until the 1950s, the number of inhabitants increased, in 1950 the historical maximum of the population was reached with more than 47,000 residents, and new residential districts were built¹⁴.

This example, to which others can be compared, such as the case of Gavorrano, in Tuscany (Italy), where around 50% of the miners came from other regions¹⁵, shows how the opening of a mine, in addition to giving rise to phenomena of creation of a new community very quickly, makes a large part of the population highly dependent on the mining activity for employment. To make another example, in the 1990s, more than 25% of the population living in the Central coal basin in Asturias (Spain) was employed in mining activities¹⁶. At present, according to the European Commission study entitled *The EU's coal regions: opportunities and challenges ahead*, in 2018 around 185,000 people were employed in coal mining in Europe, and 128,000 of them (two-thirds of the total amount) will be directly affected by the closure before 2030¹⁷.

A study entitled *Navigating coal mining closure and societal change: learning from past cases of mining decline*¹⁸, published in 2019 by the SEI (Stockholm Environment Institute), identified several organizations that dealt with the unemployment phenomenon caused by the closure of mines and summarized the types of responses they adopted. National governments have often provided support to workers through welfare programs, such as early retirement and individual subsidies, or by offering financial compensation for the job loss, often co-funded by the local administration and mining companies. In Germany, after the crisis in hard coal production that began in 1958, alternatives like early retirement and retraining kept the unemployment rates relatively low¹⁹. In other places, as in Kiruna, Sweden, the government established a special agency to deal with unemployment linked to an iron mining decline in the 1980s.

14 Data extracted from from the permanent exhibition on the history of coal, *Museo del carbone, Grande Miniera di Serbariu*, Carbonia, Italy. (April 2021).

15 Preite M., Maciocco G. *Da miniera a museo, il recupero dei siti minerari in Europa*. Alinea editrice, Florence. 2000.

16 Álvarez Argüelles C. *The effect of mine closures on depopulation in the Principality of Asturias, Spain*. Master's Thesis Degree in Economic Development and Economic Growth at Lund University. 2023.

17 Alves Dias P., Kanellopoulos K., Medarac H., Kapetaki Z., Miranda-Barbosa E., Shortall R., Czako V., Telsnig T., Vazquez-Hernandez C., Lacial Arantegui R., Nijs W., González-Aparicio I., Trombetti M., Mandras G., Peteves S., Tzimas E. *EU coal regions: opportunities and challenges ahead*. 2018.

18 *Navigating coal mining closure and societal change: learning from past cases of mining decline working paper*. Source: <https://justtransitionforall.com/wp-content/uploads/2022/11/navigating-coal-mining-closure-and-societal-change.pdf> (Accessed: June 2024).

19 Oei P. Y., Brauers H., Herpich P. *Lessons from Germany's hard coal mining phase-out: policies and transition from 1950 to 2018*. 2019.

The study²⁰ also notes that former miners may be reluctant to learn new skills and often prefer to seek re-employment in the coal industry. Therefore, in many contexts lacking in alternatives, the closure is followed by the discharge of labor that has no possibility of re-employment in alternative activities located in the same territory. This leads to another outcome, the sudden and increasing flow of depopulation of mining regions and cities.

The research *Does anyone live here? Mine closures and depopulation in Spanish coal mining areas*²¹ highlights the negative impact of coal mine closures on the urban shrinkage of industrial areas in Spain, analyzing the change in population growth of mining and non-mining areas in different periods. Between 1991 and 2011, “after implementing policies that cut public subsidies to coal mining”, mining areas had a much larger negative trend: a decline of about 17%, compared to an increase of more than 25% in non-mining areas). This negative trend got even worse from 2011 to 2021, losing more than 12% of the population, while non-mining areas in the same provinces lost on average less than 4% in the same period²². Another study related to the Spanish case entitled *The effect of mine closures on depopulation in the Principality of Asturias, Spain*, attempts to document the depopulation in the region relating it to the mining activity of the recent decades, showing how the decline was faster and more critical after the closure of the last mines, starting from the 1990s. According to this research, “Asturias has lost nearly 60,000 inhabitants in these twenty years, representing about 6% of the total population.”²³

Data related to the de-industrialization of the early 20th century in Eastern Europe show a population decline of about 25-33% occurred mainly in the eastern mining centers of the Donetsk region of Ukraine, and a decline of about 15-17% in the case of the Silesian Region in Poland²⁴. In the Petrosani area in Romania, the migration rate was around 24% in 1997²⁵, after the closure of the industrial sites and the increase in layoffs.

20 Strambo C., Thazin Aung M., Atteridge A. *Navigating coal mining closure and societal change: learning from past cases of mining decline*. 2019.

21 Perez-Sindin X.S., Fernandez Vazquez E., Sanz-Hernández A. *Does anyone live here? Mine closures and depopulation in Spanish coal mining areas*. 2023.

22 Perez-Sindin X.S., Fernandez Vazquez E., Sanz-Hernández A. *Does anyone live here? Mine closures and depopulation in Spanish coal mining areas*. 2023.

23 Álvarez Argüelles C. *The effect of mine closures on depopulation in the Principality of Asturias, Spain*. Master’s Thesis Degree in Economic Development and Economic Growth at Lund University, 2023.

24 Rechlłowicz M., Tkocz M. *Depopulation of traditional mining regions in central and east Europe: case study of the upper Silesian Basin (Poland) and the Donetsk basin (Ukraine)*. Faculty of Earth Sciences, University of Silesia. 2013.

25 Mureșan G.A., Lung M. S. *The Demographic Consequences of the Restructuring Process of Mining Industry in Romania. Case Study: The Petroșani Depression*. Acta Montanistica Slovaca, Volume 27, p. 254-266. 2022.

Data show a common trend in several European mining regions, united by similar processes of de-industrialization that have led in the short term to the lack of alternatives and economic opportunities, which forced part of the population to migrate to other places, but the social issues related to the communities of workers are not the only critical consequences of the closure. The loss of population and economic activity leads to an overall economic decline. Just as the end of mining activity has caused the departure of people from the mining sites, the disuse of the facilities has led to their abandonment and isolation from urbanized inhabited contexts.

« *Once their activity has ended, mining settlements tend to become depopulated [...] at the end of the mining activity there are numerous satellite settlements that have depopulated around the main inhabited center and today appear as Ghost Towns* »²⁶

Globally, there are numerous examples of so-called “Ghost Towns” where the closure of the mine has led to the closure of the town, especially if it was built to house mine workers as a single-purpose village²⁷. To give an example related to the case study analyzed in the thesis, there are several cases of completely abandoned mining villages in Southern Sardinia (Italy). These centers arise near the wells and were once inhabited by workers and their families, while today they are neglected, in a state of structural degradation, forgotten even by the local population. The speed of change and the isolation of these structures have not allowed the transition from an active industrial system to a context capable of regenerating itself, as instead happened in other contexts like the Ruhr (Germany), where industry and urban centers were close and connected.

The disuse of the sites, combined with the distance from the inhabited centers, does not make it easy to reintegrate the industrial complexes into local economic activities. Furthermore, the transition from an operating mine to the closure of the extraction site often involves the shift from a model in which local interests are subordinated to a distant system of economic interests, to a situation in which local administrations take on the responsibilities and effects of the closure, having to seek a development model integrated with the exploitation of their resources²⁸.

In this perspective, the disused mining heritage can be seen as a potential opportunity for local development, if included in policies and programs that support its promotion and enhancement.

26 Peghin G. *Paesaggi minerari. Tecniche, politiche e progetti per la riqualificazione del Sulcis-Iglesiente*. LetteraVentidue, Siracusa. 2016.

27 Nicholas B., Sarah Holcombe S. *The social aspects of mine closure: a global literature review*. 2018.

28 Preite M., Maciocco G. *Da miniera a museo, il recupero dei siti minerari in Europa*. Alinea editrice, Florence. 2000.

► Image 7

Remains of the mining village
Villaggio Asproni (Italy). 2021.

Source: personal archive.



► Image 8

Remains of the mining village
Villaggio Asproni (Italy). 2021.

Source: personal archive.



1.2 MINING HERITAGE AS A DRIVER OF DEVELOPMENT

The enhancement of mining heritage implies first of all the recognition of its value by institutions, organizations, and communities, a state that starts from the knowledge of the sites, their history, and their interaction with the territory, and by a continuous action of conservation of the structures.

Often, in circumstances in which the closure corresponded to the decommissioning of large areas, abandoned mining complexes have been neglected for long periods until reaching a state of critical decay. As described in the previous chapter, in similar cases it is not easy to think of a reintegration of the site into the economic life of the place, if attention is not first paid to the value of this heritage and its protection. In this sense, the field of research can represent an important branch for awareness and information sharing, to ensure that isolated sites regain recognition and interest by the local and non-local population.

« The decline can also impact the way local areas are self-perceived, making more difficult to envision alternative futures »²⁹

In several contexts, it has been possible to successfully address the decline that mining territories have faced, through the acknowledgement of the mining heritage as an element of identity and legacy of the past, with the potential to be an economic and social asset for the development of the territory.

In response to critical issues derived from the closure related to work, depopulation, abandonment, and environmental problems, mining heritage can be considered a driver of development, taking into account several areas of interest to which many fields of opportunities are linked: research and education, job creation, community revitalization, and tourism.

Before providing a description of practical examples and successful cases, some preliminary considerations to the development process are analyzed, such as the difficulties, the challenges to consider, who are the actors of the process and what measures they can adopt.

²⁹ Perez-Sindin X., Van Assche K. *From coal not to ashes but to what? As Pontes, social memory and the concentration problem*. 2020.

1.2.1 Challenges, actors and opportunities

A first step towards the enhancement process, which is also a step towards the recognition of the legacies of the mining industry as worthy of attention, is given by the identification and systematization of the same in the territorial context. This process involves research, understood as collecting information on data relating to the mines: their position, history, and current state.

In contexts in which mines have been abandoned following their closure, the historical data and their actual location might have been lost, making their documentation hard to process. Although there are tools that facilitate this procedure, such as censuses carried out by local and state administrations, documents stored by mining companies and historical archives, and research, mainly carried out in the academic field, there is often difficulty in finding the information due to long research operations caused by lack of systematization in an easily accessible data set. This implies both a lack of knowledge of the heritage and a great limitation in communicating and publicizing it. Furthermore, without a detailed and categorized inventory, it is complicated to plan intervention strategies on the territory. A study³⁰ on the rehabilitation of mines in Australia, published in 2012, highlights the importance of quantifying the number of abandoned mines, mapping them, and providing information such as size, type, historical data, and so on. The creation of such a systematic data set is fundamental to evaluate programs, priorities, and costs for the heritage to be enhanced.

Therefore, this phase of the process, that of knowledge, is followed by the planning of initiatives and interventions that require the cooperation of multiple disciplines, both technical and scientific, starting from the field of architecture and leading to subjects of landscape planning, economics and politics, and environmental engineering. The intervention of the latter is due to one of the most common critical issues in the matter of mining sites: the pollution that they have caused on the territories often makes the remediation and restoration of ecological systems necessary. In fact, mining activity radically changes the conformation of the land, damages natural systems and habitats, and pollutes water and soil due to contamination. To deal with this problem, in addition to the need for specific skills, a significant economic intervention is necessary. However, the technical, economic, and environmental challenges are not the only ones that need to be addressed, it is also crucial to take into account the social sphere.

For a successful development program, it is essential to involve local communities, taking into account their needs and expectations. As will be described later, in some contexts there has been an involvement of communities in development policies through communication platforms, activities, and workshops, for the creation of new economic opportunities for locals, such as services for tourism, culture, and crafts. Engaging

30 Unger C., Lechner A.M., Glenn V., Edraki M., Mulligan D.R. *Mapping and prioritising Rehabilitation of Abandoned Mines in Australia*. 2012.

their active participation helps to create interest in residents through the rediscovery of local cultural values, to maintain a sense of identification linked to heritage, and also to promote initiatives for land use, the creation of services, and jobs. Local communities, in fact, are both stakeholders in the development process of post-industrial regions and recipients of positive economic effects, such as new job opportunities or opening of new commercial activities.

In addition to the public, key actors include the national government, local administrations, mining companies, research institutes, and international organizations.

The aforementioned research *Navigating coal mining closure and societal change: learning from past cases of mining decline*³¹, made a selection of 154 international publications dealing with mine closures, distinguishing “which actors took steps to address the potential and actual impacts of mining decline and what types of measures they took”, summarizing the types of responses adopted³². The majority of actions coming from organizations that have actively addressed the decline, mainly national, provincial, and local authorities, have provided assistance funding for workers and financial support for programs, such as infrastructure development and research on economic diversification.

Also mining companies were regularly involved in supporting the workers’ transition together with the national government, and in some cases, the private sector has also been involved in identifying measures aimed at the diversification or conversion of core activities, as with the definition of new uses for the structures.

Collaboration between parties is also important. Competition between local administrations has hampered efforts to address the impacts of mine closures in Tasmania³³ (Australia), while collaboration has been essential in countries like Germany and Poland. Besides the level of attention and involvement of the actors, a key to success is their mutual support. The study *Challenges of the Polish coal mining industry on its way to innovative and sustainable development*³⁴ attempts to present a model of cooperation among stakeholders in the mining industry, emphasizing the importance of collaboration between the government, universities, and industrial companies for the exchange of financial capital, educational capital, and practical knowledge, to seek innovative and sustainable development strategies that positively influence the economy, society and the environment.

As previously stated, there are various opportunities that the mining heritage offers,

31 Strambo C., Thazin Aung M., Atteridge A. *Navigating coal mining closure and societal change: learning from past cases of mining decline*. 2019.

32 The majority of the publications analyzed are related to European coal mines (table 1, p. 6).

33 Strambo C., Thazin Aung M., Atteridge A. *Navigating coal mining closure and societal change: learning from past cases of mining decline*. 2019.

34 Jarosław B., Magdalena T. *Challenges of the Polish coal mining industry on its way to innovative and sustainable development*. 2022.

related to fields such research and education, culture, nature, and tourism, often exploited through the reuse of industrial buildings, or their inclusion in projects or initiatives for tourism, sport, and leisure. Educational activities are often integrated into exhibitions and guided visits of the facilities: buildings, tunnels, and machinery, offer the opportunity to study the functioning of the mine, and also geology, engineering, and technology related to the extraction and processing of minerals. This is why, in many contexts, disused mines have become museums. This solution allows for the use of cultural and historical aspects for commercial benefit without compromising the nature of the place, exploiting the composition of the site, the presence of machinery, and the opening and setting up of underground tunnels, making the mine simultaneously an exhibition display and an exhibited object.

Large industrial buildings are flexible, and the adaptive reuse process can give rise to the creation of different spaces, such as event centers, fairs, conferences, auditoriums, shops, housing, and sports venues. In the Duisburg Coal Mine (Germany), some structures have been reused to create spaces where it is possible to practice sports activities: there are cycle and pedestrian paths that follow the old railway systems, the reinforced concrete walls of the mine facilities are used for climbing, and the gasometer hosts a pool for underwater sports³⁵.

Although the prospect of reuse suggests an easy conversion of the economic activity of the site, in contexts “far” from inhabited centers it is difficult for such a reuse plan to be successful.

In these cases, a more sustainable intervention program can lead to the fruition of industrial spaces without going through an invasive project. One scenario for this type of site, which will be discussed in more detail in the second chapter, is their inclusion in hiking, cycling, and pedestrian routes, which offer the possibility of taking nature trails, thus taking into account the mining heritage within a wider spectrum of attractions, including landscape and cultural ones.

To provide some examples of successful development driven by mining heritage, two cases of socioeconomic redevelopment following the decline of the coal industry are presented: the Ruhr in Germany and the Silesian Basin in Poland, to describe in more detail what measures have been taken, which organizations were involved, and what is the ongoing situation in two of the largest mining regions in Europe.

35 Official website of the Duisburg-Nord Park: <https://www.landschaftspark.de/en/> (Accessed: June 2024).

1.2.2 The case of the Ruhr, Germany

The Ruhr region has been able to reverse the downward population trend in the mining areas after the closures and is now one of the most populated parts of the country. It was one of the most productive mining sites in Europe, whose cultivation entered into crisis and suffered a long decline starting at the end of the 1950s. The post-deindustrialized panorama of the late 20th century, like many other European contexts, was of a desolate territory, modified after being disfigured by open-pit and underground mines for over a century with no prospect of reuse. During this period, a major renewal process was carried out by the Land of North Rhine-Westphalia with the IBA Emscher Park³⁶ program (*Internationale Bauausstellung Emscherpark*) from 1989 to 1999.



◀ Image 9

Zeche Zollverein Mine, Essen (Germany).

Source: Jochen Tack, Zollverein Foundation.

The company was based in Gelsenkirchen, and it was made up of a Board of Directors composed of political representatives, a Steering Committee composed of architects and engineers, and a Funding Control Committee (60% of the funding came from private investments, the remaining 40% was made up of public funding), with the task of supervising and coordinating the various projects, carried out at the same time, concerning the entire area covered by the redevelopment plan.

The peculiarity of the IBA is that it was not born as a planning authority, it had no legal power over the parties involved, its role was to guide local organizations and professionals by keeping under control the various proposed initiatives in favor of a continuous

³⁶ Official website of IBA: <https://www.internationale-bauausstellungen.de/en/> (Accessed: June 2024).

exchange of ideas and projects. To underline once again the importance of diversification and collaboration among stakeholders, in the first phase of the program a call for proposals was published, and about 350 projects were proposed by architecture and engineering firms, associations, students, and the 17 municipalities that are part of the area.

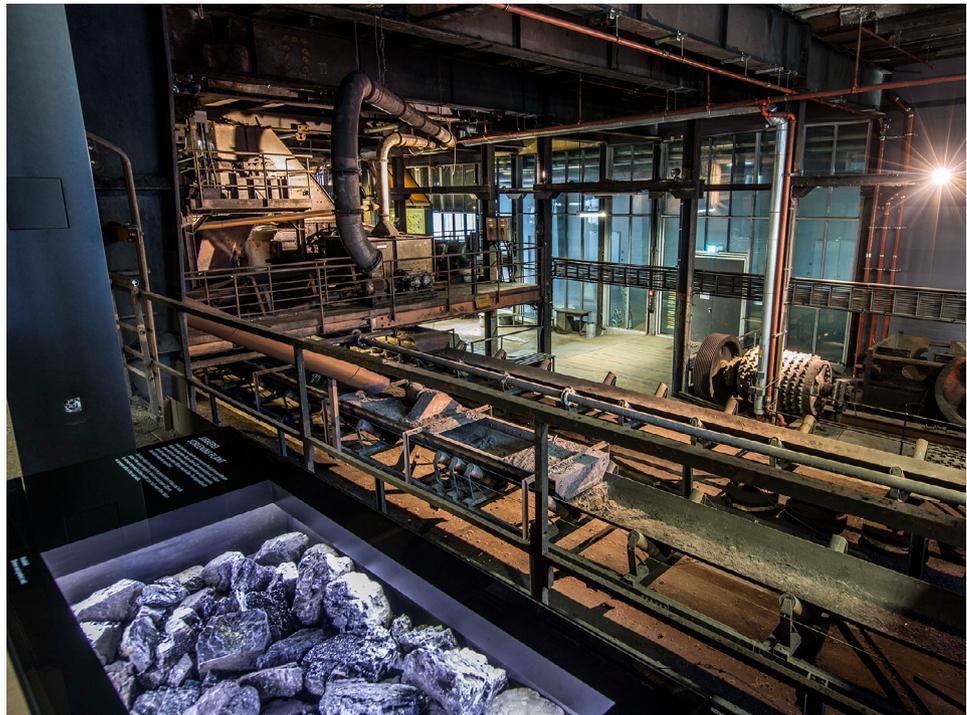
The program, intended to guide the proposed choices, consisted of guidelines that included the reclamation of the landscape and the Emscher River, the restoration of industrial monuments as historical testimonies, the creation of new neighborhoods and residential zones, and the encouragement of the formulation of proposals for social, cultural, and sport activities. The result of the interventions (to be considered in a long-term strategy lasting 25 years) on the territory was the creation of the Emscher Landscape Park, a large system of parks connected by cycle paths, green routes and water channels.

As for the industrial facilities, the choice was to recover them as a symbol of the historical and cultural identity of the region, inserting them into a restoration and enhancement program. In many cases, the reuse of the facilities was directed toward cultural activities: theaters, museums, schools, art centers, and exhibition spaces.

► Image 10

Ruhr Museum, Essen
(Germany).

Source: Jochen Tack, Zollverein
Foundation.



In the last decades of the 20th century, significant results on the growth of tourism were obtained: overnight stays in the Ruhr area increased by more than 60%, from 3,598,300 in 1990 to 5,777,500 in 2009³⁷. The Rhineland kept updating its marketing strategy, based on the TSK state tourism plan for North Rhine-Westphalia³⁸, and it's still undergoing a process of urban evolution and economic growth in the mining areas, supported by local, national, and European programs, within the framework of the ERDF (European Regional Development Fund) funding for 2021 - 2027³⁹. The Ruhr Tourismus GmbH, a company founded in 1998 with the task of coordinating the development of tourism products, is currently working on the implementation of a database to manage and share tourist information, taking advantage of the opportunities of digitization to offer accommodation and destination services⁴⁰.

In 2020, the German government promulgated the law for strengthening the mining regions in the Rhineland and in Lusatia in the ongoing structural transformation process (*Strukturstärkungsgesetz Kohleregionen*), with investments for new traffic infrastructure and new scientific institutions⁴¹. To underline the importance of stakeholder engagement and communication, development projects are often supported by the work of universities, as in the case of the Lausitz Science Park in Cottbus, where a new research hub is to be created over the next few years, accommodating various company settlements and small to medium-sized enterprises, under an initiative led by the BTU Cottbus-Senftenberg⁴².

Another example is the one from RWTH Aachen University, which created REVIERa⁴³, a “transformation platform” which seeks to find a dialogue between professionals and stakeholders of the Rhineland: they can actively participate to activities to propose long term projects and ideas that can generate positive economic effects in the region.

37 Copic S., Đorđević J., Lukic T., Stojanović V., Đukićin S., Besermenji S., Stamenković I., Tumaric A. *Transformation of industrial heritage: An example of tourism industry development in the Ruhr area (Germany)*. 2014.

38 *Territoriale Strategiekonzept Tourismus plan*. Source: https://www.ruhr-tourismus.de/wp-content/uploads/2022/04/Territoriales_Strategiekonzept_Tourismus_Ruhrgebiet_-220207.pdf (Accessed: June 2024).

39 European Regional Development Fund. Source: https://ec.europa.eu/regional_policy/funding/erdf_en (Accessed: June 2024).

40 Official website of the Ruhr Tourismus GmbH: <https://www.rvr.ruhr/politik-regionalverband/ueber-uns/beteiligungen-eigenbetriebe/ruhr-tourismus-gmbh/> (Accessed: June 2024).

41 Gerwin W., Raab T., Birkhofer K. et al. *Perspectives of lignite post-mining landscapes under changing environmental conditions: what can we learn from a comparison between the Rhenish and Lusatian region in Germany?*. *Environ Sci Eur* 35. 2023.

42 Official website of the Lausitz Science Park: <https://www.b-tu.de/lausitz-science-park/> (Accessed: June 2024).

43 REVIERa platform. Source: <https://www.reviera.rwth-aachen.de/cms/reviera/~ogjey/plattform/> (Accessed: June 2024).

1.2.3 The case of the Silesian Basin, Poland

A decline similar to that described for the German case took place in the Silesian Basin, in Poland. During the last decades of the 20th century, most of the mines of the basin were closed due to the increase in costs and the decrease in accessibility to the coal deposits, leading to high unemployment rates and out-migration. Although it is located in a different context, it is possible to find similar methods and initiatives in the recovery processes.

► Image 11

Julia Mine, Wałbrzych (Poland).

Source: <https://sievert-international.com>



Regarding the financing of programs, investments made in the 1990s improved the situation in the labor market, in response to growing unemployment. State funds financed the protection of the mining heritage and the creation of museums for the restructuring of the region. In 1997, the Wałbrzych Special Economic Zone (WSEZ)⁴⁴ was created, also known as “Invest Park”. It is a set of areas designated for opening businesses on favorable terms, such as tax exemptions. In recent decades, European funds have mainly financed urban regeneration projects and the ecological restoration of former mining areas. The National Revitalization Plan aimed at creating housing services, transforming the industrial facilities into residential housing, and working specifically on three pilot projects for revitalization in the cities of Wałbrzych, Lodz,

⁴⁴ Official website of the WSEZ: <https://invest-park.com.pl/en/> (Accessed: June 2024).

and Bytom, to develop a model based on guidelines to be implemented in other cities of the region⁴⁵. The Julia Mine, located in Wałbrzych, is among the largest mining complexes of the country, and represents one of the most successful interventions: today it hosts a museum, a technological research center, an art gallery, and a service center. The need for a reliable data set is highlighted once again in the case of its recovery program, due to an inaccuracy in the inventory of the area, which led to corrections and changes to the project while it was in progress. It started in 2008 and was financed by the EU, but at the end of the works in 2014, the project ended up over three times more costly⁴⁶. Proper collection of information at an early stage is essential for assessing the schedules and costs of the process and includes the number of facilities and machinery, their type, and their location. This procedure is facilitated by censuses and scientific research. In the Silesian mining region, different programs have been launched to assess this issue over time. Already in the 1980s, the first censuses were carried out by the Regional Conservation Board, and by educational institutes such as the Wrocław University of Technology, with the cataloging of sites and technical machinery⁴⁷. Furthermore, to spread knowledge on sites and objects related to the mining industry, meetings and conferences were held, such as the *Mining Heritage and History and Use of Remains of Former Mining Works* conference, yearly organized since 2005⁴⁸.

A recent study, published in 2016, performed modeling of mining-induced land subsidence in the Wałbrzych coal mine area, using geographic information systems (GIS) that allowed mapping and digitization, including georeferencing of data on subsidence factors (thickness, slope, depth, etc), to evaluate the hazard in former mining areas⁴⁹. These types of initiatives contribute to expanding knowledge of the territory and can be used to plan interventions but also to promote lesser-known sites. From this point of view, there has been a great development in heritage publicity in the Silesian area in recent decades. Data on tourism show an increase in the flow of visitors in the 2010s (+40% of the overnight stays), the number of gastronomic establishments, and tourist attractions⁵⁰.

45 *Poland National Revitalization Plan*. Source: https://single-market-economy.ec.europa.eu/document/download/2f32e99b-2906-4414-87d0-c996c5445e0a_en (Accessed: June 2024).

46 Jaroszevska E. *Urban shrinkage and regeneration of an old industrial city: the case of Wałbrzych in Poland*. 2019.

47 Preite M., Maciocco G. *Da miniera a museo, il recupero dei siti minerari in Europa*. Alinea editrice, Florence. 2000.

48 Madziar M. *Historical ore mining sites in Lower Silesia (Poland) as geo-tourism attraction*. 2013.

49 Blachowski J. *Application of GIS spatial regression methods in assessment of land subsidence in complicated mining conditions: case study of the Wałbrzych coal mine (SW Poland)*. 2016.

50 Naramski M., Herman K. *The Development of Mobile Tourism in the Upper Silesian Metropolitan Area of Poland*. 2019. Tables 1, 2, 4, available at: https://www.researchgate.net/publication/338120120_The_Development_of_Mobile_Tourism_in_the_Upper_Silesian_Metropolitan_Area_of_Poland/figures (Accessed: June 2024).

Taking into account the objectives and programs implemented in the Ruhr and in the Silesian regions and the results obtained, it is possible to identify some key points relating to the development initiatives, that highlight the importance of the concepts discussed in the chapter, namely the digitization and online sharing of information, and the collaboration between parties for the success of the enhancement strategies, which have allowed the regeneration of areas damaged by industrial decline. Assuming that there is no common recovery methodology applicable to all cases, the presentation of the described cases is an attempt to analyze some of the responses to decline and highlight common aspects of heritage promotion.

Mining regions have a great cultural offer that can be exploited. The conservation of the industrial heritage is fundamental to maintaining the historical and cultural assets linked to it, but its enhancement passes through initiatives of inclusion in broader processes of economic and social reactivation of the territories, of which the mining heritage, properly preserved and made available to visitors, can be the driving force.

2. CULTURAL TOURISM

« *Tourism is an excellent way to encourage and provide access to cultural heritage* »⁵¹

When we talk about “cultural tourism”, we are referring to the planning and advertising of initiatives, services or events, aimed at the enjoyment of the culture of one place by local and non-local visitors. This topic does not only concern the field of architectural heritage, there are different types of cultural interests that range from the spiritual world, such as pilgrimages, to that of gastronomy, to that of landscape attractions, referring to types of tourism that take into account several cultural assets (historical, social, architectural, environmental).

This chapter tries to describe, starting from the origins of the concept of cultural tourism and its evolution up to the current state, which activities, interests and purposes are involved nowadays in the tourist’s choice. By dealing with the topics of promotion and enjoyment of cultural and architectural heritage, the importance of sustainability issues in the tourist offer is underlined, in particular through the presentation of cultural itineraries as a sustainable solution for the fruition of the heritage. Associations such as ERIH⁵², an information network of industrial heritage in Europe, connects the main sites through thematic routes, which are described as case studies.

⁵¹ European Commission. Source: <https://culture.ec.europa.eu/cultural-heritage/cultural-heritage-in-eu-policies/sustainable-cultural-tourism> (Accessed: July 2024).

⁵² Official website of the European Route of Industrial Heritage: <https://www.erih.net/> (Accessed: July 2024).

2.1 WHAT IS CULTURAL TOURISM?

The UN Tourism⁵³ General Assembly adopted a definition of cultural tourism during its 22nd session in 2017, as “a type of tourism activity in which the visitor’s essential motivation is to learn, discover, experience and consume the tangible and intangible cultural attractions / products in a tourism destination”⁵⁴. This definition refers to the notions of tangible and intangible heritage, including not only architectural and natural monuments, archaeological sites, works of art, or gastronomy, but also traditions, festivals, and events, as long as they are connected to the identity of a place. In fact, typical tourist activities include visits to museums and monuments, as well as participation in festivals and cultural events, or even spiritual and religious worship, considering a range of attractions that allow the combination of leisure and learning, and to fully enjoy the local traditions.

2.1.1 Evolution of the concept of Cultural Tourism

Cultural tourism is not a recent phenomenon, it originates from the activity of deepening one’s knowledge through contact with an unfamiliar place. The idea of traveling for educational purposes began to spread in Europe at the end of the 16th century, and became a common activity of young artists and aristocrats, who began to undertake it regularly, aiming at personal development through discovery and comparison. This type of travel became a trend and began to be known as the “Grand Tour”⁵⁵: a tour of the main cities and areas of artistic and cultural interest in Europe. The main destination of the trip was Italy, and especially Rome, with its archaeological sites and its collections of art and antiques, but also Venice, Florence, Naples⁵⁶. In the 18th and 19th centuries it was considered an essential part of the education of young people from wealthy families, it could last up to two years and would always include several months staying in each city visited.

Regarding travel literature, it is proper to mention Alberto La Marmora⁵⁷ (or Alberto della Marmora), who wrote one of the most popular works among the travel accounts of the 19th century, entitled *Voyage en Sardaigne* (Journey to Sardinia), which appeared

53 Specialized agency for tourism, formerly known as “World Tourism Organization” (UNWTO).

54 Official website of the UN Tourism: <https://www.unwto.org/tourism-and-culture> (Accessed: July 2024).

55 The term “Grand Tour” was introduced in 1670 by Richard Lassels with the publication of the book *An Italian Voyage*. Source: <https://www.horti-hesperidum.com/show.php?item=226> (Accessed: July 2024).

56 The tradition of the Grand Tour. National Central Library of Florence. Source: <https://grandtour.bncf.firenze.sbn.it/racconto/tradizione-del-grand-tour/la-nascita-del-grand-tour> (Accessed: July 2024).

57 Italian General and cartographer born in Turin in 1789. Source: <https://lamarmora.net/alberto-la-marmora-biografia.html> (Accessed: July 2024).

in a first edition in 1826 and then again in 1840 with the addition of a second part⁵⁸. The work contains 19 illustrated plates and is structured as a paleontological, geological, physical and political description of Sardinia. This volume, in addition to being a model and an incentive for travelers to reach the island, gave rise to the *Itinéraire de l'île de Sardaigne* (Sardinia Island Itinerary), published in Turin in 1860⁵⁹. This second work was more specifically dedicated to the traveller, as a sort of tourist manual in which the most significant things to see and know are indicated. These publications not only fit into the panorama of “cultural tourism” of the time, they are connected to the legacy examined in this thesis that was born shortly thereafter, the Coal Mining Heritage. In 1834, during his travels, La Marmora was the first to detect some fragments of coal in Southern Sardinia, describing the discovery in his works, a few years before the opening of the first extraction site in the area, the Mine of Bacu Abis.

In the second half of the 18th century, thanks to the socio-economic transformation of the Industrial Revolution, a large part of the population moved from rural areas to large cities and the transport system developed throughout Europe, allowing for a more accessible railway network that connected various destinations. It was during this period that the first travel agencies emerged, such as Thomas Cook and Son, a global travel agency that was the first to offer a type of travel similar to modern tourism⁶⁰.



◀ Images 12 and 13

Geological map of Sardinia surveyed and drawn by Alberto La Marmora, Turin 1856 (left), and stages of the Grand Tour in Europe and Italy (right).

Sources: <https://discoverportovenere.com/it/viaggio-italia-itinerario-storico-grand-tour/>; <https://parcogeominerario.sardegna.it/cartografia/>

58 *Voyage en Sardaigne*. Source: <https://www.sardegna.digitalibrary.it/detail/6499b95fe487374c8f80333b> (Accessed: July 2024).

59 *Itinéraire de l'île de Sardaigne*. Source: <https://www.sardegna.digitalibrary.it/detail/6499b95ae487374c8f803254> (Accessed: July 2024).

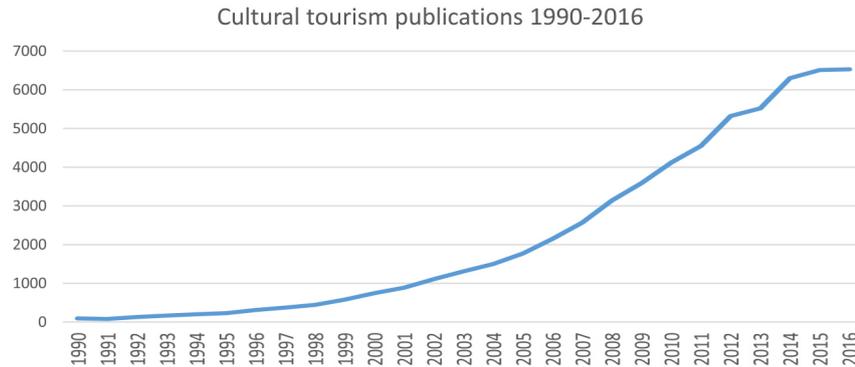
60 History of tourist industry, Britannica. <https://www.britannica.com/topic/Thomas-Cook-and-Son> (Accessed: July 2024).

Tourism as we know it today became a more widespread social phenomenon in the second half of the 20th century. After World War II, particularly in the 1960s and 1970s, tourism contributed to the reconstruction of local economies, thanks to a rapid expansion of the general interest in leisure travel, which went from being an exclusive activity to being accessible to the masses. In the following years, there was an increase in the number of travel agencies and hotel facilities, and a diversification of the tourist offer with new products also focused on sports and nature. As described by Greg Richards, only recently the relation between culture and tourism has been recognized as a form of consumption⁶¹, and the phenomenon has been studied by an increasing number of publications over the last decades.

► Image 14

Publications on cultural tourism from 1990 to 2016.

Source: Google Scholar.
Richards G. *Cultural tourism: A review of recent research and trends*. 2018.



The growing number of tourists travelling for educational purposes or to folklorist attractions has led to the recognition of the label “cultural tourism” as an emerging market sector. Over the past few decades, the global number of international visits has more than doubled, with overnight visitors from one country to another increasing from 1.08 billion in 1995 to 2.4 billion in 2019⁶², and cultural tourism has recently been re-affirmed by the UN Tourism as a major element of international tourism consumption, accounting for over 39% of the arrivals⁶³. The interest in this sector and the proposal of initiatives would seem to increase even more in the future: according to the report *Cultural Tourism Market Outlook (2023 to 2033)*⁶⁴ published by Future Market Insights, in the next few years the demand for cultural tourism will have an increase of 14.4% CAGR (Compounded Average Growth Rate).

61 Richards G. *Cultural tourism: A review of recent research and trends*. Journal of Hospitality and Tourism Management, Volume 36. 2018.

62 Yearbook of Tourism Statistics, UN Tourism. Source: <https://data.worldbank.org/indicator/ST.INT.ARVL> (Accessed: July 2024).

63 Richards G. *Cultural tourism: A review of recent research and trends*. 2018.

64 *Cultural Tourism Market Outlook (2023 to 2033)* report, Future Market Insights. Source: <https://www.futuremarketinsights.com/reports/sample/rep-gb-16797> (Accessed: July 2024).

2.1.2 Types of Cultural Tourism

The tourism sector is becoming very diverse. The segmentation of its market is based on the distinct interests of the tourists, that can give rise to different demands and different responses. According to Wendell Smith, the segmentation “consists of viewing a heterogeneous market (one characterized by divergent demand) as a number of smaller homogeneous markets”, and the advantage of this process is that a tourist destination becomes able to specialize on the needs of one or more specific groups⁶⁵. Therefore, the segmentation criteria based on the tourists targeting take into account, in addition to the motivations and purposes of travelers, also their age and economic condition, in order to group them into similar clusters based on common traits and consumer behavior.

In the specific case of cultural tourism, it is a type of tourism that cuts across different generational targets, so it is important, in addition to framing the visitor’s interests, to provide a variety of services and attractions that complete the cultural offering and satisfy different needs. The groups identified as most interested in this type of travel range between the older generations aged between 40 and 60⁶⁶, especially families or couples, and young students aged between 16 and 25⁶⁷, categories that most likely have different interests and motivations to associate with the primary reason for the trip. As highlighted by a comparative study between Poland and USA⁶⁸, cultural travelers are not only interested in monuments, but also to spend the night, eat and shop. In the same way, the recent publication *Turismo Culturale Report*⁶⁹ of 2022 by ISNART (Italian National Institute for Tourism Research) shows that despite the main reasons for traveling include the presence of historic attractions (city centers, monuments, churches, museums, archaeological sites), cultural tourists increasingly alternate cultural visits with recreational and entertainment activities: 21.9% go shopping, 15.9% dedicate their vacation to tasting local food and wine products, 5% participate in traditional and folklorist events.

As a constantly evolving sector, there are several types of cultural activities that diversify the market into smaller categories. These types of tourism, although united by the

65 Dolnicar S. *Market segmentation in tourism*. 2008. Reference made to: Smith W. *Product Differentiation and Market Segmentation as Alternative Marketing Strategies*. 1956.

66 *Turismo Culturale Report 2022*, Istituto Nazionale Ricerche Turistiche. Source: <https://www.isnart.it/it/report-sui-turismi/turismo-culturale-report-2022/> (Accessed: September 2024).

67 *Cultural Tourism Market Outlook (2023 to 2033)* report, Future Market Insights. Source: <https://www.futuremarketinsights.com/reports/sample/rep-gb-16797> (Accessed: July 2024).

68 Kuzior A., Grebski W., Kwilinski A., Krawczyk D., Grebski M.E. *Revitalization of Post-Industrial Facilities in Economic and Socio-Cultural Perspectives - A Comparative Study between Poland and the USA*. 2022.

69 *Turismo Culturale Report 2022*, Istituto Nazionale Ricerche Turistiche. Source: <https://www.isnart.it/it/report-sui-turismi/turismo-culturale-report-2022/> (Accessed: September 2024).

interest in discovering and learning more about the cultural aspects of a place, can concern distinct activities, products or attractions.

Industrial tourism is the form of cultural tourism that comes closest to the topics covered in this thesis, and which concerns the enhancement of the industrial heritage of a territory with visits of disused (and restored) industrial sites, such as mines, power plants, galleries, and museums, to discover their history and their functioning. Therefore, among the prospects for the conservation and enhancement of the industrial heritage discussed in the first chapter, there is the creation of services aimed at the enjoyment of the heritage in mining regions, that will lead to an increase in tourist flows, to an economic improvement, and to the creation of new jobs and new commercial activities in the territory.

As shown by the *Industrial Tourism Market Outlook (2023 to 2033)*⁷⁰ report by Future Market Insights, in recent decades the interest in industrial heritage has grown especially among younger groups, especially students, not only to learn about the history of industries, but above all because of the possibility of enjoying the spaces and using the utilities provided by the sector, not limited to a simple exhibition. This relates to what Greg Richards describes as the visitor's desire for contact with the roots of the place and a more direct engagement with the practices of local culture, seeking experiences that involve the visitor as part of the community and not as an observer⁷¹. For this reason, solutions such as tours of underground mine galleries and facilities, and exhibits on the daily life and practices of the workers, are considered one of the trends with the highest preference.

For instance, in the Historic Coal Mine Guido in Zabrze (Poland), it is possible to perform a series of mining tasks: tourists are given miner's helmets, lamps, and the necessary protective clothing, to descend to a depth of 355 meters underground and experience first-hand the effort and working conditions of miners⁷².

The growth rate for the industrial tourism sector shows an expected increase of 31.7% CAGR (Compounded Average Growth Rate) over the next 10 years⁷³, showing that there is room for further development.

⁷⁰ *Industrial Tourism Market Outlook (2023 to 2033)* report, Future Market Insights. Source: <https://www.futuremarketinsights.com/reports/industrial-tourism-market> (Accessed: July 2024).

⁷¹ Richards G. *Creative tourism*. Tourism & Management Studies. 2019.

⁷² Official website of the GUIDO Coal Mine: <https://www.kopalniaguido.pl/index.php/kopalnia-guido-szycha> (Accessed: September 2024).

⁷³ *Industrial Tourism Market Outlook (2023 to 2033)* report, Future Market Insights. Source: <https://www.futuremarketinsights.com/reports/industrial-tourism-market> (Accessed: July 2024).



◀ Image 15

“Underground Shift” program for visitors at the Guido Coal Mine in Zabrze (Poland).

Source: <https://www.kopalnia-guido.pl/index.php/kopalnia-guido-szycha>

Another growing sector is that related to geotourism, which is also increasingly widespread in many mining contexts of the world, due to the geological conformation of the terrain, the richness of minerals and the possibility of using mining facilities to enjoy the processes of collection and processing. As the name suggests, it is a form of tourism that exploits the naturalistic aspects of the territory, mostly through excursions and trekking routes. For this reason, it is included in a broader definition of “ecotourism”, understood as a form of tourism that combines being in contact with nature with the respect for the biodiversity of the context, avoiding the overcrowding derived from mass tourism, preserving the environment, and enhancing its naturalistic aspects. Other activities as nature photography, bird watching, hiking, they all fall within this definition. Ecotourism is an evolving phenomenon thanks to the increasing resonance that the theme of sustainability is having among the younger generations, which also influences their way of travelling.

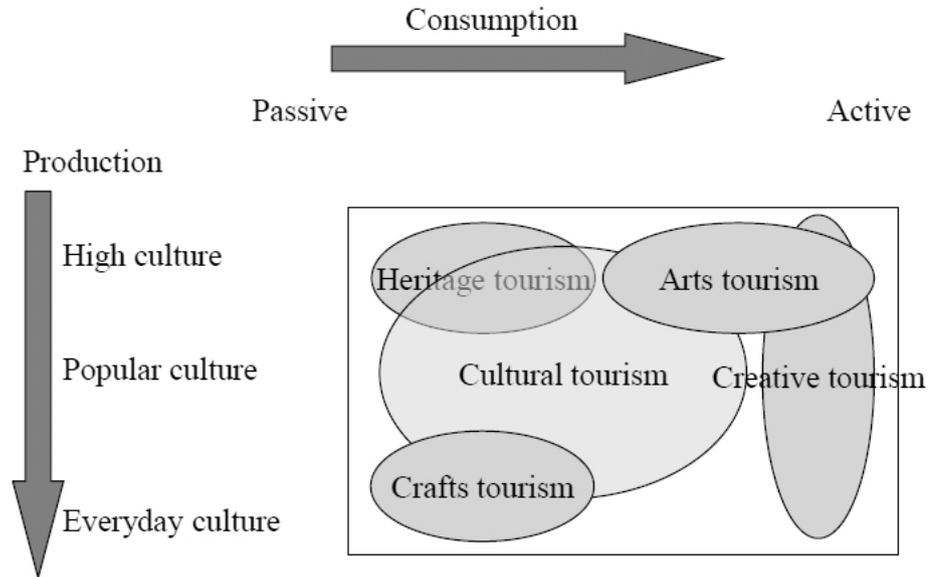
The growing attention towards these issues is more and more accompanied by a shift in the travelers’ attention to non-tangible and more sustainable resources, such as the development of creative skills and traditional practices. As mentioned before, this process is also dictated by the desire to live more stimulating and less ordinary experien-

ces, and falls within the sector of “creative tourism”⁷⁴, defined as “that form of tourism in which tourists are co-creators of their own journey and live engaging experiences, which offer them the opportunity to learn about the local culture and integrate into the daily life of the resident population”⁷⁵. Included in this conception of experience there are workshops, open ateliers and road trips.

► Image 16

Classification of cultural and creative tourism.

Source: Richards G. *Creative tourism*. 2019.



2.1.3 Challenges of Cultural Tourism

As already mentioned, the cultural tourism sector is developing and a further increase in visits is expected in the coming years, but this could cause (and is causing) over-tourism processes. The awareness of the environmental and social impacts that the tourism industry has on the most popular destinations, increasingly leads to the choice of more sustainable solutions, avoiding overcrowded places. Large flows of visitors and increasing popularity of destinations can be so widespread that the phenomenon is perceived as a threat to cultural heritage sites and becomes a concern for local populations. In developing the vision of heritage as a product for cultural tourism, very often critical issues arise such as the reinterpretation of spaces by local communities, which due to an exclusively tourist use, reduces the possibility of enjoyment of

⁷⁴ Richards G. *Creative tourism*. Tourism & Management Studies. 2019.

⁷⁵ Galvagno M., Giaccione S. C. *Il Turismo Creativo. Fondamenti teorici ed esperienze di valorizzazione del territorio*. G. Giappichelli Editore, Torino, p.1. 2017.

the heritage by residents in favor of visitors. Today this circumstance is very common in the historic centers of large cities, often overcrowded by tourist streams, as in the case of Santiago de Compostela (Spain). The article *Historic city, tourism performance and development: The balance of social behaviours in the city of Santiago de Compostela (Spain)*⁷⁶ analyzes the consequences of the tourism strategies of the 1990s (*Plan de excelencia turística*), which brought economic benefits such as an increase in the number of visitors, an increase in hotel supply, and therefore an increase in profits, but also forced the local population to continuously coexist with tourists, detaching themselves from the local context and avoiding the most overcrowded areas⁷⁷. Another significant number is given by the case of Machu Picchu (Peru), one of the most popular travels to South America for European visitors, which in the last 20 years has seen an increase from 380,000 to 1.4 million visits per year⁷⁸. It is important that development policies are not limited to the definition of a set of circumstances that favors the flow of tourists to the harm of locals, in terms of occupation of spaces, use of goods, and access methods, but it is necessary to carry out solutions that restrict these obstructive side effects.

The ICOMOS International Charter for Cultural Heritage Tourism⁷⁹ of 2022, as a revision of the previous Charter of 1999 due to the effects of the growth of the global tourism industry, places the protection of the local community rights as a principle in cultural tourism programs, suggesting a more responsible management to ensure that the phenomenon is adapted to the well-being of the community. One of the key findings of the Cultural Heritage Counts for Europe (CHCFE)⁸⁰ project of 2015, which collected and analyzed case studies on the economic, social, cultural and environmental impacts of cultural heritage, relates the quality of life to the presence of cultural heritage:

« *Cultural heritage contributes to the quality of life, providing character and ambience to neighbourhoods, towns and regions across Europe and making them popular places to live, work in and visit - attractive to residents, tourists and the representatives of creative class alike* »

76 Fernández C. *Historic city, tourism performance and development: The balance of social behaviours in the city of Santiago de Compostela (Spain)*. 2016.

77 Fernández C. *Historic city, tourism performance and development: The balance of social behaviours in the city of Santiago de Compostela (Spain)*. p. 284-286. 2016.

78 *Cultural Tourism Market Outlook (2023 to 2033)* report, Future Market Insights. Source: <https://www.futuremarketinsights.com/reports/sample/rep-gb-16797> (Accessed: July 2024).

79 Official website of the ICOMOS International Cultural Tourism Committee: <https://www.icomosictc.org/p/2022-icomos-international-cultural.html> (Accessed: July 2024).

80 Official website of the project Cultural Heritage Counts for Europe: <https://www.europanostra.org/our-work/policy/cultural-heritage-counts-europe/> (Accessed: July 2024).

Therefore, sustainable development for tourism policies is essential for the preservation of the environment, the local culture, and the quality of life of locals, and major tourist destinations are seeking conservation for future generations through data acquisition and sharing platforms, to facilitate a coordinated development of space by administrations⁸¹. Big data collection, including online and mobile network, geography and real-time data, allows for a more immediate consultation of tourists' behavior and preferences, and the turnout in restricted areas. A case in point is the one that allowed to analyze and monitor the flows in Rome and in Rimini (Italy) between 2019 and 2020, using mobile network data in order to collect precise spatial and temporal information⁸². Just as the use of these technologies can bring benefits in the management of tourists in city centers and in the creation of specific personalized experiences, it can also be used to facilitate the sharing of lesser-known destinations and spread the flows. A study⁸³ on mobile tourism in the metropolitan area of Upper Silesia in Poland shows that between 2015 and 2019 there was a significant increase in the presence of tourist sites in mobile applications, in the availability of data related to industrial attractions (but also hotels and restaurants), and searches carried out. In fact, going online is essential in the tourism field, not only for the promotion of activities and the sharing of information, but also for the immediacy and ease with which they are obtained. For this reason, mobile tourism is increasingly growing in areas that are transforming from industrial regions to tourist destinations through the creation of apps. According to a research⁸⁴ on the state of public knowledge about geotourism in Poland, the main sources of information about geoparks seem to be the internet (73%), then tourist guides (20%), and only 6% specify scientific publications. A correct use of online communication channels could lead to greater interest even in areas that are still little frequented.

For a balanced development of these areas, the European research and innovation programme Horizon 2020 has launched the IMPACTOUR project⁸⁵, as a call for proposals to fully exploit the innovation potential of cultural tourism. The project will provide strategic guidance for the efficient use of European funds and will contribute to

81 Chang V., Jiaotong X., Lu Z., Valverde R. *Big Data in Cultural Tourism and Sustainable Development: Opportunities, Challenges and Future Direction*. 2018.

82 Publication Istat and Vodafone business: *tourism statistics with mobile network data*, 2023. Source: <https://www.istat.it/en/press-release/istat-and-vodafone-business-tourism-statistics-with-mobile-network-data/> (Accessed: September 2024).

83 Naramski M., Herman K. *The Development of Mobile Tourism in the Upper Silesian Metropolitan Area of Poland*. 2019.

84 Wójtowicz B., Strachowka R., Strzyz M. *The perspectives for the development of tourism in geopark areas in Poland*. 2011.

85 Official website of the IMPACTOUR programme: <https://www.impactour.eu/pages/horizon-2020> (Accessed: July 2024).

the creation of partnerships between public and private stakeholders, through the creation of tools to improve data collection on economic and social development. As specified in the programme website as a challenge to be addressed, “the level of development of cultural tourism between certain regions and sites is still unbalanced, with deprived remote, peripheral or deindustrialized areas lagging behind whereas high demand areas being over exploited in an unsustainable manner”.

A type of cultural travel that combines the themes discussed, from choosing a destination outside of mass tourism dynamics, and therefore more sustainable, to involvement in non-ordinary experiences typical of creative tourism, is that of itinerant travels. Cultural itineraries can stimulate visitors to see a number of different attractions in a specific region, that can be a driving force for a sustainable distribution of flows and a dispersion of income from tourism. The Council of Europe is suggesting a “Cultural corridor scheme”, as a “network of long distance routes, incorporating principles of sustainability to the exchange based on culture and creativity”⁸⁶.

⁸⁶ Official website of the Cultural Routes of the Council of Europe programme: <https://www.coe.int/en/web/cultural-routes> (Accessed: July 2024).

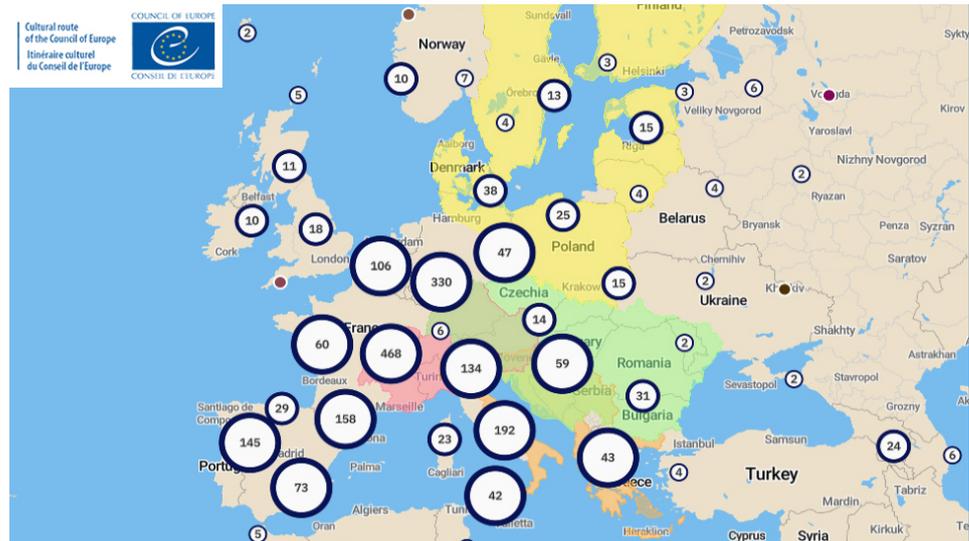
2.2 CULTURAL ROUTES: A FORM OF SUSTAINABLE TOURISM

The cultural itineraries involve different nations and regions, with the aim of connecting the network of sites, monuments and landscapes through thematic routes. Every year the European Institute of Cultural Routes (EICR)⁸⁷ certifies and adds new itineraries to the Cultural Routes programme⁸⁸, launched in 1987, aimed at sharing and experiencing cultural heritage, and also at promoting the process of Europeanisation. There are currently 48 routes on the list.

► Image 17

Amount of sites in the Cultural Routes of the Council of Europe.

Source: https://www.coe.int/en/web/cultural-routes/news-2019/-/asset_publisher/5ZUlh1YiRexz/content/cultural-routes-network-members-strong-growth-in-the-first-half-of-2019



There are several associations that deal with promoting cultural itineraries at a national and international level. Routes4U⁸⁹, a joint programme between the Council of Europe and the European Union, deals with the enhancement of the heritage of the Baltic Sea, Danube, Adriatic, Ionian and Alpine regions. The European Ramblers Association (ERA)⁹⁰, founded in Germany in 1969, is responsible for promoting walking and hiking events, preserving the right of access to all lands (maintained at a national

87 Official website of the European Institute of Cultural Routes: <https://www.coe.int/en/web/cultural-routes/european-institute-of-cultural-routes> (Accessed: July 2024).

88 Official website of the Cultural Routes of the Council of Europe programme: <https://www.coe.int/en/web/cultural-routes> (Accessed: July 2024).

89 Routes4U programme: <https://pjp-eu.coe.int/en/web/cultural-routes-and-regional-development/about> (Accessed: July 2024).

90 Official website of the European Ramblers Association: <https://www.era-eww-ferp.org/> (Accessed: July 2024).

cover the travel expenses. Other programs include online virtual exhibitions to connect stories from distant industrial contexts, or series of conferences and courses in collaboration with universities (with the University of Trier, Germany, in 2019, and with the University of Silesia in Katowice, Poland, in 2021), to analyze models and examples of industrial tourism.

In Italy there are currently 29 thematic itineraries that are part of the Cultural Routes programme, and the survey carried out by the Symbola Foundation⁹³ in 2020 shows that the Italian network includes over 100 small towns and over 2000 cultural attractions.

In recent decades, regional, national and European funds have been allocated for the safety and enhancement of various itineraries. An example is the *Via Francigena* in Tuscany, where 70% of the entire route has been covered by the Wi-Fi network. A further measure for the enhancement of the network of routes was the creation of a Digital Atlas of the Routes⁹⁴, with a map that can be consulted online, launched by the Ministry of Cultural Heritage (MiBACT). According to the 2020-2022 Italian Tourism Report⁹⁵ provided by the Research Institute on Innovation and Services for Development, the amount of visits related to the cultural itineraries shows significant growth until 2019, a decline in 2020 due to the pandemic, a recovery in 2021, and further growth is expected in the following years, showing further potential for development.

To provide examples of cultural routes comparable to the theme presented in the thesis, in this chapter two cases of itineraries connecting coal mining heritage sites are described: the Industrial Heritage Trail of Ruhr (Germany), and the Industrial Itineraries of Asturias (Spain).

2.2.1 *Route der Industriekultur* of Ruhr, Germany

As already described in the first chapter, the Ruhr was one of the most productive mining sites in Europe, located in the north-western part of Germany.

The *Regionalverbandes Ruhr* (Ruhr Regional Association) launched a program in 1999 to promote the industrial sites of the territory in a network of 32 thematic tourist routes, the Industrial Heritage Trail of Ruhr⁹⁶. It covers a total of 400 km, connecting 57 main anchor points, the most important monuments of the Ruhr basin, as well as

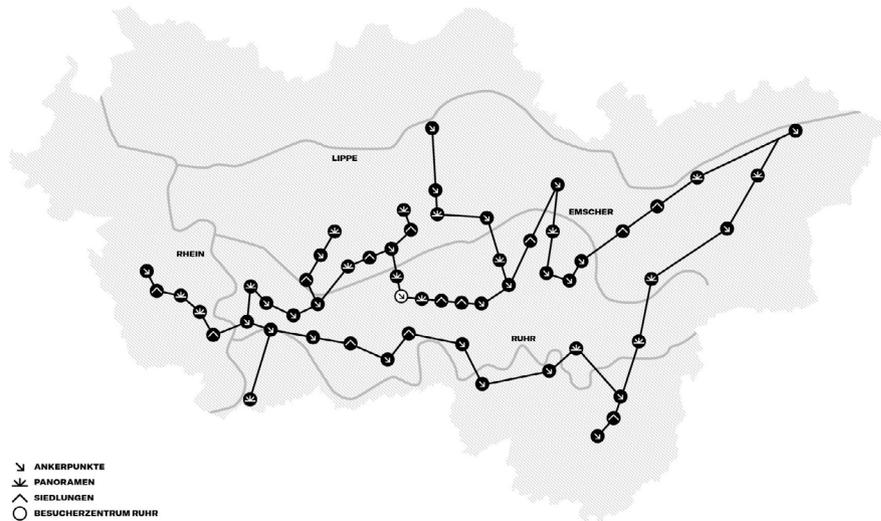
93 Official website of the Symbola Foundation: <https://symbola.net/> (Accessed: July 2024).

94 Official website of the *Atlante dei Cammini*: <https://camminiditalia.cultura.gov.it/cammini/> (Accessed: July 2024).

95 Becheri E., Maggiore G., Marasco A., Morvillo A. *XXV Edizione 2020-2022 del Rapporto sul Turismo Italiano. Istituto di Ricerca su Innovazione e Servizi per lo Sviluppo*. 2023.

96 Official website of the Industrial Heritage Trail of Ruhr: <https://www.route-industriekultur.ruhr/> (Accessed: September 2024).

viewpoints and industrial settlements. Although the region is best known for its coal mining and steelmaking history, the routes also feature attractions related to the themes of energy, transport and water.



◀ Image 19

Industrial Heritage Trail of Ruhr network.

Source: <https://www.route-industriekultur.ruhr/it/>

Simplified in the map of image 19 as a system of segments connecting individual attractions (the main ones), the itineraries are actually networks with a wide diffused development based on a theme. Rather than connecting sites on the same path, the routes are concerned with collecting sites by area, as shown in images 20 and 21 (page 39). The two maps represent the routes 16 and 17 of the Heritage Trail, the Westphalian Mining Route⁹⁷ and the Rhine Mining Route⁹⁸, the two sections that mainly relate to the coal mining history, and include the production areas of the basin, extraction towers and wells, museums and facilities.

The two routes cover adjacent areas and sometimes share the same anchor points, as in the case of the *Deutsches Bergbau Museum* (German Mining Museum)⁹⁹ in Bochum, which collects and communicates the heritage of mining through four exhi-

97 PDF of the route 16, available in the official website of the Industrial Heritage Trail of Ruhr: https://www.route-industriekultur.ruhr/wp-content/uploads/2023/03/2021_TR16_Westfaelische_Bergbauroute_RIK.pdf (Accessed: September 2024).

98 PDF of the route 16, available in the official website of the Industrial Heritage Trail of Ruhr: https://www.route-industriekultur.ruhr/wp-content/uploads/2023/03/2021_TR17_Rheinische_Bergbauroute_RIK.pdf (Accessed: September 2024).

99 Official website of the *Deutsches Bergbau Museum*: <https://www.bergbaumuseum.de/> (Accessed: September 2024).

bitions on hard coal, mining, mineral resources, and art. The museum houses a replica of a mining gallery 20 meters underground, which is the setting for a permanent exhibition of machinery, everyday objects used by miners and historical photographs. Another common anchor point for both routes is the *Zeche Zollverein*¹⁰⁰ Coal Mine, declared a World Heritage Site by UNESCO in 2001. The industrial complex was the protagonist of a major recovery project completed in 2007 which allowed, in addition to the musealization of the rooms of the former washing plant, which now houses the Ruhr Museum¹⁰¹, the creation of cultural and commercial activities through the reuse of the mine facilities. Some examples include the *PACT Zollverein*¹⁰², a performing arts center that offers an artist-in-residence program, the Red Dot Museum¹⁰³, one of the world's leading design museums, and the Zollverein School of Management and Design¹⁰⁴.

Apart from museums and mines, the Heritage Trail also gives great importance to the panoramic points, from which it is possible to enjoy the view of the territory. A case of particular interest is the *Tetraeder*¹⁰⁵ structure, a 60 meters high panoramic terrace that stands on the former Beckstrasse dump, built between 1969 and 1993 with 11.8 million cubic meters of waste material from the Prosper Mine, which today serves as a panoramic viewpoint after the IBA recovery program, one of the most famous and visited attractions in the Ruhr.

For the 25th anniversary of the program, in 2024, various events were organized, involving all areas of the region. These are scheduled within the initiative of Local Hero Weeks: each week between June and October an anchor point is celebrated. Each event has different themes, special guided visits are organized with activities such as photo walks, guided bike tours, exhibitions, yoga, and picnics. The Agenda of the program is available in the website of the Regional Association¹⁰⁶, where specific programs and registration methods are easily accessible.

With more than 7 million visits in 2023, the number of tourists who travel to the region's attractions is constantly increasing year after year. What engage so many travelers is the diversity of the offer highlighted in the analysis carried out: the Route

100 Official website of the *Zeche Zollverein*: <https://www.zollverein.de/> (Accessed: September 2024).

101 Official website of the Ruhr Museum: <https://ruhrmuseum.de/en/> (Accessed: September 2024).

102 Official website of the *PACT Zollverein*: <https://www.pact-zollverein.de/en> (Accessed: September 2024).

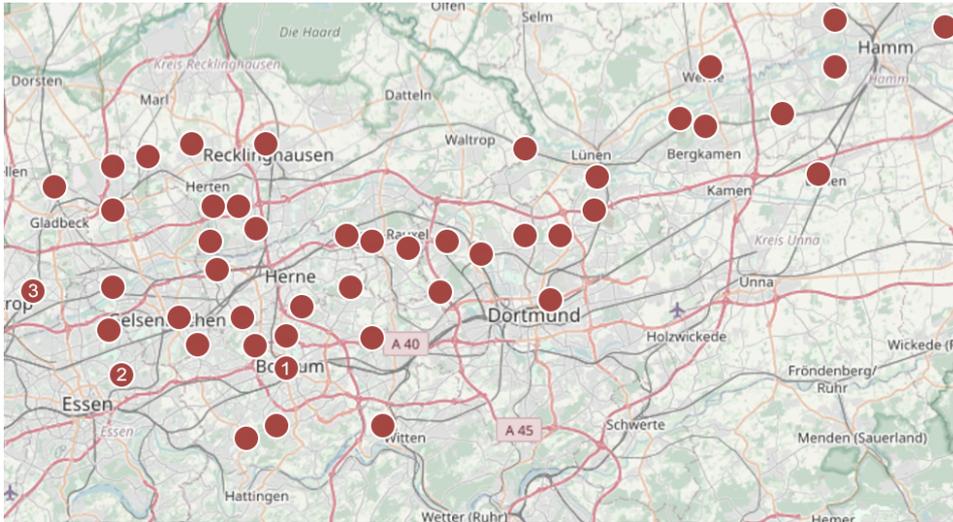
103 Official website of the Red Dot Museum: <https://www.red-dot-design-museum.org/essen> (Accessed: September 2024).

104 Article on the project of the Zollverein School of Management and Design: <https://www.domusweb.it/en/architecture/2006/09/25/zollverein-school.html> (Accessed: September 2024).

105 Official website of the *Tetraeder*: <https://www.route-industriekultur.ruhr/it/panoramen/tetraeder-bottrop/> (Accessed: September 2024).

106 Web page of the Ruhr Regional Association dedicated to the Local Hero Weeks: <https://www.rvr.ruhr/themen/tourismus-freizeit/route-industriekultur/localherowochen/> (Accessed: September 2024).

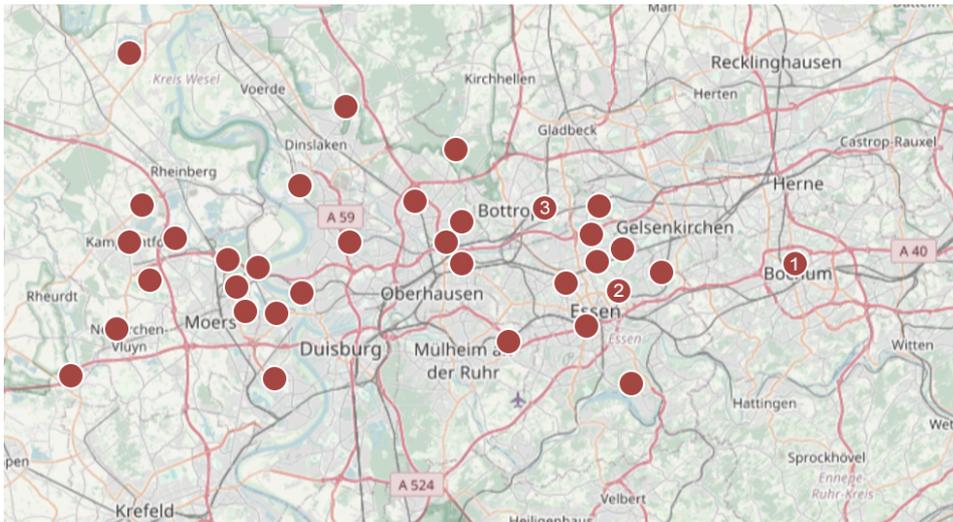
includes visits to disused structures for educational and cultural purposes as well as entertainment activities such as music events, performing arts shows, art galleries, workshops and conferences, to meet the interests of different targets, within a framework of sustainable tourism development.



◀ Image 20

Map of the Route 16 anchor points, Heritage Trail of Ruhr.

Elaborated by the author.



◀ Image 21

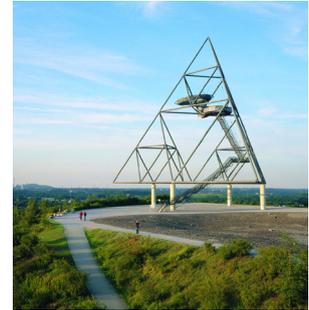
Map of the Route 17 anchor points, Heritage Trail of Ruhr.

Elaborated by the author.

► Images 22, 23 and 24

German Mining Museum (1)
and Zeche Zollverein (2)
extraction towers, Tetraeder (3).

Sources: <https://www.erih.net/i-want-to-go-there/site/german-mining-museum>; Jochen Tack, Zollverein Foundation; <https://www.eghn.org/en/tetraeder-on-halde-beckstrasse-in-bottrop/>



2.2.2 Itinerarios por el Patrimonio de Asturias, Spain

Located in the north of Spain, the autonomous community of Asturias is an area rich in mining history, with industries of different types thanks to the great availability of minerals, but also rich in natural attractions, with high mountain landscapes, forests and villages. Its territory offers a network of long-distance routes suitable for various kinds of travel, interesting for different target groups of visitors, attracted by more adventurous activities such as trekking, hiking and cycling, or even by spiritual activities such as pilgrimage.

The *Sociedad Pública de Gestión y Promoción Turística y Cultural del Principado de Asturias*¹⁰⁷ (Public Company for the Management and Promotion of Tourism and Culture of the Principality of Asturias) launched a project called Heritage Itineraries¹⁰⁸ in 2018, to facilitate accessibility and visitability of the region's cultural heritage. It consists of an array of routes to connect both the cultural and natural landmarks of the territory, with many points of interest that belong to the sphere of industrial heritage, the lead promoter of most of the routes. All itineraries are available in the Agenda¹⁰⁹ managed by the organization (Heritage Itineraries Agenda 24 for the year 2024), and are structured as guided tours for groups ranging from 10 to 24 people.

The tour of the Nalón Valley is dedicated exclusively to the history of coal mining and steelmaking. The first stop is the visit to the Museum of Mining and Industry (MUMI)¹¹⁰ in El Entrego, in which is possible to see machinery, minerals, and bibliography related

107 Institutional web page of the company: <https://www.turismoasturiasprofesional.es/spgp> (Accessed: September 2024).

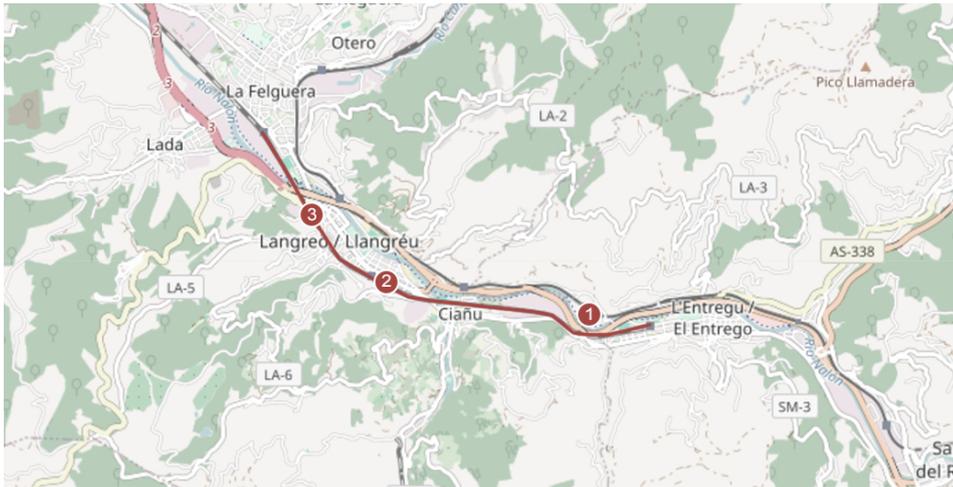
108 Official website of the initiative Heritage Itineraries: <https://www.turismoasturias.es/en/itinerariospatrimonio> (Accessed: September 2024).

109 Official website of the Agenda: <https://www.turismoasturias.es/it/agenda-de-asturias> (Accessed: September 2024).

110 Official website of the Museo de la Minería y de la Industria de Asturias: <http://www.mumi.es/> (Accessed: September 2024).

to the labour of mining. The museum is located nearby the *Pozo Sotón* (Sotón Well)¹¹¹, declared an Asset of Cultural Interest in 2014, accessible for guided visits in the underground galleries.

Then a visit to the Iron and Steel Museum (MUSI)¹¹², in La Felguera, Langreo, located in an old cooling tower of the Duro Felguera Factory, whose facilities, saved from the demolition work of the 1980s of the steel factories in Asturias, were reconverted for educational uses. Finally, a visit to the coal extraction wells of *Pozo Fondón*¹¹³ and *Pozo Modesta*¹¹⁴, integrated in the Duro Felguera Company in 1902 and closed in 2007.



◀ Image 25

Map of the Nalón Valley Industrial Tour.

Elaborated by the author.



◀ Images 26, 27 and 28

MUSI (1), *Pozo Modesta* (2) and *Pozo Fondón* (3) extraction towers.

Sources: <https://www.turismoasturias.es/en/descubre/cultura/museos-y-espacios-culturales/museos/museo-de-la-mineria-y-de-la-industria-mumi>

111 Official website of the *Pozo Sotón*: <https://www.pozosoton.es/en/> (Accessed: September 2024).

112 Official website of the *Museo de la Siderurgia* (MUSI): <https://musi.ayto-langreo.es/> (Accessed: September 2024).

113 Official website of the *Pozo Fondón*: <https://patrimoniuiustrial.com/fichas/pozo-fondon-archivo-historico/> (Accessed: September 2024).

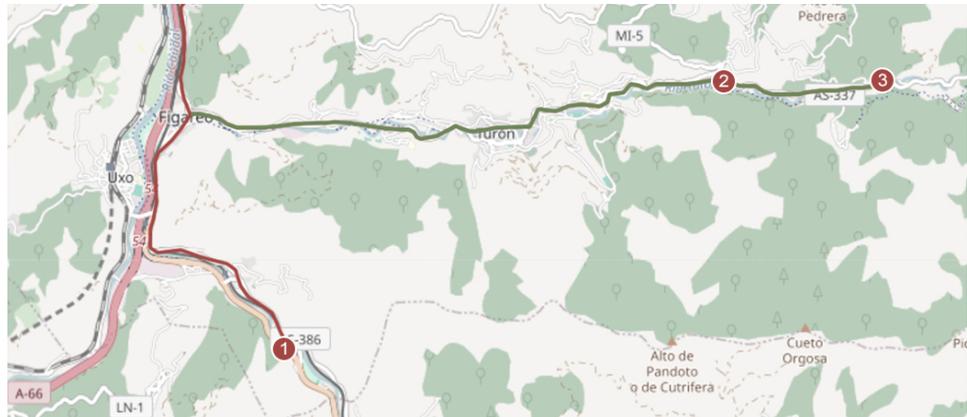
114 Official website of the *Pozo y Lavadero de Modesta*: <https://patrimoniuiustrial.com/fichas/pozo-modesta/> (Accessed: September 2024).

Another route related to coal mining history is the one of the Caudal Valley, a 43 km long path accessible both on foot and by bike. Different sections can be covered, modified or shortened as desired, as in some parts the route intersects with other tourist paths. The one organized by the program Heritage Itineraries includes the visit to the Bustiello Mining Village¹¹⁵, near Mieres. Here there are old houses for miners and residences for company engineers, and it is possible to discover how the working environment and everyday life of workers were. The *Pozu Espinos* Interpretation Room¹¹⁶, a structure on the top of the mine well's tower, is used with the educational function of informing about the history and development of the land with guided visits. Other industrial facilities are accessible walking through the 14 km long *Via Verde* (Green Path) of the Turón Valley, an hiking path that follows the old railway track, dotted with coal mines structures: mining villages, machinery, and the wells of Figaredo, San José, La Rebaldana, and Fortuna, ending point of the route.

► Image 29

Map of one section of the Caudal Valley itinerary with the *Via Verde* path.

Elaborated by the author.



► Images 30, 31 and 32

Bustiello Mining Village (1), *Pozu Espinos* Interpretation Room (2), and *Pozu Fortuna* (3).

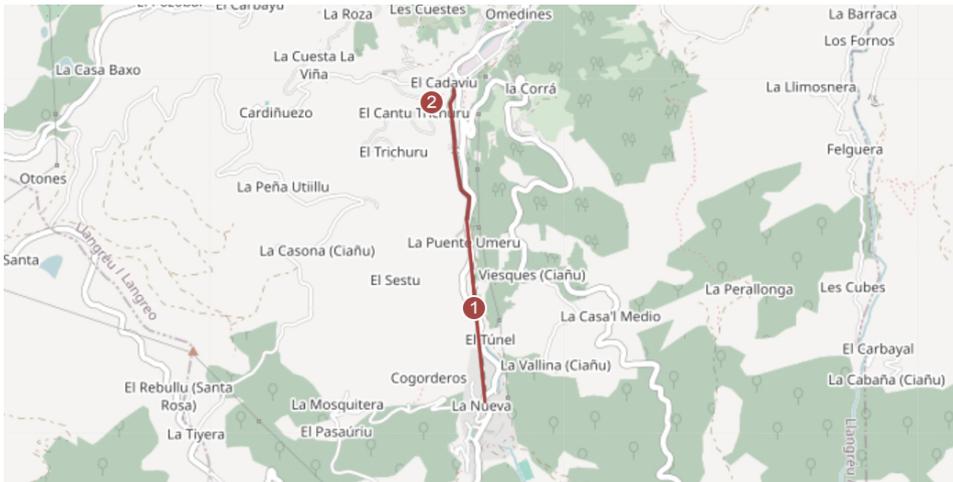
Sources: <https://www.turismoasturias.es/it/-/blogs/bustiello-una-visita-al-legado-minero-de-asturias>, <https://www.mieres.es/turismo/patrimonio/patrimonio-industrial/pozo-fortuna/>



¹¹⁵ Official website of the Bustiello Mining Village: <https://patrimonioundustrial.com/en/fichas/bustiello-village/> (Accessed September 2024).

¹¹⁶ Official website of the Pozu Espinos Interpretation Room: <https://www.turismoasturias.es/it/descubre/cultura/museos-y-espacios-culturales/otros-espacios/centro-de-interpretacion-poblado-minero-de-bustiello> (Accessed September 2024).

To cite another example of coal mining route in the Asturias, of particular interest is the one that today allows to retrace the “old coal route” thanks to the recovery of the railway that transported the mineral from the mountain mines of Samuño to the Nalón Valley, accessible by train with a visit to the *Ecomuseo Minero Valle de Samuño*¹¹⁷. The route runs along the Samuño River, then proceeding underground for more than 1 km through the *Socavón Emilia*, a 19th century mountain mine, finally arriving at the first floor of the *Pozo San Luis*¹¹⁸, that, with the extraction tower of its well, drilled between 1928 and 1930 and operative until 1969, is the most iconic element of the Ecomuseum. It was opened in 2013, after the recovery of the industrial heritage in the surroundings of the mining town of La Nueva, where the itinerary starts, and today is one of the most famous attractions for industrial tourists.



◀ Image 33

Map of the Mining Train Route of the *Ecomuseo Minero Valle de Samuño*.

Elaborated by the author.



◀ Images 34 and 35

Tren Minero railway (1) and *Pozo San Luis* (2) at the *Ecomuseo Minero*.

Source: <https://www.turismoasturias.es/it/descubre/cultura/museos-y-espacios-culturales/otros-espacios/ecomuseo-minero-valle-de-samuno>

117 Official website of the *Ecomuseo Minero Valle de Samuño*: <https://ecomuseo.ayto-langreo.es/> (Accessed: September 2024).

118 Official website of the *Pozo San Luis*: <https://ecomuseo.ayto-langreo.es/pozo-san-luis> (Accessed: September 2024).

Among the programs to encourage itinerant industrial tourism, in addition to the initiatives of the mining regions such as those described, there are international connection programs between cultural organizations that allow collaboration and sharing. The aforementioned institutions of German Mining Museum in Bochum (Germany)¹¹⁹ and Museum of Mining and Industry (MUMI) in El Entrego (Spain)¹²⁰, are both anchor points of the European Network of Coal Mining Museums¹²¹. It is composed of five more of the main European production sites, all converted into museum centers: the National Coal Mining Museum in Wakefield (England)¹²², the *Centre Historique Miniierdu Nord Pas-de-Calais* in Lewarde (France)¹²³, the *Bois du Cazier* in Marcinelle (Belgium)¹²⁴, the *Muzeum Gornictwa Weglowego Kopalnja Guido* in Zabrze (Poland)¹²⁵ and, since 2012, the *Centro Italiano della Cultura del Carbone* (Italian Coal Culture Center)¹²⁶ of the Great Mine of Serbariu in Carbonia, in Southern Sardinia (Italy).

As described in the official website of the *Museo del Carbone* (Coal Museum)¹²⁷, the purpose of the partnership is to strengthen their collaboration in four main fields of cooperation:

- 1) Exchange in scientific research: members can participate in different research programs and share information related to the mining industry;
- 2) Exchange of cultural productions: members activate collaborations on cultural productions such as exhibitions, publications, multimedia products, etc.;
- 3) Exchange of professional practices in the fields of public reception, ticketing, cultural mediation, communications, documentary practices and conservation of collections;

119 Official website of the *Deutsches Bergbau Museum*: <https://www.bergbaumuseum.de/> (Accessed: September 2024).

120 Official website of the *Museo de la Minería y de la Industria de Asturias*: <http://www.mumi.es/> (Accessed: September 2024).

121 Web page of the *Centro Italiano della Cultura del Carbone* dedicated to the European Network of Coal Mining Museums: <https://www.museodelcarbone.it/en/surroundings/the-european-network-of-coal-mining-museums/> (Accessed: September 2024).

122 Official website of the National Coal Mining Museum: <https://www.ncm.org.uk/> (Accessed: September 2024).

123 Official website of the *Centre Historique Miniierdu Nord Pas-de-Calais*: <https://www.chm-lewarde.com/en/> (Accessed: September 2024).

124 Official website of the *Bois du Cazier*: <https://www.leboisducazier.be/> (Accessed: September 2024).

125 Official website of the *Muzeum Gornictwa Weglowego Kopalnja Guido*: <https://kopalniaguido.pl/index.php/en/> (Accessed: September 2024).

126 Official website of the *Grande Miniera di Serbariu*: <https://www.museodelcarbone.it/en/> (Accessed: September 2024).

127 Official website of the *Grande Miniera di Serbariu*: <https://www.museodelcarbone.it/en/> (Accessed: September 2024).

4) Tourist promotion, marketing, communication, as a result of the exchange work of the first three axes of intervention.

The following chapter will examine the case of the coal industry in the region of Sulcis, in Southern Sardinia (Italy), starting from its history to the current state of its industrial heritage, and then focusing on the case study of Bacu Abis, first coal mining site of the area, included in the cultural route *Cammino Minerario di Santa Barbara*.

3. COAL MINING HERITAGE IN SOUTHERN SARDINIA

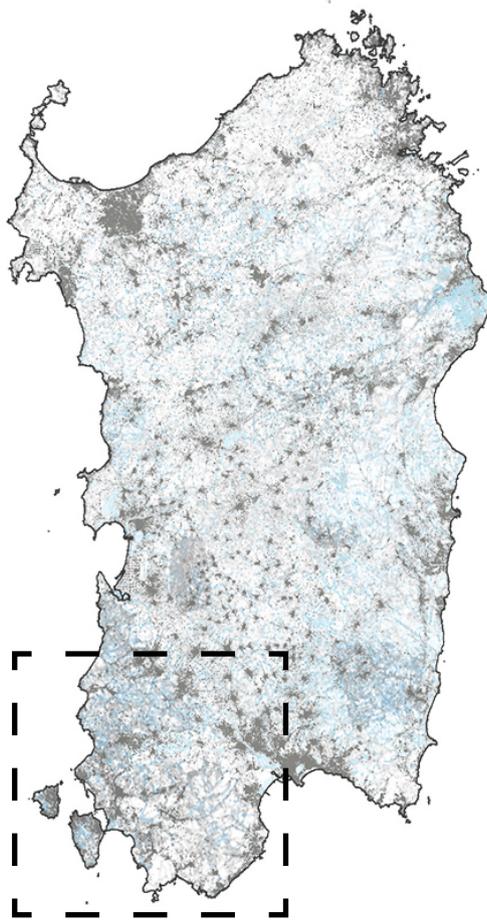
The coal mining industry played a main role in the history of the territories of Southern Sardinia (Italy) until the second half of the 20th century. The cessation of mining activity led to the abandonment of the plants, to the disposal of larger areas of the territory and to the consequent depopulation of satellite settlements around the main industrial centers, leaving mining complexes and regions in a condition of decline and poverty. The first part of the chapter deals with the birth and development of the industry, to picture a framework related to the history and current state of the mines, in particular introducing the case study of Bacu Abis, the first mining hub of the coal basin and the object of the final proposal of the thesis, and the *Cammino Minerario di Santa Barbara*, the cultural itinerary connecting the main mining sites of the region.

The second part of the chapter consists in the presentation of a proposal that seeks to improve the existing route of the *Cammino Minerario*, based on the analysis carried out in the previous chapters, considering two lines of intervention: the addition of a shorter path in the main route, within the city of Bacu Abis, and the digitization of the city's mining heritage. The work presented is the result of the creation of 3D models of historical buildings of the mine, elaborated on the basis of the original documents and drawings consulted in the archives of local history in Carbonia, and their inclusion in the experience of the cultural route thanks to augmented reality technologies.

In this way, the thesis proposal has two main objectives, the digitization of the architectural heritage, and the promotion of cultural tourism within the *Cammino Minerario* through the enrichment of the tourist experience with new technologies, aimed at a better sharing and enjoyment of the heritage.

3.1 HISTORY AND CURRENT STATE

Addressing the birth and development of the coal industry in Southern Sardinia, taking into account the phases of the evolution of the extraction sites, from their foundation to their closure, is useful to describe and understand the current state of the heritage, a starting point from which enhancement policies must begin. In particular, it is useful to provide details on how mining has influenced settlement processes, the constructions of new urban centers and their growth, and social and economic development of the region.



◀ Image 36

Focus area in Southern Sardinia.

Elaborated by the author.

3.1.1 The coal mining industry between the 19th and 20th centuries

The Sulcis coal basin extends for about 100 km² in the south-western part of Sardinia, from Fontanamare (Gonnesa) passing through Serbariu (Carbonia), until it extends even further south and west under the sea. Dating back to the Tertiary, it is inserted in a wider basin rich in mineral deposits such as lead, iron and zinc, mostly extracted in the adjacent area of Iglesiasiente and along the western coast, going north. The mining history of this region has very ancient origins, the exploitation of lead and silver minerals began around the 2nd millennium BC. This territory is in fact populated by mines, both open-pit and underground, and it is known as the “Mining Coast”, with suggestive structures overlooking the sea such as *Porto Flavia*, a gallery through which minerals were transported on cargo ships, the nearby *Laveria Lamarmora*, a mineral washing plant located on a cliff, and vast areas modified in their conformation due to excavations, such as the Masua Mine, continuing inland with scattered abandoned mining villages and important complexes such as Monteponi, in Iglesias.

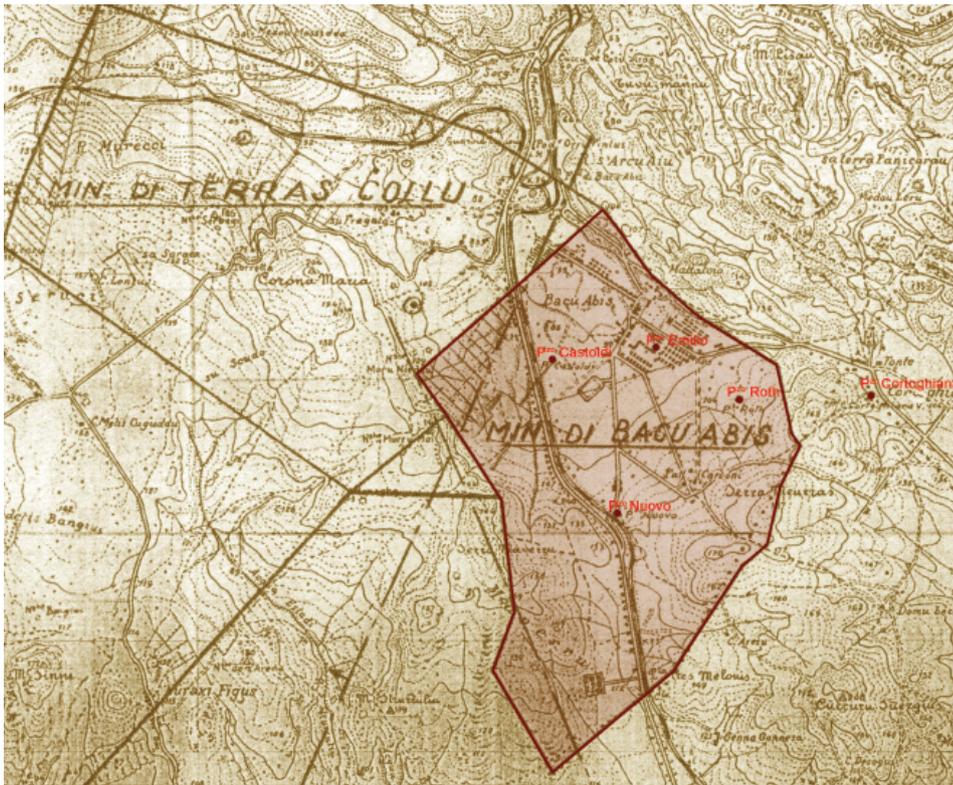
► Images 37 to 40

Photos of some of the sites of “Mining Coast” and Iglesiasiente (*Laveria Lamarmora*, *Porto Flavia*), taken during the walk of the cultural route *Cammino Minerario di Santa Barbara*. 2021 - 2024.

Source: personal archive.



As already mentioned in the previous chapter (2.1.1), the discovery of the coal basin of Sulcis is attributed to Alberto La Marmora, who in the 1830s detected some fragments of coal. The deposit was then exploited when Ubaldo Millo, a merchant from Genova, had the first extraction wells built. After founding a Mining Company called Tirsi-Po together with his partner Vincenzo Montani, in 1853 he obtained a concession to begin excavations in the areas of Bacu Abis, Terras Collu and Fontanamare. The mining activity had to stop in 1865 due to financial problems. During those years, the construction of a railway line for the transport of minerals from the Monteponi Mine (which extracted lead and zinc) to the port of Portovesme was planned, managed by the Monteponi Company, and inaugurated in 1870. Anselmo Roux, the engineer supervising the construction of the railway line, and managing the Bacu Abis mining site from 1871, considered taking over the concessions of the Tirsi-Po Company in order to use the extracted fossil fuel as a source of energy for the machinery of the Monteponi washing plant and the convoys that transported the minerals. In 1873 he acquired the concession and founded the Bacu Abis Mining Company, based in Turin.



◀ Image 41

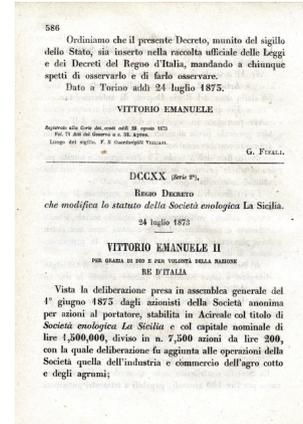
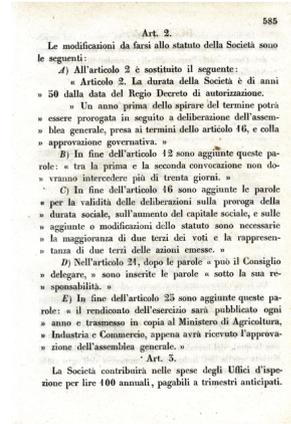
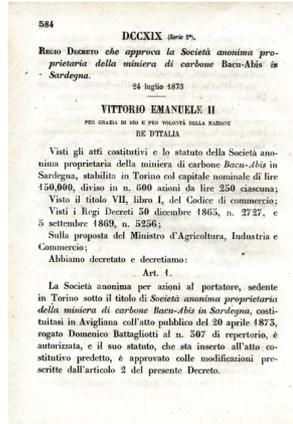
Historical map of the location of the concessions of Terras Collu and Bacu Abis.

Source: *Biblioteca comunale di Serbariu, sezione di storia locale. Fondo Cossu* (documentation digitized by the local history section of the municipal library of Serbariu, and presented during the exhibition “Le carte del Fondo Cossu 1852-1958”).

► Images 42, 43 and 44

Acquisition of the Bacu Abis Mine by Anselmo Roux, 24 July 1873. “*Regio decreto che approva la società anonima proprietaria della miniera di carbone Bacu-Abis in Sardegna*”.

Source: *Archivio Centro Italiano della Cultura del Carbone, Le carte del Fondo Cossu 1852-1958*.



Regarding the settlement, the core of the mining village consisted of a fabric built without a precise urban plan, which included scattered buildings placed close to the work areas. Since the mineral outcrops were located on the surface of the soil, the mining method used was the open-pit, with large stepped excavations surrounding the few existing buildings, as shown in image 45. Even though during the first period the deposit was poorly exploited, over the decades the coal production increased steadily, until reaching 15,000 tons per year in the end of the 19th century. Later on, new facilities were built, as the new washing plant in 1896, and underground constructions were developed as well, such as *Pozzo Emilio*, built between 1914 and 1916.

► Image 45

Bacu Abis open-pit mine (south construction site) in the second half of the 19th century (Roux on the right side).

Source: *Biblioteca comunale di Serbariu, sezione di storia locale*.



After the First World War, during which the maximum annual production was reached, with about 70,000 tons of coal per year, the Sardinian mining industry suffered a crisis due to the high costs of managing the mines, and the competition from cheaper foreign coals.

The Bacu Abis Mine changed management several times during this period, first in 1909 with the acquisition by Ferruccio Sorcinelli, then again in 1927 with the transfer of ownership to the Montevecchio Company, which filed for bankruptcy in 1932 because of debts. In 1933 it was then taken over by the SMCS (*Società anonima Mineraria Carbonifera Sarda*). Due to the research campaign carried out by the fascist regime, there was a renewed increase in mining activity with the further development of existing sites, and the foundation of new industrial centers and new cities, as result of the need to provide housing for workers near the mines, and hence of a growing economic system. The birth of neighborhoods and facilities for miners and their families were therefore necessarily linked to the exploitation of the subsoil, a direct consequence of the development of the industry on the territory.

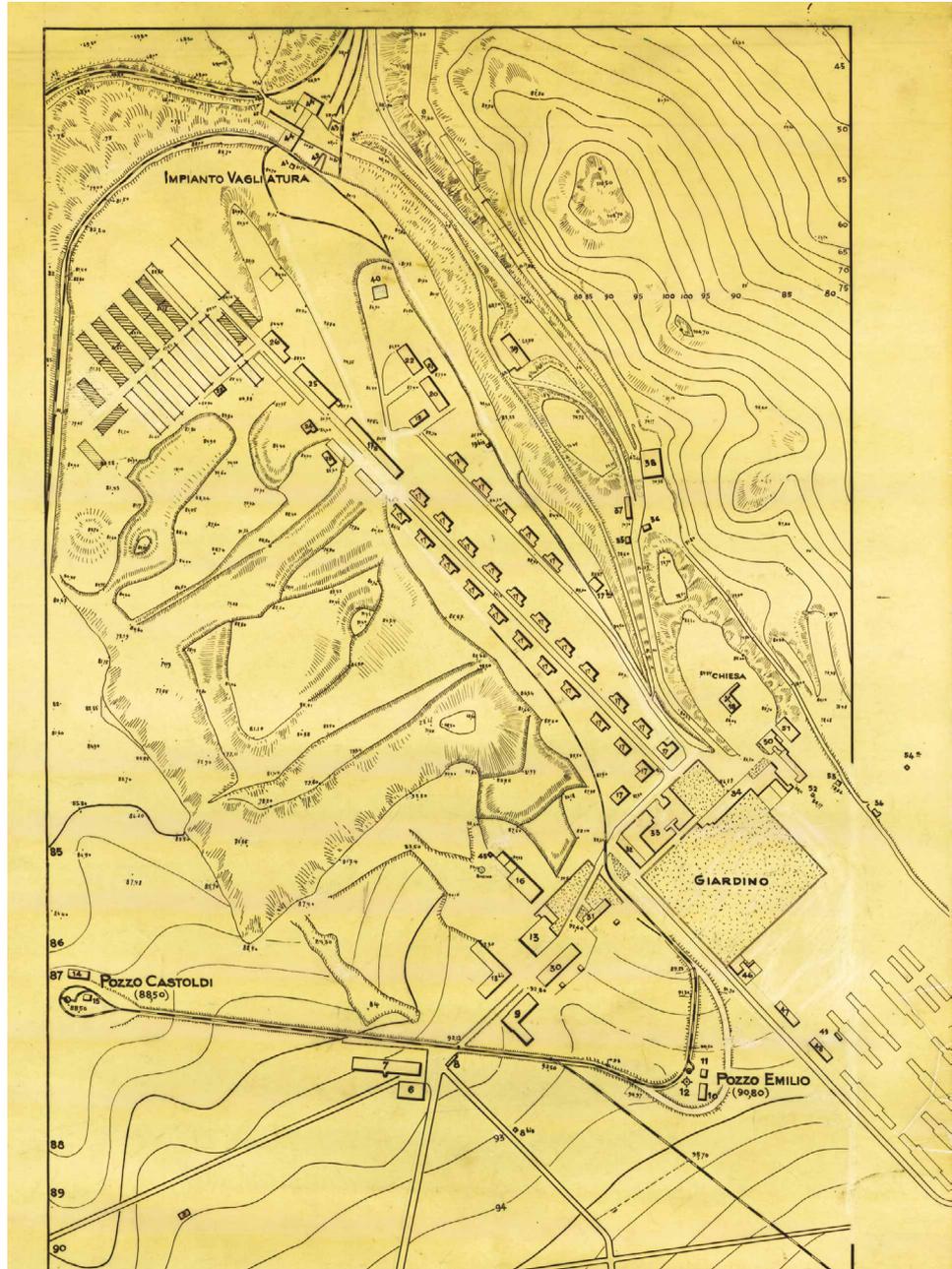
In these years there were three major urban expansions, with the birth of the cities of Carbonia and Cortoghiana (1938, 1940), and the growth of Bacu Abis (1935), on the traces of the earlier conformation of the mining system, fabrics, excavations and railways. Although developed on the previous configuration, today there is no trace of the buildings belonging to the first settlement of the mining village, except for a few, such as the headquarters of the mine management.

Already in 1934 a colonization plan was prepared including the construction of 5 farmhouses and the expansion of some existing buildings. Then, in 1935, a new urban plan was carried out for the workers' village, including 3 blocks with housing for 7 families of employees, and 20 blocks with housing for 80 families of miners, located along a road axis, the current *Viale della Libertà*, which connected the mine management offices to the first industrial plants, as shown in image 46 (page 52). Other buildings were built along the current *Via Santa Barbara*. Both axes develop from the current city centre, where there were public buildings such as the church, the cinema, the "*dopolavoro*" (for the organization of recreational initiatives for workers), and a school. With this new settlement, the village moved from a scattered building system to an organized urban system divided into zones, which saw further growth in 1940 with the construction of neighborhoods for workers in the south, near *Pozzo Emilio* and in the direction of the more recently built mine wells, such as *Pozzo Castoldi* (1929). The planning of this latest expansion can be seen in the lower right part of the master plan shown in image 46 (page 52), where some changes to the original drawing are visible, probably made later to develop the plan with the new project elements in the south-east.

► Image 46

Master plan of Bacu Abis in the mid 1930s.

Source: *Biblioteca comunale di Serbariu, sezione di storia locale.*





◀ Image 47

Legend of buildings (image 46).

Source: *Biblioteca comunale di Serbariu, sezione di storia locale.*

The major intervention in the surrounding area occurred in 1938 with the foundation of Carbonia. The urban layout of the city took shape around the industrial hub, and was characterized by the architectural type already experimented in Bacu Abis, the four-family house. During the first phase of construction approximately 600 two-story units were built, with a second expansion from 1939 to 1940, extending the main road axes with new districts and new building types. The facilities of the mine, named the Great Mine of Serbariu, were built before the city, as were the thermoelectric power plant, the boiler room, the compressor room, the administrative offices and the two main wells (1936, 1937).



◀ Images 48 and 49

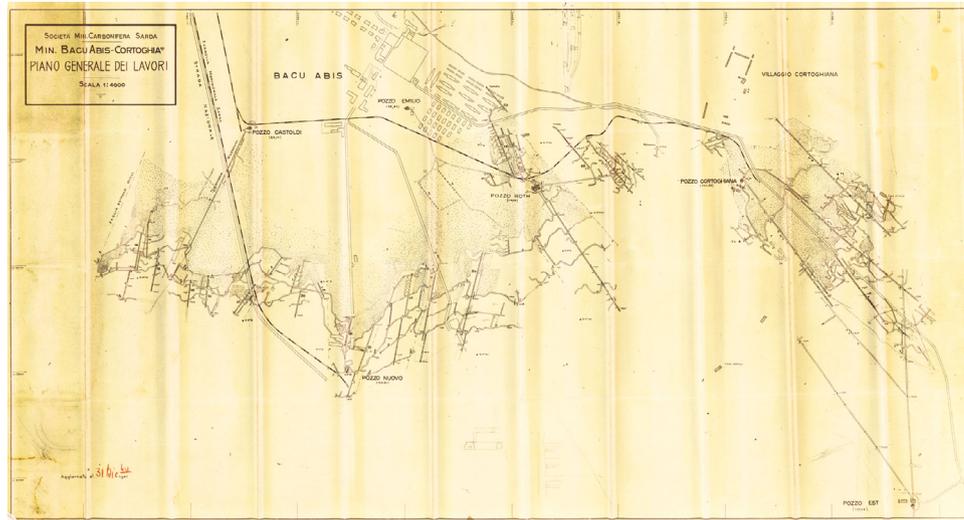
Extraction well towers (left) and workers' room (right) of the Great Mine of Serbariu, Carbonia, in 1938.

Source: *Archivio Centro Italiano della Cultura del Carbone.*

► Image 50

General plan of works of the underground galleries of the Bacu Abis and Cortoghiana Mines in 1941.

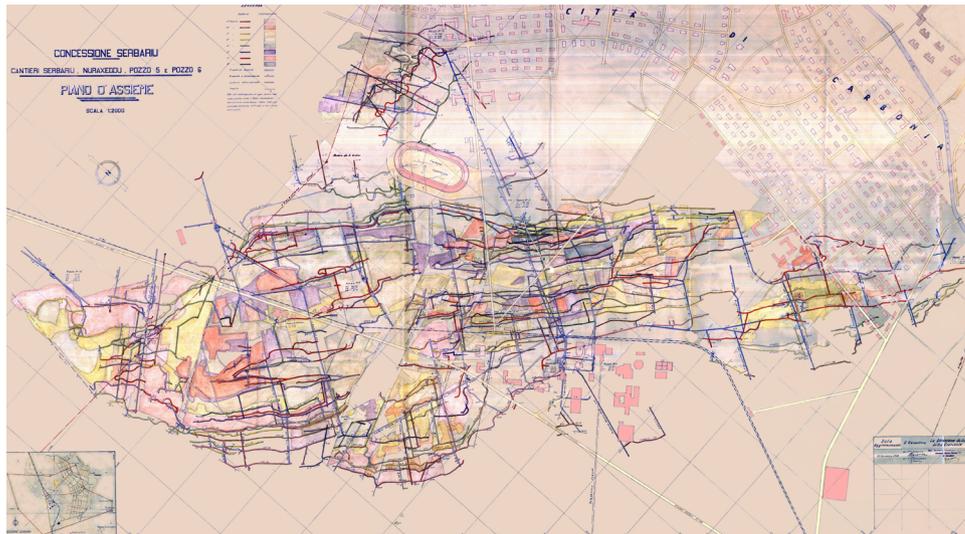
Source: *Biblioteca comunale di Serbariu, sezione di storia locale.*



► Image 51

General plan of works of the underground galleries of the Great Mine of Serbariu in 1948.

Source: *Archivio Centro Italiano della Cultura del Carbone.*



The final years of the Second World War led to a decline in coal production in the Sulcis mining sites, with a renewed increase from 1946 (a record of 1,199,283 tons of coal was extracted in 1947), and a further reduction thereafter. This decline caused strikes and a series of emigrations of miners who had lost their jobs. In 1965 the management of the mines passed to the Enel company, which decided to close them in 1971.

In 1978, the Carbosulcis company was founded by the Sardinian Mining Institution, with the aim of taking over the mines from Enel, to reactivate the Sulcis coal industry reopening the sites of Seruci and Nuraxi Figus, to supply coal to the aluminum production plant of Portovesme. The ownership passed to the Region of Sardinia in 1996.

As described previously, after the closure, the mining sites fell into disuse and the buildings were abandoned, leading to the deterioration of machinery and sometimes to the illegal occupation of the spaces. The state of decay was reflected in the surrounding territory, with alterations in the urban fabric and in the elements that characterized it, and the depopulation and abandonment of the inhabited centers.

3.1.2 *Cammino Minerario di Santa Barbara, Italy*

In the second half of 19th century, the industrial heritage of the abandoned mines was in a state of decay due to neglect that led to the loss of many structures. As a tool for the conservation of this heritage, the idea for the creation of a “Geo Park” was born, that led to the birth of the institution called Historical and Environmental Geo-mining Park of Sardinia (*Parco Geominerario Storico e Ambientale della Sardegna*)¹²⁸ in 2001.

The proposal for the creation of the park was presented for the first time during a conference on industrial archaeology held in 1983 in Iglesias, during which proposals for the creation of an industrial park began to be defined, with the aim of safeguarding and protecting the mining heritage. In 1989 a committee promoting the park was born, and in 1991 the association called “Permanent Committee for the Geo-mining, Environmental and Historical Park of Iglesiente” was established, whose first initiative was presented during the conference “Sardinia in the Mediterranean World” held in Alghero (Italy) in 1993, with the presentation of a study regarding the analysis of 37 mining sites according to their potential for reuse. The proposal was brought up again in 1996 during an international conference for the centenary of the foundation of the Sardinian Mining Association, and in November 1997 a dossier containing the identification of the areas of the park, the proposals for intervention, and the development prospects were presented to the General Assembly of UNESCO, which welcomed the proposal.

Finally, in 1998, the “*Carta di Cagliari*”¹²⁹ was signed by UNESCO, the Italian Government, the Sardinia Region, the Sardinian universities and EMSA (*Ente Minerario Sardo*). It was a document in which the key objectives of the Park were outlined. Among

128 Official website of the Geo-mining Park: <https://parcogeominerario.sardegna.it/> (Accessed: October 2024).

129 *Carta di Cagliari*. 1998. <https://parcogeominerario.sardegna.it/carta-di-cagliari> (Accessed: October 2024).

these, the recovery of polluted sites to protect naturalistic values, the recovery of mining sites for cultural and tourist purposes, and the promotion of educational activities stood out.

Starting from the end of the 1990s, the first interventions for the protection of some underground and surface mining structures began. In the context of the recovery of the territory of Southern Sardinia, in this period a research project was started, concerning the definition of a cultural, historical, environmental and pilgrimage itinerary called “*Cammino Minerario di Santa Barbara*”¹³⁰. The idea of a route was born with the aim of enhancing the mining heritage of the Geo-mining Park, following the great participation of citizens in the excursions organized by the ONLUS Association *Pozzo Sella Per il Parco Geominerario*, founded in 2001 for contributing to the development of the Park. It consists of a 500 km long path, which passes through the most important sites of cultural and natural interest in the Sulcis Iglesiente and Guspinese regions. It takes its name from the patron saint of miners, *Santa Barbara*, because exactly in this area are grouped the majority of the mining sites of Sardinia.

The route is developed in a loop path and consists of 30 stages in total, starting and ending in Iglesias. It can be travelled both on foot and by bike (with one stage, that of San’t Antioco, also accessible on horseback).

► Image 52

Interactive map of *Cammino Minerario di Santa Barbara*, showing the cultural, industrial, historical and natural points of interest.

Source: <https://www.cammino-minerariodisantabarbara.org/mappa-interattiva/>



- Cosa vedere
 - Esperienze
 - + Beni culturali
 - Centri storici
 - + Edifici religiosi
 - Outdoor
 - Parchi e natura
 - Archeologia industriale
 - Museo storico, artistico
 - Centro storico
 - Siti archeologici
 - Ciclofficina
 - Infopoint
- Ospitalità
 - Dove dormire
 - Ristorazione
 - Timbratori
 - Posadas
- Tappe
 - A piedi
 - In bici
 - A cavallo

130 Official website of the cultural route: <https://www.camminominerariodisantabarbara.org/> (Accessed: October 2024).

To facilitate accessibility and tourist advertising, the CMSB Foundation (foundation of *Cammino Minerario di Santa Barbara*) created a mobile application that, thanks to georeferencing, allows visitors to follow the route directly from their smartphones and discover points of interest, restaurants, and hotel facilities. Travelers can access discounts on various activities and assistance along the walk by purchasing a credential, a sort of hiker's "passport", also useful for keeping track of the paths covered: in the document there are spaces for stamps that certify the travelling of the individual stages of the route.

Some initiatives aimed at promoting the itinerary were also launched, one of these is "Let's go in Cammino"¹³¹, proposed by the Foundation, reserved for visitors under 35, which allows them to stay for free in some of the affiliated hotel facilities.



◀ Image 53

Credential "passport" for visitors of *Cammino Minerario di Santa Barbara*.

Source: <https://www.cammino-minerariodisantabarbara.org/credenziali-2/>

To describe the *Cammino Minerario*, in order to obtain an analysis useful for defining a case study for the thesis, a GIS file was created containing the various stages of the route, as well as useful information to picture the current state of the post-mining landscape in Southern Sardinia, considering the presence and location of mining sites, quarries, architectural remains, and historic railway networks.

Furthermore, to enrich the information contained in the project, two shapefile layers were created, the first one regarding the stages of the walk, containing data such as duration, length, difference in altitude and difficulty of the journey, extracted from the official website of *Cammino Minerario*, and the second one including data on the state of the sites, with information on the type of mine, current state and use, accessibility, services provided, websites and contacts of the associations that manage them.

¹³¹ Official website of the initiative: <https://www.camminominerariodisantabarbara.org/legsgoincammino/> (Accessed: October 2024).

► Image 54

Map of the *Parco Geominerario Storico e Ambientale della Sardegna* including the cultural route of *Cammino Minerario di Santa Barbara*.

Elaborated by the author.

- *Cammino Minerario*
- *Parco Geominerario*

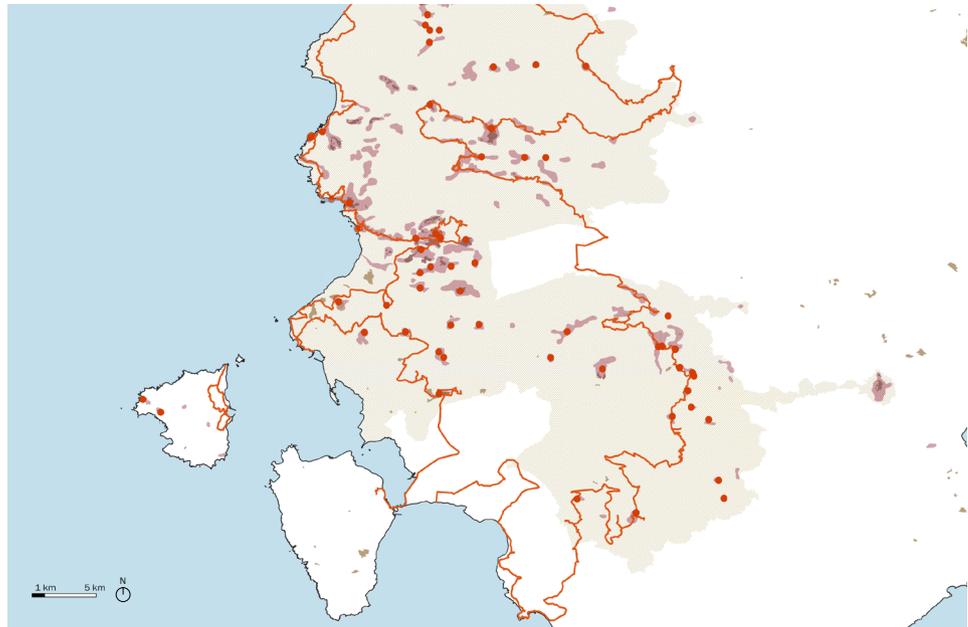


► Image 55

Map of the mining sites located within the path of the cultural route of *Cammino Minerario di Santa Barbara*.

Elaborated by the author.

- *Cammino Minerario*
- Mining sites
- Areas of mining organization
- Quarries
- Disused mining areas



ACRONYM	DESCRIPTION	TYPE	GLOSSARY	EXAMPLE
id	Site identification number, associated with the legend of the table "Cartography of the main Mining Sites and Geosites" (pdf)	Whole number (integer)	Write the number without symbols or decimals	01
Name	Name of the site	Text (string)	Write the first letter capital, the others lowercase	Porto Flavia
Type	Type of building / infrastructure	Text (string)	Write the first letter capital, the others lowercase	Mine / Gallery / Village
State	Current state of decay	Text (string)	Write the first letter capital, the others lowercase	Restored / Decayed
Use	Current use of the space / building	Text (string)	Write the first letter capital, the others lowercase	Museum / Accommodation / Abandoned / ...
Services	Services offered	Text (string)	Write the first letter capital, the others lowercase	Permanent exhibitions / Guided tours / No services
Visitab	Visitability of the site (is it possible to visit it?)	Whole number (integer)	Write the number without symbols or decimals	1. (Open to the public) 2. (Open but abandoned) 3. (Closed)
Access	Accessibility of the site (how is it possible to access?)	Text (string)	Write the first letter capital, the others lowercase	On foot / By car
Website	Web page of the site	Text (string)	-	-
email	Email, contact	Text (string)	-	-

◀ Table 1

Description of the attributes inserted in the layer "Mining sites", to be considered for further enrichment of the shapefile.

Elaborated by the author.

► Table 2

Attribute table created for the shapefile “Cammino di S. Barbara”.

Elaborated by the author, using the data available on the *Cammino Minerario* website: <https://www.camminominerariodisantabarbara.org/itinerari-il-cammino/>

id	route	length	duration	height_dif	difficulty	info
1	Iglesias to Nebida	20.9 km	7 h	ascent 753 m - descent 797 m	medium	NULL
2	2 Nebida to Masua	9.2 km	3 h 30 min	ascent 371 m - descent 500 m	medium	NULL
3	3 Masua to Buggerru	18.8 km	7 h	ascent 887 m - descent 889 m	challenging	NULL
4	4 Buggerru to Portixeddu	9.5 km	3 h 30 min	ascent 464 m - descent 460 m	easy	NULL
5	5 Portixeddu to Piscinas	16.2 km	5 h 30 min	ascent 462 m - descent 467 m	medium	NULL
6	6 Piscinas to Montevecchio	18.7 km	6 h 30 min	ascent 890 m - descent 532 m	medium	NULL
7	7 Montevecchio to Arbus	15.4 km	5 h	ascent 541 m - descent 609 m	medium	NULL
8	8 Arbus to Perd'e Pibera	15.4 km	5 h	ascent 498 m - descent 375 m	medium	NULL
9	9 Perd'e Pibera to Villacidro	15.6 km	5 h 30 min	ascent 975 m - descent 1098 m	challenging	NULL
10	10 Villacidro to Monti Mannu	18 km	6 h	ascent 571 m - descent 502 m	medium	NULL
11	11 Monti Mannu to Arenas	15.5 km	5 h 30 min	ascent 912 m - descent 667 m	challenging	NULL
12	12 Arenas to Su Mannau	13.4 km	4 h	ascent 399 m - descent 788 m	easy	NULL
13	13 Su Mannau to San Benedetto	14.6 km	5 h	ascent 687 m - descent 485 m	challenging	NULL
14	14 San Benedetto to Marganai	7.3 km	3 h	ascent 472 m - descent 127 m	easy	NULL
15	15 Marganai to Domusnovas-Musei	16.4 km	5 h 30 min	ascent 596 m - descent 1187 m	medium	NULL
16	16 Musei to Orbai	17.6 km	5 h 30 min	ascent 530 m - descent 323 m	medium	NULL
17	17 Orbai to Rosas	18 km	6 h	ascent 641 m - descent 723 m	challenging	NULL
18	18 Rosas to Nuxis	12.5 km	4 h	ascent 297 m - descent 348 m	easy	NULL
19	19 Nuxis to Santadi	15.3 km	4 h	ascent 390 m - descent 457 m	easy	NULL
20	20 Santadi to Is Zuddas	15.6 km	5 h	ascent 191 m - descent 216 m	easy	NULL
21	21 Is Zuddas to Masainas	24.6 km	8 h	ascent 826 m - descent 873 m	challenging	NULL
22	22 Masainas to Candiani	19.3 km	6 h 30 min	ascent 333 m - descent 370 m	medium	NULL
23	23 Candiani to Tratalias	24 km	8 h	ascent 433 m - descent 437 m	challenging	NULL
24	24 Tratalias to Sant'Antioco	16.9 km	5 h 30 min	ascent 199 m - descent 179 m	medium	NULL
25	24 Tratalias to Sant'Antioco	16.9 km	5 h 30 min	ascent 199 m - descent 179 m	medium	NULL
26	25 Sant'Antioco to Carbonia	23.4 km	7 h 30 min	ascent 273 m - descent 198 m	medium	NULL
27	26 Carbonia to Nuraxi Figus	22.5 km	8 h	ascent 504 m - descent 498 m	challenging	NULL
28	27 Nuraxi Figus to Carloforte	11.4 km	3 h 30 min + 40 min (ferry)	ascent 196 m - descent 310 m	easy	NULL
29	28 Carloforte to Portoscuso	18.8 km	6 h 30 min + 40 min (ferry)	ascent 412 m - descent 412 m	challenging	NULL
30	29 Portoscuso to Bacu Abis	18.8 km	6 h 30 min	ascent 459 m - descent 386 m	challenging	NULL

Q Mining sites — Elementi Totali: 79, Filtrati: 79, Selezionati: 1

123 id = 123 Aggiorna Tutto Aggiorna selezione

id	Name	Type	State	Use	Services	Visitab	Accessib	Website	email
1	1 Pozzo Castoldi	Well	Restored	Abandoned	No services	1	By car	NULL	NULL
2	26 Grande Miniera di Montevecchio	Mine	Restored	Museum	Guided tours	1	By car	http://www.mini...	info@lug...
3	29 Laveria Brassey – Naracauli	Washing ...	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
4	29 Pozzo Lambert	Well	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
5	29 Laveria Pireddu	Washing ...	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
6	29 Pozzo Turbina	Well	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
7	29 Pozzo Gal	Well	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
8	29 Villaggio Minerario di Ingurtosu	Village	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
9	29 Pozzo Casargiu	Well	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
10	29 Pozzo 92	Well	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
11	29 Miniera di Casargiu	Mine	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
12	29 Laveria La Marmora	Washing ...	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
13	29 Pozzo Amsicora	Well	Ruin	Abandoned	No services	2	By car	https://arbus.it/fi...	info@arb...
14	33 Miniera di Capo Rosso	Quarry	NULL	Abandoned	No services	2	By car	https://www.mi...	NULL
15	34 Miniera di Capo Becco	Mine	Ruin	Abandoned	No services	2	On foot	https://parcoge...	NULL
16	36 Miniera di Nuraxi Figus	Mine	Active	Reuse	Research centre	3	By car	https://www.mi...	NULL
17	39 Miniera di Monte Onixeddu	Mine	Ruin	Abandoned	No services	3	On foot	https://www.sar...	NULL
18	40 Laverie minerarie di Serra Scoris	Washing ...	Ruin	Abandoned	No services	3	On foot	https://www.vill...	villaggio...
19	40 Villaggio Minerario Asproni	Village	Ruin	Abandoned	Ongoing resto...	2	By car	https://www.vill...	villaggio...
20	41 Miniera di Genna Luas	Mine	Restored	Museum	Permanent exh...	1	By car	http://www.parc...	museo.g...
21	43 Miniera di Seruci	Mine	In activity	Reuse	Research centre	3	By car	https://parcoge...	NULL
22	44 Cava Sa Corona 'e sa Craba	Quarry	NULL	Abandoned	No services	3	On foot	https://www.mi...	NULL
23	45 Miniera di Barbusi	Quarry	NULL	NULL	No services	3	NULL	NULL	NULL
24	46 Miniera di Mont'Ega	Mine	Ruin	Abandoned	NULL	NULL	NULL	https://www.mi...	NULL
25	47 Miniera di Orbai	Village	Restored	Abandoned	No services	2	By car	https://parcoge...	NULL
26	48 Miniera di Sa Marchesa	Mine	Ruin	Abandoned	Natural park	1	By car	NULL	NULL
27	48 Sa Marchesa furnace	Furnace	Ruin	Abandoned	No services	NULL	NULL	NULL	NULL
28	48 Miniera di Illario	Quarry	Ruin	Abandoned	No services	3	By car	https://www.mi...	NULL
29	48 Miniera Su Sinibidraxiu	Quarry	Ruin	Abandoned	No services	3	By car	https://www.mi...	NULL

Mostra Tutti gli Elementi

◀ Table 3

Attribute table created for the shapefile “Mining sites”.

Elaborated by the author.

Despite the interventions and initiatives already carried out in the region by the local governance, the works necessary for the recovery and restoration of many mining sites and the definition of the route are still being developed, including guidelines for the signage, the installation of the temporary one, and the inventory of the heritage present along the path. The enhancement proposal of this research, presented in the next chapter, fits into this scenario, in an attempt to offer an innovative didactic tool, improve accessibility to the mining heritage of the cultural route, and facilitate the sharing of its history.

3.2 PROPOSAL FOR THE ENHANCEMENT OF THE MINING HERITAGE OF BACU ABIS

The second part of the chapter is dedicated to a proposal that aims to respond to the two main goals of the thesis: to digitize the heritage of the Bacu Abis Mine through the creation of 3D models of the structures that are part of the original conformation of the early 1930s settlement, and to enrich the tourist-cultural offer of Sulcis through the sharing and use of the digitized models, inserting them into the path of *Cammino Minerario di Santa Barbara*. The former allows to have a virtual version of the facilities, intended to “conserve” the existing heritage, virtually replicating it, and providing a tool for knowledge and sharing of information, such as the state of the built environment, the transformation of the urban fabric, and the original conditions. The latter allows to connect the digitization process to the theme of cultural tourism, using the 3D models created to enrich the fruition of the heritage (both the preserved and the lost heritage), making available to tourists and visitors travelling along the route to interact with the buildings with augmented reality (AR), easily accessible through the smartphone camera. By scanning a QR code, it will be possible to view the geo-located 3D model in scale 1:1 showing the original state of structures, superimposed on the existing buildings (or positioned exactly where they stood in the case of buildings that no longer exist) and placed into the real context. This allows any user to view in real time the virtual model at 360° by moving around it. Furthermore, with a tap on the phone display, visitors will be redirected to a dedicated online archive, where they can consult historical photos and information on the history of the building.

The proposal, inserted in an ongoing development context that has not yet fully enhanced the cases examined, important for their historical significance in the exploitation of the Sulcis coal basin, intends to improve the enjoyment of the heritage, facilitate accessibility to data not yet shared, and strengthen the connection between the anchor points that are not currently effectively highlighted within the signage of the main route. The following paragraphs provide a detailed overview of the procedures for digitization and creation of the AR program.

3.2.1 Digitization of the Mining Heritage

The Cambridge Dictionary defines the word digitization as “to put information into digital form, so that it can be used by computers and other electronic equipment”¹³². When it comes to the architectural heritage, the process of digitization refers to the creation of replicas of real buildings and monuments using 3D modeling techniques,

¹³² Cambridge Dictionary website: <https://dictionary.cambridge.org/dictionary/english/digitize> (Accessed: October 2024).

based on reliable documents, from historical photos, project drawings, to more precise tools such as point clouds. The European Commission has launched a campaign in 2023 called “Twin it! 3D for Europe’s culture”¹³³, aimed at encouraging and accelerating the use of 3D modeling to digitize all monuments and sites considered at risk, and the most visited ones, by 2030. All 3D assets submitted by the Member States are available in the online gallery¹³⁴. This campaign is part of the ongoing program to preserve cultural heritage, bringing it into this “digital decade”. As mentioned on the European Commission website¹³⁵, new opportunities offered by technology can help make cultural heritage easily accessible to all, allowing people to visit objects or sites that were previously poorly accessible to the public.

« *The most important reason for putting ‘Cultural Heritage’ online is to enhance accessibility so as to provide provisions for students, teachers and researchers to explore and connect with our past. This will help cultural archivists to measure their success by analyzing how people use, reuse, explore, and understand these objects.* »¹³⁶

This quote underlines the importance of two phases in the process of digitizing heritage, the first, that of documentation, which can be facilitated by putting online materials, sources and tools useful for the research, and the second, that of sharing the results and making them available to people. The two phases summarize the intentions of the processes carried out in the thesis, from the creation of easily explorable 3D models, to sharing them with a wider audience.

The 3D modelling process that was applied to the case of Bacu Abis and carried out in this research is based on the consultation of documents during a visit to the Archives of the local history section located at the former machine room of the Great Mine of Serbariu, in Carbonia, and a dossier¹³⁷ on the building types of the city included in the municipal urban plan (*Piano Urbanistico Comunale*). The documentation consisted of master plans, executive project plans, sections, elevations, and historical photos dating back to the 19th and 20th centuries.

133 Official website of the initiative: <https://pro.europeana.eu/page/twin-it-3d-for-europe-s-culture> (Accessed: October 2024).

134 Official website of the 3D models collection: <https://www.europeana.eu/en/galleries/15694-twin-it-a-pan-european-collection-of-heritage-3-d-models> (Accessed: October 2024).

135 European Commission, Shaping Europe’s digital future: <https://digital-strategy.ec.europa.eu/en/policies/cultural-heritage> (Accessed: October 2024).

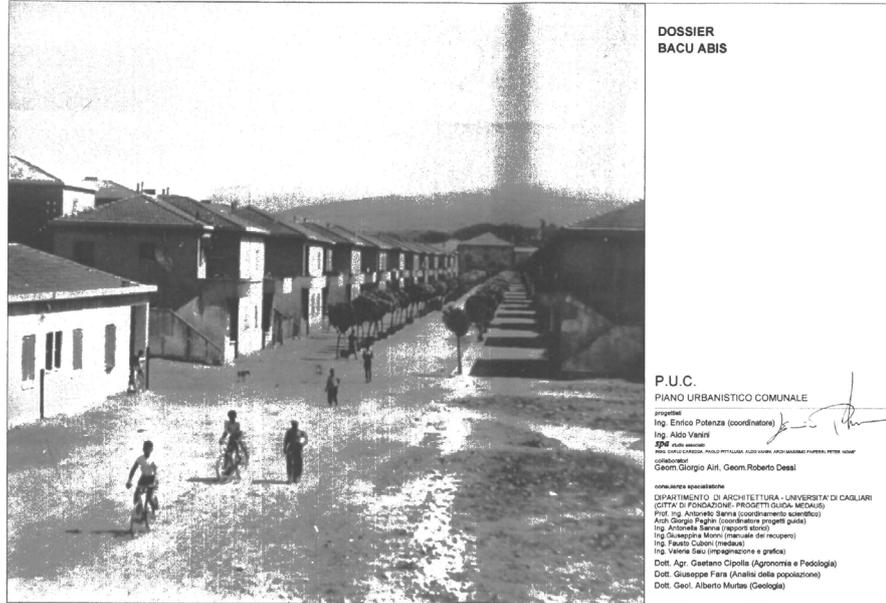
136 Khan N. A., Shafi S. M., Ahangar H. Digitization of Cultural Heritage: Global Initiatives, Opportunities and Challenges. *Journal of Cases on Information Technology (JCIT)*, introduction. 2018.

137 PPCS Comune di Carbonia. *Quadro Conoscitivo - Dossier Bacu Abis*. 2009.

► Image 58

PPCS Comune di Carbonia.
*Quadro Conoscitivo - Dossier
Bacu Abis. 2009.*

Source: https://www.comune.carbonia.su.it/wp-content/uploads/2024/06/3_Dossier_Bacu_Abis.pdf



**DOSSIER
BACU ABIS**

P.U.C.
PIANO URBANISTICO COMUNALE

progettista
Ing. Enrico Potenza (coordinatore)
Ing. Aldo Vantini
SPR - ARCHITETTO
ING. ENRICO POTENZA, PAOLO SPITILLARI, ALDO VANTINI, ANDREA MARRAS, PIERLUIGI PETER NARDI
collaboratori
Geom. Giorgio Aili, Geom. Roberto Desai

consulenza specializzata
DIPARTIMENTO DI ARCHITETTURA - UNIVERSITA' DI CAGLIARI
CITTA' DI FONDAZIONE - PROGETTI GIULIA MEDAUS
Prof. Ing. Antonio Serra (coordinamento scientifico)
Arch. Giorgio Paglia (coordinatore progetti guida)
Ing. Antonella Serra (report storico)
Ing. Giuseppe Sironi (analisi del recupero)
Ing. Fausto Caboni (realizzazione)
Ing. Valeria Sola (impaginazione e grafica)
Dott. Agr. Gaetano Cipolla (Agronomia e Pedologia)
Dott. Giuseppe Fara (Analisi della popolazione)
Dott. Geol. Alberto Murtas (Geologia)

► Image 59

PPCS Comune di Carbonia.
*Manuale del recupero
dell'edilizia moderna.*

Source: <https://www.comune.carbonia.su.it/amministrazione-trasparente/pianificazione-e-governo-del-territorio/ppcs-centro-storico/piano-di-riqualificazione/>



**MANUALE DEL RECUPERO
DELL'EDILIZIA MODERNA**

del Comune di Carbonia

P.U.C.
PIANO URBANISTICO COMUNALE

progettista
Ing. Enrico Potenza (coordinatore)
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SPR - ARCHITETTO
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Dott. Giuseppe Fara (Analisi della popolazione)
Dott. Geol. Alberto Murtas (Geologia)

◀ Image 60

Master plan of the digitized heritage of the Bacu Abis mining village.

Elaborated by the author.



- 01 Pozzo Castoldi
- 02 Pozzo Emilio
- 03 Management Offices
- 04 Warehouse
- 05 Food store
- 06 Ex "dopolavoro"

- 07 Cinema
- 08 Warehouse
- 09 Power plant
- 10 Power plant
- 11 Public gardens
- 12 Viale della Libertà

- Residential building type A
- Residential building type B
- Residential building type C
- Residential building type D
- Residential building type E
- Residential building type Gra B

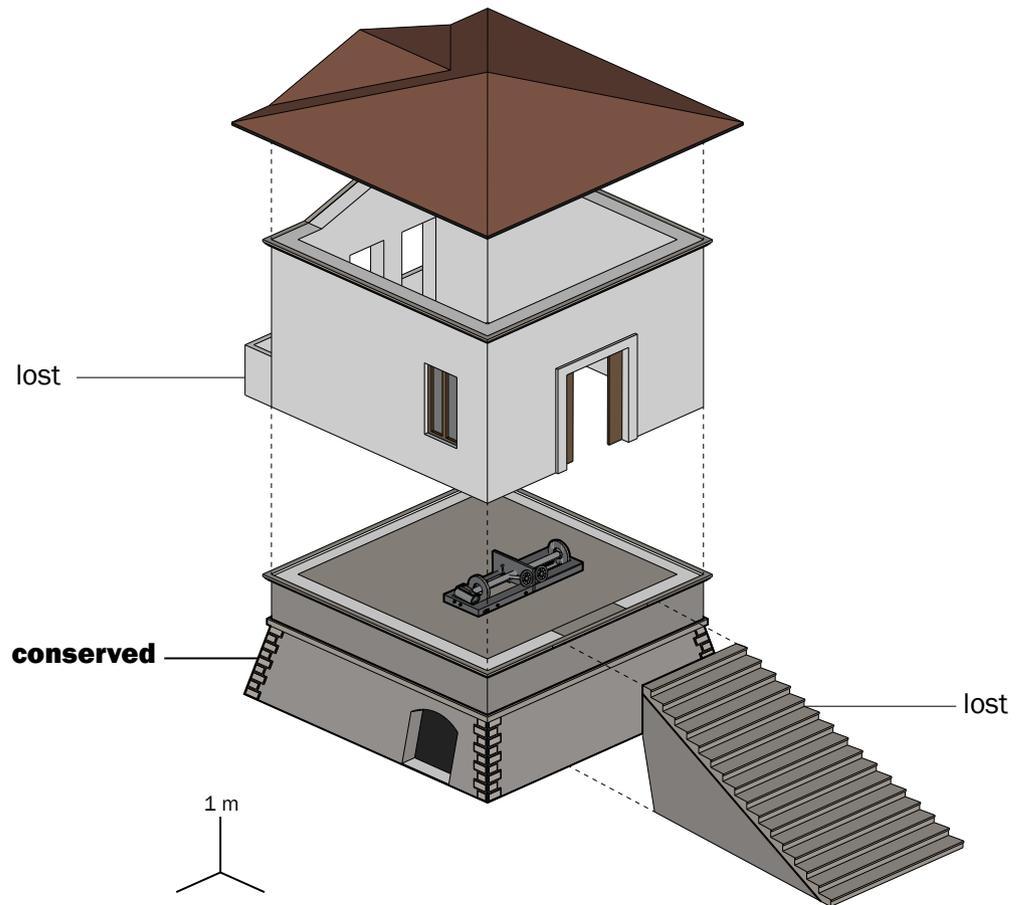
01 Pozzo Castoldi

It is located in the south-western area of Bacu Abis, close to the road that leads to Iglesias. Currently, only the masonry basement and the underground part of the winch room, which is not accessible, remain. Part of the original winch (even if deteriorated due to exposure) is visible at the top of the conserved part of the structure, on the first floor. Although the site was restored in 2004 with the ACTION project, funded by the Alcoa Foundation, there are currently no information panels or indications of what the original and complete structure looked like.

► Image 61

Exploded axonometric view of the 3D model of *Pozzo Castoldi* (conserved parts highlighted in thick outline).

Elaborated by the author.





◀ Image 62

Photo taken during the survey in Bacu Abis (Italy) in August 2024, showing the current state of the building.

Source: personal archive.



◀ Image 63

Historical photo used for the digitization process of Pozzo Castoldi.

Source: *Biblioteca comunale di Serbariu, sezione di storia locale.*

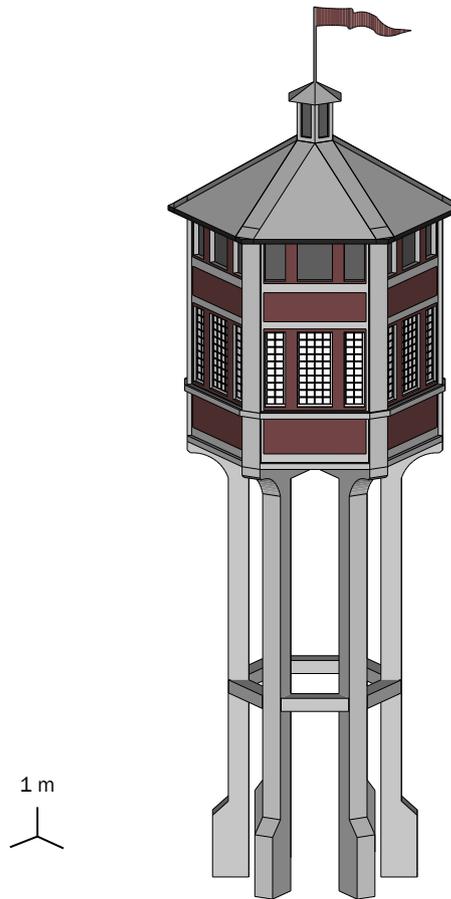
02 Pozzo Emilio

Once located in the centre of the town, it is among those structures of the mine that have been completely lost. Originally, the complex of the extraction site consisted of a winch room, an extraction tower, and a power plant (which is still existing, it has been reused and now houses a bar). Next to it, there was the water supply tower, one of the most iconic facilities of the mine, almost 28 meters high. Following its demolition a residential building was built near the power plant. Currently there is no indication regarding the history of the structures that previously stood on the site, other than the name given to the street (*Via Pozzo Emilio*).

► Image 64

Axonomic view of the 3D model of the water supply tower of *Pozzo Emilio*.

Elaborated by the author.



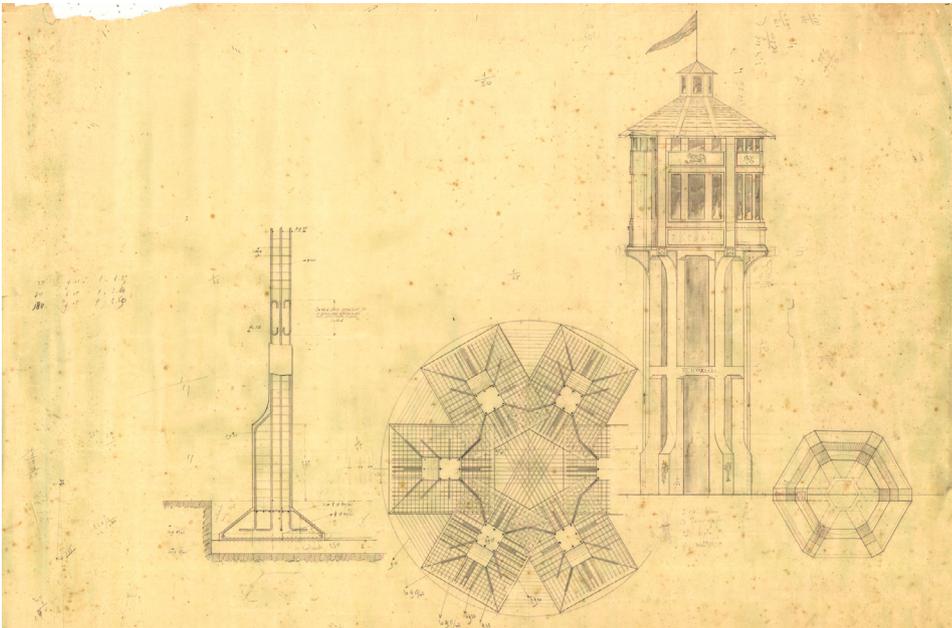


◀ Images 65, 66 and 67

Documentation used for the digitization process of the water supply tower of *Pozzo Emilio*:

historical photos (top left and right), elevation and section drawings (bottom).

Source: *Biblioteca comunale di Serbariu, sezione di storia locale.*



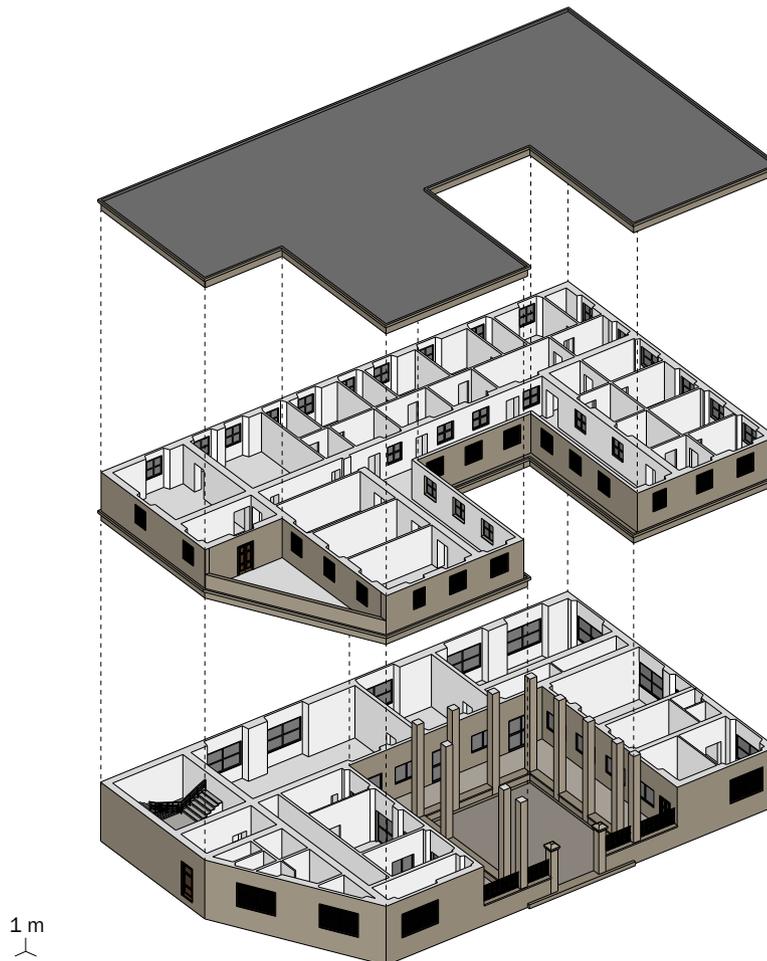
02 *Uffici Direzione Miniere Bacu Abis*

The management of the mine was based in a two-story building with access through an internal courtyard, located in the centre of the town, not far from *Pozzo Emilio*. Although in an evident state of deterioration, the structure is still preserved in its original conformation, and have not undergone any major modification over the years, except for a few changes to the size of the front windows, the positioning of entrances, and the addition of small volumes.

► Image 68

Axometric exploded view of the 3D model of the management offices of the Bacu Abis Mine.

Elaborated by the author.





◀ Images 69 to 72

Documentation used for the digitization process of the management offices:

photos taken during the survey in Bacu Abis (Italy) in August 2024, showing the current state of the building.

Source: personal archive.

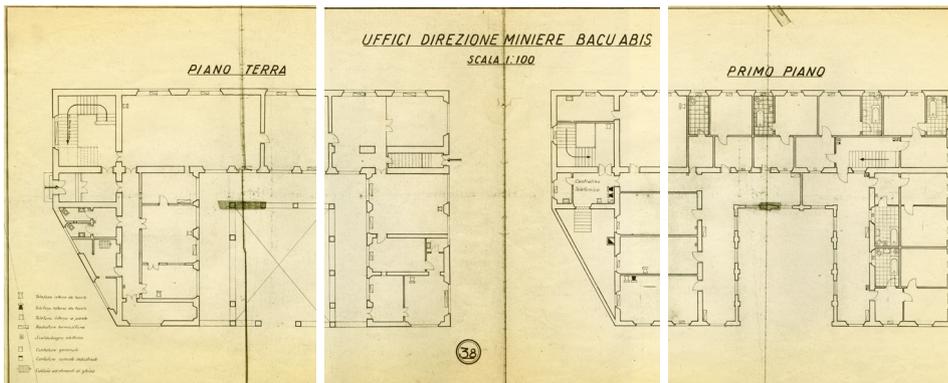


◀ Images 73, 74 and 75

Documentation used for the digitization process of the management offices:

ground floor and first floor plans.

Source: *Biblioteca comunale di Serbariu, sezione di storia locale.*



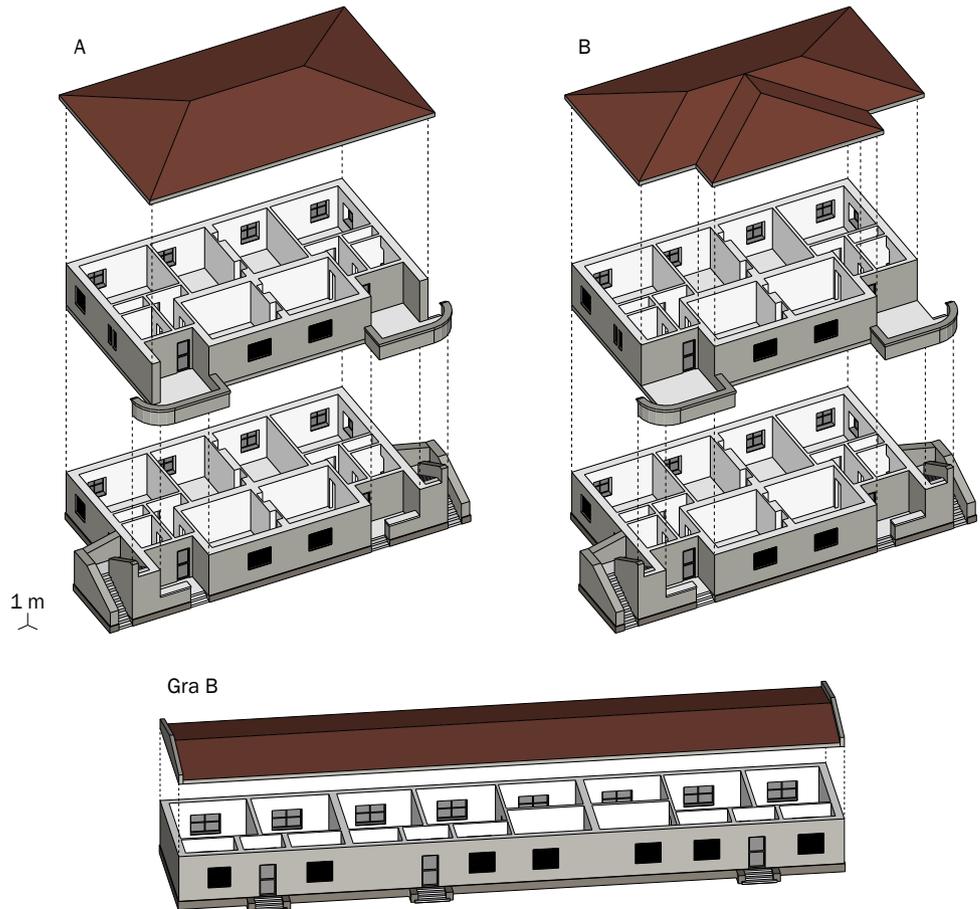
Tipologie abitative per impiegati (A, B, C, D, E, Gra B)

Residential buildings reflected the social hierarchy of the regime, they were assigned according to the profession performed (miner, employee, manager). Those built along the axis of the current *Viale della Libertà*, were houses for miners or employees, four-family units that differed in a few characteristics, but maintained more or less the same size. Today, most of these buildings show various additions, but it is still possible to distinguish the different architectural types.

► Images 76, 77 and 78

Axonometric exploded views of the 3D models of the residential building types A (top left), B (top right), and Gra B (bottom) of the Bacu Abis mining village.

Elaborated by the author.



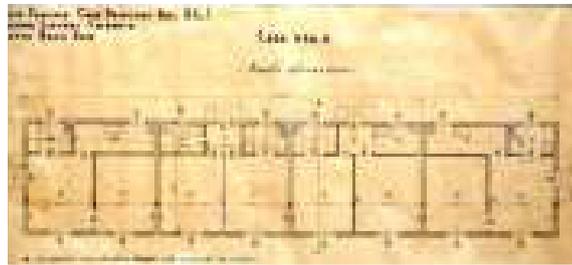
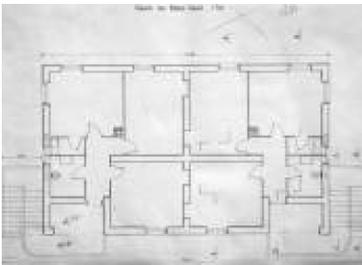


◀ Images 79, 80 and 81

Documentation used for the digitization process of the residential buildings for employees of the Bacu Abis mining village:

photos taken during the survey in Bacu Abis (Italy) in August 2024, showing the current state of the buildings, and the additions made over the years.

Source: personal archive.



◀ Images 82 and 83

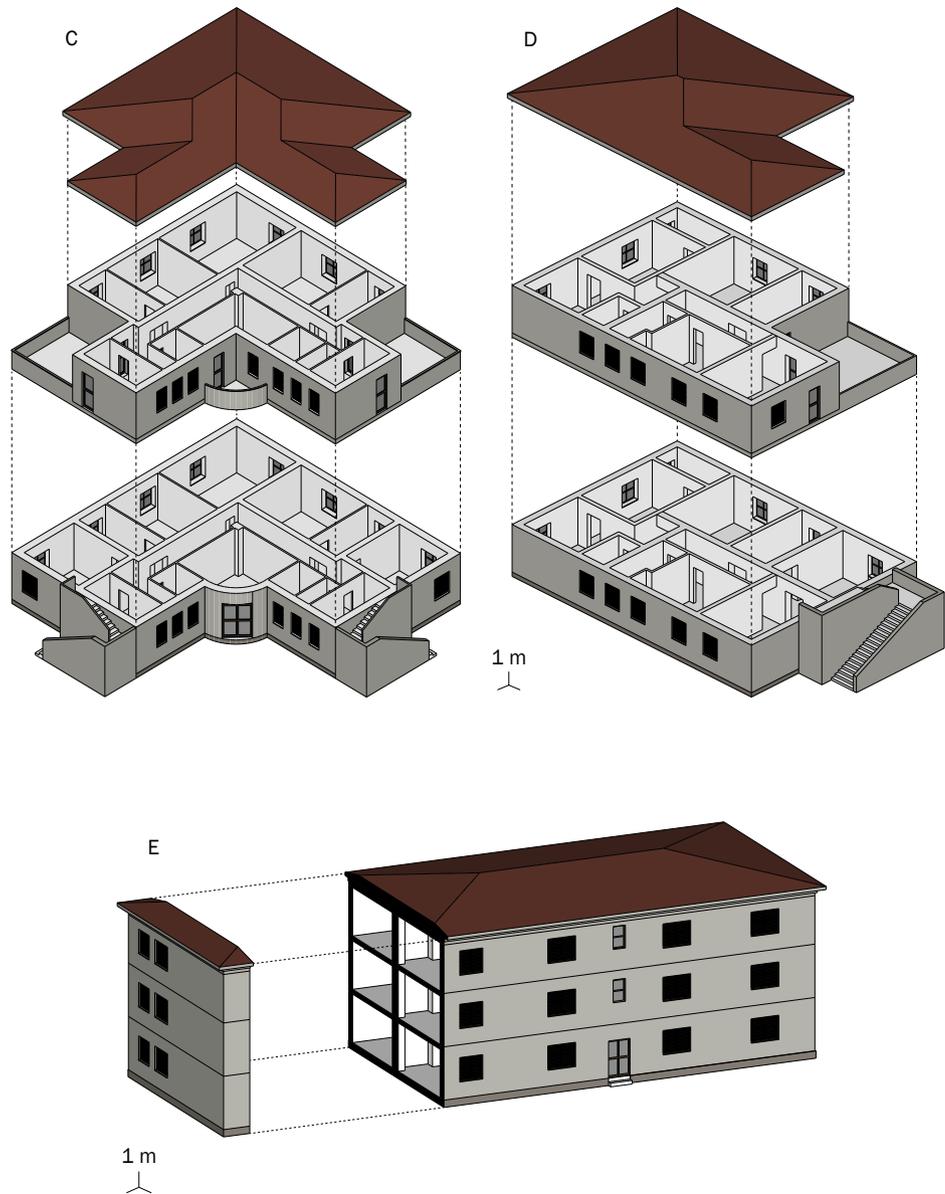
Plans of the building type A (left) and Gra B (right).

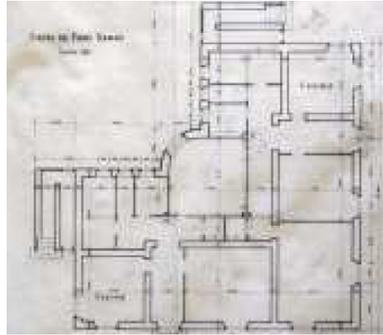
Source: *Comune di Carbonia, Quadro Conoscitivo - Dossier Bacu Abis*. 2009.

► Images 84, 85 and 86

Axometric exploded views of the 3D models of the residential building types C (top left), D (top right), and 3D section of the model of the residential building type E (bottom) of the Bacu Abis mining village.

Elaborated by the author.

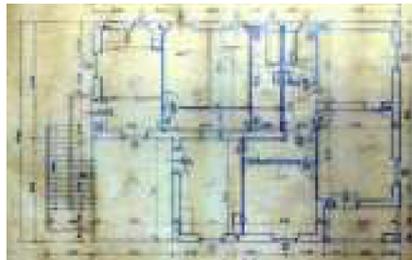




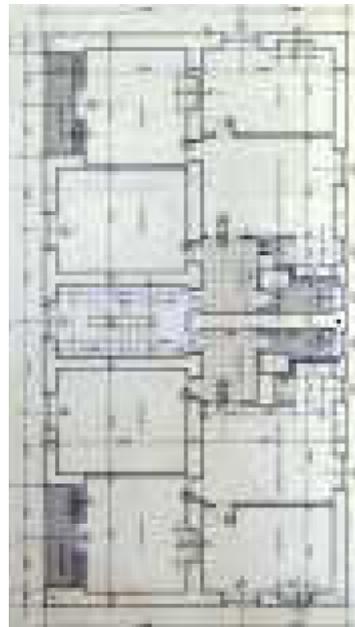
◀ Images 87 to 92

Documentation used for the digitization process of the residential buildings for employees of the Bacu Abis mining village:

photos taken during the survey in Bacu Abis (Italy) in August 2024, showing the current state of the buildings, and the additions made over the years; plans of the building type C (top), D (mid), and E (bottom).



Sources: personal archive; *Comune di Carbonia, Quadro Conoscitivo - Dossier Bacu Abis*. 2009.



Other civic buildings

As regards the remaining digitized buildings, the consulted documentation was not sufficient to reach a high level of detail, therefore the process was limited to defining the volumetric footprint of the civic buildings of the village center.

► Images 93 and 94

Axonomic views of the digitized heritage, showing the conformation of the settlement in the 1930s: the wells, the complex of civic buildings, and the residential buildings of *Viale della Libertà*. The current urban context is illustrated with less opacity to show how the city has transformed until today.

Elaborated by the author.



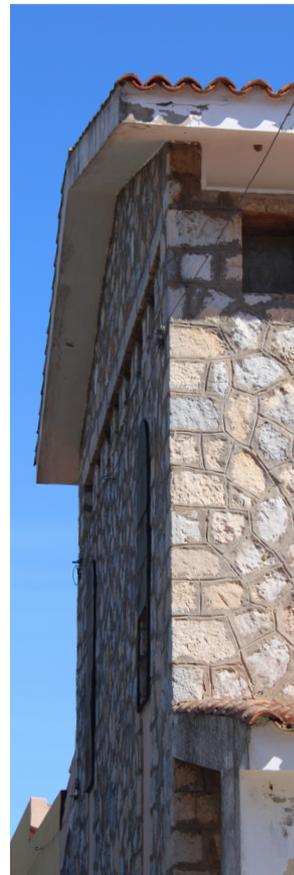


◀ Images 95 to 98

Documentation used for the digitization process of the civic buildings of the Bacu Abis mining village:

photos taken during the survey in Bacu Abis (Italy) in August 2024, showing the current state of the buildings, and the additions made over the years.

Source: personal archive.



As mentioned before, the digitization process was the first step in developing an intervention for the enhancement of the mining heritage of Bacu Abis. To complete the proposal, in addition to the creation of digital models, it is necessary to share them to improve their accessibility and use, in order to have an understanding of what the heritage looked like. From this perspective, the 3D models can become both an educational tool and an attraction for cultural tourists interested in industrial heritage, if included in a program that involves visitors in an innovative way. For this reason, by creating a “route within the route” dedicated to the history of Bacu Abis in which is possible to interact with the 3D models, it is possible to fully exploit the potential of digital tools to improve the tourist experience.

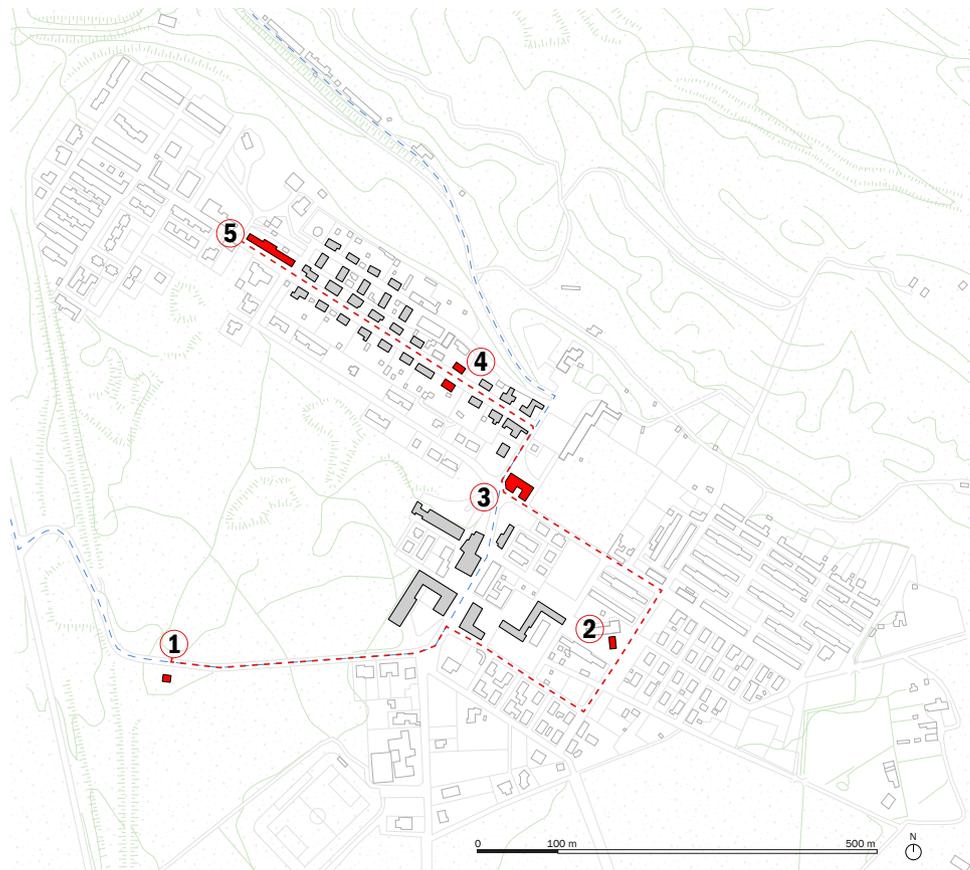
3.2.2 Proposal for a path integrated with an augmented reality experience

► Image 99

Anchor points of the route implemented with the AR experience.

Elaborated by the author.

- PATH PROPOSAL
- - - EXISTING ROUTE
- AR EXPERIENCE
- DIGITIZED BUILDINGS
- BUILT ENVIRONMENT
- ① POZZO CASTOLDI
- ② POZZO EMILIO
- ③ MANAGEMENT OFFICES
- ④ HOUSE TYPOLOGY A, B
- ⑤ HOUSE TYPOLOGY GRA B



The proposal can be implemented in the existing cultural route of *Cammino Minerario*, precisely between stage 29, which goes from Portoscuso to Bacu Abis, and stage 30, which goes from Bacu Abis to Iglesias. It consists of a 1.6 km long path within the city, which can be travelled on foot, by bike or by car, which partially follows the existing route of the *Cammino Minerario*, with some deviations. Specifically, the path is made up of short walks that connect 5 anchor points, historical buildings important for the history of the mine, which have been digitized and geo-located. The proposal provides that, by scanning a QR code with their phone, the visitors are able to view and interact with the 3D model of the building, accessing, in addition to the image of the structure as it was after its construction, a series of information including its history, archive documents, historical photos, or even videos of testimonies of those who lived and worked in those places. As described before, the digitization process included conserved buildings, which have undergone few modifications or additions over the years, such as the management offices and the residential units (3, 4, 5), buildings only partially preserved, such as *Pozzo Castoldi* (1), and structures that no longer exist, such as the water supply tower of *Pozzo Emilio* (2). This means that during the journey the visitor will be able to test different reconstruction methods in augmented reality: superimposition on an existing structure, completion of the missing parts of the building, or re-proposal of the entire building on a currently empty lot. To provide a detailed documentation on the process of creating the AR experience, the tools used and the results obtained are presented.

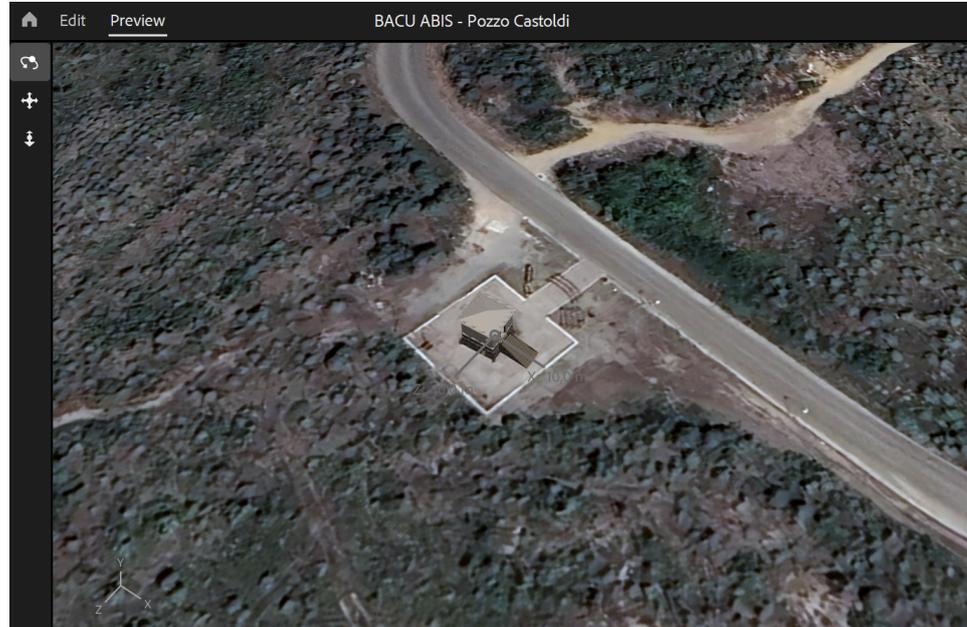
The first step involved the optimization of 3D models created on the SketchUp software, through the removal of non-visible components, the reduction of polygons and surfaces, and the compression of textures, to lighten the model and make its navigation more fluid. This step allowed to export the 3D in obj format while maintaining a reduced file size. To link the model to the actual location of the site, the software Adobe Aero, still in beta and under development, was used. It is a program for creating augmented reality services, in which it is possible to import 3D models and “anchor” them to a specific geographic location, so they appear in the real world when viewed through the mobile app. By selecting the exact coordinates of the sites, it was possible to place the models at the right scale and size. Once the process was complete, the projects were shared, generating a link and a QR code.

To verify the functioning of the AR experiences, their operation were tested on site: by scanning the QR codes of images 104, 105 and 106 (page 84), it was possible to view the digitized heritage inserted in its context. To share the results obtained, a video was created with the aim of showing the potential of the experience.

This experiment lays the foundations for a possible implementation of the service on a larger scale, to exploit the potential that new technologies offer in the field of cultural tourism, and in the accessibility and enjoyment of heritage.

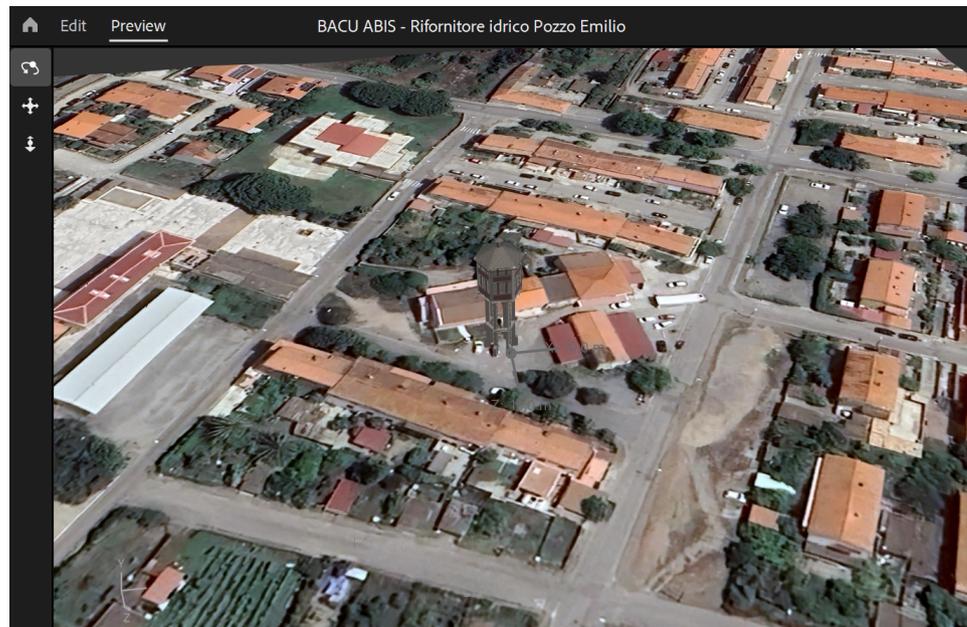
► Image 100

Preview of the project *Pozzo Castoldi* for augmented reality in the Adobe Aero software.



► Image 101

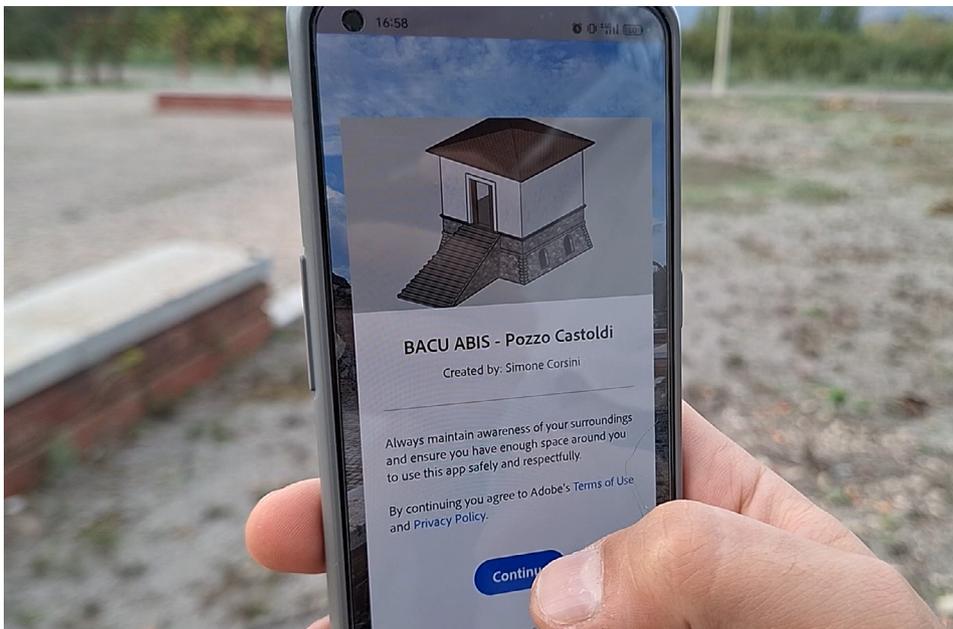
Preview of the project *Pozzo Emilio* for augmented reality in the Adobe Aero software.





◀ Image 102

Preview of the project *Uffici Direzione* for augmented reality in the Adobe Aero software.



◀ Image 103

Preview of the AR user interface. Bacu Abis (Italy), 25 October 2024.

► Image 104

QR codes generated for *Pozzo Castoldi* AR experience.

Elaborated by the author.



► Image 105

QR codes generated for *Pozzo Emilio* AR experience.

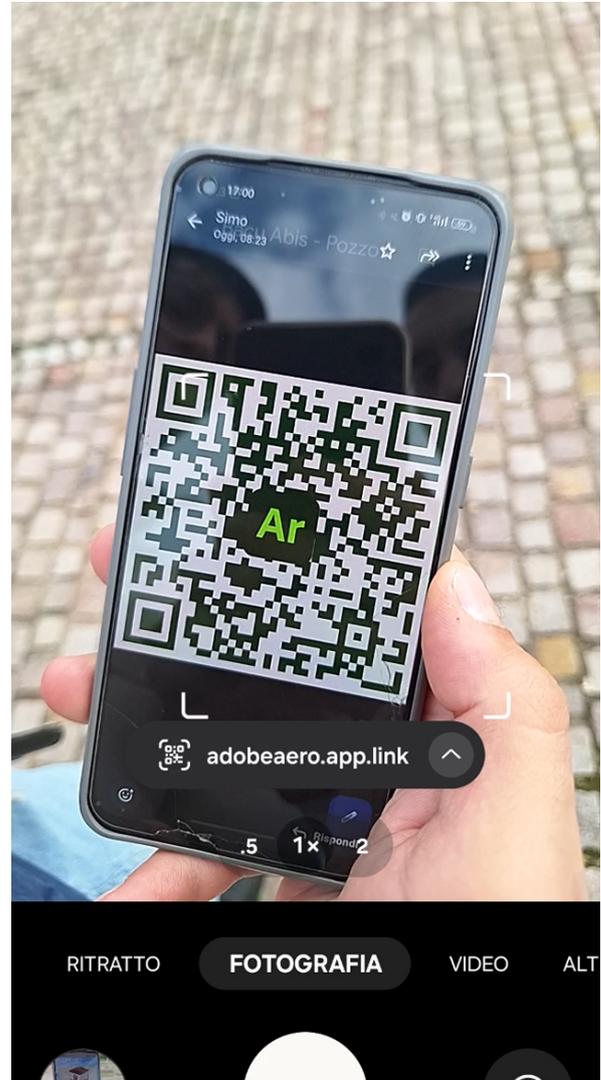
Elaborated by the author.



► Image 106

QR codes generated for *Management offices* AR experience.

Elaborated by the author.





◀ Image 107

AR experience in Bacu Abis
(Italy), 25 October 2024.



◀ Image 108

AR experience in Bacu Abis
(Italy), 25 October 2024.

Conclusion

The contents of the thesis, which had as a common thread the enhancement of industrial heritage as a driver of development of mining areas, were aimed at developing an improvement proposal for the case of the Bacu Abis Mine, located in the Sulcis coal basin, in Southern Sardinia (Italy).

Starting from the introductory analysis on the current state of the mining heritage and the examples of redevelopment of industrial areas, up to the analysis of the cultural tourism sector to define its challenges and opportunities, the topics covered have provided a series of key points to try to respond to the research goals.

In particular, the cases examined have highlighted how the networking of information has been a fundamental factor in the success of enhancement policies, suggesting that the preservation of heritage aimed at social regeneration and economic development of the territory must pass through processes of collaboration between the parties involved, and data sharing. Another factor highlighted in the research is the use of these data as an opportunity to promote cultural and sustainable tourism activities, identifiable as an alternative to mass tourism. New technologies can help the process of promoting lesser-known destinations, managing tourist flows, creating innovative and personalized experiences and increasing the accessibility of sites, allowing a wider audience to enjoy them. These points can be summarized in the need for an innovative approach, which connects the preservation and enhancement of the heritage to its accessibility and enjoyment. For this reason, the final proposal of the research has tried to connect the theme of heritage conservation through its digitization, to the exploitation of the result obtained to improve the tourist experience of the cultural route of *Cammino Minerario di Santa Barbara* with the use of augmented reality.

The outcomes of the research, although limited to a part of the entire network of cultural sites of the route of *Cammino Minerario*, are intended to put the basis for further development, supported by more in-depth research, and aimed at exploiting the potential that the presented methodology can have in the enhancement of industrial heritage.

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