

Energy transition and production landscape in the early 20th century. The case of Sardinia

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Abstract. This paper examines the historical landscape of Sardinia and how it was affected by the energy transition that took place at the beginning of the twentieth century. In particular, a preliminary assessment is provided of the impact of the implementation of the hydroelectric system on the transformation of the production architectural landscape. Based on numerous existing analyses, most of which have been developed using a sectoral typological-functional approach, the historical production architectural system will be studied as a “constellation”. The objective is to develop a holistic approach capable of recomposing the complex historical landscape, which is essential for the implementation of a policy of protection, conservation and restoration that respects the heritage and the values at stake.

Keywords: Hydroelectric system, Cultural heritage, Conservation.

1 Introduction

Energy is an issue of strategic importance in the current international political debate. In the European context, there is a desire to reduce energy consumption and waste, and as a result there is a greater focus on effective energy efficiency measures. These measures contribute to achieving sustainable supplies, improving security, limiting greenhouse gas emissions, and reducing the cost of imports¹. The main alternatives to fossil fuels are renewable energy sources such as wind, solar, hydro, ocean, geothermal, biomass and biofuels. They reduce dependence on oil and gas and allow diversification of energy supply². Particularly in Sardinia, energy and the ongoing process of transition are also strategic aspects for development, which are closely linked not only to the issues of energy efficiency and climate change, but also to the possibilities for production. Indeed, attracting industrial investment directly depends on energy. No less important is the environmental impact of the extensive and uncontrolled use of wind or photovoltaic power plants on the landscape. As a result, there is growing opposition to renewable energy sources such as wind and photovoltaics because of the land they take up and the damage they do to the landscape. Certainly, with the introduction of new

¹ <https://www.europarl.europa.eu/factsheets/it/sheet/69/efficienza-energetica> (last access: 16.01.2024).

² <https://www.europarl.europa.eu/factsheets/it/sheet/70/energie-rinnovabili> (last access: 16.01.2024).

“green” energy production systems, the Sardinian landscape is expected to suffer significant and irreversible changes.

The situation is similar to what happened in Sardinia at the beginning of the last century during the process of electrification based on hydroelectric power. The construction of dams and artificial lakes for energy production had a significant impact on the regional landscape. It changed not only the natural and man-made characteristics of the areas directly involved, but also the way they were used (Cadoni 2000). However, for a variety of reasons, this system quickly lost its strategic relevance and became obsolete. In many cases, their infrastructures were definitively abandoned.

The aim of this work is to provide a preliminary assessment of the impact that hydroelectric infrastructures have had on the transformation of the historic Sardinian landscape, also from the point of view of heritage and landscape protection. A brief, non-exhaustive summary that illustrates the relationship between the characteristics of the historic landscape of Sardinia and the hydroelectric processes that have contributed most to its formation may be considered useful.

1.1 Historical landscape shaping processes

From a morphological point of view, the complex geological history has led to the creation of unique landscapes, very different from those of the surrounding islands (Corsica, Sicily and the Balearic Islands). In the evolution of the island’s physiognomy, tectonics has certainly played the most important role, as well as the 600 million years of evolution that have determined the emergence of significant differences between the eastern and western sectors. The main characteristics are large block morphology, absence of folded mountain ranges, prevalence of flat forms and modest extent of floodplains due to low flow of watercourses (Fadda 2001, 15-27). In recent times, however, human activity has been the geomorphological agent that has had the greatest impact on changing the landscape. At present, the natural heritage can be considered largely intact, despite the deforestation and mining activities that have taken place over the last two centuries.

Different degrees of human impact and diversified land use have always characterised the Sardinian landscape. Anthropologist Giulio Angioni explains: «In traditional Sardinia, that is to say before the modernisation that took place in the second half of the 20th century, even in non-urban Sardinia, that is to say in most of the Sardinian territory, people lived in the village (“bidda”), and worked outside the village, as a centre of habitation, usually in a very centralised form (“su sartu”). The distinction between “sartu” on the one hand and “bidda” on the other is usually very clear in most parts of the island and serves to distinguish places of residence from places of production in the traditional agro-pastoral way» (Angioni 2009, 73). However, the distinction between the two main settlement functions (dwelling, work) corresponds to a mixture of uses within the same territorial area, where the social rules of production are developed by balancing the needs of agricultural and pastoral life, production activities that until most of the 19th century remained the main source of income on the island.

As the historian Gian Giacomo Ortu points out, the processes and dynamics of the formation of the local historical landscape are peculiar and not always easy to understand. In fact, he notes that even illustrious scholars such as Carlo Cattaneo and Maurice Le Lannou have found it difficult to accept that Sardinia has survived with “landscapes” and “systems of life” that seem never to have changed since the Carthaginian conquest, «almost as if the island [...] was still - in the 1930s - immersed in its “oldest” and original form» (Ortu 2009, 48). Paolo Fadda, in his report on recent regional economic events, notes that Sardinia has often been described as “a prisoner of the past”, “a prisoner of an eternal Middle Ages, trapped in a world of its own that has remained archaic and primitive» (Fadda 2008, 6). Indeed, he notes that even at the beginning of the 19th century, the social environment of the island remained «stuck in the rigidity of feudal constraints [...], a place where all production was for self-consumption, for the satisfaction of one’s own physiological needs, and where the exchange of goods and services was governed only by barter» (Fadda 2008, 9).

Industrial modernisation only reached Sardinia with the so-called “perfect union” with the Savoy States in the mid-19th century. This event contributed to the creation of social and cultural conditions that were favourable to overcoming the backwardness of the productive and economic system. The emergence of modern and capitalist entrepreneurial activities can be traced back to the industrialisation of agriculture. Its impact on the landscape is well represented in the cartography of the period, especially in the peri-urban context of Cagliari (Ortu 2015, 140). Another sector in transition in the same context was the production of salt, which was essential for food preservation at the time. Sardinia, and specifically the lagoon-coastal area of Cagliari, was considered one of the most important production centres, even at the international level. In general, these areas were structured between the 18th and the first half of the 19th century. They underwent subsequent industrial restructuring aimed at integrating hydraulic-mechanical systems and new canalisations while preserving the basic features that made up the environmental system³.

In 1848, the main industrial interest was in mining⁴. This led to the construction of the railway system, which began in 1863. The effects of these two activities later facilitated the emergence of the first industrial factories, particularly in the south of the island, with a greater concentration in the surrounding area of Cagliari⁵. In the latter

³ The Molentargius salt pans are an example of a Regional Natural Park, designated as such by Regional Law No. 5 of 26 February 1999. (Cadinu 2009, 50).

⁴ The mining tradition in Sardinia has ancient origins. Significant initiatives in the Middle Ages were decisive in the development of some urban centres, such as Villa di Chiesa (now known as Iglesias). In addition, at the end of the 18th century, some important veins of galena were discovered and concessioned to a company managed by the Swedish consul Gustavo Mandell. The company constructed a smelter to refine low-grade minerals. Later, the administration was returned to the Savoy government (Tore 2006, 27).

⁵ «In terms of capital investment and employment of labour, Luigi Doglio’s foundry and mechanical workshop (1868) in piazza del Carmine and Luigi Merello’s mill (1879) in corso Vittorio Emanuele stand out in particular, as well as the pre-existing tobacco factory in viale Regina Margherita. However, numerous other activities also have an industrial character, such

half of the 19th century, although industrialisation began to take shape in the mining sector, Sardinia appeared to be a land that was barely affected by the industrial and agrarian transformations that were taking place in the rest of Europe.

During the Giolitti period, a development process was initiated to reduce the historical backwardness of the south⁶. This process was «of a far-reaching nature, based on the conviction of the interdependence between mountain hydraulic systems, energy production and the transformation of the plains into irrigated land» (Cadoni 2000, 23-25). In other words, the construction of large hydroelectric dams would not only have drained the swamps and eradicated malaria but would have transformed vast arid plains into intensively cultivated irrigated land. At the same time, it would have provided an abundant and cheap source of energy, increasing the potential for using it in industry (Cadoni 2000, 24). The productive, economic, social and environmental systems of southern Italy would have been profoundly altered by the proposed project. Examples of this development model, even if with very different dynamics and results, are Sicily, Calabria, Basilicata and Sardinia (Cadoni 2000, 25).

Engineer Angelo Omodeo's (1876-1941) experience, gained during his time in Eritrea in 1902, played a crucial role in the decision to construct vast artificial lakes (Di Felice 2015, 595-623; Putzu 2008). He pointed out that the topographical, hydrological and geological conditions of almost the whole of southern and island Italy would have allowed the large-scale application of the system of hydroelectric dams. This system involves the construction of artificial lakes with the dual purpose of irrigation and electricity production, thus opening up new economic prospects. Until now, the quality of available energy has been low, while its cost tends to rise due to the inconsistency of the river regime and the high variability of consumption. This was partly due to the limited number of industrial users capable of maintaining a substantial, constant and complementary level of demand to that for lighting.

Water has played a crucial role in modernising Sardinia's economy. It has transformed the arid lands of the Campidani into fertile areas has also provided a source of "white coal" for electricity generation. The commissioning of hydroelectric power plants has resulted in the availability of large amounts of energy, which has significantly improved the quality of life and work⁷. Engineer Dionigi Scano, one of the most enlightened intellectuals on the island, stated that «Here in our country, where animal power, specifically that of oxen and donkeys, has historically been the primary source of energy, the ability to have motive power transmitted through thin copper wires represents a significant achievement. This development has the potential to illuminate the future of the Sardinian people, both literally and figuratively». As his words clearly reveal, Scano understood the importance of the development of the

as the Devoto bathing establishment in Giorgino (1879), the Carboni carpentry workshop, the Cao furniture factory and various construction companies [...]» (Ortu 2015, 142).

⁶ The regulatory framework has undergone significant changes, particularly with the enactment of Law no. 985 on 11 July 1913. This law authorised the government to grant permission for the construction and operation of reservoirs and artificial lakes on the Tirso river in Sardinia and on the Neto River and its tributaries in Sila for a period of sixty years (Cadoni 2000, 25).

⁷ At the same time, thermal coal, mainly from Sulcis, was used to produce electricity in addition to the hydroelectric system (Benincasa 2015, 3-7).

electrical industry: not only did he recognise the exceptional nature of the technological transition, but above all he understood its potential in social, economic and political terms.

1.2 Energy transition and production changes in the early 20th century: effects on the landscape

As previously mentioned, at the beginning of the 20th century, Sardinia's economy was heavily reliant on agro-pastoral activities. Although the mining industry was seen as a potential source of development, it faced challenges in extracting and processing raw materials, which hindered its competitiveness on the international stage. Similarly, the agricultural sector encountered difficulties in maintaining consistent production due to the lack of an effective water management system. Consequently, the water supply and irrigation capacity for the fields were highly uncertain and variable⁸. In the context of government policies promoting production between 1900 and 1914, the Cocco-Ortu law (R.D. 10.11.1907) was enacted, leading to a unique territorial plan. This plan was inspired by the ideas of Nitti and Omodeo, who believed that the production of electricity was necessary for both industrialisation and agrarian transformation on the island (Barone 1993, 217-218).

In the early 1900s, Angelo Omodeo analysed the hydrogeological conditions of Sardinia, which he called the "island of lakes". Obviously, this alludes not so much to the natural lakes, of which the island is almost completely devoid⁹, as to the artificial reservoirs that he wanted to build to develop irrigated agriculture and modern industry¹⁰.

In 1910, the Sardinia Study Commission¹¹ entrusted Angelo Omodeo, Vittorio Alpe and Arrigo Serpieri to carry out a feasibility study for the construction of a dam on the Tirso River, the main river on the island. The proposed dam at "Santa Chiara", near Paulilatino, would have created a 30 square kilometre artificial lake with a reservoir capacity of over 460 million cubic metres (Tola 1998). The lake would have powered a 70,000-kilowatt power station and irrigated about 30,000 hectares of land, even

⁸ Already in the second half of the previous century, several reservoirs were built to supply water to the cities: in 1867, for example, the dam of Rio Corongiu was built for Cagliari at the foot of the Serpeddi mountain complex; in 1878, the Bunnari lake was built for Sassari. For the same reasons, the dams of Iglesias and Sinnai were built, as well as many others linked to the needs of the mining industry (Fadda 2008, 51).

⁹ In Sardinia there is only one natural lake, the Baratz side, located in the north-west, in the historical region of Nurra. To the south-west, near Bugerru, there is another small natural lake, called Piscina Morta because of its temporary nature.

¹⁰ In the second half of the last century, several reservoirs were built to supply water to the cities: in 1867, for Cagliari, the dam of Rio Corongiu was built at the foot of the Serpeddi mountain complex; in 1878, for Sassari, the lake of Bunnari. For the same reasons, the dams of Iglesias and Sinnai were built, as well as many others linked to the needs of the mining industry (Fadda 2008, 51).

¹¹ The commission is made up of engineers Giuseppe Colombo, Leopoldo Pirelli, Attilio Odero and Luigi Orlando (Putzu 2008, 33).

during the driest months. If we take into account the knowledge and experience acquired in those years and the economic context of Sardinia at that time, we can understand the importance of this great work, even if public opinion, as can be seen from the newspapers of the time, showed a certain aversion to it, not understanding the social usefulness of these works, but only seeing them as a reason to take land away from agricultural and pastoral activities and to cause major changes in the agricultural landscape. In 1913, the hydroelectric concession was awarded to the Imprese Idrauliche ed Elettriche del Tirso (founded with capital from the Banca Commerciale Italiana, the Bastogi Finance Company and the British company Vickers Ltd)¹². Work did not begin until 1917, under the direction of engineer Luigi Kambo, and was completed in April 1924, under the direction of engineer Felice Costamagna, when the dam was inaugurated in the presence of King Vittorio Emanuele III. The Santa Chiara construction site, located at the “Pranu de sa Mortì”, was equipped with modern facilities, such as an aerial cableway connecting the two banks of the river, two gravity cableways and eight bridge cranes for transporting materials for the construction of the dam and the thermal power plant, as well as two lifts on 20-metre towers (Fig. 1).

The 1912 outline project was followed by the 1915 construction project, which included a triangular section dam, a hydroelectric power station, irrigation canals, electricity transmission and distribution lines, and a back-up steam power station¹³. The irrigation canals were designed to irrigate approximately twenty thousand hectares of flat land, suitable for the most valuable crops. From the hydroelectric power station, electricity lines would have been laid to transport electricity to Cagliari and the Iglesiente area.



¹² A.S.E., A. Omodeo, TS 19, Bando Gazzetta 2 settembre 1913, art. 1.

¹³ In the 1920s, however, a redesign was required to change the cross-section of the dam from a triangular gravity dam to a multiple arch dam with an internal power station (Putzu 2008, 37-74).

Fig. 1. Ula Tirso (Sardinia). Inauguration of the Tirso dam at Santa Chiara - 28 April 1924
 (source: ISRE, Fondo Guido Costa - https://www.isresardegna.it/immagini/16_38_20071218173230.jpg - last access 01.03.2024)

This would allow the power to be distributed to individual users and main centres. The construction site of the dam was directly linked to the workers' village (Fig. 2). The village provided housing for around 1,300 workers and also had facilities such as a machine shop, carpentry shops, warehouses, garages, a material testing laboratory, a meteorological cabinet, and a photography laboratory. The village had a gauge railway running through it and housed all the necessary buildings for civil use, such as a food shop, water tanks, a hospital with an adjoining chapel, various workshops, a laundry, a mill, a bakery, kitchens, a school, and a kindergarten. There were also two buildings for the construction manager, one of which was used as personal accommodation and was in an isolated position. In addition, the small town of Zuri had to be relocated due to the dam's construction, as it would have been submerged. This fact has been known since the 1912 project. Despite this, the construction of the dam was considered so important that the residents of Zuri themselves approved the relocation of the town, the construction of new houses elsewhere, and the transfer of the medieval church of St. Peter¹⁴. The construction of the new artificial lake resulted in the submergence of several elements of the landscape, including the Tadasuni iron bridge (which was later rebuilt), a section of the Tadasuni-Sorradile provincial road, the "ghost forest", the church of Nostra Signora di Boele, a Roman road, and numerous prehistoric and historic archaeological remains (Putzu 2008, 9-17).



¹⁴ The case is well known and involved the superintendent Dionigi Scano, who was initially in charge of the work; when Scano resigned as superintendent, he was replaced by Carlo Aru, who partly revised his predecessor's regulations and prepared a restoration with a more philological approach (Putzu 2008, 9-17).

Fig. 2. Ula Tirso, loc. Santa Chiara (Sardinia). Construction of dam on Tirso, entrance to the village (source: <https://www.sardegna.digitallibrary.it/detail/6499bc40e487374c8f8088e1> - last access 01.03.2024)

In this scenario, landscape transformations affect not only the natural environment that the intervention seeks to govern, such as the water of the Tirso river, the reservoir area, and the surrounding land, but also indirectly involve the territorial settlement structure. This includes the abandonment of one urban centre and the foundation of another to accommodate its population, changes in the road layout, and other infrastructures. These changes would even have compromised the cultural heritage.

The changes have been significant and have had far-reaching effects, especially after the completion of the island's electrification. In 1927, the second hydroelectric power station was built by damming the Coghinas river, expanding the electricity coverage to the north of the island and the city of Sassari. However, it was only after the Second World War that the planning of the energy production and distribution infrastructure was completed, with the opening of the Flumendosa hydroelectric plant in 1949.

In the mid-20th century, the energy supplies from the Tirso, Coghinas, and Flumendosa power stations enabled the opening of factories and workshops throughout the island, increasing the supply of operating engines and lighting the streets and houses of around three hundred Sardinian towns. A notable example of this progress occurred in the historic eastern outskirts of the city of Cagliari (Fig. 3). The Contivecchi salt pans were established in this area, which has already been the subject of numerous in-depth studies, at the end of the 19th century. A village was annexed to the salt pans. On the opposite side, the Santa Gilla thermal power plant was built, followed by chemical and manufacturing industries.

The area is undergoing a slow but radical process of transformation due to the gradual abandonment of an increasing number of industrial structures that began at the end of the 20th century, the demographic growth and the increasing pressure of speculative building, in a process similar to that which has occurred in many other Italian and European cities. It is important to note that this statement is objective and does not contain any subjective evaluations. A comparison between the current state and that of the 1950s reveals the distortion of the ancient urban configuration caused by building development and the replacement of entire industrial blocks with new residential blocks.

2 Conclusion

This framework aims to demonstrate the impact of the energy transition in the first half of the 20th century on the historic landscape of Sardinia, with a focus on the construction of three hydroelectric plants. The technical advances in industrial production during this period were accompanied by significant social changes and territorial upheavals. In addition, during the same decades, land reclamation projects were undertaken, a railway line was constructed, and road connections were expanded. Reconstructing the historical architectural production landscape is a complex task due to the distribution of the object was more widespread around the main urban centres of

Cagliari and Sassari. However, some of the manufacturers and factories were also located in more peripheral areas.

The overlapping of individual elements over time has created an organic system that can be distinguished at different scales of interpretation. As the material evidence forming its load-bearing framework disappears, the recognisability of these landscapes weakens. Several areas have undergone significant changes, often resulting in complete demolition to make way for new housing. They have definitively lost their industrial or productive function. In some cases, the current reality presents a historical landscape that has been strongly ruderalised. This landscape is composed of fragments of the original organism, on which design visions, infrastructures, and interventions have been added. These additions can be disproportionate and incongruous, eroding the landscape's primitive functional nature and urban value.

Indiscriminate demolitions, fragmentation into subsets, and the progressive subtraction of parts, as well as changes in function and meaning, risk compromising the scope of the landscape system. This can reduce it to a mere summation of parts, which is incapable of representing the original values of the place.



Fig. 3. Cagliari (Sardinia). Project for the industrial area in the west of Cagliari and the list of the existing industrial companies within the area. (source: Archivio storico dell'Associazione degli Industriali della Provincia di Cagliari)

In conclusion, the preceding information serves as a starting point for studying the local productive architectural system in terms of a “constellation”. By utilizing existing studies, primarily developed through a typological-functional sectorial approach, we aim to create a cognitive overview that can reconstruct the complexity of historical landscapes. This is crucial for implementing protection, conservation, and restoration measures that uphold the heritage and values involved.

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