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Hydropower and Industrial Transformation: The Construction of the Tereble–Rika Hydroelectric Power Station in Transcarpathia

Abstract: The purpose of this study is to conduct a comprehensive analysis of the construction process of the Tereble–Rika Hydroelectric Power Station (1949–1956) in the Zakarpattia region, to identify the main engineering, organizational, economic, and social factors that influenced the timeline of the project's implementation, and to evaluate the contribution of the power station to the development of regional energy infrastructure. The research is based on archival analysis of project documentation, including technical and economic reports, annual investment project lists, consolidated financial and economic plans, and acceptance reports for completed construction works. The study also involves a comparative examination of engineering solutions and the material and technical support of the project. Particular attention is paid to the geographical and hydrological conditions of the area, especially the significant altitude difference between the Tereblia and Rika rivers, the planning of a reservoir with a capacity of 24 million cubic meters, the construction of a concrete dam 45 meters high and 153 meters long, the development of a diversion tunnel with a length of 3.7 km and a diameter of 2.15 m, and the installation of a pressure pipeline 380 meters long with an internal diameter of 2.2 m. The hydroelectric station was equipped with three hydraulic turbines with a nominal capacity of 9 MW each. The results of the research show that the construction process was accompanied by considerable difficulties caused by a shortage of qualified workers and engineers, limited availability of construction materials such as cement, steel, and timber, difficult logistical conditions in mountainous terrain, and frequent technical failures of equipment. Analysis of annual construction plans indicates delays in the construction of the dam, diversion tunnel, turbine hall, and narrow-gauge railway, which resulted in postponing the completion of the project from 1954 to 1956. At the same time, the study reveals effective management of financial resources, the development of residential and social infrastructure for workers, the construction of transport and engineering networks, and the integration of international equipment, including turbines manufactured in Finland and generators produced in the Ural region. During the construction process more than 2,000 workers were employed, with a peak workforce of 2,736 people in 1954. Approximately 420,000 cubic meters of concrete and 84,000 tons of cement were used. The total cost of the project exceeded 200 million rubles, while the reservoir covered an area of approximately 80 hectares.

Keywords: hydropower engineering, Tereble–Rika HPP, archival research, construction logistics.

Introduction

The water resources of the Zakarpattia region possess significant potential for the development of hydropower due to considerable altitude differences, a dense network of mountain rivers, and favourable natural conditions for the creation of hydraulic structures. Among the most important examples of the use of this potential is the Tereble–Rika Hydroelectric Power Station, which became one of the key infrastructure projects in the post-war transformation of the regional energy system. The construction of this station was based on the original engineering idea of using the natural difference in elevation between the Tereblia and Rika rivers, which flow almost parallel to one another but are located at different hypsometric levels.

The idea of constructing a hydroelectric power station on the Tereblia and Rika rivers emerged in the early twentieth century and was further developed during the period when the region belonged to the Czechoslovak Republic. However, due to unfavourable historical and political circumstances, the practical implementation of the project was postponed. The actual construction of the Tereble–Rika Hydroelectric Power Station began only in the late 1940s and continued until the mid-1950s. This period was marked by the inclusion of Zakarpattia into the Soviet economic and administrative system, the need to modernise the regional energy infrastructure, and the broader post-war industrial transformation of the region.

The relevance of this research is determined by the need for a comprehensive analysis of the historical, economic, technical, organisational, and social aspects of the construction of the Tereble–Rika Hydroelectric Power Station. The project was not merely an engineering undertaking; it also involved complex processes of financial planning, labour mobilisation, transport infrastructure development, settlement construction, resettlement of local inhabitants, procurement of materials, and coordination between different institutions and regions. Therefore, the study of this project makes it possible to understand not only the technological history of hydropower development in Zakarpattia, but also the mechanisms through which large-scale infrastructure projects were implemented under difficult geographical, economic, and administrative conditions.

The research problem lies in the insufficiently comprehensive study of the relationship between engineering planning, material and technical supply, workforce organisation, financial management, construction logistics, and the actual timeline of the project. Previous studies have mainly focused on the general history of the Tereble–Rika Hydroelectric Power Station or on its technical characteristics. At the same time, archival materials related to annual investment plans, financial estimates, labour resources, housing and social infrastructure, construction delays, equipment failures, and logistical difficulties have not been fully systematised. As a result, the reasons for the deviation of the project from the initial construction schedule and the broader socio-economic significance of the construction process remain insufficiently clarified.

The scientific novelty of the study consists in the use of archival materials to reconstruct the construction process of the Tereble–Rika Hydroelectric Power Station as a complex historical and infrastructural phenomenon. The article analyses not only the technical parameters of the hydropower facility, but also the organisational, financial, logistical, and social factors that influenced the implementation of the project. Particular attention is paid to the comparison between planned construction indicators and the actual state of work performed, which makes it possible to identify the main reasons for delays and to assess the effectiveness of project management under the conditions of mountainous terrain, shortage of qualified personnel, limited material resources, and technical difficulties.

The object of the study is the construction of the Tereble–Rika Hydroelectric Power Station in the Zakarpattia region during 1949–1956 as a major hydropower and infrastructure project.

The subject of the study is the engineering, organisational, economic, logistical, and social factors that influenced the construction process, the timing of implementation, and the formation of the regional energy infrastructure.

The article aims to conduct a comprehensive analysis of the construction process of the Tereble–Rika Hydroelectric Power Station in the Zakarpattia region, to identify the main factors that influenced the course and duration of construction, and to evaluate the significance of the station for the development of regional hydropower and industrial infrastructure.

To achieve this aim, the study addresses the following objectives:

- to trace the historical development of the idea of constructing a hydroelectric power station on the Tereblia and Rika rivers from the early engineering concepts to its practical implementation;
- to analyse the geographical and hydrological conditions that determined the engineering logic of the project;
- to examine the main technical characteristics of the hydroelectric complex, including the dam, reservoir, diversion tunnel, pressure pipeline, turbine hall, and generating equipment;
- to study archival materials concerning project planning, annual investment lists, financial estimates, and construction documentation;
- to identify the main organisational and logistical difficulties that affected the construction process;
- to analyse the impact of shortages of qualified workers, engineers, construction materials, equipment, and energy supply on the pace of construction;
- to examine the development of residential, transport, social, and auxiliary infrastructure connected with the construction site;
- to determine the reasons for the postponement of the completion of the project from the originally planned date to 1956;
- to evaluate the contribution of the Tereble–Rika Hydroelectric Power Station to the development of the regional energy system and the industrial transformation of Zakarpattia.

The theoretical significance of the research lies in deepening the historical understanding of hydropower development in Zakarpattia and in clarifying the role of large-scale infrastructure projects in regional industrial transformation. The study contributes to the historiography of Soviet-era infrastructure construction, regional energy policy, and the economic history of Transcarpathia. It also demonstrates the importance of analysing infrastructure projects not only through their final technical results, but also through the processes of planning, financing, labour organisation, logistics, and social adaptation.

The practical significance of the study lies in the possibility of using its results for further research on hydropower engineering, regional infrastructure development, historical geography, economic history, and the management of large-scale construction projects in mountainous areas. The archival evidence analysed in the article may also be useful for specialists studying the historical development of the energy sector, the transformation of industrial regions, the planning of infrastructure facilities, and the social consequences of major engineering projects. The experience of the Tereble–Rika Hydroelectric Power Station demonstrates the importance of effective resource management, workforce organisation, logistical planning, and coordination between technical and social infrastructure in the successful implementation of complex hydropower projects.

Methods

The study is based on a qualitative historical and archival research design aimed at reconstructing the construction process of the Tereble–Rika Hydroelectric Power Station as a complex engineering, economic, organisational, logistical, and social phenomenon. This methodological approach is appropriate because the construction of the hydroelectric power station cannot be analysed only as a technical event. It involved long-term project planning, financial management, labour mobilisation, supply of materials, resettlement of the local population, creation of transport and social infrastructure, and adaptation of engineering solutions to mountainous geographical conditions.

The chronological framework of the study covers the period from the first engineering concepts of the Tereblia–Rika hydropower project in the early twentieth century to the official commissioning of the hydroelectric power station in 1956. Particular attention is paid to the period from 1949 to 1956, when the practical implementation of the project took place. This period makes it possible to analyse the transition from the design stage to construction, the dynamics of annual planning, the emergence of technical and logistical difficulties, and the reasons for the postponement of the project's completion from the originally planned date.

The source base of the research consists primarily of archival materials from the State Archive of the Zakarpattia Region. The study uses documents from Fond R–1097 and Fond R–1914, which contain project, administrative, technical, financial, and construction-related materials concerning the Tereble–Rika Hydroelectric Power Station. These archival sources include annual title lists of investment projects, financial and economic plans, reports on the performance of construction and installation works, correspondence between construction organisations and ministries, acceptance acts for completed works, documents concerning the supply of materials and equipment, records on workforce numbers, and materials related to housing construction, social infrastructure, land withdrawal, compensation, and resettlement.

The archival method was used as the central specialised method of the study. It made it possible to identify, systematise, and interpret primary documents related to the construction of the hydroelectric power station. Archival analysis was applied not only to extract factual data, but also to reconstruct the administrative and economic logic of the project. Particular attention was paid to documents that reflect the discrepancy between planned and actually completed works, since these sources reveal the internal difficulties of the construction process more clearly than retrospective descriptions.

The method of source criticism was applied to evaluate the reliability, completeness, and interpretative value of the archival materials. Since the documents were produced within the administrative and technical system responsible for the construction project, they contain both factual information and institutional perspectives. Therefore, the study considered the purpose of each document, its administrative context, the type of data presented, and its relation to other archival materials. This approach helped reduce the risk of treating planning documents, reports, estimates, and correspondence as neutral records without considering their function within the construction management system.

The historical method was used to trace the evolution of the Tereble–Rika project from its initial conception to its final implementation. This method allowed the study to reconstruct the sequence of key events: the emergence of the engineering idea, the preparation of design documentation, the beginning of construction in 1949, the development of the reservoir and dam, the construction of the diversion tunnel and pressure pipeline, the creation of railway and road infrastructure, the expansion of the workers' settlement, and the commissioning of the station in 1956. The historical method also made it possible to connect the project with broader processes of post-war industrialisation and regional energy development in Zakarpattia.

The historical-genetic method was used to analyse the origin and transformation of the engineering concept of the hydroelectric power station. This method helped identify how the natural difference in elevation between the Tereblia and Rika rivers became the basis for a specific hydropower solution involving water diversion through a tunnel and pressure pipeline. It also made it possible to examine how earlier Czechoslovak and Hungarian engineering ideas were later incorporated into the Soviet construction project.

The systemic method was applied to examine the construction of the Tereble–Rika Hydroelectric Power Station as an integrated system consisting of several interdependent components. These included the main hydraulic structures, transport routes, energy supply, material procurement, labour resources, housing, social facilities, financial planning, administrative management, and technical supervision. The systemic approach made it possible to demonstrate that delays in one component, such as material supply, energy provision, tunnel construction, or workforce qualification, affected the progress of the entire project.

The comparative method was used to compare planned construction indicators with the actual volume of work completed in different years. This method was particularly important for identifying the reasons for delays in the construction of the dam, diversion tunnel, turbine hall, narrow-gauge railway, high-voltage transmission line, and auxiliary infrastructure. Comparative analysis also allowed the study to assess the difference between the planned commissioning dates and the real pace of construction. The comparison of archival plans and acceptance reports made it possible to determine how resource shortages, logistical constraints, and technical failures influenced the overall implementation schedule.

The quantitative-descriptive method was used to analyse numerical data contained in archival documents. This included information on the estimated and actual cost of works, annual volumes of construction and installation activities, workforce numbers, salary indicators, quantities of concrete and cement used, the scale of land withdrawal, the number of resettled households and inhabitants, reservoir dimensions, and technical parameters of the hydraulic structures. Although the study is not econometric in nature, the use of quantitative indicators strengthens the historical analysis by showing the real scale of the project and the material intensity of construction.

The technical and economic analysis method was applied to evaluate the interaction between engineering decisions and economic resources. The study analysed the parameters of the dam, reservoir, diversion tunnel, pressure pipeline, turbines, generators, railway infrastructure, and auxiliary facilities in relation to financial expenditures, material supply, and construction capacity. This method helped demonstrate that the implementation of the project depended not only on the correctness of the engineering solution, but also on the availability of construction materials, specialised equipment, qualified personnel, transport infrastructure, and stable energy supply.

The logistical analysis method was used to examine the influence of mountainous terrain and transport limitations on the construction process. The location of the project required the delivery of large quantities of cement, steel, timber, rails, equipment, and machinery to a difficult-to-access area. The study therefore considered the role of the 750 mm narrow-gauge railway, road reconstruction, internal transport routes, and the supply of construction materials. This method made it possible to identify logistics as one of the central factors that delayed the construction process and increased organisational complexity.

The socio-economic analysis method was applied to examine the human and social dimensions of the construction project. The study analysed the mobilisation of the workforce, the shortage of qualified workers and engineers, labour turnover, accommodation conditions, construction of dormitories and residential buildings, creation of medical, educational, cultural, and everyday infrastructure, as well as the resettlement of households affected by the formation of the reservoir. This method helped show that large-scale hydropower construction was not only an engineering process, but also a social transformation of the surrounding territory.

The method of infrastructure history was used to interpret the Tereble–Rika Hydroelectric Power Station as part of the broader industrial transformation of Zakarpattia. The power station is analysed not as an isolated facility, but as a node within a developing regional energy system. This perspective made it possible to assess how the construction of the station contributed to electrification, industrial development, transport modernisation, settlement formation, and integration of the region into wider economic and infrastructural networks.

The research procedure consisted of several stages. At the first stage, archival sources related to the construction of the Tereble–Rika Hydroelectric Power Station were identified and grouped according to their thematic content: technical documentation, financial planning, annual construction plans, acceptance reports, labour records, material supply documents, correspondence, and social infrastructure materials. At the second stage, the chronology of construction was reconstructed on the basis of these sources. At the third stage, the planned indicators were compared with the actual progress of construction. At the fourth stage, the main factors causing delays were identified and classified. At the fifth stage, the technical, economic, logistical, and social significance of the project was evaluated.

The study has certain limitations. First, the research is based primarily on archival documents preserved in the State Archive of the Zakarpattia Region, and therefore reflects the available documentary record rather than the full range of possible oral, personal, or local community perspectives. Secondly, many archival sources were created by institutions involved in construction management, which means that they may emphasise administrative and technical aspects more strongly than everyday experiences of workers or resettled inhabitants. Thirdly, some quantitative indicators differ across documents because they were produced at different stages of planning, reporting, or acceptance of works. For this reason, the study uses cross-checking between sources wherever possible.

Despite these limitations, the selected methodology makes it possible to provide a comprehensive analysis of the construction of the Tereble–Rika Hydroelectric Power Station. The combination of historical, archival, systemic, comparative, quantitative-descriptive, technical-economic, logistical, and socio-economic methods allows the project to be studied not only as a hydropower facility, but also as a major infrastructure undertaking that reflected the engineering ambitions, organisational constraints, resource limitations, and regional transformation processes of the post-war period.

Literature Review

Recent studies have examined individual aspects of the construction of the Tereble–Rika Hydroelectric Power Station, including technical engineering solutions, the social consequences of population resettlement, and the organization of construction works. Earlier research has provided a general understanding of the project; however, most studies were limited primarily to chronological descriptions or superficial analyses of the technical characteristics of the hydroelectric facility.

At the same time, the relationship between material and technical supply, workforce composition, logistics, and construction efficiency has remained insufficiently studied. Furthermore, the influence of external factors—such as historical, political, and socio-economic conditions—on the timeline of project implementation has not been comprehensively assessed.

The study relies on archival materials that make it possible to analyze these relationships in greater detail and to identify the reasons for deviations from planned construction indicators.

Unresolved Issues of the Research Problem: Several issues remain insufficiently explored in previous research:

- a comprehensive evaluation of archival materials concerning financing, technical decisions, and the development of social infrastructure;
- the impact of shortages of qualified personnel and material resources on the pace of construction;
- the relationship between engineering structures and the development of social and transport infrastructure;
- the reasons for delays in the implementation of construction plans and their consequences for the project;
- the practical significance of the experience of the Tereble–Rika Hydroelectric Power Station for modern hydropower projects.

Addressing these gaps highlights the scientific novelty of the study and emphasizes its significance for both academic research and practical applications.

Results

A Czech engineer, Křižka, proposed an original engineering concept in 1923, which was based on the rational use of the natural difference in elevation between the Tereblia and Rika rivers. Similar hydrotechnical solutions were also developed by Hungarian specialists both before and after the Czech projects.

The project envisaged the construction of a hydraulic structure in the form of a dam on the Tereblia River with a height of approximately 45 meters and a reservoir with a useful capacity of up to 45 million cubic meters. Both rivers flow almost parallel along the Bovtsarsky Ridge but are located at different hypsometric levels.

The riverbed of the Tereblia River is approximately 200 meters higher than that of the Rika River, while the distance between their upper courses does not exceed four kilometers. According to the project, water was to be continuously diverted from the Tereblia River to the turbines of the planned hydroelectric power station located on the Rika River through a diversion tunnel with a diameter of 2.7 meters and a length of 3,700 meters, followed by transmission through a pressure pipeline (*State Archive, Sprava 3, Ark. 1–7*).

At the time when the project was initially developed, the region belonged to Czechoslovakia. Due to unfavorable historical and political circumstances, however, the project was not implemented and remained limited to the preparation of technical and design documentation.

After Zakarpattia became part of the Soviet Union, the Ukrainian branch of the scientific research and design institute Hydroenergoproekt initiated comprehensive studies of the region's hydropower potential. The research was carried out by a Lviv-based project and survey group.

As a result of these investigations, February 1949 was determined as the starting date for the construction of the Tereble–Rika Hydroelectric Power Station. Initially, the duration of the project was planned for four years, but later it was extended by an additional three years.

During the construction period from 1949 to 1956, the project involved specialists, technical equipment, and labor resources from various regions of the Soviet Union, as well as from Czechoslovakia and the German Democratic Republic.

In accordance with reparation agreements, hydro-turbine equipment was manufactured by a Finnish company producing Francis turbines, while electric generators were supplied by industrial enterprises in the Ural region. In addition, Finnish manufacturers produced the metal pressure pipeline, which was 380 meters long with a diameter of 2.15 meters and was installed along the mountain slope (*State Archive, Sprava 3, Ark. 1–7*).

The water discharge in the pressure pipeline reached 18 cubic meters per second. The tunnel, constructed in rocky formations, had an inclination of approximately 37 degrees relative to the horizontal plane, ensuring the necessary hydraulic head for water flow. The water was then transported through a metal pipeline approximately 350 meters long.

The pipeline manufactured in Finland had wall thicknesses of 2.5 centimeters and an internal diameter of 2.2 meters. Within this section the water gained considerable velocity before entering three hydro turbines installed in the main turbine hall of the hydroelectric station (*State Archive, Sprava 3, Ark. 1–7*).

The turbines used at the power station were manufactured by the UralElectropribor enterprise located in Sverdlovsk (USSR). Oil systems required for the stable operation of the turbines were supplied from Finland, while the equipment responsible for regulating rotational frequency was developed and produced in Sweden.

Each turbine unit generated up to 9 MW of electrical power under nominal operating conditions. The turbines operated at a rotational speed of approximately 600 revolutions per minute (*State Archive, Sprava 19, Ark. 1–7*).

Before the start of construction, a specialized construction and installation organization was established on the basis of the DniproHESBud trust, operating under the name ZakarpattiaHESBud. In order to initiate construction activities, the parent organization transferred part of its technical and production resources to the newly created structure.

The construction of the hydroelectric power station required the creation of extensive infrastructure and a large construction workforce. At the initial stage of the project, the management organization prepared a detailed financial and material balance in order to ensure the provision of necessary equipment and construction materials.

Archival documentation indicates that the first section of the financial plan, entitled "Planned Works and Procurement", allocated the entire amount of funding to the purchase of construction equipment and necessary materials. During this period, construction machinery and specialized equipment that had previously been lacking were purchased.

The analysis of archival documents also indicates the formation of significant stocks of raw materials. This measure allowed the construction administration to ensure a continuous and organized start of the building works.

In addition to these documents, archival materials contain general financial estimates for the entire project. One of the key documents was the "Annual Title List of Investment Projects", which was compiled annually to determine the cost of construction works planned for a given year.

According to the investment plan approved on 26 October 1950, the total estimated cost of constructing the hydroelectric power station amounted to 186,265.9 thousand rubles in prices as of 1 January 1950. According to these records, during 1950 the construction trust ZakarpattiaHESBud carried out construction and installation works for the hydroelectric station in the amount of 25,850 thousand rubles (*State Archive, Sprava 45, Ark. 1–3*).

These data indicate that in 1950 priority was given primarily to preparatory works. The largest share of financial resources was directed to the construction of the diversion tunnel, electrification of the construction site, and the construction of both temporary and permanent residential buildings for workers.

An important role was also played by scientific and technical activities, including geodetic surveys, which were necessary for the correct positioning of the main hydraulic structures.

The construction of the hydroelectric power station began with the establishment of a workers' settlement and the formation of the future reservoir. This required the withdrawal of significant areas of land totaling 662 hectares.

The implementation of such large-scale territorial changes required appropriate legal regulation and administrative management in order to protect the property rights of individuals and organizations affected by the construction works.

For this purpose, a special commission was created to assess the damages caused to land plots and private property during the implementation of the project (*State Archive, Sprava 12, Ark. 1–47*).

Archival materials from the State Archive of the Zakarpattia Region indicate that as a result of the project 160 households were resettled in the village of Vilshany, affecting 1,229 residents.

Additionally, 21 households in the villages of Bovtsar and Nyzhnii Bystryi were also relocated.

The total amount of compensation paid to the affected population amounted to 1.497 million rubles, while the total damage caused by flooding and other economic interventions was estimated at 8 million 887 thousand rubles (*State Archive, Sprava 13, Ark. 1–42*).

The reservoir of the hydroelectric power station was put into operation in 1955.

The surface area of the reservoir varied between 72 and 90 hectares, depending on the water level, with an average value of approximately 80 hectares. The maximum depth reached 8 meters, while its length exceeded 10 kilometers and the average width was approximately 100 meters.

The useful storage capacity of the reservoir amounted to 24 million cubic meters.

The dam constructed for the hydroelectric power station had a height of 45 meters and a length of 153 meters. Approximately 200,000 cubic meters of concrete were used during its construction (*State Archive, Sprava 18, Ark. 1–19*).

The first head of the construction project was Viktor Lyovushkin, while Mykola Zinevych, head of the DniproHESBud trust, served as chief engineer. The engineering staff included 11 engineers and technical specialists, while financial operations were supervised by a chief accountant (*State Archive, Sprava 20, Ark. 1–4*).

In 1950, the Council of Ministers of the USSR assigned the Ministry of Energy the task of constructing a 750 mm narrow-gauge railway with a total length of 35 kilometers.

The railway connected the village of Tereblia with the dam construction site and passed through the settlements of Bushtyno, Tereblia, Kolodne, Krychevo, Drahovo, and Vilshany.

The railway line was intended to ensure the delivery of construction materials and to improve transportation connections with nearby districts.

Finnish PT-4 narrow-gauge steam locomotives were used on this line, with a maximum speed of 35 km/h (*State Archive, Sprava 50, Ark. 1–6*).

The construction process was accompanied by considerable difficulties. These problems were described in detail by Hryhoruka, head of ZakarpattiaHESBud, in a letter addressed to Deputy Minister Ivan Dmitriev in April 1952.

According to the report, the total demand for construction materials amounted to 4,080.5 thousand rubles, while by 1 April only 1,795.2 thousand rubles worth of materials had been delivered. This created a shortage of 2,285.3 thousand rubles, significantly slowing down the progress of construction works.

Additional problems arose with railway rails: instead of the planned rails, heavier types were supplied, which increased costs by 400 thousand rubles.

Furthermore, timber of lower quality was used for sleepers and bridge structures instead of the materials originally planned (*State Archive, Sprava 192, Ark. 1–18*).

The construction of the hydroelectric station required the creation of a large number of auxiliary facilities intended to meet the social and everyday needs of the construction workers and future residents of the settlement.

Archival documents show that the initial construction plans included:

- 25 residential houses
- 29 dormitories with 2,039 places
- a kindergarten for 25 children
- a school for 40 pupils

- a hospital with 25 beds
- an outpatient clinic
- a maternity ward
- a bakery
- a medical centre
- a cultural club
- a cinema (*State Archive, Sprava 26, Ark. 1–10*).

In addition, the construction plans included the creation of a permanent settlement that would contain a horse riding arena, five dining facilities, a bathhouse with showers, and 17 industrial facilities, including a stone crushing plant.

Transport infrastructure was also developed, including routes through the Bovtsarsky Ridge, rural roads, and internal railway lines intended to support further construction activities (*State Archive, Sprava 26, Ark. 1–10*).

Further archival research also revealed additional planning documents, including the "Consolidated Economic and Financial Plan". This document contained detailed information regarding housing construction, workforce numbers, and financial expenditures related to the project.

Archival data indicate that the construction of the hydroelectric power station required a large labour force and the construction of numerous residential facilities. Workers were accommodated in dormitories where the living space per person was approximately 4 square meters, while the rent amounted to 42 rubles per month.

In 1951, with an average occupancy of 800 dormitory places, the total income generated from housing rental amounted to 249,660 rubles, while the maintenance costs of these facilities exceeded 402,822 rubles (*State Archive, Sprava 87, Ark. 1–3*).

During the middle of 1951, when construction work was already underway for approximately two and a half years, the Ministry of Energy of the USSR established a special commission to evaluate the progress of construction.

According to the original plans, the first production unit of the hydroelectric power station was expected to start operating at the end of 1952, while the complete construction of the facility was scheduled for 1954. However, archival materials indicate that under the existing conditions these deadlines were unrealistic (*State Archive, Sprava 111, Ark. 1–21*).

An analysis of the two-year construction plans revealed significant delays, particularly in the construction of the dam and the turbine building.

The main reasons for these delays included:

- a shortage of qualified personnel (e.g., only 3 of 9 managers possessed appropriate qualifications, and among 19 drilling specialists only 4 were properly trained);
- a lack of specialized workers and high labour turnover;
- logistical problems caused by poor road conditions and long transportation routes;
- low efficiency of the available vehicle fleet;
- energy supply limitations, as only 10–25% of the required electricity supply was available;
- delays in the launch of high-voltage power lines for approximately one and a half years.

- In order to overcome these difficulties, several measures were proposed:
- expansion of the Uzhhorod thermal power plant;
- reconstruction of the Khust–construction site road;
- delivery of 250 units of construction equipment;
- establishment of a concrete production plant directly at the construction site;
- deployment of additional cranes and technical specialists;
- support for tunnel construction works by nearby collective farms.

More than 2,000 workers participated in the construction process, with the highest number reaching 2,736 workers in 1954.

All engineers and technical specialists involved in the project were transferred from the DniproHESBud construction trust in Zaporizhzhia.

The average annual salary of construction workers was approximately 7,297 rubles, while the estimated total value of construction works as of 1 July 1950 was approximately 213.3 million rubles (*State Archive, Sprava 34, Ark. 1–5*).

After the inspection conducted in 1951, the construction policy was revised. Additional funding was allocated to the project, and more construction works were performed to accelerate the completion of the Tereble–Rika Hydroelectric Power Station (*State Archive, Sprava 165, Ark. 1–6*).

The results of 1952 indicate that the construction trust ZakarpattiaHESBud planned to perform works amounting to approximately 15 million rubles more than in 1951, which represented an increase of nearly 50% and approximately 70% of the total construction volume carried out during the previous three years.

The largest share of funding was directed toward the construction of the dam, the diversion tunnel, the narrow-gauge railway, and the main power station building.

The 110 kV high-voltage power transmission line was more than 90% completed, while automobile roads and the residential district continued to develop rapidly, including improvements in housing capacity and living conditions (*State Archive, Sprava 165, Ark. 1–6*).

Despite these efforts, construction of the dam, diversion tunnel, railway line, and turbine hall still lagged behind schedule. The first generating units, originally planned to be launched during the second half of 1952, could not be commissioned due to the unfinished main building and dam.

The most significant progress was observed in the development of the railway infrastructure, which reached 33% completion by the end of 1952.

However, the overall readiness level of the main hydroelectric structures reached only 12.75%, making it impossible to commission the station in 1954.

The most active stage of construction occurred during 1953–1954, as confirmed by archival acceptance reports. In 1954 alone, 114 acceptance acts were recorded.

Most of these documents concerned the installation of individual concrete blocks forming the dam structure.

During the construction works, numerous technical malfunctions were recorded, primarily related to electrical equipment. These failures were caused by manufacturing defects, equipment wear, insufficient staff training, and frequent interruptions in electricity supply (*State Archive, Sprava 370, Ark. 1–114*).

In 1953, one of the smallest volumes of construction work during the entire building period was completed. According to the work plans for 1954, by the beginning of that year construction works worth 114,500 thousand rubles had been completed.

Based on the completed portion of the 1952 construction plan, the total value of works performed in 1953 amounted to approximately 20,000 thousand rubles (*State Archive, Sprava 344, Ark. 1–5*).

In 1954, the volume of construction work doubled compared to the previous year. The planned value of works reached 40,000 thousand rubles, of which approximately 80% were related to construction activities.

This year is considered the most productive period of the entire construction process (*State Archive, Sprava 344, Ark. 1–5*).

During the fifth year of construction, total expenditures reached 40 million rubles, with approximately 80% allocated to construction works. The largest share of these funds was spent on the construction of the dam (46% of the construction budget) and the diversion tunnel (32%). Together they accounted for 78% of the total construction expenditures (*State Archive, Sprava 344, Ark. 1–5*).

At the same time, plans included the completion of roads, residential houses, fire stations, garages, and bridges, as well as the narrow-gauge railway and the high-voltage power transmission line.

Significant funds were also spent on the demolition of buildings in resettled villages in order to prepare the territory for the formation of the reservoir (*State Archive, Sprava 344, Ark. 1–5*).

By the beginning of 1954, the average completion rate of the hydroelectric power station was approximately 62.75%. The narrow-gauge railway had reached 85% readiness, while deviations of up to 1.5 meters were recorded in the dam structure, requiring additional corrections.

In August 1955, a commissioning commission headed by engineer Kozhevnikov was established. The commission discovered several problems related to financial reporting, the absence of certain technical documents, and the absence of key specialists.

After these issues were resolved, the hydroelectric power station was successfully commissioned in 1956.

The final hydroelectric complex included:

- a concrete dam 45 meters high,
- a reservoir covering 1.6 sq. km,
- diversion tunnels 3.7 km long (2.15 m diameter) and 100 m long (7 m diameter),
- hydraulic structures measuring 37 × 16.4 × 19.1 meters.

Construction delays were primarily caused by technical difficulties, logistical problems, and shortages of qualified personnel.

Discussion

The construction of the Tereble–Rika Hydroelectric Power Station demonstrates that large-scale hydropower projects in mountainous regions should be analysed not only as technical achievements, but also as complex historical, organisational, economic, logistical, and social processes. The archival materials examined in this study show that the implementation of the project depended on the interaction of several factors: the natural hydrological potential of the area, the engineering feasibility of the diversion scheme, the availability of financial and material resources, the organisation of labour, the development of transport infrastructure, the provision of housing and social services, and the capacity of the construction administration to respond to delays and technical failures.

The first important issue concerns the engineering logic of the project. The Tereble–Rika Hydroelectric Power Station was based on the rational use of the natural altitude difference between the Tereblia and Rika rivers. This geographical condition made it possible to create a hydropower system in which water from the Tereblia River was accumulated in a reservoir and then transferred through a diversion tunnel and pressure pipeline to the turbines located on the Rika River. From an engineering perspective, this solution was highly efficient because it transformed the specific relief of the region into an energy resource. The project therefore illustrates how mountainous geography, which often creates transport and construction difficulties, can simultaneously become a strategic advantage for hydropower development.

At the same time, the results of the study confirm that engineering feasibility does not automatically guarantee successful project implementation. Although the basic technical concept was well justified, the construction process was significantly affected by organisational and resource-related constraints. The original plan envisaged the completion of the power station earlier, but the actual commissioning took place only in 1956. This delay was not caused by a single factor. It resulted from the combined influence of shortages of qualified personnel, insufficient supply of construction materials, difficult logistics in mountainous terrain, limitations in energy supply, technical malfunctions of equipment, and the need to build extensive auxiliary infrastructure almost simultaneously with the main hydropower facilities.

The shortage of qualified workers and engineers was one of the most serious constraints. Archival evidence indicates that the construction administration lacked a sufficient number of trained managers, drilling specialists, engineers, and technical personnel. This problem was especially important because the project required specialised knowledge in tunnel construction, concrete works, installation of hydraulic equipment, operation of heavy machinery, railway construction, and high-voltage transmission infrastructure. In such conditions, labour quantity alone could not compensate for the deficit of technical competence. Even though more than two thousand workers participated in the construction process, the efficiency of construction depended on the availability of skilled specialists capable of performing complex and high-risk operations.

The material and technical supply problems also had a decisive influence on the pace of construction. The shortage of cement, steel, timber, rails, equipment, and machinery created direct obstacles to the fulfilment of annual construction plans. The archival data show that the construction organisation often received fewer materials than planned, and in some cases the supplied materials did not correspond to the required technical characteristics. Such discrepancies increased costs, complicated construction logistics, and slowed down the implementation of key works. This confirms that large infrastructure projects are highly sensitive not only to the total volume of financing, but also to the rhythm, quality, and timeliness of material supply.

Logistics represented another structural challenge. The construction site was located in a mountainous area where the delivery of materials and equipment required special transport solutions. The construction of the narrow-gauge railway, roads, bridges, and internal transport routes was therefore not a secondary element of the project, but a necessary precondition for its implementation. The fact that railway infrastructure itself lagged behind schedule demonstrates a typical problem of large infrastructure construction: the main project depends on auxiliary infrastructure that must be developed under the same difficult conditions. In the case of the Tereble–Rika Hydroelectric Power Station, transport limitations affected the delivery of concrete, cement, metal structures, technical equipment, and workforce resources, thereby influencing the overall construction schedule.

The study also shows that the power station cannot be understood only through the construction of the dam, tunnel, pressure pipeline, and turbine hall. The project required the creation of an entire construction and settlement environment. Residential houses, dormitories, dining facilities, medical institutions, a school, a kindergarten, a bakery, cultural facilities, workshops, and auxiliary industrial sites were planned and developed to support the workforce and ensure the continuity of construction. This aspect is important because it reveals the social dimension of hydropower development. The construction site functioned not merely as a technical workplace, but as a temporary and partly permanent social space created around the needs of industrial construction.

The resettlement of local inhabitants and the withdrawal of land for the reservoir represent another significant aspect of the project. The creation of the reservoir required the transformation of the local landscape and affected households in nearby settlements. Compensation mechanisms were introduced, but the archival evidence also indicates the scale of economic damage and social disruption caused by flooding and territorial reorganisation. This demonstrates that hydropower projects produce not only energy and infrastructure benefits, but also social costs. In historical analysis, these costs should not be treated as marginal, because they shaped the lived experience of local communities and formed part of the broader consequences of industrial transformation.

The financial dimension of the project also deserves attention. The annual investment lists, financial plans, and reports on completed works make it possible to reconstruct the changing rhythm of construction. The data show that some years were marked by slow progress, while others, especially 1954, became periods of intensified construction activity. This unevenness reflects the dependence of the project on administrative decisions, additional funding, availability of materials, workforce mobilisation, and correction of earlier delays. The increase in funding after inspections and the revision of construction policy demonstrate that project management was adaptive, but often reactive: additional measures were introduced after accumulated problems had already affected the schedule.

The comparison between planned and actual construction indicators is particularly important for understanding the internal dynamics of the project. The delay in the construction of the dam, diversion tunnel, turbine hall, narrow-gauge railway, and other facilities shows that the original schedule underestimated the complexity of the work. This does not necessarily mean that the planning was technically incompetent. Rather, it suggests that the planners did not fully account for the cumulative impact of personnel shortages, logistical difficulties, unstable energy supply, technical failures, and the need to develop social and transport infrastructure in parallel with the main hydropower works. The case therefore demonstrates the importance of integrated planning in complex infrastructure projects.

The international dimension of the project is also notable. The use of equipment manufactured in Finland and the involvement of technologies and resources from different parts of the Soviet Union and other countries show that the Tereble–Rika Hydroelectric Power Station was not a purely local construction project. It was embedded in broader post-war economic, technological, and political networks. Finnish turbines, metal pressure pipeline components, equipment from the Ural region, and technical solutions associated with earlier Czechoslovak and Hungarian concepts illustrate the transregional and international nature of the project. This aspect complicates a narrow regional interpretation and shows that the station was part of a wider system of post-war industrial reconstruction and technological exchange.

From the perspective of regional history, the construction of the Tereble–Rika Hydroelectric Power Station was an important element of the industrial transformation of Zakarpattia. The station contributed to the development of the regional energy system and strengthened the infrastructure basis for further economic activity. Its significance should be evaluated not only in terms of installed capacity, but also in terms of the broader infrastructural changes associated with its construction: roads, railway connections, settlements, transmission lines, construction enterprises, and technical labour experience. In this sense, the power station functioned as a catalyst of regional modernisation.

However, the project also reveals the contradictions of post-war industrialisation. On the one hand, it mobilised substantial resources, introduced advanced engineering solutions, developed infrastructure, and expanded the energy potential of the region. On the other hand, it was implemented under conditions of administrative pressure, resource scarcity, labour shortages, social displacement, and repeated delays. This duality is important for historical interpretation. The Tereble–Rika Hydroelectric Power Station should not be presented only as a story of technical success or only as a story of construction difficulties. It was both: an ambitious and ultimately successful hydropower project whose implementation exposed the organisational and social costs of rapid infrastructural development.

The findings of this study are relevant for the analysis of modern hydropower and infrastructure projects. Contemporary projects also require careful assessment of terrain conditions, resource availability, transport logistics, workforce competence, environmental consequences, social impacts, financing, and project risk management. The historical experience of the Tereble–Rika Hydroelectric Power Station shows that delays often arise not from the main engineering design itself, but from the interaction of supporting systems: roads, material supply, energy provision, housing, labour organisation, documentation, and coordination between institutions. Therefore, modern infrastructure planning should pay particular attention to auxiliary and social infrastructure as integral components of project success.

The study also demonstrates the value of archival research for infrastructure history. Archival documents make it possible to move beyond general descriptions of construction and to identify specific mechanisms of implementation: how much funding was allocated, which works were prioritised, where delays occurred, what materials were lacking, how labour was organised, what technical failures were recorded, and how administrative decisions changed over time. This level of detail is essential for understanding the real history of infrastructure projects. It also allows historians to reconstruct the relationship between policy, engineering, economy, and everyday organisation of construction.

At the same time, several limitations should be acknowledged. The study relies primarily on administrative, technical, and financial documentation preserved in archival fonds. Such sources are highly valuable for reconstructing the construction process, but they reflect mainly the perspective of institutions responsible for planning and implementation. They provide less direct information about the everyday experiences of workers, resettled inhabitants, and local communities. Future research could therefore supplement the archival documentation with oral history, local memory studies, visual materials, and comparative analysis of other hydropower projects in mountainous regions.

Further research may also focus on the environmental consequences of the creation of the reservoir and the long-term operation of the hydroelectric power station. The present article concentrates mainly on construction history, logistics, financing, engineering decisions, and organisational difficulties. However, a comprehensive history of the Tereble–Rika Hydroelectric Power Station should also include the transformation of river ecosystems, changes in land use, the impact on local settlements, and the station's role in later regional energy policy. Comparative studies with other hydropower projects in the Carpathian region would also help clarify what was unique and what was typical in the Tereble–Rika case.

Overall, the discussion confirms that the construction of the Tereble–Rika Hydroelectric Power Station was a complex infrastructural process in which natural conditions, engineering innovation, administrative planning, financial resources, labour organisation, logistics, social infrastructure, and regional industrial policy were deeply interconnected. The project became an important milestone in the development of Zakarpattia's energy sector, but its delayed completion demonstrates the practical difficulty of implementing large hydropower projects in mountainous areas under conditions of material scarcity and organisational pressure. The historical significance of the station lies not only in its final technical parameters, but also in the experience of planning, constructing, financing, and socially supporting a major infrastructure project in a challenging regional environment.

Conclusion

The construction of the Tereble–Rika Hydroelectric Power Station between 1949 and 1956 became one of the most significant infrastructure projects for the energy sector of the Zakarpattia region.

The main challenges faced during the construction process included a shortage of qualified workers, limited availability of construction materials such as cement, steel, and timber, and complex logistical conditions caused by the mountainous terrain. These factors ultimately led to the postponement of the completion of the project from the originally planned year 1954 to 1956.

During construction, approximately 420,000 cubic meters of concrete and 84,000 tons of cement were used. The total cost of the project exceeded 200 million rubles.

Despite numerous difficulties, the Tereble–Rika Hydroelectric Power Station was successfully completed and became a crucial component of the regional energy system. The project also provided valuable experience in organizing large-scale infrastructure construction in mountainous areas.

The analysis of archival sources demonstrates the importance of effective workforce organization, resource management, and logistical planning in the successful implementation of complex hydroengineering projects. The construction of the Terebla-Ritskaya hydroelectric power station (1949–1956) was a key project for the Transcarpathian energy sector. The main problems are a shortage of skilled workers, a shortage of materials (cement, steel, wood) and difficult logistics conditions in the mountainous area, which delayed completion from 1954 to 1956.

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Conflict of Interest

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