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SCIENTIFIC SUPPORT OF THE DNIPRO CONSTRUCTION (20-30'S OF THE 20TH CENTURY): NATURAL SCIENCE STUDY ASPECT

The article reveals the process of accumulating natural knowledge within the framework that outlines the historical prerequisites, construction and prospective functionality of the Dnieper HPP. Using the methodological tools of historical research, certain theoretical and methodological aspects and features of scientific and organizational support for the construction of a hydroelectric power station on the Dnieper River in 1927–1939 were recreated, which was what our search goal envisaged. The scientific achievements of prominent natural scientists on the problem of arid southern lands and the achievements of domestic scientists on various issues of using the Dnieper HPP in the agricultural sector were analyzed.

It was established that the Dnieper steppes belong to the southeastern strip, where numerous droughts have long caused crop losses. However, the presence of fertile soils and a warm climate indicated the priority of the agricultural sector in the region, the ability to overcome the negative impact by developing certain agronomic measures. At the end of the 19th century, outstanding works of natural scientists V. Dokuchaev, P. Kostychev, O. Izmailsky, V. Rotmistrov and others appeared. Researchers managed to substantiate the true causes of drought, methods and techniques for their prevention, etc. At the beginning of the 20th century, engineers proposed numerous projects for the construction of the Dnieper Hydroelectric Power Plant, which were practically implemented by the Soviet authorities in 1927–1939. The grandiose construction of a hydroelectric power plant on the Dnieper River took place with the participation of foreign specialists, domestic scientists and other segments of society. The Dnieper Hydroelectric Power Plant was built without taking into account environmental, financial, local historical and other factors, which made it possible to obtain cheap electricity, improve navigation on the river, and contributed to the establishment of heavy industry, hydraulic engineering and land reclamation.

Scientific developments of scientists intensified the organization and further development of irrigated agriculture in Ukraine.

Keywords: *development of natural science study, irrigation of the southern lands, agriculture, history of the Dnieper HPP.*

НАУКОВИЙ СУПРОВІД ДНІПРОВСЬКОГО БУДІВНИЦТВА (20-30-і рр. ХХ ст.): ПРИРОДОЗНАВЧИЙ АСПЕКТ

У статті розкрито процес накопичення природничих знань у межах, що окреслюють історичні передумови, побудову та перспективну функціональність Дніпровської ГЕС. За допомогою використання методологічного інструментарію історичного дослідження відтворено окремі теоретико-методологічні аспекти й особливості науково-організаційного супроводу спорудження гідроелектростанції на р. Дніпро у 1927–1939 рр., що і передбачала мета пошуку. Проаналізовано науковий доробок видатних учених-природознавців з проблеми посушливих південних земель та напрацювання вітчизняних науковців з різних питань використання Дніпровської ГЕС в аграрній сфері.

Встановлено, що наддніпрянські степи належать до південно-східної смуги, де численні посухи з давніх часів спричиняли втрату врожаю. Однак наявність родючих ґрунтів і теплого клімату свідчила про пріоритетність сільськогосподарського сектору в регіоні, здатність долати негативний вплив шляхом розробки певних агрономічних заходів. Наприкінці XIX ст. з'явилися видатні праці учених-природознавців В. Докучаєва, П. Костичева, О. Ізмаїльського, В. Ротмістрова та інших. Дослідникам вдалося обґрунтувати справжні причини посухи, методи та прийоми їх запобігання тощо. На початку ХХ ст. інженери запропонували численні проєкти будівництва Дніпровської ГЕС, які практично були реалізовані радянською владою у 1927–1939 рр. Грандіозне будівництво гідроелектростанції на Дніпрі відбувалося за участю іноземних спеціалістів, вітчизняних учених та інших верств суспільства. Без урахування екологічних, фінансових, місцевих історичних та інших факторів було збудовано ДніпроГЕС, що дозволило отримати дешеву електроенергію, покращити судноплавство на річці, сприяло становленню важкої промисловості, гідротехнічного будівництва та меліорації. Наукові розробки вчених активізували організацію та подальший розвиток зрошуваного землеробства в Україні.

Ключові слова: *розвиток природознавчих досліджень, зрошення південних земель, сільське господарство, історія Дніпровської ГЕС.*

Introduction. The shaky foundations of the globalized world do little to help young nations in their state-building. Mostly left alone, they slowly overcome difficult

obstacles, or stop in their aspirations for long periods. In order to avoid simplified interpretations of the past, arbitrary projection of the present, the state-building activity of the Ukrainian people must be based on an uncensored historical heritage. The current situation in Ukraine with a variety of problems and contradictions, ongoing armed resistance to Russian aggression actualizes an objective review and rethinking of historical events against the background of social relationships.

In the late 1920s, the construction of the Dnieper Hydroelectric Power Plant became one of the numerous Soviet projects for the development of the national economy of the Ukrainian republic. This was the first all-state long-term plan for the development and expansion of the economy of the RSFSR based on electrification, initiated by V. Lenin, in which much attention was paid to the southern economic region (parts of the territories of the RSFSR and the Ukrainian SSR without border demarcations). An important factor, but as it turned out later, not the main one, was the possibility of using Dnieper water for irrigation of agricultural lands in the Upper and Lower Dnieper regions.

Within the framework of Soviet propaganda with the maximalism characteristic of its initial stage, the scientific justification of the construction mostly concerned the engineering and technical projects of the Dnieper Hydroelectric Power Plant. The authorities counted on the rapid rise of industry and subsequently built a powerful industrial complex around the Dnieper Hydroelectric Power Plant (an aluminum plant, sheet steel plants and Dneprospetssteel). However, there were also significant scientific developments by agricultural scientists, soil scientists, etc. Scientists adhered to firm beliefs in the need and rationality of irrigation of southern lands, in particular V. Rotmistrov noted that «The interests of agriculture must not only be taken into account when building the Dnieper region, but they must be allocated a place not even a centimeter further than the place of industry» [1, p. 14].

In this regard, it is relevant to study one of the famous events of the first half of

the 20th century – the construction of the Dnieper Hydroelectric Power Plant through the prism of scientific developments of a natural science nature that preceded and accompanied the legendary project of the last century. The scientific works of famous scientists V. Dokuchaev, O. Izmailsky, P. Kostychev, G. Makhov, V. Rotmistrov and many others on the study of drought and methods of its prevention, the possibilities of using the Dnieper Hydroelectric Power Plant for the needs of the agricultural industry contributed to the development of various areas of science and management in Ukraine.

Sources overview. Despite the broad propaganda nature of the outstanding construction on the Dnieper River in the 1920s and 1930s, historiographical works of the Soviet period do not constitute a specific layer of scientific publications on the specified range of issues. With the exception of publications with a predominant ideological content, popular science works of engineering and technical direction by V. Viktorov [2], A. V. Winter, E. M. Fateyev [3] and others have been published. The historical component is contained in scientific publications of contemporaries of the events, such as the works of M. Rozov, B. Kornilyev, Yu. Prokopenko, A. Zuzik [4]. The authors reveal the history of the emergence of construction projects against the background of the need to establish shipping, irrigation, and later electricity production.

A sharp contrast in the scientific development of the problem is made by modern historiographical developments. These include publications on issues of local history by I. Atamanchuk [5], V. Linikov [6], etc. Scientific publications of modern historians of agricultural science tangentially reveal certain aspects of scientific and organizational support for the development of the agricultural industry in the period under study. We have passing mentions of the problem of irrigation of the southern zone in comprehensive studies by V. Vergunova [7], N. Shchebetyuk [8], etc. The authors were the first to develop and apply methodological approaches to studying the history of industry research.

Historiographic analysis of the problem of scientific support for the construction and use of the Dnieper Hydroelectric Power Plant for the needs of the agricultural sector of the Ukrainian SSR showed the absence of systematic publications where the specified problem would be the object of a separate scientific search. The source base of the study is the archival materials of the Central State Archive of the Higher Bodies of Government and Administration of Ukraine. The main informative source was the original works of prominent naturalists and agricultural scientists of the studied period. It was expedient and useful to involve publications of local historians, as the greatest connoisseurs of the historical heritage of their land. The methodological basis of the study is built on the principles of historicism, objectivity, comprehensiveness, etc. The solution of research tasks became possible through the use of general scientific methods, methods of analysis and synthesis, comparative, problem-chronological, historical-situational, personification, etc. The indicated methodological approaches made it possible to study the state of scientific development of the specified problem and analyze the main positions of prominent scientists, information from archival documents, and on this basis to highlight theoretical, methodological and scientific-organizational factors, some of which to a certain extent influenced the construction of the Dnieper HPP.

Purpose of the article is to highlight the features of scientific and organizational support for the construction of the Dnieper HPP and analyze the main scientific achievements of individual natural scientists. To achieve it, it is necessary to solve the following scientific and research tasks: to generalize and systematize the results of research searches of agricultural scientists – soil scientists, land reclamation specialists and economists, etc.

Main part. The Dnieper steppes, stretching from the Dnieper rapids to the Dnieper-Bug estuary, are part of the southeastern strip, where droughts have long caused great damage. Unstable crop yields with periodic crop failures or even plant

death caused a semi-starvation of the local population. The droughts of 1891 and 1921 had particularly catastrophic consequences.

The problem of the occurrence and spread of droughts, the development of measures to combat them were addressed by many prominent Ukrainian and Russian natural scientists, in particular V. Dokuchaev, P. Kostychev, O. Izmailsky, V. Rotmistrov, etc. The first work to appear was the work of the already well-known soil scientist V. Dokuchaev «Our Steppes Then and Now» (1892) [9]. The scientist described the natural and historical conditions of the steppe, that is, its geological structure, surface and groundwater, soils, flora, fauna, and climate. Based on extensive historical material, the scientist highlighted the reasons for the progressive dehydration of soils, which occurs not due to a decrease in atmospheric precipitation, but due to indiscriminate human intervention in nature.

O. Izmailsky outstanding work «How our steppe dried up» (1893) [10] is based on experimental material that the author collected during long-term observations in different parts of the steppe. This allowed the scientist to argue that due to the almost complete plowing of the steppes and irrational cultivation of steppe soils, their water balance deteriorated and the result was frequent droughts. He argued that the condition of the soils can be improved through appropriate agricultural techniques and generally changes in agricultural methods in the steppe part.

While studying southeastern soils, scientist and practitioner P. Kostychev [11] made conclusions about the physical and physicochemical properties of virgin and plowed soils, the essence of which was the important positive value of soil structure. This confirmed the conclusions of O. Izmailsky about the influence of favorable physical properties of soils and deep tillage on the accumulation of moisture in them, and as a result - on the yield of agricultural crops.

The work of V. Rotmistrov «The Essence of Drought» [12] became well-known and in a certain way classic, where the author revealed not only the features and nature

of droughts, but a set of methods of combating them using agrotechnical techniques and land reclamation, and also substantiated the methodology for conducting observations of soil moisture, the laws of water movement, etc.

Later, the above-mentioned works influenced not only the solution of the question of methods of soil cultivation at the beginning of the 20th century. In their combination, they became the basis for the development of promising scientific approaches in preventing droughts, low yields, etc.

One of the first hydroelectric power plants in the world was designed by the American inventor T. Edison (Wisconsin, 1882). Since then, the active development of this type of renewable energy began, that is, the creation of electricity using energy water. By 1887, more than two direct current power plants based on the three-wire system of T. Edison were operating in the USA [13, p. 268]. His confirmation turned out to be far-sighted, since hydropower is now one of the discovered renewable energy sources in the world. Only thanks to it can the country be fully provided with clean, «green» electric energy. For example, the developed Western European country Norway, with its huge deposits of combustible minerals, satisfies 99% of its electricity needs precisely thanks to hydropower. Brazil's hydroelectric power plants generate 75% of all electricity. These facts indicate that thanks to renewable energy, the country can function effectively and fully. Currently, there are four hydroelectric power plants in the world with a capacity of over 10 GW – two each in China and South America [14, p. 287]. In Ukraine, hydropower has been actively developing since the beginning of the 20th century, the largest hydroelectric power plants are located on the Dnieper and Dniester rivers. The first and at the same time the most powerful hydroelectric power plant – the Dnieper HPP in Zaporizhia was built during 1927–1939.

The Dnieper steppes were characterized by fertile soils and a long frost-free period and, with appropriate agrotechnical measures, were able to overcome the negative impact of numerous droughts. At the beginning of the last century, many

proposals appeared on the use of Dnieper water for the purpose of irrigating nearby agricultural lands. Thus, in 1908, engineer O. Kortatszy put forward the idea of creating an irrigated area of 10,000 hectares in Dnieper County or the so-called Lower Dnieper district by mechanically raising Dnieper water. In 1913 and 1914, projects by engineers F. Morgunenkov and V. Nikolsky appeared. The first of these projects proposed to irrigate 600,000 hectares of the left-bank steppe by supplying water via a gravity canal. The second project, unlike the first, proposed to irrigate the same area by means of mechanical water lifting by pumping stations in the Kakhovka area. In 1915, a detailed project by engineer V. Chikov appeared, according to which it was envisaged to irrigate 121,500 hectares within the Dnipro district with mechanical water lifting using electricity from the Dnipro hydroelectric power station provided for in the project [4, p. 12]. In addition to the above, there were other projects that did not differ significantly and repeated each other. However, by the 1920s, only individual irrigation areas were created, in particular in the territory of the modern Dnipro region near the Vovcha River, Kamiansk (Zaporizhzhya region), Sahaidacka (Mykolaiv region), etc. [15, p. 221]

The project of I. Alexandrov and I. Belkov, which during 1921–1926 had about ten options, simultaneously with solving the tasks of developing energy and transport, provided for the irrigation of 480,000 hectares of agricultural land, and the second five-year plan for the development of the national economy of the Ukrainian SSR provided for up to 700,000 hectares [4, p. 56]. However, the plans remained unfulfilled, because the interests of the state and party leadership of the former USSR were directed at the rapid development of industry. This required an increase in electricity production, and the irrigation of large areas would have led to a decrease in the capacity of the Dnieper hydroelectric power station. As a result, the Dnieper water level was raised by 40 meters, which expanded the possibilities of shipping, and the industrial complex received the cheapest electricity in the world.

As already noted, the construction of the Dnieper Hydroelectric Power Plant lasted from 1927 to 1939, which at that time became the largest in Europe. Its capacity was 560.4 thousand kW, and the average annual electricity production was 2.3 billion kWh [16]. In addition to cheap electricity, the Dnieper HPP made navigation on the Dnieper possible and further contributed to the development of heavy industry in the Donbas, hydraulic engineering and the production of powerful hydrogen generators, road construction machines, etc. Before the construction of the Dnieper HPP, headed by Academician O.V. Winter, during 1921–1925, search and design work was carried out under the leadership of Professor I. Alexandrov. American specialists and consultants were involved, in particular, hydraulic engineer Hugh Cooper. The well-known American organization for the design and construction of hydroelectric power plants, Hugh Cooper & Company, checked the design documentation for compliance with the technical requirements of other American and European firms from which it was planned to purchase equipment for the construction and operation of the hydroelectric power plant. In the process, repeated changes were made, various proposals were made regarding the angle of connection of the hydroelectric power plant with the dam, its length, etc. Given Hugh Cooper's previous experience in the construction of several hydroelectric power plants in Canada and the USA, possible risks were taken into account. It should be noted that in the future, Americans will consider Hugh Cooper's work in the former USSR as a certain example or model of transferring production experience from technologically advanced societies to those who need it [17, p. 43].

The construction and use of the Dnieper HPP was of great importance not only for the formation of hydropower, but also for the development of agriculture in the Ukrainian SSR. Research into the issues of scientific justification in this direction was within the competence of the People's Commissariat of Land Affairs and the State Planning Commission, in particular, the Special Commission on the Dnieper HPP

under the Agricultural Scientific Committee of Ukraine (1926) [18], the Commission on the Dnieper HPP under the Scientific Advisory Council (1927), and the Department of Land Reclamation and the Cabinet of Agricultural Electrification of the Ukrainian Institute of Economics and Organization of Agriculture (now the National Scientific Center «Institute of Agrarian Economics») (1928). There was also a Research Directorate on the Lower Dnieper, which coordinated the study of the natural and historical conditions of the southern steppe of Ukraine, the Committee for the Promotion of Dnieperstan under the RNK of the Ukrainian SSR, etc. The block of agricultural issues included the following: «topographical and geodetic works, geological, ... soil and botanical works, meteorological observations, research works on the study of old and new crops under the conditions of irrigation of southern Ukraine, agro-economic surveys of areas of intended irrigation» [19]. Research on these issues was carried out by researchers of a number of scientific research institutions subordinate to the People Commissariat of Land Affairs of the Ukrainian SSR, in particular, regional and regional agricultural stations (Dnipropetrovsk, Odessa, Kherson, Radomysl, Rudnya-Radovel swamp and reclamation research stations, etc.).

It is confirmed by archival documents that in 1929 the Cabinet of Economic Studies of Dnipro of the Ukrainian Research Institute of Economics and Organization of Agriculture [20] worked on the following tasks: determining the profitability and economic feasibility of irrigation; establishing the area of irrigated areas; identifying the most profitable agricultural crops for cultivation in these areas, etc. The Cabinet was headed by the director of the institute M. Kazhanov, and among the employees were S. Vorobiev, M. Rozov, I. Nemolovsky, T. Sekunda, and others. They studied the possible effectiveness of the use of electricity in agriculture in general and as such, which will be used for other needs of the industry; they studied the possible impact of the Dnipro River as a transport highway on the pace and nature of the development of agriculture in certain areas of Polissya, Forest-Steppe, and Steppe; they worked out

methods of processing agricultural raw materials and markets for agricultural products from irrigated areas. The reclamation direction included work on determining individual irrigation areas of the first and second stages of the Dnieper construction based on topographic, soil, hydrogeological, and economic data; clarifying the feasibility and effectiveness of individual types of irrigation; studying the situation with the state of groundwater in the flooding zone and possible measures to prevent negative consequences, etc. Issues of labor organization, land management, fisheries, etc. were not left out of consideration.

Among other state tasks for economic scientists was the study of new forms of socialized economic organizations, the so-called agricultural combines. It was about creating "new, most rational" forms of organizing agricultural production that would contribute to the effective use of electricity in the areas adjacent to the Dnieper Hydroelectric Power Plant. It was assumed that such combines would include socialized enterprises, raw material processing plants, agricultural research stations, and educational institutions. And even more, the authors of the design of these combines, apparently under the influence of the growing «pace of propaganda», proposed creating «communarities» on their basis, eliminating such definitions of settlements as «village, town, city….» [21]!

In general, during the 1920s, Ukrainian scientists tried to comprehensively study various possibilities of using the Dnieper Hydroelectric Power Plant. Many agricultural scientists worked on the problem of using hydroelectric power plants in agriculture, put forward their vision of projects, proposals and individual comments. As already noted, the main issue was the irrigation of low-fertile semi-deserts, which occupied the southern, warmest part of Ukraine with an area of over 500 thousand des. Professor V. Rotmistrov, based on the results of many years of research, proved the prospects for growing such valuable crops as cotton, paradise tree, kenaf, soybeans, sugar sorghum, alfalfa, etc. He established that of these crops, the most productive under irrigation

conditions is cotton. The scientist developed a technology for its cultivation with the following components: growing areas, botanical differences between varieties, growing without irrigation and with irrigation, protecting the crop from pests, its place in crop rotation, and prospects for growing cotton in Ukraine [22]. The results of V. Rotmistrov many years of research on cotton varieties contributed to the further development of Ukrainian cotton growing.

One of the leading places in this problem was occupied by scientific developments of domestic soil scientists. In Dnipro and Melitopol counties since the beginning of the 1900s. soil research was carried out by M. Klepinin and S. Fedorovsky [23]. Based on the results of the work, they compiled soil maps of a 6-verst scale. A descriptive map appeared before it in 1911 and only in general terms. The cartographic material was based on formal data – the amount of humus and mechanical composition, which corresponded to the then knowledge about soils. Therefore, it was necessary to study the issue of the presence of solonets and solonetz-like soils, salinity, crimson (chestnut) soils, as well as determine their area.

It should be noted that in 1923–1924 the specified territory was studied by soil scientists G. Makhov and O. Piotrovsky, and a year later the People Commissariat of Land Affairs of Ukraine organized a comprehensive study of the Oleshkiv sands and the adjacent steppe. Based on the results of the research, A. Levenhaupt, E. Lavrenko and A. Poretsky compiled a 3-verst map of soils and vegetation of the wide terrace-delta of the Dnieper. They were the first to describe the complexity of the soil cover of the coastal steppes, discovered the absence of a connection between the chernozem-solonets complex of the elevated steppes and the solonetz-solonchak complex above sea level. They were the first to point out the primitive complexity of the soil cover, and provided an explanation of its origin, which was later confirmed in further studies. The western border of the irrigation area was determined by this map. At the same time, a study of the soils of the Askania-Nova State Steppe Reserve was conducted, which

confirmed the presence of a chernozem-solonets complex similar to that described by the Oleshkiv expedition.

During 1906–1911, under the leadership of O. Nabokikh, soil surveys were conducted in the Bessarabian and Kherson provinces. Based on the results of these studies, a schematic map of the soils of southwestern Russia was compiled based on the methodology of V. Dokuchaev [24]. The map had a morphological and genetic description, analytical justification, etc. Oppokiv E. studied the Upper Dnieper basin and substantiated the dependence of the river confluence primarily on meteorological factors (precipitation, temperature) and noted a slight dependence on the relief and soils [25]. The scientist clarified the processes of moisture accumulation in the soils of flat river basins, its loss, as well as a certain interdependence in the regulation of reserves. Thus, we can state a notable role of representatives of soil science in the development of a number of issues related to the problem of using the Dnieper Hydroelectric Power Station for the needs of the agricultural sector of the Ukrainian republic.

Conclusions. The analysis made it possible to formulate the essence of the conclusions obtained. It was established that the problem of arid southern lands, which most often manifested itself in numerous droughts over a long period, was reflected in the works of prominent naturalists: V. Dokuchaev, O. Izmailsky, P. Kostychev, G. Makhov, V. Rotmistrov, etc. Scientists managed to clarify the essence of the dangerous natural phenomenon, its causes and consequences, as well as suggest ways to prevent it. Scientists argued about incorrect human intervention in nature and the availability of opportunities to improve the condition of soils through appropriate agrotechnical measures.

A concise excursion into the history of designing irrigation arrays with various methods of raising Dnieper water has been made. The emergence and discussion in the early 1900s of several complex projects for using Dnieper waters culminated in 1921–1926 with the active refinement of I. Alexandrov project with the involvement of

American specialists. The construction of the Dnieper HPP continued during 1927–1939 and in the end the authorities received cheap electricity and opportunities for creating a powerful industrial complex of the country, solved the long-standing historical problem of navigation on the Dnieper, water supply to cities and irrigation of arid lands of southern Ukraine.

It was found that simultaneously with the preparatory stage and the construction of the hydroelectric power station, numerous studies were conducted on the possibilities of its use for the needs of agricultural production in the southern regions of the Ukrainian SSR. In addition to the existing research institutions of agricultural direction, new research structures were created, united under the competence of the People's Commissariat of Land Affairs and the State Planning Committee of the Ukrainian SSR. One of the leading roles belonged to the Ukrainian Research Institute of Economics and Organization of Agriculture, whose employees received results from the following tasks: determining the profitability, economic feasibility of irrigation; establishing the area of irrigated areas; identifying the most profitable agricultural crops for cultivation in these areas, etc.

The work of domestic soil scientists, whose priority in the formation and further development of many areas of natural sciences is undeniable, has been analyzed. Representatives of soil science in the studied period contributed to the compilation of soil maps, irrigation projects and the study of other versatile issues of agriculture. In the future, the work of scientists influenced not only the resolution of issues regarding soil cultivation methods at the beginning of the twentieth century. In their combination, they became the basis for the development of new promising scientific approaches to numerous requests for economic activity.

Observing the logical progress of the evolutionary path of natural sciences regardless of socio-political factors, it seems possible to expand the range of factors studied around the problem of the Dnieper construction and the further development

of hydropower in the country. Especially since the prerequisites, construction and prospects for the functionality of the hydroelectric power station were created without regard to the local history, environmental and other socio-cultural problems of the region. We hope that the analysis and synthesis of knowledge about the scientific, methodological and socio-political factors of the interaction of scientific and social spaces will contribute to the preservation of a safe state of the environment in the context of global climate change and, in general, to the strengthening of civil society in Ukraine.

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