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CHEMICAL SCIENCES

APPLICATION OF MEMBRANE TECHNOLOGY FOR THE SEPARATION OF C1–C4 GASES FROM CATALYTIC CRACKING PROCESSES

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Abstract

Membrane technology is emerging as a cost-effective alternative for C1–C4 gas separation. Membrane technology is characterized by low capital and operating costs, high energy efficiency, and automation capabilities. Cellulose acetate, polyimide, polysiloxane, and perfluorinated polymers are utilized for gas purification. Each polymer has a different permeability, selectivity, and chemical stability, and its resistance to plasticization is important in certain applications. Block copolymers (e.g., Pebax) provide a balance between hydrophilic and hydrophobic properties, providing high permeability and mechanical strength. Anodic alumina membranes have a nanochannel structure and are characterized by high permeability and tunable parameters, but their sensitivity limits their industrial application. Porous hollow-fiber polypropylene membranes are characterized by chemical stability and are manufactured by various manufacturing methods. Such membranes are widely used in gas drying, separation, and filtration processes.

Keywords: Catalytic cracking; absorption; absorbent; membrane method; methane; ethane; propane; butane.

Introduction

Membrane technology as an innovative approach in gas separation processes has been in the spotlight in recent years. Although membranes currently hold a limited market share in the separation of C1–C4 hydrocarbons, their application is steadily expanding. Given the complexity of absorption and adsorption methods and high energy requirements, the simplicity and efficiency of membrane devices are of great importance. Membrane technologies have the ability to simultaneously purify gas from both water vapor and acid components. Low capital costs, automation potential and flexible application areas increase the attractiveness of membranes. Materials such as cellulose acetate, polyimides, perfluorinated polymers and polysiloxanes act as the main membrane components in this field. Block copolymers, especially membranes based on Pebax, are considered promising in terms of selectivity and permeability. Porous membranes and anodized alumina-based structures are used to increase the efficiency of gas separation processes. Porous polymers such as polypropylene are widely used in membrane technologies. For this reason, membrane technologies play an important role in the future direction of Navtsiya gas processing.

Experimental part

Membrane separation technologies for C–Ca gases currently have a small market share (up to 10%). The main reasons for this are the complexity of the operation scheme of traditional absorption and adsorption methods and the complexity of membrane technologies for processing processes with volumes of hundreds and thousands of millions of tons. However, as the development of large gas fields is completed, and the demand for complex gas and oil and gas condensate fields increases, simple devices with high productivity and not requiring complex maintenance prove to be effective.

Membrane technologies have the necessary potential for the creation of such devices. With the help of membranes, it is possible to simultaneously dry the gas from water vapor and higher hydrocarbons, as well as purify it from acidic components.

The main advantages of membrane technologies include:

- Low capital and operating costs
- Compactness, reliability and lightness
- Energy efficient, environmentally friendly, Possibility of full automation.

Membrane units can be integrated into conventional gas treatment processes, which allows for a 20–40% reduction in operating costs. MTR offers membrane roll cartridges based on the block copolymer Pebax 1074 in combination with absorption technologies. Currently, the membrane market is dominated by membranes based on cellulose acetate and polydimethylsiloxane [1]. Laboratory research is focused on the application of new polymers, such as polyether block polyamides (Pebax). The gas permeability and selectivity of membranes depend on the properties of the polymer, but in practice, due to the plasticization of polymers, the efficiency is 2–5 times lower than ideal. This problem is especially observed in raw gases with a high hydrocarbon content. The gas separation efficiency of membranes depends on the difference in partial pressures of the components in the waste gas and in the outlet stream. The mass transfer process is expressed by the following formula.

$$X_1 \cdot p_1 > X_2 \cdot p_2$$

Here X_1 , X_2 are the mole fractions of gas, and p_1 and p_2 are the pressures. The loss of methane during membrane purification can be 10% or more. To reduce losses, cycles with a second stage of purification are

used. In addition, before entering the membrane process, the gas must be cleaned of condensate and mechanical particles with a diameter of more than 3 microns, which creates additional capital and operating costs. An alternative direction of membrane technology that has been developing in recent years is the combination of membrane and absorption processes using membrane contactors. This method is based on the absorption of polluting components by liquid absorbents

through a membrane that acts as a separator of gas and liquid phases, provides a constant contact area and prevents the phases from penetrating into each other. Below, we consider in more detail the characteristics of membrane materials and membrane technologies for solving the main problems of natural and oil gas preparation.

Table 1

Gas transport parameters of membranes for water vapor removal			
Polymer	$P(H_2O), m^3/m^2$	Separation factor (H ₂ O/N ₂)	Conditions
Cellulose acetate	0,036	190000	35C, 27 atm
Pebax 1074	0,18	6060	30C, 1 atm
Nafion 117	1,5	4,1.106	30C, 35C, 1 atm
PDMS	0,16	38	30C, 350C, 1 atm

Non-porous polymers for gas purification and drying: Four main types of polymers are used for drying gases and removing acidic components: cellulose acetate, polyimides, siloxanes, and perfluoropolymers. Asymmetric membranes based on cellulose acetate were introduced into the industry in the early 1980s by Grace Membrane Systems, Separex, and Cynara, and currently account for 80% of the market. These membranes are widely used in offshore installations and for gas purification with high carbon dioxide content [2]. Cellulose acetate membranes are also capable of removing hydrogen sulfide with selectivities of up to 60 H₂S/CH₄ is able to separate. The permeability of cellulose acetate membranes is proportional to the degree of acidification of glycoside residues in the monomer unit of macromolecules. Bulky acyl groups prevent the dense packing of polymer chains. In addition, a decrease in the total proportion of OH groups in macro-

molecules leads to a decrease in the number of hydrogen bonds. As a result, the mobility and elasticity of polymer chains increase, and the permeability of membranes increases. The main disadvantage of cellulose acetate is its instability under the influence of water vapor, carbon dioxide and heavy hydrocarbons [3]. As a result of plasticization, the selectivity of separation decreases and the mechanical strength of the membranes weakens. Cellulose acetate is resistant to aromatic hydrocarbons such as benzene and xylene.

An alternative that offers greater resistance to water vapor is membranes based on polyimides. At the same time, polyimides are unstable to the effects of aromatic hydrocarbons, ammonia, and carbon dioxide. Increasing the plasticization resistance of polyimides has been achieved by chemical crosslinking [4;5], the introduction of inorganic fillers, and the production of composite membranes. Polyimide-based membranes are likely to have industrial demand.

Table 2

Gas transfer parameters of membranes for CO ₂ removal						
Polymer	$(CO_2)m^3/atm$	Separation factor (CO ₂ /CH ₄)	Pressure process	Selectivity ratio of gases (CH ₄ /CO ₂ /H ₂ S)%	CH ₄ losses during purification with up to 2% CO ₂	Source
Cellulose acetate	$8,3 \cdot 10^{-5}$	38	10 atm	M(90.3/9.7/0)	2,67	[133]
Matrimid 5218 (stitched)	$1,8 \cdot 10^{-4}$	34	10 atm	M(95.92/4/800ppm)	3,21	[204]
Teflon AF2400	$6 \cdot 10^{-2}$	5,6	27 atm	M(88/10.5/1,5)	29	[88]
Hyllon AD40	$4,1 \cdot 10^{-3}$	16	27 atm	M(90/10/0)	11,7	[AvantaneOS 2206]
Cytop	$9,6 \cdot 10^{-4}$	18	27 atm	M(90/10/0)	7,6	[151]

Table 3

Gas transport parameters of membranes for hydrogen sulfide removal

Polymer	P(H ₂ S)	Conversion coefficient H ₂ S/CH ₄	Pressure process	Gas mixture ratio (CH ₄ /CO ₂ /H ₂ S)%	CH ₄ losses while cleaning to ppm.	Source
Cellulose acetate	-	50	-	M(98\0\2)	16,29	[168]
Poly (ether urethane)PU3	271	58	10	M(70.8/27.9/1.3)	13,47	[24]
PDMS coated	28.86a	10,6	10	PES M(97.5/2.1/0.4)	51,5	[158]
Pebax 4011	-	70	26,66	M(95.79/4.12/870ppm)	7,41	[103]
PVBTAf	9.6c	1920	4,85	M(79.7/10/10.3)	0,53	[149]

Perfluoropolymers have high resistance to water, CO₂ and higher hydrocarbons.

Representatives of perfluoropolymers are Cytop, Teflon AF, Hyflon AD [5]. Due to the presence of high-energy C-F bonds, the macromolecules of perfluoropolymers are resistant to plasticization. For example, at pressures of up to 20 atm, plasticization of Teflon AF2400 and Hyflon AD80 polymers is not observed, while in cellulose acetate and polyimides this process begins at a pressure of 5-7 atm. Perfluoropolymer membranes for CO₂ removal under the trade name "Z-Top" are manufactured by Membrane Research, Inc. (MTR). Perfluoropolymers are suitable for cleaning low-quality gas with high water vapor and acid gases due to their hydrophobicity and low wettability by acid gases. Polysiloxanes are mainly used for the separation of C₁-C₄ hydrocarbons, drying of gases and removal of sulfur-containing components [6]. They have been widely used due to their high permeability and ability to form composite membranes with thin selective layers. There are three main approaches to increasing selectivity: modification of the chemical structure of polysiloxanes, creation of copolymers based on polysiloxanes, and incorporation of fillers into the polymer matrix.

Conclusion

Membrane technology is an effective and energy-efficient method for the separating of gas mixtures. The selection of membrane materials used in this process depends on their properties such as absorption, mechanical strength and chemical stability. The process of gas permeation through membranes is based on diffusion and dissolution mechanisms. In membrane technology, which determines the separation efficiency, different polymer and non-polymer-based materials are used to ensure the selective separation of various gases. This method, which is widely applied in fields such as petrochemical and ecology, requires less energy, consumption and simpler equipment compared to traditional gas separation methods. In recent years, experi-

ments have been conducted on new materials and nanocomposites to increase the efficiency of membranes. The development of membrane technology not only contributes to the solution of environmental problems, but also allows for the optimization of industrial processes. The continuous development of membrane technology will lead to the implementation of gas separation processes with higher efficiency and their widespread use in industrial sectors. Ultimately, the membrane method offers modern and effective solutions in the fields of gas processing and purification. Future scientific and technological achievements in this field will enable membrane systems to become more durable and high-performing.

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SYNTHESIS OF N1-[2-(4 H-1,2,4-TRIAZOL-4-YL) ACETYL]-(1-ADAMANTYL)-4-BENZOHYDRAZIDE AS A POTENTIAL ANTICANCER DRUG

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National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"DOI: [10.5281/zenodo.20824230](https://doi.org/10.5281/zenodo.20824230)**Abstract**

The 1,2,4-triazole ring and azaglycine are two pharmacologically significant structural units associated with cytotoxic activity. In particular, the azaglycine scaffold exhibits increased affinity for the enzyme cathepsin B, an established molecular target in breast cancer. Accordingly, a product (3) containing an adamantyl substituent at position 4 of the phenyl ring was synthesized, significantly increasing the lipophilicity of the substrate.

Keywords 1, 2, 4-Triazole, Azaglycine, Cathepsin B, Anticancer, Adamantane.

Introduction

Breast cancer remains one of the leading causes of cancer deaths among women worldwide, with a higher incidence rate observed in older adults and postmenopausal women [1, 2]. The development of new anticancer drugs remains a major focus of medicinal chemistry, and heterocyclic compounds have emerged as promising candidates.

Due to their ability to modulate various molecular targets associated with cancer, several FDA-approved anticancer drugs, including tucatinib, alpelisib, capmatinib, pralsetinib, and darolutamide, contain heterocyclic rings in their structures.

Among various heterocycles, the 1,2,4-triazole system has attracted considerable attention due to its potent cytotoxic properties. Other important activities of 1,2,4-triazoles include antimicrobial, antioxidant, antituberculosis, antiviral, analgesic, anti-inflammatory, anticonvulsant, and antidepressant activities [3–5]. In the field of oncology, triazole derivatives are actively investigated as next-generation anticancer drugs. Their anticancer activity is mediated by various mechanisms, including enzyme inhibition, microtubule destabilization, and activation of cell cycle arrest. The triazole ring binds tightly to receptors via hydrogen bonds, dipole–dipole interactions, and π -stacking, which contributes to high binding affinity and therapeutic potential [6–11].

One promising approach to the development of triazole-based anticancer agents is the creation of complex hybrids combining the 1,2,4-triazole core with other anticancer pharmacophores such as coumarin, phthalazine, pyrimidine, pyridine, piperidine, quinoxaline, quinazoline, thiadiazine, and indole [12–14]. Numerous studies have also highlighted the therapeutic potential of 1,2,4-triazole amides. Tukey et al. synthesized 1,2,4-triazole-narylamide hybrids and evaluated the anticancer activity against a multidrug-resistant human breast adenocarcinoma cell line (MDA-MB-231) [15]. Another study reported the synthesis of 1,2,4-thiadiazole-1,2,4-triazole derivatives containing an amide functional group, which demonstrated anticancer activity against breast cancer (MCF-7 and MDAMB-231), lung cancer (A549), and prostate cancer (DU-145) cell

lines [16]. Tom et al. synthesized a series of thirty N-acyl-1,2,4-triazoles and evaluated their antimalarial activity [17].

Azaglycine is a synthetic analogue of glycine in which the alpha carbon is replaced by nitrogen, resulting in a hydrazide-like structure ($-\text{NH}-\text{NH}-\text{CO}$). Incorporation of the azaglycyl (Agly) moiety into the peptide structure enhances conformational stability and increases hydrogen bonding capacity, thereby improving biological activity and resistance to enzymatic degradation [18, 19]. This structural modification has been shown to facilitate the design of highly potent and selective cathepsin B inhibitors by constraining the peptide backbone in a kinked conformation that facilitates target binding [20]. In preclinical cancer studies, azaglycine has demonstrated moderate antiproliferative effects [21]. Despite the extensive study of triazole-based hybrids and the pharmacological significance of azaglycyl units, the systematic evaluation of the cytotoxicity of molecular systems integrating both structural motifs remains largely unexplored. [22] reported the cytotoxic potential of 4-amino-5-substituted 1,2,4-triazole-3-thiol derivatives against a breast cancer cell line (MCF-7) and emphasized the therapeutic importance of the 1,2,4-triazole core in the development of anticancer drugs. Based on this logic, in the present study, a benzoyl-azaglycinamide moiety containing an adamantyl substituent is introduced into the 1,2,4-triazole structure (Fig. 2), combining two complementary pharmacophoric units in a single molecular structure. The benzoyl group containing 1-adamantyl was chosen to enhance lipophilicity and facilitate π - π stacking interactions with aromatic residues in the target binding site, potentially improving biological activity.

This hybridization strategy aims to combine the electronic and binding versatility of the triazole core with the conformational and hydrogen bonding advantages of the azaglycine moiety.

The synthesis protocol is shown in Scheme 1.

1,2,4-Triazole (0.01 mol, 1 equiv) was dissolved in dichloromethane (50 mL) with constant stirring at room temperature (25 °C). Triethylamine (2 mL, ca. 1.5 equiv) was added, followed by dropwise addition of ethyl chloroacetate (0.01 mol, 1 equiv). The reaction

mixture was stirred for 3–5 h. After completion of the reaction, the solvent was removed under reduced pressure. The resulting solid was washed with cold water to remove residual triethylamine. The resulting solid was dried under vacuum to obtain 1,2,4-triazole ethyl ester (1) [23].

Synthesis of substituted benzohydrazide (2): The substituted benzohydrazide was prepared by esterification of substituted benzoic acid followed by hydrazinolysis.

Preparation of 4-(1-adamantyl)methyl Experimental

1,2,4-Triazole, ethyl acetoacetate, triethylamine, substituted benzoic acid, hydrazine hydrate, methanol, ethanol, dichloromethane, concentrated sulfuric acid, and carbon tetrachloride were purchased from Macrokhim (Ukraine) and Aldrich.

All chemical reagents were of analytical grade and were used without further purification.

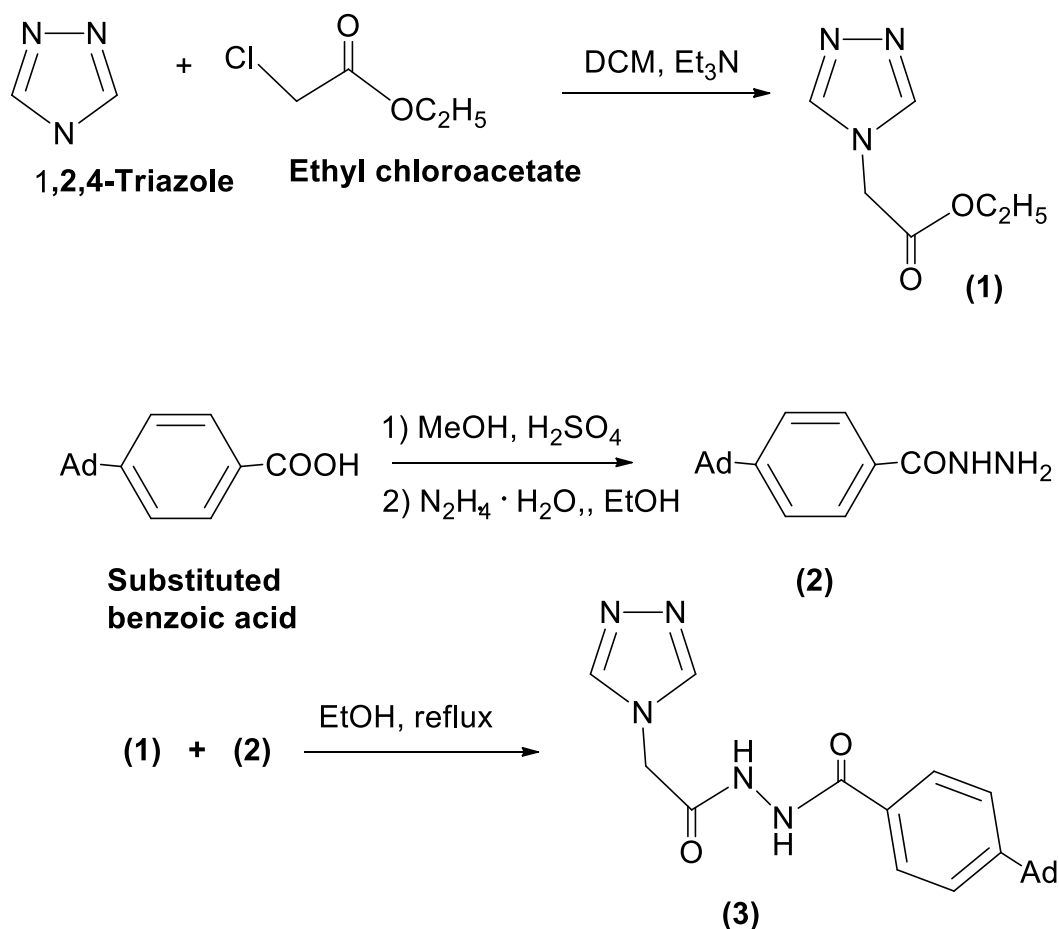
Reaction progress was monitored by thin-layer chromatography (TLC) on silica gel plates using appropriate solvent systems. Melting points were determined in open capillaries and are uncorrected. Infrared spectra were obtained using a Bruker FTIR spectrometer. Spectrophotometer (cm⁻¹). NMR spectra were recorded in dimethyl sulfoxide (DMSO-d₆) on Bruker 400 MHz and Joel 400 MHz instruments. Mass spectra (m/z) were obtained using an Apex mass spectrometer (300800.D) Синтез этилового эфира 1,2,4-триазола (1).

benzoate: Substituted benzoic acid (0.1 mol, 1 equiv) was dissolved in excess methanol, and concentrated sulfuric acid (5.7 mL, catalytic amount) was added dropwise with stirring. The reaction mixture was refluxed at 65°C for 4–6 h. After cooling to room temperature, the reaction mixture was poured into ice water. The resulting methyl 4-(1-adamantyl)benzoate was extracted with carbon tetrachloride. The organic layer was separated, dried over anhydrous magnesium sulfate, and concentrated under reduced pressure. The yield is quantitative.

Preparation of substituted benzohydrazide:

The resulting methyl ester (0.1 mol, 1 equiv) was refluxed with hydrazine hydrate (0.15 mol, 1.5 equiv) in ethanol (5.7 mL) for 4–6 h. Excess ethanol was removed under vacuum, and the crystalline benzohydrazide was filtered. The product was washed with cold ethanol and dried to obtain the substituted benzohydrazide (2). Yield 92%.

Synthesis of N1-[2-(4 H-1,2,4-triazol-4-yl)acetyl]-4-(1-adamantyl)benzohydrazide (3): A mixture of 1,2,4-triazole ethyl ester (1) (0.01 mol, 1 eq.), substituted benzohydrazide (0.02 mol, 2 eq.) was dissolved in ethanol (50 mL) and refluxed for 4–6 h. After completion of the reaction, the solvent was removed using a rotary evaporator. The resulting solid was collected and purified by recrystallization from a mixture of ethanol and water. Yield 89%.



Scheme 1. Synthesis protocol.

Physical and spectral data of intermediate compound (2).

4-(1-Adamantyl)benzohydrazide (2). Off-white solid, M.P. 193–195 °C, Rf: 0.61 (ethyl acetate: hexane: methanol 3:1:4). FT-IR (KBr) cm^{-1} : 3309.42 (N-H str), 1661.83 (C = O str); ^1H NMR ($\text{CDCl}_3\text{-d}_6$, 400 MHz) δ (ppm): 1.48, 1.92, 1.68 (m, 15H), 4.58 (s, 2 H, NH_2), 6.91–7.82 (m, 4 H, Ar-H), 10.21 (s, 1H, CO-NH).

Physical and spectral data of the final compounds (3).

N1-(2-(4 H-1,2,4-Triazol-4-yl)acetyl)-4-(1-adamantyl)benzohydrazide (3). M.P. 211–213 °C Rf: 0.80 (ethyl acetate: hexane: methanol 2:1:1); FT-IR (KBr) cm^{-1} : 3380.13 (N-H str), 2981.00 (C-H str, aromatic), 1665.44 (C = O str), 1497.46 (C-N str), 1190.63 (Ar-CO str); ^1H NMR ($\text{CDCl}_3\text{-d}_6$, 400 MHz) δ (ppm): 1.48, 1.92, 1.68 (m, 15H), 4.6 (s, 2 H, CH_2), 7.2–7.4 (m, 4 H, Ar-H), 8.5 (s, 2 H, CH of 1,2,4-triazole), 10.2 (s, 1H, NH-CO), 10.8 (s, 1H, NH-CO-Ar); ^{13}C NMR ($\text{CDCl}_3\text{-d}_6$, 300 MHz) δ (ppm): 29.0 (γ , CH, AdC), 31.6 (α , C, AdC), 37.5 (δ , CH_2 , AdC), 43.3 (β , CH_2 , AdC), 48.7 (CH_2), 125.6 (2 x ArC), 128.2 (2 x ArC), 129.8 (ArC), 131.1 (ArC), 145.2 (2 x TrC), 164.4 (CO), 164.9 (CO); MS (EI) m/z : 379[M] $^{+}$.

Results and discussion

1,2,4-Triazole ethyl ester (1) was condensed with substituted benzohydrazide (2) to afford the title compound (Scheme 1). The benzohydrazide (2) were obtained by treating benzoic acid esters with hydrazine. Subsequently, the reaction between 1,2,4-triazole ethyl ester and substituted benzohydrazide led to the formation of the title compound (3). Both reactions involve the nucleophilic substitution mechanism. The structures of the final compounds were confirmed by spectral analysis. The ^1H NMR spectrum displayed characteristic peaks ranging from 4.2 to 4.6 (s, CH_2), 6.8–7.8 (m, Ar-H), and 10.0–10.8 (s, NH). In the ^{13}C NMR spectra, methylene carbons were observed at δ around 40, phenyl carbons were found with δ values in the range of 114–150, and amide carbons were observed at around δ 164.

Conclusion

The present study describes the synthesis of a novel of N1-[2-(4 H-1,2,4-triazol-4-yl) acetyl]-4-(1-adamantyl)benzohydrazides (3), incorporating both the 1,2,4-triazole scaffold and the benzoyl azaglyciny pharmacophore, which are well-recognized structural motifs in anticancer drug design.

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EARTH SCIENCES

REGULARITIES OF THE FORMATION OF HYDROGEOLOGICAL CONDITIONS IN THE EASTERN ZANGAZUR ECONOMIC REGION

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Abstract

Hydrogeological conditions are one of the key factors influencing the socio-economic development of any region, as well as agricultural activity, industrial production, and urban planning processes. The presence, quantity, quality, flow direction, and overall characteristics of both groundwater and surface water are closely interconnected with soil, vegetation, and human activities within a given area (Israfilov, 2020). Therefore, hydrogeological studies play a crucial role not only in the efficient use of natural resources but also in preventing environmental problems. The Eastern Zangezur economic region is characterized by a complex geological and hydrogeological structure. The area includes rocks of different ages and compositions, fault and fracture zones, as well as a combination of mountainous and plain landscapes. This diversity directly affects the distribution of groundwater and the formation of hydrogeological processes. Both surface and groundwater resources in the region are of strategic importance for agriculture, industry, and drinking water supply.

Keywords: Hydrogeological conditions, groundwater, geological structure, agriculture, drinking water supply, urban planning processes.

Introduction

The scientific novelty of the research lies in the systematic investigation of the formation patterns of hydrogeological conditions in the Eastern Zangezur economic region and the development of new methodological approaches for assessing its hydrogeological potential. The practical significance of the study is based on providing a scientific foundation for the efficient management of water resources, as well as for the

planning of agricultural and infrastructure projects in the region (Geosciences of Azerbaijan: Volume I – Geology, 2016). The Eastern Zangezur economic region is located in the southeastern part of the Republic of Azerbaijan, on the eastern slopes of the Zangezur mountain range. The territory borders the Nagorno-Karabakh region and represents a strategically important geological, hydrological, and economic zone.



The boundaries of Eastern Zangezur are defined not only administratively but also economically. Administrative boundaries include the distribution of settlements within the region, while economic boundaries are determined by the region's resource potential, surface and groundwater reserves, soil and vegetation conditions, and agricultural opportunities. These boundaries are important for conducting hydrogeological research, assessing groundwater resources, and planning irrigation systems (Imanov & Alakbarov, 2018).

Geological processes play a decisive role in the formation of hydrogeological conditions in the Eastern Zangezur economic region. Over long geological periods, these processes have altered the composition, structure, and spatial distribution of rocks, thereby determining the formation, accumulation, and movement mechanisms of groundwater. The main geological processes include tectonic movements, weathering (erosion), sedimentation (accumulation), metamorphism, and magmatism, each of which exerts a specific influence on the hydrogeological system.

First of all, tectonic processes play a fundamental role in shaping hydrogeological conditions. Tectonic fractures and fault zones create fissures in rocks, forming natural pathways for water infiltration and movement (Geosciences of Azerbaijan: Volume II – Economic Geology and Applied Geophysics, 2018). In areas dominated by hard and low-permeability magmatic and metamorphic rocks, groundwater primarily accumulates and flows through these fracture systems. Along fault zones, groundwater may emerge at the surface, leading to the formation of springs and mineral water sources.

The hydrogeological significance of geological processes is also reflected in the formation of groundwater regimes and balance. The lithological properties of rocks, tectonic structure, and geomorphological conditions collectively determine infiltration, storage, and flow directions of groundwater. As a result of these processes, different types of hydrogeological systems—fractured, porous, and mixed aquifers—are formed within the region.

At the same time, geological processes influence the quality and mineralization of groundwater. The mineral composition of rocks determines the chemical characteristics of water, which in turn affects its suitability for drinking, technical, or therapeutic use.

Thus, geological processes form the foundation of hydrogeological conditions in the Eastern Zangezur economic region. A comprehensive study of these processes provides a scientific basis for the accurate assessment, efficient utilization, and protection of groundwater resources. This subsection serves as an important foundation for a more detailed analysis of hydrogeological and engineering-geological conditions in the following chapter (Geosciences of Azerbaijan: Volume II – Economic Geology and Applied Geophysics, 2018).

Groundwater resources

East Zangezur Economic Region is one of the regions of Azerbaijan rich in groundwater resources. The mountainous relief of the region, high annual precipitation, dense river network, and fractured-faulted geological structure have led to the formation of various types

of groundwater basins. Groundwater is mainly accumulated in foothill depressions, alluvial deposits of river valleys, volcanogenic-sedimentary rocks, and carbonate massifs.

According to official assessments of the water management sector of Azerbaijan, the total groundwater resources of the country are estimated at approximately 9 billion m³, and a significant share of this amount belongs to the Karabakh and East Zangezur regions (Imanov & Alakbarov, 2018).

The Istisu mineral springs located in Kalbajar District are among the most famous hydrothermal water sources of the region. The water temperature at different discharge points reaches up to 58°C. During the Soviet period, a sanatorium operating on the basis of this source received thousands of visitors annually. The daily reserves of the Istisu deposit have been estimated in various studies at around 3,000–4,000 m³/day (Kalandarov et al., 2025).

Mountain springs and fracture waters are widely distributed within Lachin District. The discharge of several springs is reported to vary between 5–15 l/s, which is considered quite favorable for supplying drinking water to rural settlements.

In the territories of Zangilan District and Qubadli District, alluvial groundwater has developed in the valleys of Hakari River and Bargushad River. In these areas, the groundwater table generally lies at depths of 2–10 meters, creating favorable conditions for drilling artesian and sub-artesian wells.

The quality of water resources in the region also varies. In mountainous areas, the waters are generally weakly mineralized, with mineralization levels of 0.2–0.8 g/l, making them suitable for drinking purposes. In lower valleys and enclosed depressions, this indicator may rise to 1–3 g/l. In mineral springs, the degree of mineralization is even higher (Israfilov, 2020).

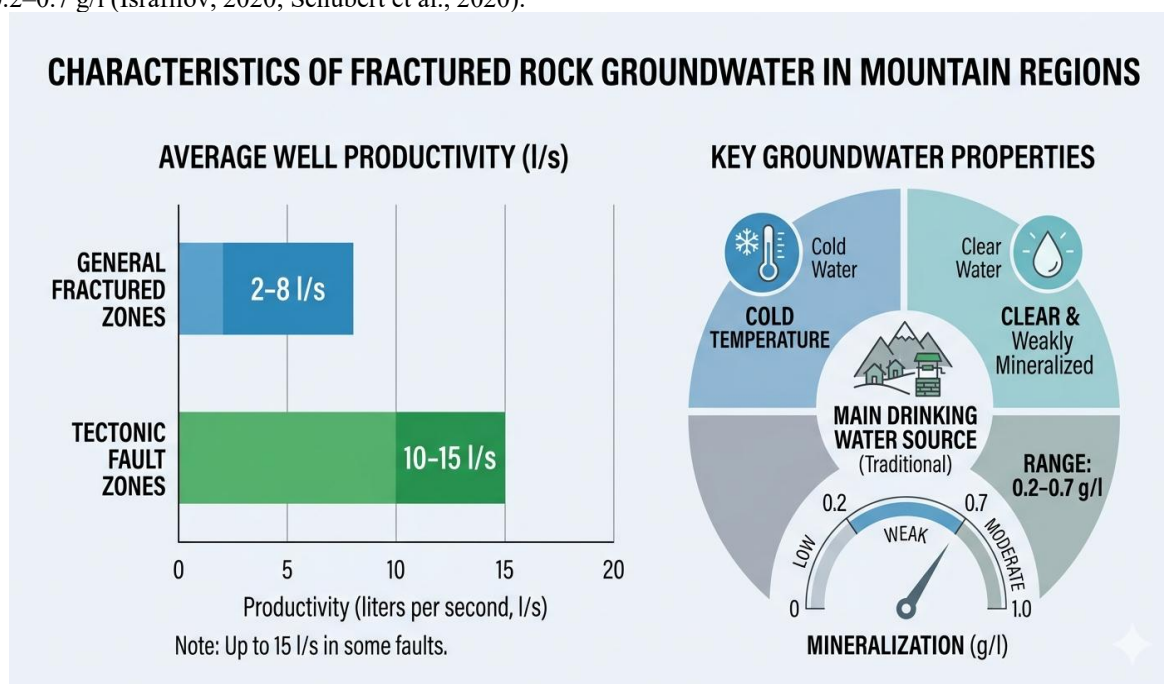
According to experts, if groundwater resources in East Zangezur Economic Region are used efficiently, they can form a strategic basis for irrigation of agricultural lands, drinking water supply for new settlements, and the development of tourism facilities. In particular, reassessment of groundwater resources is considered one of the priority directions within the reconstruction programs of the liberated territories.

Hydrogeological characteristics of water deposits

East Zangezur Economic Region is considered one of the most important hydrogeological regions of Azerbaijan due to the richness and diversity of its groundwater deposits (Imanov & Alakbarov, 2018). Within the territories of Kalbajar District, Lachin District, Qubadli District, Zangilan District, and Jabrayil District, various water-bearing horizons have formed under the influence of geological structure, tectonic activity, climatic conditions, and mountainous relief. Since the elevation range of the region varies approximately from 200 meters to 3,700 meters, hydrogeological conditions differ sharply both vertically and horizontally.

The productivity of wells in such deposits averages 2–8 l/s, while in some tectonic fault zones it reaches 10–15 l/s. In most mountain villages, this type of groundwater has traditionally served as the main

source of drinking water. Fractured rock waters are usually cold, clear, and weakly mineralized. Their mineralization degree generally varies within the range of 0.2–0.7 g/l (Israfilov, 2020; Schubert et al., 2020).



Karst springs are especially common in the territories of Lachin District and Kalbajar District. The discharge of some springs is reported to reach 20–30 l/s, and in maximum cases up to 50 l/s (Kalandarov et al., 2025). These waters are of high quality and mainly have a bicarbonate-calcium composition. Since karst waters are rapidly recharged, they are sensitive to precipitation fluctuations and exhibit a seasonal regime.

Alluvial water deposits are widely distributed in the river valleys of Zangilan District, Qubadli District, and Jabrayil District. These deposits are mainly associated with the basins of Hakari River, Bargushad River, Okhchuchay River, and Araz River.

Hydrogeological regime and formation regularities

The main source of groundwater recharge in East Zangezur is atmospheric precipitation. In mountainous parts, the annual precipitation amount is 600–900 mm, while in some high-altitude zones it exceeds 1,000 mm (Hydrological and Hydrochemical Study of the Gudiyalchay River, 2019). A significant part of this precipitation infiltrates and accumulates in fractured and porous rocks.

The second important recharge source is snowmelt (Schubert et al., 2020). In the surroundings of Kalbajar District, Lachin District, and the Zangezur Range, melting snow during spring increases groundwater levels. Therefore, from March to May, spring discharge and well water levels rise noticeably.

River water infiltration also plays an important role, especially in valleys. In the basins of Hakari River, Bargushad River, Okhchuchay River, and Araz River, a hydraulic connection exists between river channels and groundwater (Hydrological and Hydrochemical Study of the Gudiyalchay River, 2019).

Groundwater levels in the region change periodically throughout the year. Maximum levels are observed in spring due to precipitation and snowmelt. During summer, rising temperatures and increased evaporation gradually lower groundwater levels. Although some recovery occurs in Groundwater level amplitude in phreatic aquifers is usually 1–2 meters in plain areas, 2–4 meters in foothill zones, and may be even greater in some spring systems. This variability is especially more evident in shallow water-bearing horizons.

Groundwater movement is mainly directed from higher hypsometric areas toward lower areas. Mountain massifs act as recharge zones, while river valleys and plains function as discharge zones. Therefore, hydroisohypse lines in the region are generally oriented from mountains toward valleys.

$$Q = k \cdot i \cdot F$$

Here, groundwater discharge depends on the permeability coefficient of the rock, hydraulic gradient, and filtration area. Permeability is high in gravelly-alluvial deposits and low in clay layers. Therefore, it is possible to drill highly productive wells in the valleys of Zangilan District and Jabrayil District.

The chemical composition of groundwater is also an important indicator of the hydrogeological regime. In mountainous areas, mineralization remains low (0.2–0.8 g/l) because short-circulation and freshly recharged waters dominate (Israfilov, 2020).

In deeper and longer-circulating waters, mineralization increases due to prolonged contact with rocks. In valley-bottom and semi-arid zones, this indicator may reach 1–3 g/l, while in mineral springs it may exceed 5 g/l. In areas such as the Istisu mineral water deposit, water temperatures of 58–60°C are associated with deep circulation and the geothermal regime.

East Zangezur Economic Region belongs to a seismically and tectonically active zone. Faults and fracture zones serve both as collectors and movement channels for groundwater. In these zones, high-discharge springs, thermal outlets, and sometimes pressurized artesian waters are formed (Geosciences of Azerbaijan: Volume II – Economic Geology and Applied Geophysics, 2018).

In recent years, reconstruction, road construction, restoration of settlements, and agricultural development in the region may affect the groundwater regime. Intensive exploitation of wells can lower groundwater levels and, if poorly managed, may cause local depletion. Therefore, establishing monitoring systems is essential.

The hydrogeological regime of East Zangezur Economic Region is formed under the combined influence of natural zonality, seasonal variability, geological structure, and tectonic processes. The mountainous parts of the region are the main recharge areas, while river valleys function as discharge zones. Consideration of these regularities is of particular importance for drinking water supply, irrigation, engineering-geological planning, and sustainable resource management.

Conclusion

The conducted research has determined that East Zangezur Economic Region is one of the most promising and strategically important hydrogeological regions of Azerbaijan. The complex geological structure, tectonic activity, mountainous relief, diverse climatic conditions, and dense hydrographic network of the region have created favorable conditions for the formation of rich groundwater resources, mineral waters, and thermal water deposits (Geosciences of Azerbaijan: Volume I – Geology, 2016; Kalandarov et al., 2025).

The study established that fractured, karst, alluvial, and deep thermal water-bearing horizons are widely distributed in the region. High mountainous areas serve as the main recharge zones, while river valleys and lower areas function as groundwater discharge and accumulation zones. Atmospheric precipitation, snowmelt, and infiltration of river waters are the principal factors shaping the hydrogeological regime of the region. As a result of seasonal variability, groundwater resources increase during spring and decrease in summer-autumn periods.

Research shows that the territories of Kalbajar District, Lachin District, and Zangilan District are more promising zones in terms of groundwater resources (Imanov & Alakbarov, 2018). In particular, the Istisu mineral water deposit is one of the most valuable hydrothermal resources of the region and has great potential for therapeutic tourism, mineral water industry, and geothermal use in the future (Kalandarov et al., 2025).

Although the region has complex engineering-geological conditions, implementation of large infrastructure projects is possible through proper design and geotechnical measures. In mountainous zones, landslide, seismic, and erosion risks must be taken into account, while in valley-bottom areas special measures are required regarding groundwater and soil settlement.

The assessment has shown that the hydrogeological resources of East Zangezur may play an important role in the following directions in the future: drinking water supply for settlements, development of agriculture and irrigation systems, water supply for industrial and processing enterprises.

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ECONOMIC SCIENCES

POSSIBLE ANSWERS TO CONTEMPORARY CHALLENGES IN THE HEALTHCARE FINANCING SYSTEM

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Abstract

This article aims to analyze the economic challenges facing healthcare budgeting and examine potential sources of funds for sustainable financing to ensure accessibility of healthcare for the population. Healthcare financing will be examined at the macro level, encompassing the total amount of resources allocated to healthcare in society and the methods for mobilizing them. Issues related to the distribution of these resources within the healthcare system itself are beyond the scope of this paper.

Keywords: Healthcare management, financial system of healthcare, healthcare in Kazakhstan, financing of healthcare.

In the context of low economic growth and large-scale informal employment in Kazakhstan, the possibilities for increasing funding for medical care by increasing contributions from employed citizens appear to be exhausted: the tax burden on labor and production in general in Kazakhstan is currently significantly higher than in most developed countries. The reforms being implemented in the country, aimed at developing market relations, inevitably affected such a vital sector as healthcare. The primary goal of these reforms was to improve the system's efficiency, as a significant portion of its problems were caused not only and not so much by inadequate funding, but by ineffective management.

Healthcare financing has traditionally occupied a key place in health policy. However, discussions in this area have recently intensified amid the emergence of new challenges related to the global socioeconomic and political situation. The general framework for the discussion is the recognition of a developing crisis with two main characteristics. It is viewed, on the one hand, the term permacrisis has even emerged and, on the other, as multidimensional, requiring all systems of modern society to adopt new approaches to address emerging issues [1].

The chronic underfunding of the state-guaranteed program of free medical care for citizens of the Republic of Kazakhstan is a key problem in the country's healthcare system. Kazakhstan's public spending on healthcare (the compulsory medical insurance system and the state budget) is significantly lower than that of developed countries, both as a share of GDP and in absolute terms.

The healthcare system, facing several global challenges. The most serious test was the pandemic, during which, in addition to current healthcare needs, countries had to provide life-saving care to COVID-19 patients. Several public health challenges emerged, once again highlighting the importance of access to quality healthcare for the population [2].

Recently, the priority of healthcare has been raised. However, ensuring this is a complex task in today's context of new challenges. Therefore, researchers increasingly use the term "sustainable financing" of healthcare, i.e., ensuring the necessary resources to address the full range of challenges facing public healthcare systems. It should be noted that health is included in the UN Sustainable Development Goals, which provide a long-term development framework for modern countries and a benchmark for policymaking [3]. At the same time, experts acknowledge that current financing is inadequate to address public health issues, and as new challenges arise, the situation may worsen.

In analyzing healthcare financing issues, several comments are necessary. Certainly, countries differ significantly in both their overall level of socioeconomic development and their organization of public health care. Therefore, this article discusses developed countries with mature healthcare systems covering, if not all, then at least the majority of the population, which sets the general direction for the development of modern healthcare, serving as a source of best practices.

Protecting public health is one of the responsibilities of the modern state, and healthcare competes for resources with other areas of government activity. This has also manifested itself during the pandemic. Despite rhetoric about the importance of healthcare in combating the pandemic, as well as a significant increase in spending on it, data shows that the bulk of funds went to supporting the population and businesses. This is largely due to stimulus packages adopted in many countries to support various economic sectors and economic entities outside the healthcare sector.

It's worth noting that when examining healthcare financing, researchers note that:

- Higher expenditures are associated with higher life expectancy. Therefore, they are often considered one of the socioeconomic factors determining health.

– More developed countries spend more on healthcare in absolute and relative terms (expenditures as a share of GDP and government expenditures) [4].

This is certainly a general trend, although there are deviations. For example, the United States spends the most on healthcare but lags behind in life expectancy. Low-income countries such as Madagascar and Malawi spend 14 and 9 percent of their budgets on healthcare, respectively, which is comparable to developed countries. The world currently faces a challenging socioeconomic situation. The COVID-19 pandemic has caused a simultaneous health and economic crisis. In Russia, the economic restrictions used against it are an additional source of stress. The result has been an energy crisis and increased inflationary pressure. Researchers note such phenomena as rising prices, declining household incomes, declining tax revenues, growing budget deficits, and slower economic growth [5].

It should be noted that in recent years, healthcare spending in developed countries has outpaced inflation, and in 2022/2023, inflation will exceed previous years' levels in many countries. This has led to rising costs for healthcare resources and, accordingly, requires increased spending. For example, rising prices for gas, fuel, and electricity are particularly important for hospitals and emergency services. Rising labor costs have a dual impact on healthcare. On the one hand, they drive up wages in resource-producing industries, while on the other, they drive up wages in healthcare itself, which is particularly significant for healthcare as a labor-intensive industry [4]. The shortage of medical personnel was already noted before the pandemic, but the recent pandemic has led to an increased burnout among healthcare workers. Therefore, raising wages in the industry is urgent.

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which is particularly significant for healthcare as a labor-intensive industry [6]. The shortage of medical personnel was already noted before the pandemic, but the recent pandemic has led to an increased burnout among healthcare workers. Therefore, raising wages in the industry is urgent.

As a result, healthcare competes with a multitude of new public spending priorities, including defense, investments in the green economy and climate change measures, rising direct energy costs, and government support for citizens and businesses. Under these conditions, maintaining healthcare's priority in state budgets is becoming more challenging, especially as the healthcare system itself faces new challenges, including ensuring its sustainability.

Against this backdrop, the need for medical services is not decreasing; factors such as the aging population and its increasing demands, as well as technological progress, continue to operate, leading to the need to increase healthcare costs. An analysis of the discussion allows us to identify three basic scenarios, namely:

– changing the financing system itself and the relationship between its main elements (replacing tax systems with social health insurance (SHI) or vice versa);

– using additional funding sources that fit within the existing system (additional health insurance; co-payments; a tax on the consumption of goods harmful to health);

– searching for savings within the existing system in order to redistribute funding and reduce the need to increase overall healthcare spending (limiting the range of services, eliminating irrational spending).

Improving the efficiency of healthcare resource use is essential given the demand for new investments. Therefore, there is a growing need to justify additional targeted investments to create more sustainable healthcare systems, while also taking measures to reduce wasteful healthcare spending. Improving public financial management to ensure the proper use of funds and transparency in their flow can be considered as a means of achieving savings. In particular, cost analysis allows for assessing their effectiveness and ensuring a transition to more cost-effective programs.

Service rationing implies that the state funds only certain services. The problem, as with any restrictive system, is that it is difficult to determine what exactly should be included in the list of services provided. It is important not only to determine which services are selected, but also the procedures used to achieve them. A public system requires collective decision-making regarding the use of public funds. However, the requirements of economic efficiency can conflict with social and ethical considerations.

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HISTORICAL SCIENCES

THE MAHALLA SYSTEM IN THE MUSLIM WORLD AS A PLATFORM FOR SOCIAL RELATIONS AND INTERRELIGIOUS DIALOGUE

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Abstract

This article examines the historical formation of the mahalla system in the Muslim world and its role in social and interreligious relations. The mahalla is analyzed as an important social institution that ensures not only territorial organization but also social control, mutual assistance, religious life, and economic cooperation. The study traces the development of the mahalla from early settlements in Mecca and Medina through the Umayyad, Abbasid, and Ottoman periods. Particular attention is given to the coexistence of different religious communities in regions such as the Middle East, Central Asia, and Andalusia. The article concludes that the mahalla system played a significant role in fostering social integration and interreligious interaction while preserving ethnic and religious diversity.

Keywords: Hitat (allocated quarters/plots), mahalla (neighborhood community), Quraysh al-Bitah, Quraysh al-Zawahir, Shi'b Abu Talib, Umayyads, Abbasids, Mamluks, Ottomans (Ottoman Empire), Central Asian khanates, ra'is (community leader), sheikh, aksakal (elder), ahdas (urban militia), zu'ar (urban youth groups), "mixed quarter".

KIRISH INTRODUCTION

Throughout the history of Muslim societies, the mahalla has been recognized not merely as a territorial unit but also as an important form of social control, mutual assistance, religious and practical life, economic cooperation, and local self-governance. At the same time, the concept of "mahalla" was not uniformly used across all Muslim regions. In Ottoman Turkish cities, it was commonly referred to as *mahalle*; in the Arab world, the term *hitat* was often employed; while in Central Asia, the term *mahalla* remained prevalent.

Modern scholarship demonstrates that it is inaccurate to explain the history of Muslim cities solely through the model of "districts inhabited exclusively by adherents of one religion." In reality, many cities witnessed both close neighborhood interaction and varying degrees of coexistence among Muslims, Christians, and Jews.

Etymologically, the term *mahalla* derives from the Arabic root *hall* (*halal* and *hulul*), meaning "to settle," "to reside," or "to occupy a place." The word thus refers to "small residential settlements established for permanent or temporary habitation." With slight linguistic variations, the term has been used in similar meanings throughout the Islamic world.

MAIN PART

Early Formation of Mahallas in Mecca and Medina. Islamic historical sources indicate that the earliest residential settlements in Mecca were established around the Ka'ba by Qusay ibn Kilab, one of the ancestors of the Prophet Muhammad (peace be upon him). Two major neighborhoods known as *Quraysh al-Bitah* and *Quraysh al-Zawahir* emerged in the city. Historical reports further mention that approximately twelve mahallas existed in Mecca during the early Islamic period. Muslims themselves experienced severe hardship while residing in the quarter of Abu Talib (*Shi'b Abu Talib*)

during the social and economic boycott imposed upon them.

At the time of the Prophet's migration (*Hijra*) to Medina, Arab and Jewish tribes lived in relatively distant neighborhoods. Even after the construction of Al-Masjid an-Nabawi, this urban pattern continued, though the city's spatial organization was rearranged. Peripheral neighborhoods were integrated into the city plan in order to avoid overcrowding, ensure security, and maintain connections between distant settlements and the city center.

During the medieval period, the number of neighborhoods in Medina increased as the city expanded according to circular urban planning models. Some old neighborhoods disappeared while new suburban quarters emerged. Residents of peripheral neighborhoods occasionally enjoyed privileges, particularly regarding taxation [9:70].

Mahalla Organization During the Umayyad and Abbasid Periods. Following the early Islamic conquests, newly established cities developed according to tribal and military principles. The term *hitta* (plural: *hitat*) was used to designate quarters allocated to specific tribes or tribal groups.

Cities such as Basra, Kufa, Fustat, and Kairouan, initially established for military purposes, gradually evolved into religious, political, and cultural centers. Their neighborhoods were organized around central urban institutions such as mosques, administrative headquarters (*dar al-imara*), hospitals, and markets. Each tribe often occupied its own separate quarter.

For instance, every tribe settled in Kufa possessed a distinct neighborhood. Beginning especially in the Umayyad period, mosques and cemeteries also became important structural components of the mahalla system.

The Umayyad governor al-Hajjaj ibn Yusuf (661–714) founded the city of Wasit along both banks of the Tigris River and divided it into four neighborhoods.

Non-Arabs were prohibited from settling on the western bank, while populations brought from Bukhara and Transoxiana were settled on the eastern side. Similar policies were implemented during the Abbasid period in Samarra, where Turks and people from Ferghana were placed in separate and distant quarters.

Over time, streets developed between tribal quarters and functioned both as connecting routes and as boundaries separating neighborhoods. According to Ibn Kathir, during this period the mahalla generated a strong sense of belonging among its inhabitants, to the extent that individuals were sometimes identified by the names of their neighborhoods [7:338].

Urban Diversity and Religious Coexistence. As Muslim cities evolved, ethnic, tribal, professional, and religious forms of organization became increasingly intertwined. In Baghdad, founded according to political and economic priorities, neighborhoods and districts were organized based on ethnic origins and occupations. Such arrangements facilitated the development of urban units with distinct identities.

In Andalusia, Muslims often settled in suburban neighborhoods. During the tenth century, Cordoba contained twenty-one inner-city quarters and twenty-one suburban neighborhoods inhabited primarily by local Muslims (*muwalladun*). Ibn Hawqal recorded that Palermo in Sicily possessed four neighborhoods, one of which, mainly inhabited by Slavic slaves (*saqaliba*), was separated from the sea by a large wall.

In historic Middle Eastern cities incorporated into Muslim rule, urban structures largely preserved their earlier forms while adapting to newly arriving populations. Cities were divided into quarters according to religious and ethnic affiliation, occasionally separated by walls. For example, in Damascus Christians lived in the northeastern section, Jews in the southeastern part, and Muslims in the western districts [1:323–324].

The spread of Islam eastward into Iran and Turkestan also transformed urban organization. By the eleventh century, Central Asian cities had developed a distinctive structure. Walled cities were divided into neighborhoods according to professions, with craftsmen and occupational groups concentrated in separate mahallas. Ibn Battuta observed that people of different ethnic origins, religions, and professions lived in walled neighborhoods, demonstrating the institutionalization of this system [10:394].

The Mahalla in Anatolia and the Ottoman Empire. Beginning in the late eleventh century, Turkic migrations into Anatolia gradually produced new urban settlement patterns. Initially, Byzantine urban structures were largely preserved; however, new cities and neighborhoods emerged over time as Anatolia underwent a process of Turkification.

Religion played a particularly important role in shaping mahallas in Muslim cities. Some scholars defined the mahalla as “the urban quarter inhabited by families belonging to the congregation of the same mosque” [4:69].

Western researchers have frequently considered the division of Muslim cities into ethnic and religious districts as one of their defining characteristics. Yet the existence of non-Muslim neighborhoods in cities such as Kairouan and Wasit indicates that such divisions also

reflected practical considerations of coexistence and communal autonomy rather than rigid segregation.

In Anatolia, individuals belonging to different ethnic and religious groups generally lived within their own neighborhoods. Nevertheless, under Muslim rule this arrangement was not necessarily regarded as discriminatory. During the Ottoman period, members of different religions often found homes as neighbors within predominantly Muslim quarters, particularly in cities such as Istanbul, Bosnia, and Lebanon. Ottoman archival records reveal that Muslims and non-Muslims frequently lived within the same neighborhoods in Anatolian and former Byzantine cities.

Certain occupational groups also resided in quarters named after their professions, such as “Blacksmiths’ Quarter” or “Coal Sellers’ Quarter.”

Social Functions and Governance of the Mahalla. In classical Islamic cities, commercial and residential zones were generally separated. This separation reflected not only distinctions between private and public space but also the relative autonomy of neighborhoods from direct state interference.

Mahallas managed many local affairs independently, strengthening solidarity among residents. Archival documents indicate that residents of different professions often lived side by side within the same neighborhood.

During the Umayyad and Abbasid periods, neighborhoods were administered by figures known as *ra'is* and *sheikh*. The *ra'is* was appointed by government authorities, whereas the *sheikh* gained legitimacy through social recognition. These leaders maintained order, coordinated aid during crises, and mediated local disputes.

In medieval Baghdad, neighborhood residents organized collectively to combat rising theft and insecurity. Urban militia organizations such as the *ahdas* in Syria and Iraq later evolved into youth organizations known as *zu'ar* during the decline of the Mamluk state.

In Ottoman cities, the mahalla became the fundamental administrative unit. Tax records listed residents according to neighborhoods, and collective responsibility was imposed upon mahalla inhabitants. A commonly repeated principle stated that “the residents of the mahalla are collectively responsible for one another.”

Neighborhood imams played a central administrative role, especially until the nineteenth century. They recorded births, deaths, and marriages, supervised local affairs, collected taxes, and acted as intermediaries between residents and judicial authorities. Non-Muslim neighborhoods were similarly administered by rabbis or priests representing their respective religious communities.

Mixed Neighborhoods and Interreligious Relations. For a long time, historiography promoted a simplified model of the “Islamic city” in which Muslims occupied central districts while non-Muslims lived in strictly separate quarters. Scholars such as Janet Abu-Lughod and André Raymond criticized this schematic interpretation, arguing that urban reality was far more complex [5:155–176].

Heather J. Sharkey notes that until the early twentieth century Muslims, Christians, and Jews in the Middle East frequently inhabited “shared worlds,” using the same markets, streets, and urban spaces while speaking common languages [12:1–26].

Court records, property transactions, and wills demonstrate that non-Muslims often purchased or rented houses within Muslim neighborhoods and vice versa. Such coexistence was especially common in markets, ports, and artisan districts. Shared institutions such as streets, water sources, bathhouses, bakeries, workshops, and systems of neighborhood solidarity reinforced daily interaction despite religious differences [6:831–863].

Studies of Ottoman Istanbul by Cem Behar and Fariba Zarinebaf reveal that many neighborhoods were socially and religiously mixed rather than homogeneous. In districts such as Galata, Balat, and Hasköy, Muslims, Jews, and Christians often lived side by side [14:79–85].

Similarly, Micah Campos’ research on Ottoman Jerusalem demonstrates that even neighborhoods appearing integrated on a broad scale contained localized clusters of specific religious communities [2:133–169].

In Central Asia, especially in Bukhara, the mahalla functioned as both a territorial and spiritual institution. Although a distinct Jewish quarter existed in Bukhara, Jewish residents actively participated in the city’s commercial life and maintained close relations with Muslim communities.

CONCLUSION

The coexistence of different religious communities within the framework of the mahalla system represents a historical reality in the Muslim world. The mahalla often enabled diverse groups to live together while preserving their religious and ethnic distinctions. This coexistence was particularly visible in the practical dimensions of urban life, including trade, social interaction, and neighborhood cooperation.

Experiences from Ottoman Istanbul, Jerusalem, Damascus, and Central Asia demonstrate that the mahalla simultaneously preserved religious identities and fostered everyday neighborly and economic relations. Consequently, the mahalla system should be understood not only as an internal communal structure of Muslim societies but also as one of the foundational institutions of multi-confessional urban civilization.

Thus, the historical experience of the mahalla provides important insights for contemporary discussions concerning social integration, intercultural dialogue, and peaceful coexistence in pluralistic societies.

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SAUDI ARABIA-IRAN CONFLICTS AND CHINA'S MEDIATION MISSION

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Tədqiqatın məqsədi – Səudi Ərəbistanı və İran İslam Respublikası arasındakı münasibətləri araşdırmaq, bu münasibətlərin kəskinləşməsinə təsir edən amilləri, iki dövlət arasındakı əlaqələrin tənzimlənməsində Çinin vasitəçilik missiyasını araşdırmaqdır.

Tədqiqatın metodologiyası - Məqalənin hazırlanması zamanı mənbələrin tənqidi təhlili, tarixi-müqayisəli təhlil və xronoloji ardıcılıq metodlarından istifadə edilmişdir. Tətbiq olunan metodlar problemin fundamental şəkildə araşdırılmasına şərait yaratmışdır.

Tədqiqatın aktuallığı – Bu gün regionda gedən proseslər fonunda Səudi Ərəbistanı və İran İslam Respublikası arasındakı münasibətlər, həmçinin İİR və ÇXR arasındakı əlaqələrin araşdırılması aktualdır.

Tədqiqatın elmi yeniliyi - Səudi Ərəbistanı və İran İslam Respublikası arasındakı münasibətlərin Çinin vasitəçilik missiyası fonunda təhlil edilməsi.

Tədqiqatın əhəmiyyəti - Şah hakimiyyəti dövründə İranla Səudi Ərəbistanı arasında münasibətlər müsbət məcrada inkişaf edirdi. Lakin Xomeyni hakimiyyətdə gəldikdən sonra İran İslam Respublikası ilə Səudi Ərəbistanı arasında münasibətlər pisləşməyə doğru inkişaf edirdi. Bunun bariz nümunəsini Yəməndə Səudi Ərəbistanının qanuni hökuməti, İİR-nin isə husi hökumətini müdafiəsində görürük, hətta bu silahlı qarşıdurma ilə müşahidə olunur. İranın şiə kartından istifadə etməsi ərəb dünyasında, o cümlədən S.Ərəbistanında da qarışıqlığa səbəb yaratmışdı. S.Ərəbistanında ümumilikdə şiə əhalisi 10-15%-i təşkil etsə də, ölkənin şərq əyalətində yaşayan əhalinin 60%-i şiə təriqətinə mənsubdur. S.Ərəbistanı terror aktlarının təşkilində iştiraka görə 4 şiənin də olduğu terrorçular haqqında ölüm hökmünün çəxarılması da İran tərəfindən narazılıqla qarşılandı. İran ABŞ-ın müdafiə etdiyi S.Ərəbistanı ilə bir-başə müharibənin mümkünsüz olduğunu yaxşı başa düşürdü. İran liderləri digər taktikadan istifadə edərək, Fələstin xalqını müdafiə adı altında maliyyələşdirdiyi radikal təşkilatlar vasitəsilə öz niyyətini həyata keçirirdi. Əsas isə, İran öz ərazisindən deyil, ərəb dünyasında yerləşdirdiyi radikal təşkilatlar vasitəsilə Yaxın Şərqdə öz maraqlarını təmin etməyə çalışırdı.

S.Ərəbistanı və sanksiyalar məngənəsində sıxılmış İran danışıqlar yolu ilə gərginliyi aradan qaldırmağa səy göstərirdilər. Hər iki ölkə ilə müsbət münasibətdə olan Çinin vasitəçiliyinə önəm verildi. Əslində yuxarıda gətirilən nümunələr məqalənin önəmini önə çıxarır. Müasir dövrdə Səudi Ərəbistanı və İran arasında ziddiyyətlərinin kökünü və səbəbini düzgün anlamadan bu gün Yaxın Şərqdə baş verən siyasi proseslərin nədən qaynaqlandığını bilmərik. Burada, həmçinin Çinin bu iki müsəlman dövlətləri arasında vasitəçilik missiyasını üzərinə götürməsinin məqsədləri də aydınlaşdırılır.

Nəticə - Şin yalnız Səudi Ərəbistanı və İran İslam Respublikası ilə deyil, eyni zamanda İİR və ABŞ münasibətlərinin normalaşmasında da maraqlıdır. Çünki bu ölkələr onun enerji ehtiyatlarının ödənilməsində mühüm rol oynayır.

Abstract

The purpose of the study: The primary objective of this research is to examine the bilateral relations between Saudi Arabia and the Islamic Republic of Iran (IRI), investigate the catalysts behind the escalation of tensions between the two states, and analyze China's diplomatic mediation role in normalizing their relations.

Research Methodology: This study employs critical source analysis, historical-comparative analysis, and chronological sequencing methods. The integration of these methodological approaches facilitates a fundamental and comprehensive investigation of the research problem.

Relevance of the Research: Against the backdrop of current regional geopolitical shifts, investigating the contemporary dynamics between Saudi Arabia and the Islamic Republic of Iran, as well as the strategic relations between the IRI and the People's Republic of China (PRC), is of paramount academic and geopolitical relevance.

Scientific Novelty: The scientific novelty of this study lies in its distinct analysis of the evolving relations between Saudi Arabia and the Islamic Republic of Iran through the specific lens of China's third-party mediation mission.

Significance of the Research: During the Pahlavi dynasty (the Shah's regime), relations between Iran and Saudi Arabia developed within a cooperative framework. However, following Ayatollah Khomeini's rise to power, the bilateral relationship entered a trajectory of severe degradation. A salient contemporary manifestation of this friction is observed in Yemen, where Saudi Arabia supports the internationally recognized legitimate government, while the IRI backs the Houthi movement - a geopolitical rivalry that manifests as a direct armed proxy conflict. Furthermore, Iran's instrumentalization of sectarian dynamics has fueled domestic instability within the Arab

world, including Saudi Arabia. Although the Shia population constitutes approximately 10 -15% of the total Saudi population, they account for 60% of the demographic composition in the country's Eastern Province. Consequently, Saudi Arabia's execution of terrorists, which included four Shia individuals convicted of orchestrating terrorist acts, provoked severe condemnation from Tehran.

Concurrently, Iran recognized the implensibility of engaging in a direct military confrontation with Saudi Arabia due to the latter's strategic alliance with the United States. Adopting an alternative tactical paradigm, Iranian leadership pursued its regional ambitions through the financial sponsorship of radical organizations under the pretext of defending the Palestinian cause. Fundamentally, rather than operating from its sovereign territory, Iran seeks to secure its geopolitical interests in the Middle East by leveraging non-state radical actors deployed across the Arab world.

Trapped in a geopolitical gridlock - with Iran particularly strained under the weight of economic sanctions - both nations eventually sought diplomatic avenues to mitigate bilateral friction. Consequently, pivotal significance was attributed to the mediation of China, which maintains robust, positive relations with both capitals. The aforementioned cases underscore the profound empirical and theoretical significance of this article. Ultimately, without a precise understanding of the roots and underlying causes of contemporary Saudi-Iranian antagonism, it remains impossible to decipher the core drivers of current political processes in the Middle East. Furthermore, this study elucidates Beijing's strategic imperatives behind assuming a mediatory role between these two major Islamic states.

Conclusion: The findings indicate that Beijing is highly invested not only in stabilizing relations between Saudi Arabia and the Islamic Republic of Iran but also in the potential normalization of ties between the IRI and the United States. This diplomatic interest stems from the fact that these nations play an indispensable role in securing China's long-term energy requirements.

Açar sözlər: S.Ərəbistanı, İran, Çin, Xomeyni, Məkkə, şiə.

Keywords: Saudi Arabia, Iran, China, Khomeini, Mecca, Shia.

GİRİŞ

S.Ərəbistanı və İran arasında ziddiyyətlərin kökü keçmişə dayanır. Səudi Ərəbistanı və İranın müasir tarixinə nəzər salsaq qeyd etməliyik ki, şahın dövründə qərb yönümlü bu iki ölkənin-Tehran və ər-Riyadın münasibətləri dostluq səviyyəsində inkişaf edirdi. Hər iki ölkə ABŞ-la siyasi və iqtisadi əlaqələrə malik idi. Düzdür, 1971-ci ildə İran şahı tərəfindən Ərəb əmirliyinə məxsus üç adanın-Tombe Bozorq, Tombe Kuçək və Əbu Musa adalarının işğalı Səudi Ərəbistanı tərəfindən narazılıqla qarşılanırsa da, münasibətlər gərginlik həddinə çatmadı. Lakin şah hakimiyyəti devrildikdən sonra Xomeyni liderliyində yaranan İran İslam Respublikası ilə Səudi Ərəbistanı arasında münasibətlər çat verməyə başladı. Bu gərginliyi azaltmaq məsədilə Çinin vasitəçiliyindən istifadə etmək fikri gündəmə gəldi.

ARAŞDIRMA

S.Ərəbistanı və İran arasında ziddiyyətlərin kökünə varsaq onun uzaq keçmişdə baş verən siyasi hadisələrdən qaynaqlandığının şahidi olarıq. Əslində bu ziddiyyətlər ərəb işğalları zamanına gedib çıxır. 226-cı ildə Sasani dövlətinin, 630-cu ildə ilk ərəb feodal dövlətinin əsası qoyulmuşdur. Qədim dövlət ənənələrinə malik bir imperiyanı məğlub etmək və onun torpaqlarını zəbt etmək farsların şüurunda və zehniyyətində dərin kök salmışdır. İran tarixçisi Məhəmməd Əli İslami Naduşan qeyd edir ki, "Min ilə yaxın ölkəni özləri idarə etdiklərini iranlılar unuda bilmirlər. Bunun xatirəsi iranlıların yaddaşında bir qəlpə kimi oturur və onları bir dəqiqə belə tərk etmir". (Sokolov, 1978: 119)

Səudi Ərəbistanı müasir sərhədləri ilə dünya siyasi xəritəsində 1932-ci ildə yer almışdır. (Qarayeva, Hacıqədirlı, 2007:11) Səudi Ərəbistanı və İranın müasir tarixinə nəzər salsaq qeyd etməliyik ki, şahın dövründə qərb yönümlü bu iki ölkənin-Tehran və ər-Riyadın münasibətləri dostluq səviyyəsində inkişaf edirdi. Hər iki ölkə ABŞ-la siyasi və iqtisadi əlaqələrə malik idi. Düzdür, 1971-ci ildə İran şahı tərəfindən Ərəb

əmirliyinə məxsus üç adanın-Tombe Bozorq, Tombe Kuçək və Əbu Musa adalarının işğalı Səudi Ərəbistanı tərəfindən narazılıqla qarşılanırsa da, münasibətlər gərginlik həddinə çatmadı. Onu da qeyd etmək ki, şahlıq dövründə ABŞ-İran münasibətlərinin yüksələn xətlə inkişafı zamanı Səudi Ərəbistanı Körfəz regionunda liderlik səviyyəsinə qalxmağa çalışsa da, bir sıra məsələlərdə əsasən "müşahidəçi" mövqeyindən çıxış edirdi. (Qarayeva, Hacıqədirlı, 2012:430)

Lakin şah hakimiyyəti devrildikdən sonra Xomeyni liderliyində yaranan İran İslam Respublikası ilə Səudi Ərəbistanı arasında münasibətlər çat verməyə başladı. Şah İranı ABŞ-ın diktəsi ilə hərəkət etdiyindən Tehranı Vaşinqtonun "jandarmı" adlandırdılar. Lakin inqilabdan sonra İran öz maraqları çərçivəsində çıxış edirdisə, S.Ərəbistanı ABŞ başda olmaqla Qərb müttəfiqlərinin də maraqlarını nəzərə almalı idi. Ərəb dünyasında böyük nüfuz sahibi olan Misirin prezidenti C.Ə.Nasirin vəfatından sonra Yaxın Şərqdə liderlik uğrunda mübarizəyə ər-Riyad da qoşulmuşdu. İranda İslam inqilabının baş verməsi və Xomeyninin ərəb ölkələrində yaşayan şiələri müdafiə etməsi Səudi Ərəbistanının haqlı narazılığına səbəb olurdu. Belə ki, İslam inqilabı Səudi Ərəbistanının neftlə zəngin şərq əyalətlərində yaşayan İranla eyni təriqətin mənsublarının çıxışlarına rəvac verdi. Qeyd etmək ki, S.Ərəbistanında ümumilikdə şiə əhalisi 10-15%-i təşkil etsə də, ölkənin şərq əyalətində yaşayan əhalinin 60%-i şiə təriqətinə mənsubdur. (Mustafabəyli, 2023: 410) İran şiə kartundan istifadə etməklə Suriyada, Lubnəndə, İraqda, Yəməndə, Bəhreynə siyasi və ideoloji fəallığını artırmış və öz mövqeyini kifayət qədər möhkəmləndirmişdi.

70-ci illərin sonunda Yaxın Şərqdə baş verən siyasi hadisələr regionda geopolitik durumu kökündən dəyişirdi. Belə ki, 1978-1979-cu illər İran inqilabı ABŞ-ın və onun müttəfiqlərinin regionda siyasi və iqtisadi maraqlarına ağır zərbə vurdu. (Bağırova, 2003:162)

Şiə din xadimlərindən biri Həsən əs-Səffər 1980-ci illərin əvvəllərində öz tərəfdarlarının iştirakı ilə “Ərəbistan Yarımadasının İslam İnqilabı Təşkilatı (ƏYİİT)” adlı siyasi birliyini yaratdı. **(Mustafabəyli, 2023:410)** Həsən əs-Səffər tələbələr, gənclər və xüsusilə, S.Ərəbistanının iqtisadiyyatında mühüm rol oynaya neft müəssisələrində krallığa qarşı təbliğat aparır, onları üsyana və çıxışlara səsləyirdi. İran İslam inqilabından ruhlanan bu şəxslər mövcud rejimə qarşı çıxışlar təşkil edirdilər. Bağdad da eyni təbliğatı aparan İran İraqa müharibə zamanı şiələrin onu müdafiə edəcəyinə əmin idi və nəticədə, Səddam Hüseynin devriləcəyinə böyük ümid edirdilər. Lakin S.Hüseyn şiələr qarşısında çıxış edərək, İmam Hüseynin ərəblərin babası və həm də ərəb olduğunu qeyd edərək, Xomeynidən fərqli olaraq dini təriqəti deyil, milli mənsubiyyəti önə çəkdi və şiələrin xeyrinə bir sıra islahatlar həyata keçirdi. Krallığın rəhbərləri də şiələrin çoxluq təşkil etdiyi şərq əyalətində mənzil tikintisi həyata keçirdi, məktəblər və xəstəxanalar açdı. Lakin bu tədbirlər gərginliyi kifayət qədər azaltmadı. 1987-ci ildə bir qrup iranlı zəvvarın Məkkədə səudiyyəli şiələrin də qatıldığı icazəsiz Amerika və İsrail əleyhinə yürüş təşkil etdikdə şiələrlə şiddətli toqquşmalar baş verdi. Nümayişlərin dağıdılması zamanı 402 nəfər həlak olmuş, 640 nəfər yaralanmışdı. **(Mustafabəyli, 2023:410-411)**

Səudi Ərəbistanı başda olmaqla Körfəz ölkələri tərəfindən regionda artan fəaliyyətini nəzərə alaraq, İranla münasibətləri məcrasına salmaq istiqmətində sayılar göstərildi. 2007-ci ildə Fars Körfəzi Ərəb Dövlətləri Əməkdaşlıq Şurasının üzv dövlətləri İranla münasibətləri normallaşdırmaq məqsədilə İİR-nın FKÖDƏŞ-nın hər il keçirilən görüşlərində müşahidəçi kimi iştirakı təşəbbüsünü irəli sürdü. **(Kulaqina, Axmedov, 2014:481)** 2012-ci ildə Səudi Ərəbistanı kralı İİR-nın prezidenti M.Əhmədinecatı İÖT-da görüşdə iştiraka dəvət etdi. **(Kulaqina, Axmedov, 2014:481)** Lakin göstərilən söylər elə bir əhəmiyyət daşımadı.

2015-ci ilin sentyabrında Səudi Ərəbistanında həcc ziyarətində ayının keçirilməsi zamanı yüzlərlə iranlının sıxlıq zamanı ölməsində Tehran ərə-Riyadı düzgün təşkil etməməkdə günahlandırdı, S.Ərəbistanının rəsmi şəxsləri isə İranı faciədən siyasi məqsədlər üçün istifadədə təqsirləndirdi. **(Çernyak, 2023:142)** 2016-cı ilin yanvar ayında növ Lakin şah hakimiyyəti devrildikdən sonra Xomeyni liderliyində yaranan İran İslam Respublikası ilə Səudi Ərəbistanı arasında münasibətlər çat verməyə başladı. bəti terror aktı törədildi. S.Ərəbistanı terror aktlarının təşkilində iştiraka görə 47 nəfər ölüm hökmü çəxarıldı ki, onlardan əl-Qaidə ilə əlaqəsi olan 43 cihadçı və Şeyx Nimr ən-Nimr də daxil olmaqla dörd şiə də var idi. **(Mustafabəyli, 2023:411)** İran buna kəskin reaksiya verdi, S.Ərəbistanının Məshəddəki konsulluğu, Tehrandakı səfirliyi yandırıldı. **(Mustafabəyli, 2023:411)** S.Ərəbistanının şiə dini xadimi Nimr əl-Nimri edam etməsi bir çox ölkələrdə şiələrin ardıcıl çıxışlarına səbəb oldu, Tehrandakı isə etirazçılar S.Ərəbistanının səfirliyinə hücum etdilər. **(Çernyak, 2023:142)** Nəticədə, ərə-Riyad Tehranla diplomatik münasibətləri kəsdi.

Bildiyimiz kimi, dövlətlərin maraqları Yaxın Şərqi sonu bilinməyən münaqişə ocağına çevirmişdir. Ərəb dünyasında baş verən bir sıra münaqişələrlə yanaşı İranla Səudi Ərəbistanı arasında siyasi və dini zəmində ziddiyyətlər daha qabarıq görünür. Bunu Yəmənə timsalında da görürük. 1979-cu ildə İran İslam inqilabı nəticəsində real hakimiyyəti əlində cəmləşdirən Xomeyni şiə inqilabını ixrac edəcəyini və İraqda müqəddəs yerlərin İranın idarəsinə verilməsi və digər tələblər S.Ərəbistanı tərəfindən ciddi narazılıqla qarşılandı. **(G.Q.)** Əslində Xomeyninin yeritdiyi bu kurs “islami inqilabı”nın ixracı yolu ilə “ümumdünya müsəlman dövləti” yaratmaq planının bir hissəsi sayıla bilərdi. **(İsmayıl, Axundova, Bağirova 2008:47)** İranın şiə inqilabının ixracına cavab olaraq S.Ərəbistanı vəhhabi təlimini ixrac etməyə başladı. Bu təsir Qafqazda da özünü büruzə verir. İslam inqilabının təsiri altında S.Ərəbistanında nəinki şiələrin, həmçinin bu dövlətin təməlini qoyan vəhhabilərin çıxışları baş verdi. Vəhhabilər hətta noyabrın 29-da Məkkəni tutsalar da, kral üsyançıları zərərsizləşdirdi.

S.Ərəbistanı ilə bir-baş müharibənin mümkünsüzlüyünü başa düşən İran liderləri nəinki ərə-Riyada, əslində ərəb dünyasına qarşı mübarizəni həmin ərəzilərdə Fələstin xalqını müdafiə adı altında yaratdığı və maliyyələşdirdiyi Hizbullah, Ənsar Allah, HAMAS, İslami-Cihad və sairə radikal təşkilatlar vasitəsilə həyata keçirirdi. Bu da Yaxın Şərqdə qaynar nöqtələrin yaranmasında mühüm rol oynayırdı. 1995, 1996, 2000-2004, 2014-2017-ci illərdə baş verən terror hücumların hədəfi ABŞ hərbi bazaları və diplomatik nümayəndəlikləri, xarici mülki mütəxəssislərin yaşayış kompleksləri, məscidlər və şiə məbədləri olmuşdur. **(Mustafabəyli, 2023:410-411)**

Məkkə və Mədinənin Səudi Ərəbistanında yerləşməsi ərə-Riyada dini zəmində ərəb dünyasında liderlik etmək haqqını verirdi. Lakin Tehran S.Ərəbistanının müqəddəs yerlərə qəyyumluq iddiasını qəbul etmirdi və həmin yerlərin 90% şiənin yaşadığı İrana verilməsi fikrini irəli sürdü. Beləliklə, S.Ərəbistanı və İran arasında ideoloji və geosiyasi rəqəbat gedirdi.

S.Ərəbistanı İranla isti münasibətlərdə olan Qatara qarşı diplomatik hücumla keçdi, Dohanı terror təşkilatlarına sponsorluq etməkdə təqsirləndirdi və bir sıra ərəb ölkələri, o cümlədən S.Ərəbistanı, Bəhreyn, Misir, Yəmən və Libiya müvəqqəti hökuməti diplomatik münasibətlərini kəsdiqlərini elan etdilər.

İran Körfəz ölkələrində mövqeyini möhkəmləndirməyə çalışırdı. ABŞ-ın Səudi Ərəbistanı vasitəsilə öz maraqlarını Körfəz regionunda təmin etmək niyyəti ərə-Riyadın Vaşinqton vasitəsilə kənar qüvvələrin, xüsusilə İranın təsirinin qarşısını almaq istəyi ilə üst-üstə düşürdü. Belə bir durumda ərə-Riyad təşəbbüsü ələ aldı. Körfəz ərəb monarxiyalarının S.Ərəbistanının fəal iştirakı ilə 1981-ci ilin mayında daxil olduğu Fars Körfəzi Ərəb Dövlətlərinin Əməkdaşlıq Şurası (Körfəz Əməkdaşlıq Şurası-KƏŞ) yaradıldı. Təbii ki, Vaşinqtonun xeyir-duası ilə yaradılan bu şura təhlükəsizliyin qorunması məqsədilə ABŞ-la əməkdaşlığa önəm verirdi. Körfəz ölkələri “böyük qardaşları” hesab etdikləri Səudi Ərəbistanının rəyi və fikrini əsas götürürdülər. Təsədüfi deyildir ki, ABŞ prezidenti Karter 1980-ci il yanvarın 23-də verdiyi müsahibəsində Fars körfəzinin nəzarətini ələ keçirmək məqsədilə

ediləcək hər bir müdaxiləni ABŞ-ın həyatı maraqlarına qarşı törədilmiş bir hücum kimi qiymətləndirəcək və bu hücumun dəf edilməsi üçün silah da daxil olmaqla hər cür vasitəyə əl atacağını bildirmişdi. **(Qarayeva, Hacıqədirlı, 2012:432-433)** Körfəz müharibəsindən sonra KƏŞ-nin üzvləri 10 minlik Birləşmiş Silahlı Qüvvələr yaratmışdır ki, onun da maliyyələşdirilməsində ABŞ-ın payı 20% təşkil etmişdir.

90-cı illərin ortalarında Səudi Ərəbistanında yerləşən ABŞ hərbi bazası partladıldı. Aparılan təhqiqatlar nəticəsində burada Hizbullahın fəaliyyət göstərməsi haqqında məlumatlar dünya səhifələrində özünə yer almış oldu və həmin bazanın partladılmasını isə İran vətəndaşı həyata keçirmişdi. **(Qarayeva, Hacıqədirlı, 2012:432-433)** Məhz bu terror aktında sonralar əl-Qaidə təşkilatının lideri Usama ben Ladenin əli olduğu fikri sərgiləndi. O, Səudi Ərəbistanı vətəndaşlığından çıxarılmış və ölkədən deport edilmişdir. Bu fakt Tehranın ben Ladenlə əlaqələrinin heç də yaxın zamanlarda başlamadığını söyləməyə əsas verirdi.

S.Ərəbistanı ilə İran arasında münaqişələr hər iki tərəfə sərf etmirdi. İran ətrafında halqa daralır. İran ətrafında baş verən proseslər Tehranın xeyrinə işləmirdi. Müttəfiqi Rusiya Ukrayna bataqlığına düşmüşdü, İsrail tərəfindən Yaxın Şərqdə İranın siyasətini həyata keçirən radikal təşkilatları zəiflədilmişdi. Tehran ərə-Riyadla müharibə aparmağın ona sərf etməyəcəyini başa düşürdü. İranın əhalisi S.Ərəbistanı əhalisindən 2,5 dəfədən çoxdur, yəni 2023-cü il məlumatına əsasən İranın əhalisi təxminən 88,5, Səudi Ərəbistanında isə 33,26 milyon nəfər olmuşdur. Buna uyğun olaraq silahlı qüvvələrinin sayı da 2 dəfə artıqdır. Lakin İİR-nin hərbi büdcəsi əhəmiyyətli dərəcədə Səuidən azdır, yəni müvafiq olaraq 22 mlrd və 62 mlrd dollar civarındadır. **(İvanov, 2020:18)** Müdafiə potensialına görə də S.Ərəbistanı İrandan üstün mövqedədir. Bununla yanaşı, Rusiya İrana müdafiəsini açıq-şəkildə etməyəcəkdi, baş verən son hadisələr bunu sübut edir. S.Ərəbistanının arxasında isə ABŞ və Körfəz Əməkdaşlıq Şurasının üzv dövlətləri dururdu. Xatırladaq ki, İran-İraq müharibəsi ərəb dünyasını iki yerə parçalamışdı: Suriya və Libiya İranı, digər ərəb ölkələri isə İraqı müdafiə etdilər. Lakin hal-hazırda müharibə baş verəcəyi təqdirdə bütün ərəb ölkələri S.Ərəbistanını müdafiə edəcəkdi.

Çox güman ki, Körfəzdə yerləşdirilmiş ABŞ-ın 40 min hərbi qulluqçusu olan 15-dən artıq hərbi bazaları münaqişə baş verəcəyi təqdirdə ərə-Riyad tərəfindən çıxış edəcəkdi. ABŞ-ın sanksiyaları artırması və digər göstərilən səbəblər İranı S.Ərəbistanı ilə yaxınlaşmağa vadar edirdi. İranın müdafiə etdiyi husilərin ərə-Riyadı strateji əhəmiyyətli neft obyektlərini hədəf götürməsi və müasir silahlardan ölkəni atəşə tutması, onu maddi və maliyyə itgilərinə məruz qoyması kimi amillər S.Ərəbistanını da danışıqlara getməyə vadar edirdi. 2019-cu il sentyabrın 14-də pilotsuz uçan aparatlar və qanadlı raketlərdən istifadə edərək, Yəmən husiləri S.Ərəbistanının Xuraisə neft yataqlarına və Abkaik neft yataqlarını ilkin təmizləyən müəssisələrinə uğurlu hücumlar həyata keçirmişlər. **(İvanov, 2020:19)** S.Ərəbistanı və ABŞ bu hücumu təşkil etdiyinə görə Tehranı günahlandırdılar.

Bu iki ölkə arasında münaqişələrin baş verməsi bir çox dünya ölkələrini qane etmirdi. Çünki Hörmüz boğazından həcmi təxminən 20% və sıxılmış qazın 25% dünya neft bazarına məxsus tankerləri keçir, bu rayonda istənilən silahlı münaqişə dünyada maliyyə-iqtisadi böhranı dərinləşdirə bilər. 2025-ci ildə baş verən İsrail-İran müharibəsində Tehran Hörmüz boğazını bağlayacağı ilə hədələyirdi. Bu gün bu hadisə baş verdi.

Artıq hər iki müsəlman dövləti bu çəkişmələrin nəticələrinin nə S.Ərəbistanına, nə də İrana xeyir gətirməyəcəyini başa düşürdülər. Elə bu məqsədlə də, 2021-ci ildə İran Səudi Ərəbistanına diplomatik əlaqələri bərpa etmək məqsədilə danışıqlar təklif etdi və bu istiqamətdə fəaliyyətə başladı. Ər-Riyad da öz növbəsində güzəşt xarakterli müəyyən tədbirlər həyata keçirdi. Məsələn, 2021-ci il yanvarın 5-də Səudi Ərəbistanının əl-Ula şəhərində keçirilən Körfəz Əməkdaşlıq Şurasının (KƏŞ) sammitində Doha ətrafında diplomatik böhrana son qoyulması, quru, dəniz və hava blokadasının qaldırılmasına dair saziş imzalandı. **(Mustafabəyli, 2023:411)** Səudi Ərəbistanı və İran arasında vasitəçilik üçün Bağdad seçildi və İraqın baş naziri Mustafa əl-Qadiminin başçılığı altında hər iki tərəfin nümayəndələrinin iştirakı ilə görüş baş tutdu. Belə ki, 2022-ci ildə İran və Səudi Ərəbistanının iştirakı ilə Bağdadda müntəzəm olaraq beş raund keçirildi, lakin İraqda hökumət dəyişikliyi, yəni yeni baş nazir Məhəmməd əş-Şiə Sudani hakimiyyətə gəldikdən sonra danışıqların davam etdirilməsinə xüsusi maraq göstərmədi. **(Çernyak, 2023:142)** Küveyt, Oman, Qatar, hətta Pakistan bu iki ölkə arasında vasitəçilik etməyə hazır olduqlarını ifadə etdilər.

Lakin bu iki ölkə arasında sülh müqaviləsinin uzunmüddətli olmayacağı haqqında fikirlər ifadə olunurdu. Bu fikirləri əsaslandıran bir sıra amillər sırasında İranın ərəb ölkələrində yaşayan şiələrin müdafiəsindən imtina etməyəcəyi iddiasıdır, Huzbullah təşkilatı və Yəməndə husilərin onun bu regionda möhkəmlənmək üçün yeritdiyi siyasətin dayaq nöqtəsidir. Öz növbəsində, Səudi kralı da müsəlman dünyasında əksəriyyət təşkil edən ərəb-sünnilərin dominant rolunu qoruyub saxlamağa çalışacaqdır.

2012-ci ildə Çində Si Tsinpinin Çin Kommunist Partiyasının baş katibi vəzifəsinə gəlməsindən sonra Pekin diplomatlarının beynəlxalq vasitəçilikdə rolu əhəmiyyətli dərəcədə artmışdır. **(Çernyak, 2023:141)** 1922-ci ilin dekabrında Tsinpin ərə-Riyada səfər etdiyi zaman S.Ərəbistanı Çinə danışıqlar prosesində vasitəçilik rolu oynamasını təklif etdi. Si Tsinpinin sorğusuna cavbda Tehran Çinin vasitəçiliyinə razı olduğunu bildirdi.

2023-cü ilin fevralında İran prezidenti İbrahim Rəisi Çinə səfər etdi və Si Tsinpinlə görüşdü. İran S.Ərəbistanı ilə əlaqələrin bərpa olunmasını məqbul hesab etmişdir. Lakin İran Səudi Ərəbistanını ölkəsinin daxili işlərinə qarışmamasını, fars dilində yayımlanan İran İnternasional xəbər kanalının maliyyələşdirməsini dayandırmağı, həmçinin öz ordusunu Yəməndən tamamilə çıxarmağı və Ənsarullah (Husi) liderini ölkənin qanuni hakimiyyəti kimi tanımağı, İran müxalif qüvvələrinə yardımı dayandırmağı şərt kimi irəli sürdü. **(Çernyak, 2023:142-143)**

Seyid Əli Xameneinin müşaviri Əli Şamxani martın 5-də Çinin dövlət katibi və keçmiş xarici işlər naziri Van İ və Səudi Ərəbistanının milli təhlükəsizlik üzrə müşaviri Musaid bin Muhəmməd əl-Eybaninin iştirak etdiyi üçtərəfli görüşün gedişində müqavilənin şərtlərini tam razılaşdırmaq məqsədilə Pekinə səfər etdilər. **(Çernyak, 2023:143)**

Beləliklə, 2023-cü il martın 10-da Çinin vasitəçiliyi ilə İran və S.Ərəbistanı arasında müqavilə bağlandı. Bu tarixi müqavilə bağlandığı andan iki ay ərzində diplomatik münasibətlər və səfirlik yenidən bərpa edilməli idi.

Çin İran və S.Ərəbistanı arasında münasibətlərin inkişafında maraqlıdır. Enerji mənbələrinə malik Yaxın Şərq Çinin iqtisadiyyatı üçün tələb olunan həmin enerji resurslarını verə bilən region kimi böyük əhəmiyyət daşıyırdı. Bu ölkələrin başında isə İran və Səudi Ərəbistanı gəlirdi. Çinin neft ehtiyacının 40 faizdən çoxunu yalnız ərəb ölkələri ödəyir. Bu vəziyyətdə Çinin iqtisadi artımını yenidən artırmaq və Yeni İpək Yolu Layihəsini həyata keçirmək üçün Yaxın Şərqə ehtiyacı var.

2021-ci il martın 27-də İran İslam inqilabı ilə Çin Xalq Respublikası arasında Tehrandə 25 illik hərtərəfli strateji tərtəfdaşlıq haqqında müqavilə imzalandı. Bu müqavilənin əsasında “bir kəmə, bir yol” layihəsi də dayanır. “İranın 34 trilyon kubmetr təbii qaz ehtiyatı dünya ehtiyatlarının 16,49%-ni təşkil edir. Mövcud 208,6 milyard barel neft ehtiyatı dünya ehtiyatlarının 11,72%-ni təşkil edir. Son məlumatlara görə, İran təbii qaz ehtiyatlarına görə Rusiyadan sonra ikinci, neft ehtiyatlarına görə isə Venesuela və Səudiyyə Ərəbistanından sonra üçüncü yerdədir”. **(Koç, Çetin, 2025:131)** Çin əks mövqelərdə duran həm Səudi Ərəbistanı, həm də İranla çox gözəl münasibətlərdədir. Bu, Çinin Yaxın Şərq bölgəsində böyük təsir göstərməsinə və bununla da global mövqeyini gücləndirməsinə imkan verir. Digər tərəfdən, 2023-cü ildə Çinin İranla dron hissələri tədarük etdiyi və bu hissələrdən Rusiyanın Ukraynada istifadə etdiyi də məlumdur. **(Koç, Çetin, 2025:136)** Yeni nəsil raket və raket texnologiyasının ötürülməsi üçün danışıqlar davam etsə də, məhdud siyasətlər həyata keçirilib.

İranla S.Ərəbistanı arasında vasitəçilik missiyasını öz üzərinə götürən Pekinin Tehranla münasibətlərinin yaranmasının tarixi keçmişlərə dayansa da, XX yüzilliyin ortalarından etibarən bu iki ölkə əks qütblərdə dururdu. Məlumdur ki, Soyuq müharibənin təsiri altında dünya iki qütblü sistemə bölünmüşdü. İdeologiyalarının fərqliliyi baxımından Məhəmməd Rza şah Pəhləvi Çinlə diplomatik münasibətləri kəsdi. Buna səbəb isə Sovet İttifaqının yardımını ilə yaranmış 1949-cu ildə Çin Xalq Respublikasının elan edilməsi idi. 1960-cı ildən başlayaraq Sovet İttifaqı ilə Çin arasında gərginliyin yaranması Tehranın Pekinə qarşı münasibətində dəyişikliyə səbəb oldu. Şah İranı ilə yaxınlaşmanın ən yaxşı nümunəsi 1971-ci ildə Tehranın Çinin BMT üzvlüyünü dəstəkləməsi oldu. **(Gentry, 2005:113)** Çin İran İslam Respublikası yarandıqdan sonra onu tanıdığını və Qərb əleyhdarlığına əsaslanan xarici siyasət kursunu alqışladı. Müsəlman dünyasında liderlik iddiasında olan İran Pekinin müsəlman uyğurlara qarşı təzyiqinə göz yumur. Çinin BMT-də

veto hüququna malik olması və ondan yararlanma biləcəyi gözləntisi Tehranı Pekinin müsəlmanlara qarşı tədbirlərinə göz yummaq məcburiyyətində qoyur. Bu isə İranın müsəlman həmrəyliyi qorumaq niyyətindən deyil, öz şəxsi maraqlarını müdafiə etməsindən qaynaqlanır. İran-İraq müharibəsi zamanı Pekin Tehranı silahla təmin etmiş, sonrakı illərdə də yardımını əsirgəməmişdir. 1980-ci illərdə İranın nüvə proqramının davamı üçün gizli formada texniki dəstək vermişdir.

Yaxın Şərqdə hərbi-siyasi durumun qeyri sabit olması Çin-İran və Çin-Səudi Ərəbistanı münasibətlərinə mane olan amillərdəndir. Lakin Çin diplomatiyasının üstünlüyü ondadır ki, bir-biri ilə düşmənçilik səviyyəsində olan İran və S.Ərəbistanında öz maraqlarını təmin etməyi bacarmışdır. Çinin Vaşinqtonun iki əsas (İsrailə birlikdə) regional müttəfiqlərindən biri olan Səudi Krallığı ilə strateji dialoq qurması Çin-Amerika rəqabətinin artmasına kömək edir, lakin bu, gizli xarakter daşıyır və açıq qarşıdurma səviyyəsinə çatma bilməyəcəkdir. **(Valiaxmetova, Qerman, 130)** Çinə olan inam sayəsində rəqabətdə olan bu iki ölkə Pekini vasitəçi qismində görmək istəmişlər. 2025-ci il İsrail-İran müharibəsinin bu regionda Çinin əlaqələrinə mənfi təsir göstərəcəyi qaçılmazdır. Əgər Tehrandə rejim dəyişikliyi baş verərsə, Çinlə rəqabətdə olan Vaşinqton Pekinin burada mövqeyinə təsir göstərərək, Pekinin “Bir Kəmə, Bir Yol” layihəsinin reallaşmasını şübhə altına almış olacaqdır.

Səudiyyə Ərəbistanı müasir beynəlxalq münasibətləri araşdıraraq xarici əlaqələrində tarazlıq yaratmaq məqsədilə Çinlə əlaqələrini gücləndirmək istiqamətində fəaliyyət göstərir. Bu da, Səudi rəsmilərinin Çinə çoxsaylı səfərləri ilə artması ilə müşahidə olunur. Kral Feysəlin səfəri Səudiyyə monarxının hicri təqviminə 1391-ci ilin 22 rəbiüləvvəl ayında (20 may 1971) Çinə ilk səfəri idi. İkinci səfər isə Əlahəzrət Şahzadə Abdullah bin Əbdüləzizin hicri təqviminə 14 rəcəb ayında (14-21 oktyabr 1998) baş tutdu. **(Əl-Maliki, 2014: 91)**

Çinin enerji resurslarına tələbatı əks qütblərdə duran İran və S.Ərəbistanı ilə iqtisadi əlaqələrə böyük önəm verməsini şərtləndirirdi.. Neft Səudi-Çin münasibətlərinin inkişafında ən mühüm amil olmuşdur. Buna görə də, Çin bu ölkələr arasında düşmənçilik münasibətlərinə son qoyulmasında maraqlı idi. Elə bu məqsədlə də, tərəflər arasında sülh müqaviləsinin imzalanmasında vasitəçi rolunu üzərinə götürməyə razılıq verdi. Çünki Çinin Səudi Ərəbistanı ilə münasibətdə siyasəti iqtisadi maraqlar və enerji amili üzərində qurulmuşdur.

Hər iki tərəf Çinin vasitəçi qismində 2023-cü il martın 10-da Pekində əldə olunan İran-Səudi Ərəbistanı barışıqından sonra əlaqələrin və əməkdaşlığın bərpasının mümkünlüyünü müzakirə ediblər. **(Mustafabəyli, 2023)** İran və Səudi Ərəbistanı Krallığı (SƏK) 2023-cü il mayın 1-dən Ər-Riyad və Tehrandakı səfirliklərinin, həmçinin Ciddə və Məşhəddəki baş konsulluqlarının işini bərpa edib.

Çin Kommunist Partiyası Mərkəzi Komitəsinin Xarici Əlaqələr Komissiyası ofisinin direktoru və Çin Kommunist Partiyası Mərkəzi Komitəsinin Siyasi Bürosunun üzvü Vanq Yi deyib: İran-Səudiyyə

razılaşmalarının xüsusi əhəmiyyəti ondan ibarətdir ki, onlar dünyanın bir çox qarşıdurmalara qərq olduğu bir vaxtda əldə olunmuşdur". (Mustafabəyli, 2023:412)

BƏƏ-nin xarici işlər və beynəlxalq əməkdaşlıq naziri Şeyx Abdullah bin Zayed əl-Nəhyan qeyd edib ki, qardaş Səudiyyə Ərəbistanı ilə İran arasında münasibətlərin bərpası regionun çiçəklənməsi istiqamətində mühüm addımdır. (Mustafabəyli, 2023:412)

Lakin münasibətlərin müsbət məcrada inkişafına İran-İsrail, ABŞ müharibəsi fonunda İrandan birbaşa raket və dron zərbələrinin Səudi Ərəbistanının infrastrukturuna təsir etməsi münasibətləri zədələmiş oldu. Buna baxmayaraq, Səudi Ərəbistanı İranın bölgədəki hərbi addımlarını pisləse də, ABŞ-ın İranla apardığı danışıqlarda Səudi Ərəbistanı neytral və təmkinli mövqe nümayiş etdirərək, hər iki tərəflə münasibətləri qorumağa çalışır. Səudi Ərəbistanı öz təhlükəsizliyini təmin etmək üçün ABŞ-la əlaqələrini saxlayır, həmçinin Tehranın təzyiqlərini azaltmaq istiqamətində Vaşinqton və Təl-Əvivlə strateji müzakirələr aparır.

Dünyada ABŞ-in İrana müdaxiləsinə yanaşmalar müxtəlifdir. Vaşinqtonun İrana müdaxiləsinə haqq qazandıranlar olduğu kimi, tənqid edənlər də kifayət qədərdir. Bəziləri bunu hegemonluğun azalması fonunda dominantlıq yaratmaq cəhdi kimi görürlər. Məsələn, Çinin rəsmi dövlət xəbər agentliyi olan Xinhua, suveren dövlətə açıq şəkildə hücum etmək və rejim dəyişikliyi üçün təzyiq göstərmək təcrübəsini güc siyasətinin və hegemonluğun açıq-aşkar nümayişi kimi xarakterizə etdi (Xinhua 2026). (Gupta, Jargad, 2026:4)

Çinin hadisələrə münasibəti də maraq doğurur. Çin hökumətinin Yaxın Şərq məsələsi üzrə xüsusi elçisi Çjay Cunun 5 martda regiona göndərilməsi Pekinin böhranın idarə olunmasında iştirak etmək niyyətini göstərir. (Zhang, 2026:4) Çinin oynaya biləcəyi birbaşa rollardan biri diplomatik vasitəçi kimi çıxış edə biləcəyidir. 2023-cü ildə İran-Səudi Ərəbistanı yaxınlaşmasının asanlaşdırılmasındakı roluna əsaslanaraq, Pekin özünü rəqib aktyorları dialoq üçün bir araya gətirə bilən bir güc kimi təqdim etməyə çalışır. (Zhang, 2026:4) Çinin baş verən proseslərə münasibətində Pekinin hazırkı böhrandakı rolu hərbi deyil, diplomatik və iqtisadi olaraq qalacaqdır.

NƏTİCƏ:

Çin İran və S.Ərəbistanı arasında ziddiyyətlərin aradan qalxmasında və hər iki ölkə arasında münasibətlərin inkişafında maraqlıdır. Çünki hər iki ölkə Çinin iqtisadiyyatı üçün tələb olunan enerji resurslarını verir. Bu ölkələrin başında isə İran və Səudi Ərəbistanı gəlirdi. Bununla yanaşı, Yeni İpək Yolu Layihəsini həyata keçirmək üçün Yaxın Şərqə ehtiyacı var. Bu səbəblərdən irəli gələrək, tərəflər arasında sülh müqaviləsinin imzalanmasında vasitəçi rolunu üzərinə götürməyə razılıq verdi. ABŞ-ın İran müdaxiləsinə gəldikdə isə Çinin baş verən proseslərə münasibəti hərbi deyil, diplomatik və iqtisadi olacaqdır.

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ҚАЗАҚ ДАЛАСЫНДАҒЫ ДӘСТҮРЛІ БИЛІК ҚҰРЫЛЫМДАРЫНЫҢ ОТАРЛЫҚ РЕФОРМАЛАР ҰҚПАЛЫНДА ӨЗГЕРҮІ ЖӘНЕ ТАРИХИ НӘТИЖЕЛЕРІ

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CHANGES IN THE TRADITIONAL POWER STRUCTURES OF THE KAZAKH STEPPE UNDER THE INFLUENCE OF COLONIAL REFORMS AND THEIR HISTORICAL CONSEQUENCES

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Аннотация

XVIII ғасырдың ортасынан бастап Ресей империясының отарлау саясаты қазақ қоғамының дәстүрлі хандық билік жүйесіне үлкен өзгеріс әкелді. Ресей әкімшілік-саяси басқару жүйесін енгізу арқылы қазақ қоғамының әлеуметтік-саяси құрылымына ықпал етті. Нәтижесінде хандық билік әлсіреп, сұлтандар мен хандардың қоғамдағы маңызы төмендеді. 1822 жылғы «Сібір қазақтары туралы Жарғы» бойынша Орта жүздегі хандық билік жойылып, қазақ жері округ, болыс, ауылдарға бөлінді.

Abstract

Beginning in the mid-18th century, the colonial policy of the Russian Empire led to significant changes in the traditional system of khan authority in Kazakh society. Through the introduction of an administrative and political system of governance, Russia influenced the socio-political structure of Kazakh society. As a result, the power of the khans weakened, and the role of khans and sultans in public life declined. According to the “Statute on the Siberian Kirghiz” of 1822, the khan authority in the Middle Zhuz was abolished, and Kazakh lands were divided into districts, volosts, and auls.

Кілт сөздер: болыс, құрылым, Ресей империясы, хандық билік, жарғы, құжат, дерек.

Keywords: volost, structure, Russian Empire, khanate power, statute, document, source.

XVIII ғасырдың ортасында Қазақстанда хандық биліктің жүйесін қазақ қауымының потестарлы-саяси ұйымына әсер ететін, өзгеріске әкелгені Ресей империясының қазақ жерінде жүргізілген отарлау саясаты елеулі рөл атқарды. Әр түрлі кешенді факторлардың әсерінен қазақ қоғамында үлкен өзгерістер пайда болды.

Қазақ қоғамында әлеуметтік сүйеніш іздеуде ресейлік империяның әкімшілік-саяси жүйесі қазақтардың әлеуметтік-саяси, дістүрлі құрылымына енуі арқылы, қазақ жерінде Ресей империясының мақсаттары мен міндеттерін жүзеге асыратын жаңа функцияларды орындау үшін, әскери-саяси күштерді ойластырды [1,75].

Ресей империясының билігін заңнамалы түрде бөліп, соның нәтижесінде көшпелі қоғамның дәстүрлі саяси институты, яғни сұлтандар, хандық билік қоғамның шаруашылық және қоғамдық дамуының динамикалық тепе-теңдігін қамтамасыз ететін әлеуметтік байланыстағы өзіндік негізгі рөлін біртіндеп жоғалып, соңында осы қоғамның құрылымындағы өздерінің орнымен маңыздылығын жоғалтты.

Ресей империясы әкімшілік-аумақтық басқару нысанына жақын басқару нысанының болмауы Шыңғыс ұрпақтарының хан билігінің сақталуы патша үкіметінің іс қимылын тежеп отырды. 1817 ж. – Бөкей хан, 1819 ж. – Уәли қайтыс болғаннан кейін Орта жүзге хан тағайындалмады. Жарғының басты мақсаты – Қазақстанның солтүстік шығыс өңірін әкімшілік, сот, саяси жағынан басқаруды өзгерту, рулық-феодалдық тәртіптерді әлсірету, ре-

сейлік губерниялық басқаруға біржолата бағындыру. Сонымен қатар қазақ даласында ертеден келе қалыптасқан рулық феодалдық тәртіптерді әлсірету. Орта жүздегі хандық билікті жою. Жарғы бойынша «Сібір қазақтарының облысы» әкімшілік тұрғыда округ – болыс - ауыл болыпосындай тәртіптегі жүйеге бөлінді. Округке 15-20 болыс, болысқа 10-12 ауыл, ауылға 50-70 шаңырақ (үйлер) кірді. Округ басшылығында округтық приказдар болды [2,93].

Ал округтық приказдарды қазақтар дуан деп атаған. Округтарды формальді түрде аға сұлтан басқарды. Болыс басшылығында болыс сұлтаны тұрды, олар округтық приказға бағынды. Ауылдарды 3 жыл сайын сайланатын ауыл старшындары басқарды. Оларды халық сайлағанымен округтық приказ бекітіп отырған. Болыстар сұлтанға бағынды. Хандық билік толығымен жойылды. Бұл жарғының негізі дәстүрлі хандық билікті жоя келе, қарапайым қазақ руларының Ресей империясының әкімшілік - аумақтық құрылымдарына бағындыру болды [1,18].

Дәстүрлі хандық биліктің әлсіреп жоюылуынан аға сұлтандардың беделі өсіп, үкіметтің сеніміне кірген Шыңғыс ұрпақтары арасынан сайланған аға сұлтандар, және олардың орынбасарлары – өздері онша түсінбейтін сайлау рәсімдеріне қатысып, алқалы басқару түрін көрсетті. Көп кешікпей аға сұлтандар іс жүзінде жергілікті отаршылдық патша үкіметінің айтқанынан шықпайтын қол шоқпарына айналғандай болды. Осы тұста сұлтандар

арасында бақталастық отын жағып, олардың сенімділігіне қарай округ басшылығына ұсыну жұмыстарымен айналысқан болатын.

«Сібір қырғыздары туралы Жарғы» бойынша хандық билікті жоюды және Орта жүздің Ресей империясының құрамына толығымен енгенін білдіреді.

1824 жылы 8 ақпанда патша өкіметінің жарлығымен бірінші Қарқаралы округтық приказы бекітіледі. Оның басшылығына аға сұлтан, подполковник Тұрсын Шыңғысов отырған болатын. Дәл сол жылы Көкшетау округтық приказыда құрылды. Бұл приказдар патша өкіметінің Қазақ жерін отарлауда маңызды әкімшілік басқару орталығына айналды. 1832 жылы Ақмола округтік приказы ашылып, бұл жерде подполковник Ф.И. Шубиннің экспедициясы келгеннен кейін Қараөткел аймағында Есіл өзенінің оң жағалауына Ақмола бекінісін салу ұйғарылды. Бұндай саясат Орта жүздің ірі руларының қоныстарының, жалпы қазақ жерінің орталығы ретінде өте ұтымды стратегиялық саясат болды. Ақмола округтық приказы Қазақ жеріне ілгерідей енудің мүмкіндіктерін кеңейтті.

1851 жылы мұнда Қазақ жеріндегі Ресейдің 1200 солдатты мен офицерлері орналастырылып, ең ірі әскери орталыққа айналған болатын. 1824 жылы Ресей империясы Орынборда генерал-губернатор П. Эссеннің басшылығымен «Орынбор қырғыздары туралы Жарғы» ны жүзеге асыруға бұйырды. Яғни, Орта жүздегі сияқты енді Кіші жүзде де хандық билік жойылған болатын [4, 486].

Кіші жүзде хандық билік жойылып, Кіші жүздің соңғы ханы Шерғазы Орынборға шақыртылып айлығы төленетін басқа қызметке ауыстырылды. Кіші жүз Жарғы бойынша үш бөлікке бөлінді. Бұл бөліктерді Орынбор губернаторы тағайындайтын сұлтандар басқаратын болды.

Бұл бөліктер дистанцияларға бөлінді. Дистанциялар ауылдарға бөлінді. Дистанцияларды дистанция бастығы басқарды, ал ауылдарды старшындар басқарды. Осы басқару жүйесін губернатор бастаған шекара комиссиясы бақылап билік жүргізіп отырды. Арнайы қазақтар үшін сайлау жүйесі енгізілмеді. Сонымен қатар Кіші жүзде әскери бекіністер бойындағы қазақтар үшін арнайы сот жүйесіне қатысты қамқоршы қызметі тағайындалды. Бұл жерде сот жүйесі ережелерге сәйкес орындалды [5, 185].

Ауыр қылмыстық істер әскери соттар мен шекаралық комиссияның құзырында болды. Ал маңызы төмен істерді жергілікті билер соты қарайтын болды [5, 187]. Зиманов. Сонымен Кіші жүзде хандық билік түбімен жойылды. Ресей империясының Қазақ өлкесін отарлағаннан кейінгі уақыттарында яғни, Кіші жүз бен Орта жүздің соңғы хандары мысалы, 1781 жылы Абылай хан қайтыс болғаннан кейін, Орта жүздегі хандық таққа оның баласы Уәли тағайындалып, ол хандық билікке келгеннен кейін Абылай хан саясатын жалғастыруды көздеп, Қытай үкіметімен дипломатиялық байланыс орнатуға бірнеше әрекеттер жасайды.

Сол себепті патша үкіметі Уәли ханның билігін әлсірету үшін Орта жүзге Бөкей ханды екінші хан етіп тағайындайды. Бірақ, ол 1817 жылы қайтыс

болады Көп ұзамай 1819 жылы Уәли хан да қайтыс болған. Осыдан кейін Орта жүзде хан тағайындалмайды. Кіші жүзде Әбілқайырдың баласы Айшуақтан кейін 1809 жылы хан тағына Шерғазы тағайындалады. Бұл шешімге наразы болған Кіші жүз аға сұлтандары Арынғазыны хан етіп сайлауды жөн көреді.

Арынғазы Әбілғазыұлы (1783–1833) XIX ғасырдың 20-жылдарында қазақ хандықтары жойылар алдындағы кезеңде саяси қызметімен ерекшеленген ықпалды тұлғалардың бірі болды. Ол өзінің саяси әрекетін Хиуа хандығының шектен тыс ықпалына қарсы күрестен бастап, қазақ даласындағы бытыраңқылықты жою және орталықтандырылған тәртіп орнату мақсатын көздеді. Осы мақсатта хандық билікке қарсы күресте Ресей империясымен одақтасуды және оның саяси-әскери әлеуетін пайдалануды тиімді деп санады.

Орынбор әкімшілігімен қарым-қатынас орната отырып, Арынғазы өз иеліктерінде ішкі тәртіпті күшейтуге бағытталған бірқатар реформаларды жүзеге асырды. Атап айтқанда, дәстүрлі түрде хан билігімен қатар ел басқаруға араласқан билердің өкілеттігін шектеді. Қазақ қоғамында бұрыннан қолданылып келген әдет-ғұрып құқықтарының орнына шарият заңдарын енгізіп, билер сотының қызметін қазы-молдалар атқаратын сот жүйесімен алмастырды. Сонымен қатар, халықтан зекет, үшір сияқты діни салықтар жинала бастады.

Арынғазы ел ішіндегі тәртіпсіздіктерге, әсіресе барымта мен шапқыншылыққа қарсы қатаң шаралар қолданды. Барымташылар мен ел арасына іріткі салушыларға қатысты өлім жазасына дейінгі ауыр жазалар белгіледі. Бұл жөнінде Азия департаментіне жолданған құпия хабарламалардың бірінде оның өз маңына беделді батырлар мен ықпалды адамдарды жинап, қоғамдық тәртіпті қалпына келтіру мақсатында бірқатар адамдарды өлім жазасына кескені баяндалады [6, п. 156]. Бұған дейін мұндай жаза билер кеңесінің шешімісіз қолданылмайтын.

Ол басқару мен сот ісіне енгізген өзгерістер арқылы биліктің орталықтануын күшейтті. Арынғазы өзінің діндарлығымен, әділдігімен және жомарттығымен халық арасында үлкен беделге ие болды. Жеке басының ұйымдастырушылық қабілеті мен саяси ерік-жігерінің арқасында қысқа уақыт ішінде ел ішіндегі тұрақсыздықты еңсеріп, халықтың қолдауына ие болды.

Мықты орталық биліктің жоқтығынан ретсіздікке ұшыраған дала өмірін белгілі бір жүйеге келтіріп, нәтижесінде ел ішінде тыныштық пен тәртіп орнады. Арынғазының беделі бүкіл Кіші жүзге және оған шектес Орта жүз аймақтарына тарады. Халық оның ел басқарудағы қызметіне қанағаттанып, хан сайлауды бірауыздан қолдады. Орта жүздің Жұма, Жантөре, Жаһангерей сұлтандары мен Шақшақ Мұса батыр оны өз аймақтарындағы барымталарды тоқтату үшін шақырса, Ұлы жүзде де оны қолдаушылар қатары көбейді. Ел ішіндегі тыныштықты қамтамасыз еткені үшін халық Арынғазыны «Тыным хан» деп атады.

Осы кезде Сұлтанның аталған жетістіктері Ресей империясының жоғарғы билік орындарының да

назарын аударып бастады. Сыртқы істер министрлігінің Азиаттық комитетіне бірнеше жылдан кейін жолданған құпия баяндамада Арынғазының басқарушылық қабілетімен қатар, оның табандылығы мен қатаң мінезінің арқасында 1815–1820 жылдар аралығында көптеген дала билерін өз ықпалына қаратқаны атап өтіледі. Құжат деректеріне сәйкес, ол үкімет бекіткен әлсіз ханнан іс жүзінде билікті тартып алып, басқару тетіктерін өз қолына шоғырландырған.

Аталған мәліметтерде Арынғазының дала аумағында тәртіп орнату мақсатында қылмыс жасаған шамамен қырыққа жуық адамды өлім жазасына кескені көрсетіледі. Бұл шаралар халық тарапынан қолдау тауып, оның билігіне сенім білдірушілердің саны арта түскен. Ол әртүрлі ру өкілдерінен батырлар мен жасақтар жинап, олармен бірге ел аралап, кінәлілерді анықтап, жазалау ісін тікелей өзі басқарған. Нәтижесінде сұлтанның билігіне қарсы келу жағдайлары байқалмаған. Сонымен қатар, талап етілгеніне қарамастан, ол бірде-бір істі Шекара комиссиясының сотына өткізбеген [6, 152–153-бб.].

Осылайша, Арынғазы Ресей империясының қазақ даласындағы ықпалын әлсіретіп, халықтың қолдауына ие болып, жұртшылықтың саяси сенімін өзіне шоғырландыра алды. Мұндай жағдай империялық биліктің назарынан тыс қалған жоқ. Орынбор губернаторы Эссеннің ашық қолдауы сұлтанның беделін одан әрі арттырғанымен, жергілікті шенеуніктердің қақтығыстардан шаршаған көзқарасынан өзгеше түрде, жоғарғы билік орындарының Арынғазының қызметіне қатысты ұстанымы әлдеқайда сақ әрі күмәнді болды.

1826 жылы Орынбор губернаторы Эссен Азиаттық комитетке Кіші жүзде хандық билік жойылғаннан кейін Арынғазының аға сұлтан қызметін атқаруға лайықты, іс жүзінде жалғыз кандидат екенін алға тартып, оны елге қайтару туралы өтініш білдірді. Ол Хиуа хандығында билікке келген жаңа хан Аллақұлдың Арынғазының ұзақ уақыт тұтқында болған інісі Арда сұлтанды марапаттап, босатқанын хабарлаған. Эссен өзінің аймақ басшысы ретіндегі міндеті Орданың игілігін қамтамасыз ету екенін атап өтіп, бұл игіліктерді қалпына келтіру тек басқаруға қажетті қасиеттерге ие әрі бұрын мемлекеттік маңызы бар қызметтерде өзін көрсете білген Арынғазы туған ауылдарына қайтарылған жағдайда ғана мүмкін болатынын мәлімдеген [6, 114–115-бб.].

Аталған өтініш император І Николайдың қарауына да ұсынылды. Алайда император көрсетілген уәждердің барлығын жан-жақты зерделеуді жөн санады. Осы орайда Арынғазының Ресей аумағында ұзақ уақыт ұсталып келуі «кекшіл мінезді азиаттықтар үшін» жағымды әсер қалдырмайтынын, оны сый-сияпаттармен немесе қолдау көрсету арқылы өздеріне бейімдеу мүмкін еместігін ескерткен. Сұлтанның бұдан былай империялық билікке сенім білдіруі екіталай деп бағаланды.

Сонымен қатар, Арынғазының Хиуадағы соңғы саяси өзгерістерге байланысты жаңа ханмен ымыраға келуі немесе, керісінше, бұрынғы дұшпандық ұстанымын жалғастырып, Хиуа керуендеріне кедергі келтіруі Ресей империясының

Орта Азиядағы мүдделеріне қайшы келуі ықтимал деп есептелді. Осы мәселеге байланысты Сыртқы істер министрі, граф К.В. Нессельроде Эссенге жолдаған ресми қатынасында Арынғазыны «батыл, билікқұмар әрі жомарт» тұлға ретінде сипаттай отырып, оның халықтың ықыласын ояту немесе қорқыту арқылы Орданың дара билеушісіне айналу мүмкіндігі бар екенін, мұндай жағдайда Ресейдің оның саяси бағытына тәуелді болып қалу қауіпі туындайтынын атап көрсетті [6, 117-б.].

Құжатта «азиаттық халықтардың» кез келген ымырашылдықты әлсіздік ретінде қабылдайтынына ерекше назар аударылып, осы себепті император тарапынан Арынғазыны босатудан күтілетін ықтимал пайда оның туындатуы мүмкін қауіптермен салыстырғанда әлдеқайда төмен деп бағаланғаны көрсетіледі.

Патша үкіметі бұл іс-әрекеттерді барынша құпия ұстауға тырысқанымен, белгілі деректердің кейбірі сақталған. Атап айтқанда, император І Александрдың губернатор Эссенге 1821 жылы 7 желтоқсанда берген арнайы жарлығы бойынша, 1800 жылдан бастап ұзақ жылдар бойы Орынбор Шекара комиссиясына қазақ өкілі ретінде қатысып келген би, коллегиялық ассесор Байжазық Күшікбайұлы өз қызметінен алынған. Ол барлық лауазымдардан босатылып, қазақ даласына қайтуы қауіпті деп танылғандықтан, өмір бойына қатаң бақылауда Орынборда немесе орыс шебінде қалдыру туралы шешім қабылданған. Бұл шешім оның орыс қызметінде болуына қарамастан Арынғазы сұлтанды қолдауы және Шерғазы ханға ашық қарсылық танытуымен байланысты болған. Императордың жарлығы Шерғазы ханның ордадағы саяси салмағы мен ықпалын қолдауды мақсат еткен баптарға сәйкес шығарылған [7, п. 435-438].

Қазақ қоғамындағы билік жүйесінің өзгеруі және қоғамдағы наразылықтың етек алуы Ресей империясының елдегі жүргізіліп жатқан реформаларының нәтижесімен отарлау саясатының аяқталу жайлары болатын. Соның бірі ретінде хан тағына беделі жок сұлтандардың таласуы, ордадағы ықпал үшін алақөздік пен қырқысулар күшейе түсті.

Патша үкіметіде хандық билікті әлсірету және жою мақсатында тарихшы осы кезеңнің майталманы С.М.Машимбаевтың еңбектеріне үңілсек: «қазақ даласын бөліктерге бөліп, атап айтқанда Ресей императорының нұсқауымен қырғыздар даласын басқарудың жаңа жобасы жасалынып, Кіші жүзді басқару ішкі орда ханы Жәңгірге жүктелсін және даланы үшке бөліп, ірбір бөлікті басқару үшін аға сұлтан тағайындалсын» деп жазды [8,36]. Яғни, жаңа жүйені енгізе отырып, билікті жергілікті өкілдерге, сұлтандарға жүктеп, даланы бөліктерге бөлу арқылы, қазақтардың руларын қарастырып, оны сақтай отырып, халық санын білу, арақатынастарын анықтау, салық жүйесін енгізу, жайылымдық мәселелерді шешу жұмыстарын жеңілдеткен.

Қазақ өлкесінде Ресей империясының қол шоқпары болмасада, көзі мен құлағы қызметін атқарған кейбір аға сұлтандар қарамағына 100 ден 200 ге дейінгі орыс казак солдаттарын алғаны мә-

лімделеді [1,201]. Ал ол солдаттар отрядының міндеттері сұлтандарды қорғау және Шекара Комиссиясының заңдарын қазақтарға орындату және сұлтандарға қазақтардан салық жинауда көмек беру болып табылды. «Аға сұлтандар, қазақ өлкесінде салықтың дұрыс жиналуын тексереді, халық санын, ауыл, бөлімшелер туралы мәлімет алуы керек делінген».

Ресей империясы құрамына Қазақстанның қосылуы, оның орналасқан геосаяси жағдайы патша үкіметі үшін өте тиімді болды. Сонымен қатар Қазақстанның Қытаймен, Орта Азия халықтарымен Сібірмен тиімді сауда қатынасы Ресей үшін тиімсіз еді. Сондықтанда Патша үкіметі өзінің отарлау саясатын тездетіп жүргізілетін шараларды жандандыра түсті. Ал қазақ өлкесінде халық арасында ықпалы төмендей түскен қазақ хандықтары патша үкіметінің билеу саясатына қарсылық ұйымдастыра алмады. Қытай жағына “ауып түсіп”, “Богдыханның бодандығын қабылдауы” мүмкін деген қауіптері де хандық институттың жойылуын тездетті [9,24].

Ресей империясы қазақ даласында жаңа басқару жүйесін енгізіп, хандық билікті жою мақсатында реформалық өзгерістер жасай келе, қазақ халқының өмірі қатты өзгерістерге ұшырап, өзіне жат менталитетке көше бастады. Елдегі саяси биліктің әлсіреуі, ел ішіндегі билік үшін күресте, Ресей империясының жүргізген әскери отаршылдық реформалық шаралары қазақ қоғамның билік жүйесіне, әлеуметтік құрылымына қатты өзгерістер әкелді [10,28].

Патша үкіметі хан тұқымдарының билігін әлсірету мақсатында, ақсүйектерді кемсіту мақсатында барлық шараларды қолданды. Беделді сұлтандардың арасында ұрыс тудырып, ойлы көсем, шешендерін кемітіп, еріксіз, байлықты жақсы көретін адамдарды өздеріне тартты. Сонымен қатар қазақтың дәстүрлі мемлекеттік жүйесімен күрес барысында Ресей шенеуніктері барымтаны жалауды қолайлы шара деп тапты.

Патша үкіметі мемлекетсіздендіру саясатын жүргізу барысында, рулар арасындағы қайшылықтармен ханға, сұлтандарға сенімсіздік білдірген ру тайпаларды өз жақтарына шығуға пайдалануға тырысқан. Сонымен қатар кейбір қазақ ру басшылары және аға сұлтандарды Ресей империясының марапаттауымен марапатталасыз, алтын, күміс медальдармен марапатталасыз деп өздеріне тартып, жоғары шенді лауазым атағын беру арқылы жұмыстарда жасап отырған. Сол кездері император Павел І ші Ресей империясының қол астына өтуге ниет білдіргендерге өзінің сыйақысы бар екенін ашық тұрғыда өз жарғысында атап өткен болатын. Мысалы, әскери инженер, генерал – лейтенант Бларамберг И.Ф. өз естеліктерінде былай деп жазған екен: «...қырғыз – қайсақ Кіші ордасындағы хан кеңесіне басшылық жасап отырған Нұралы ханның баласы, Бөкей сұлтанды өз қарамағыма шын ниетіммен қабылдаймын және қай жерге көшіп барам десе де ерікті, оған марапатым ретінде өз бейнем бейнеленген алтын медаль сылаймын» деген жарғы шығарады [11,191].

Ресей империясына бағынышты аймақтарда саяси – әкімшілік жүйенің енгізілуі әртүрлі саяси – әлеуметтік құрылымдық өзгерістерге әкелді ол бірінші хандық биліктің түп тамырымен жойылуы, үкіметтің басқару билігін өзіне ыңғайлы қылдырып орналастырып жасауы, қазақтарды ережелерге сай басқарумен оларды сол ережелер арқылы шеттету де көзделді. Мысалы архив дерегіне сүйенетін болсақ «Сібір қазақтарын жеке басқару туралы ережеден» соң орталықтарды өзгертіп 1839 жылдың 1 қаңтарынан Омбы облысын таратып, сол кезде ашылған Шекаралық басқарманың бастығы полковник М.В.Ладыженский қойылып ол, «сібір қазақтарының шекаралық бастығы» деп аталды [12,109-1236].

Жалы қазақ халқында, қазақ қоғамындағы протестарлық билік жүйесінің өзгеруі көптеген наразылықтарға және де ұлт – азаттық күреспен әртүрлі көтерілістерге әкеп соқтырды. хан билігі жойылғаннан соң іс – жүзінде аға сұлтандармен ру басшыларының беделі өскендей болды. Жарғыға сәйкес аға сұлтандармен старшындарды тағайындауда, қазақ дәстүрімен жасалатын оның кейбір принциптері хан тұқымы немесес шыңғыс тұқымы болуы керек деген заңдар патша үкіметінің енгізген жарғыларында қабылданбай барлық ірілі ұсақты сұлтандарды теңестірді. Сұлтандардың барлығы 1822 жылғы жарғы бойынша оларға берілген өкілеттіліктерге қарамастан, өзінің қоғамдағы бұрынғы әлеуметтік маңызы мен билігінен айырылды [1,122]. Сол кездегі жағдайдың әртүрлі кезеңіне байланысты ма немесе елдегі саяси – әлеуметтік жағдайдың қиыншылығы әсер етті ма сұлтандар шенеуніктер сословиясына енгенімен Ресей империясының шенеуніктерге қойылатын талаптарына сай келмеді. Оның үстіне кейбір аймақтарда аға сұлтандар билік қолға тиісімен билікті пайдаланып әртүрлі қиянат жұмыстарды да жасап үлгергендей болды. Мысалы, Н.И.И.Красовский өзінің жазбаларында былай деген: «сұлтандар барлық жағдайларда халық алдында да орыс әкімшілігі кіналы» деп айтаын деген [13,167].

Тарихшы, ғалым Е.Б.Бекмахановтың пікірінше сұлтандар беделі болғанымен кейбір жағдайларда «аға сұлтандарға Ресей империясынан қолдау жасалғанына қарамастан қарапайым қазақтар арасында беделі болмады, бүлік шығарған уақытта құрметтемегелі тұрмақ өлтіріп те тастаған кездер болды. Бұның соңы халықтан заңсыз алым салық жинауда сұлтандардың дағдылы ісіне айналғандай болды. Мысалы, дистанциялық бастық Асфендияр Сүйеуғалин Шөмекей, төртқара руларының қазақстарынан түтін басы салығынын орнына мүйізді ірі қара алған. Сол кезде батыр Жанқожа Нұрмұхамедов басқарған бес рудың қазақтары Орынбор губернаторына хат жазып, дистанциялық бастық сұлтандарды сотқа беріп қарап және де орнынан алып тастауын талап еткен. Ол істің соңы ол түтін басы салығын жинаудан шеттетілді. [14,138].

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JURIDICAL SCIENCES

LEGAL MECHANISM FOR THE USE OF DIGITAL MONITORING TECHNOLOGIES IN ENSURING ENVIRONMENTAL SECURITY AND COMBATING ENVIRONMENTAL OFFENSES UNDER CONDITIONS OF MILITARY THREATS

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Abstract

A comprehensive analysis of the legal mechanism for the use of digital monitoring technologies in ensuring environmental security and counteracting environmental offenses under conditions of military threats has been conducted. Particular attention is paid to the examination of international legal standards in the field of environmental security, as well as to the practice of applying satellite monitoring, geographic information systems, remote sensing of the Earth, and digital platforms in the process of identifying environmental threats. The issues of the legal status of digital information, the admissibility of electronic evidence, and the reliability of environmental monitoring data are also considered.

The necessity of improving Ukrainian legislation in the field of digitalization of environmental control is substantiated. The formation of a comprehensive system of digital support for the environmental security of the state is proposed. Prospective directions for adapting legal regulation to contemporary challenges related to military risks and the transformation of environmental governance systems are identified.

Keywords: legal regulation, environmental security, digital monitoring, environmental offenses, military threats, digital evidence, environmental control, satellite monitoring, ecocide, geographic information systems, remote sensing of the Earth.

Relevance of the Topic

Ensuring environmental security under contemporary conditions is one of the key directions of state policy. It is directly connected with the realization of the constitutional human right to an environment that is safe for life and health. This issue is becoming increasingly relevant in the context of military threats, which are accompanied by a growing scale of environmental offenses, increased technogenic pressure, destruction of critical infrastructure facilities, and the emergence of new risks to the natural environment. Under such circumstances, there is a growing need to develop an effective legal mechanism for the use of digital monitoring technologies as a tool for ensuring environmental security, as well as for the timely detection, recording, and documentation of environmental offenses.

Modern digital technologies, in particular satellite monitoring, geographic information systems, unmanned aerial vehicles, remote sensing of the Earth, and automated systems for collecting and analyzing environmental data, create new opportunities for environmental control and enhance the effectiveness of law enforcement activities in the field of environmental protection. Their application contributes to the rapid response to environmental threats, ensures the objectivity of the evidentiary base, and increases the transparency of the activities of authorized bodies.

At the same time, the use of digital monitoring technologies is associated with the exercise of public authority, the processing of large volumes of information, the application of special control measures, and interference in the sphere of individual private rights and freedoms. This, in turn, necessitates ensuring an

appropriate balance between public interests in environmental protection and the observance of human rights, in particular the right to privacy, personal data protection, and procedural guarantees.

The practice of applying digital technologies in the field of environmental security reveals a number of regulatory and legal problems, including:

- the fragmentation of legal regulation governing the use of digital monitoring tools,
- insufficient definition of procedures for the collection, processing, and use of digital evidence,
- the lack of a comprehensive approach to legal regulation of inter-agency cooperation in environmental control,
- the insufficient level of legal guarantees for the protection of human rights in the application of digital technologies.

These circumstances negatively affect both the effectiveness of mechanisms for counteracting environmental offenses and the level of public trust in state institutions. In this regard, the need to improve the legal mechanism for the use of digital monitoring technologies under conditions of military threats becomes particularly urgent. It is necessary to develop unified approaches to the legal regulation of digital environmental control and to establish an effective system of guarantees of legality and human rights protection within the relevant legal relations.

Purpose of the Study

A comprehensive analysis of the environmental consequences of military actions and the substantiation of the role of digital monitoring technologies as an in-

strument for ensuring environmental security, documenting environmental damage, and improving the legal mechanism for environmental protection under conditions of armed conflict.

Main Body of the Study

Under contemporary challenges, the concept of environmental security acquires particular significance. Environmental security is aimed at ensuring favorable conditions for human existence and the preservation of natural resources. It constitutes an integral component of national security and reflects the state of protection of the environment, human life, and public health from the negative impact of environmental factors. This is closely connected with the increasing technogenic risks, climate change, and the consequences of armed conflicts. Armed conflicts are accompanied by large-scale destruction of natural ecosystems, air, water, and soil pollution, the occurrence of technogenic accidents, and the disruption of ecological balance. Military actions create long-term environmental risks, the consequences of which may pose a threat not only to individual states but also to international environmental security as a whole.

In legal terms, environmental security is understood as a system of legal, organizational, and managerial measures aimed at preventing environmental risks and minimizing negative impacts on the environment. In this context, environmental security ceases to be merely an element of environmental policy and transforms into a comprehensive component of the state governance system. Such an approach requires the implementation of modern mechanisms of monitoring, forecasting, and rapid response to environmental threats.

Military threats significantly transform the nature of environmental legal relations, necessitating a revision of traditional approaches to legal regulation in the field of environmental protection and environmental security. Under martial law conditions, new types of environmental risks emerge, associated with the destruction of industrial facilities, damage to critical infrastructure, contamination of territories with explosive remnants of war, as well as the destruction of natural resources and ecosystems.

Of particular importance in contemporary conditions is the issue of qualifying large-scale environmental consequences of war as ecocide and an international environmental offense. In this context, there is an increasing need to improve mechanisms for documenting environmental damage, to define procedures for assessing environmental harm, and to develop effective mechanisms of international legal responsibility for environmental consequences of armed conflicts.

Military threats also affect the system of state environmental control, as a significant part of territories may become temporarily inaccessible for direct inspection measures. This creates the necessity for the active implementation of digital monitoring technologies, remote observation, and automated collection of environmental data.

Digitalization of public administration is one of the key directions in the development of a modern rule-of-law state, encompassing also the sphere of environmental security and environmental protection. The use

of digital technologies in the environmental control system contributes to improving the effectiveness of managerial decision-making, enhancing the speed of response to environmental threats, and increasing the transparency of the activities of authorized public bodies.

The practical implementation of digital monitoring technologies ensures continuous observation of the state of the environment and increases the efficiency of environmental control under conditions of military threats. Their application makes it possible to continuously monitor environmental conditions, timely detect environmental threats, and promptly record environmental offenses.

At the same time, the digitalization of environmental control requires appropriate legal and regulatory support. It is necessary to define the legal status of digital data, the procedure for its use as evidentiary information, as well as guarantees for the protection of human rights in the application of digital monitoring technologies.

The Constitution of Ukraine establishes that everyone has the right to an environment that is safe for life and health (Article 50) [3]. This constitutional provision reflects the fundamental approach of the state to guaranteeing environmental human rights. The Constitution also defines the State's obligation to ensure proper environmental conditions.

The development of legal doctrine in this field is associated with the formation of awareness, both at the national and international levels, of the necessity not only of the rational use of natural resources but also of creating safe living conditions for humans. This includes ensuring the right to clean air, safe drinking water, environmentally safe food products, and other basic natural and social goods necessary for human life and development. The Law of Ukraine "On Environmental Protection" establishes a system of guarantees of citizens' environmental rights. In particular, it provides for the participation of public associations and citizens in environmental protection activities. It also enshrines the principle of inevitability of legal liability for violations of environmental legislation [7].

Furthermore, current Ukrainian legislation stipulates that violated environmental rights of citizens are subject to restoration. Their protection is carried out through judicial proceedings in accordance with the legislation of Ukraine (Article 11 of the Law of Ukraine "On Environmental Protection") [7]. It should be emphasized that the legal system provides both preventive and restorative mechanisms for the protection of environmental human rights.

Contemporary environmental risks of war represent a complex phenomenon. They primarily encompass the negative impact of armed conflicts on the natural environment and are characterized by large-scale and long-term consequences. This creates the need to identify the following key risks.

1. Air Pollution from Explosions, Fires, and Industrial Destruction.

Air pollution caused by continuous explosions, fires, and the destruction of industrial facilities, which lead to the release of toxic substances into the environment.

Scientists of the National Academy of Sciences of Ukraine have, for the first time, conducted a study on the impact of the full-scale war on air quality in Ukraine, covering both short-term consequences of missile and drone strikes and long-term national-scale changes [14, p. 3601]. The study established that explosions cause a sharp local increase in concentrations of air pollutants, sometimes by 100–400%, and in certain cases by more than 1000%. At the same time, due to limitations of the monitoring system, the direct impact could be confirmed only in a limited number of cases. Undoubtedly, long-term trends are heterogeneous and depend on the region. In industrial centers and large cities, a partial decrease in certain pollutants has been observed, whereas in areas of active hostilities their increase is recorded. Satellite data indicate an overall reduction of NO₂ levels across Ukraine by 10–30%, which is associated with reduced industrial production and transport activity. At the same time, an increase in SO₂ concentrations is observed, indicating changes in the energy structure and the use of more polluting energy sources. Certain changes are also of natural and climatic origin and are not directly related to military activities [6].

Overall, researchers emphasize the existence of an environmental paradox: a general decrease in certain emissions is accompanied by dangerous local pollution peaks caused by hostilities [14, p. 3602]. The conducted assessments should be taken into account in evaluating the environmental consequences of war and in shaping environmental recovery policies in Ukraine.

2. Water Resource Pollution

Water pollution occurs due to the damage of wastewater treatment facilities and infrastructure, creating threats to drinking water supply and ecosystems. The state of Ukraine's water resources in the period 2022–2026 is characterized by a combination of war-related destruction, technogenic accidents, and cumulative consequences of environmental disasters from previous periods. Particularly vulnerable remain the Black Sea basin, the Dniro River basin, and coastal ecosystems, which are effectively operating under conditions of heightened environmental risk. Results of monitoring studies indicate a persistent deterioration of water quality, a decline in biodiversity levels, and the accumulation of toxic substances in the aquatic environment, forming long-term threats to public health and the ecological stability of ecosystems [18].

As a result of the tanker accident involving the “Volgoneft” vessels in December 2024, more than 5,000 tons of fuel oil entered the Black Sea, causing prolonged marine pollution and repeated oil product leaks that continue to be recorded in 2026 [15].

Additional negative impact was caused by a military strike on the “Pivdennyi” port at the end of 2025, resulting in significant quantities of sunflower oil entering the marine environment [13].

Storm activity contributed to the spread of pollution to the territory of the Tuzlivski Lymany National Nature Park, significantly complicating the natural recovery processes of ecosystems.

Military actions have also caused massive losses of marine fauna. During the period of full-scale war, the death of more than 50,000 dolphins has been recorded

due to the acoustic impact of military sonar systems and blast waves. In addition, a sharp decline in mussel populations, which perform a natural water filtration function, has been observed near the coast of Odesa, along with the death of approximately two thousand waterfowl as a result of oil pollution of the marine environment [5].

Under martial law conditions, the state of Ukraine's water resources has significantly deteriorated due to the contamination of surface and groundwater by explosion residues, petroleum products, and toxic substances released from destroyed infrastructure facilities. Collectively, these factors create long-term risks for environmental security, the food system, and public health, as a significant portion of the population loses access to safe drinking water supply and adequate wastewater treatment.

Particular attention is drawn to the disaster caused by the destruction of the Kakhovka Hydroelectric Power Plant, which led to large-scale degradation of aquatic ecosystems, mass mortality of hydrobionts, and significant economic losses for the fisheries sector. These consequences demonstrate the complex nature of environmental damage, encompassing both environmental protection and socio-economic dimensions.

Overall, Ukraine's water resources are undergoing systemic environmental degradation caused by the combined impact of military, technogenic, and anthropogenic factors. Military actions generate long-term risks for ecosystem recovery and require comprehensive legal and environmental response at both national and international levels [18].

From a legal perspective, the regulation of water resource protection is carried out on the basis of national environmental legislation, water law, and Ukraine's international environmental obligations, in particular within the framework of the EU-Ukraine Association Agreement. Harmonization with European law provides for the implementation of the EU Water Framework Directive and related environmental protection mechanisms.

The port of “Pivdennyi” and the Allseeds terminal constitute civilian infrastructure and do not perform any military functions. In accordance with Articles 52 and 54 of Additional Protocol I to the Geneva Conventions, civilian objects and objects indispensable to the survival of the civilian population are protected from attack, and any deliberate targeting of such infrastructure is prohibited under international humanitarian law.

Strikes on large-capacity vegetable oil storage facilities generate significant environmental risks and have led to large-scale pollution of the marine environment, loss of wildlife, and long-term degradation of coastal ecosystems. Such consequences may be assessed as meeting the criteria of serious, widespread, and long-term environmental damage, which are commonly referenced in international legal doctrine when addressing the concept of ecocide.

From the perspective of domestic criminal law, the described actions may fall within the scope of Article 441 of the Criminal Code of Ukraine, which defines ecocide as the mass destruction of flora or fauna, poisoning of water resources, and other actions capable of causing an ecological catastrophe.

In addition, Article 8(2)(b)(iv) of the Rome Statute of the International Criminal Court prohibits intentional attacks expected to cause excessive and clearly disproportionate environmental damage in relation to the anticipated military advantage. This provision is particularly relevant in cases involving large-scale environmental contamination resulting from attacks on industrial or port infrastructure.

The systematic nature of attacks on ports, terminals, oil storage facilities, and other sites containing hazardous substances indicates a broader pattern of conduct resulting in significant environmental harm. This circumstance strengthens the legal argument for conducting comprehensive international investigations into such actions, not only within the framework of war crimes, but also in the context of emerging approaches to environmental crimes under international law.

Legal regulation of water resource protection under conditions of military threats requires strengthened environmental control, improvement of monitoring systems, and the implementation of effective mechanisms for the restoration of aquatic ecosystems as a key component of environmental and national security of the state.

3. Soil Degradation

Soil degradation is associated with the contamination of territories due to landmining and the penetration of hazardous substances into the soil, which significantly complicates further use of land resources or their complete conservation.

In accordance with Article 51 of the Law of Ukraine "On Land Protection," land conservation is carried out with the aim of restoring their ecological condition and preventing further degradation processes [9].

This legal mechanism applies to lands that have been subject to substantial anthropogenic or technogenic pressure. It also covers territories contaminated with hazardous substances or affected by explosive remnants of war, particularly in the context of armed conflict. Accordingly, it serves as a legal instrument for restoring the ecological condition of land and minimizing long-term environmental consequences of contamination [2].

Research conducted by Ukrainian scientists in cooperation with the Royal Agricultural University (Cirencester, United Kingdom) indicates the presence of localized changes in the concentrations of heavy metals (including lead, cadmium, mercury, arsenic, rubidium, vanadium, and zirconium) in soils, depending on the nature of territorial damage and the type of soil cover.

It has been established that the most variable indicators are recorded in areas of explosion craters and adjacent zones, which is conditioned both by the technogenic impact of munitions and by the natural properties of soils. Overall, exceedances of maximum permissible concentrations of heavy metals have not been detected; however, spatially localized heterogeneity in their distribution has been identified, which may indicate potential long-term environmental risks.

The obtained results confirm the necessity of systematic environmental monitoring of agricultural lands, expansion of sampling coverage, and implementation of legal and organizational mechanisms for controlling

the condition of agroecosystems, particularly under conditions of armed conflict impact [4].

In accordance with the Laws of Ukraine "On Environmental Protection" and "On Land Protection," the State ensures the normative establishment of maximum permissible soil contamination indicators and introduces mechanisms for monitoring compliance with such standards [8]. Land legislation prohibits the use of land contaminated with hazardous substances without compliance with special restrictions. It also establishes the obligation of state authorities to conduct soil monitoring, conservation, and restoration in cases of detected contamination. In this context, the system of state environmental monitoring and agrochemical land certification becomes of crucial importance, as it enables the identification of heavy metal accumulation levels and the assessment of land suitability for agricultural use.

International legal approaches and national legislation (including provisions on ecocide) form a basis for qualifying large-scale soil contamination as a potentially criminally punishable act in the event of an environmental catastrophe. The legal mechanism for counteracting soil degradation under conditions of war is based on the combination of environmental standards, monitoring procedures, and instruments of legal liability.

4. Armed conflict-induced degradation of natural ecosystems

Armed hostilities cause large-scale degradation of natural ecosystems, which is accompanied by the destruction of forest areas, damage to protected nature reserves, disruption of natural migration routes of wildlife, and significant loss of biodiversity. Particularly vulnerable are the territories of the Nature Reserve Fund of Ukraine, which are directly affected by hostilities, fires, landmining, and technogenic pollution.

According to estimates of the Ministry of Economy, Environment and Agriculture of Ukraine, a significant proportion of protected areas is under threat of degradation or temporary loss of ecological functions. The destruction of natural ecosystems is accompanied by the disruption of natural self-regeneration processes, a reduction in ecosystem resilience to climate change, and a general deterioration of environmental conditions across affected territories.

The issue of biodiversity conservation is of particular importance in the context of Ukraine's European integration. Ukraine aims to implement post-war recovery in accordance with the environmental standards of the European Union and the principles of sustainable development, which presupposes the implementation of nature-based solutions as one of the key instruments of environmental policy.

In contemporary conditions, nature-based solutions are understood as approaches aimed at restoring degraded ecosystems, adapting to climate change, reducing environmental risks, and ensuring the long-term ecological resilience of the state.

The Summary for Policymakers "Nature-Based Solutions with Consideration of Climate Change" emphasizes that the restoration of natural ecosystems should become one of the fundamental directions of

Ukraine's environmental and climate policy, particularly in the context of post-war recovery [12].

Nature-based solutions involve the integration of environmental, social, and economic mechanisms of natural resource management aimed at enhancing ecosystem resilience and reducing the adverse impacts of climate change and anthropogenic factors.

In this context, the implementation of modern digital environmental monitoring systems becomes of particular importance, including satellite observation, geographic information systems, and remote sensing of the Earth. These technologies enable the operational detection of changes in ecosystem conditions, the identification of cases of illegal destruction of natural resources, and the assessment of the scale of environmental damage. The use of digital technologies creates a basis for forming evidentiary materials in environmental law enforcement cases, improving the effectiveness of state environmental control systems, and ensuring efficient management of environmental protection activities.

From a legal perspective, the protection of ecosystems and biodiversity is regulated by the provisions of national environmental legislation, international environmental conventions, and Ukraine's obligations in the process of harmonizing its legislation with European Union law. At the same time, contemporary challenges demonstrate the necessity of improving the legal framework for environmental monitoring, expanding the system of environmental guarantees, and developing a comprehensive state policy for ecosystem restoration under conditions of armed conflict and climate change.

5. Soil degradation and digital environmental monitoring technologies

Special attention should be paid to the problem of soil degradation, which is associated with landmining, destruction of the soil cover, and the accumulation of hazardous chemical substances as a result of hostilities. Soil contamination with heavy metals, residues of explosive materials, and petroleum products significantly complicates the restoration of agricultural land, reduces the level of environmental security, and creates long-term risks for the state's food system. These environmental consequences are complex and long-lasting, and in certain cases may be irreversible, which substantially complicates natural ecosystem recovery processes. According to United Nations data, Ukraine is among the most heavily mined countries in the world, which generates long-term environmental risks for both the population and natural ecosystems.

Digital monitoring technologies constitute an integrated set of interconnected instruments, including satellite observation, remote sensing of the Earth, geographic information systems (GIS), digital environmental platforms, and tools for automated processing of large-scale environmental datasets. Their integrated application enables multi-level analysis of environmental conditions and timely response to environmental threats, namely:

- Remote sensing of the Earth is a technology for obtaining information about the state of the natural environment without direct contact with the object of

study. From a legal perspective, it serves as an instrument for documenting environmental offenses, assessing the consequences of armed conflicts, and recording environmental damage, which may be used as evidence in national and international legal proceedings.

- Satellite monitoring, as a component of remote sensing, ensures systematic real-time observation of the environment. Its significance lies in the ability to promptly detect changes in environmental parameters, identify zones of contamination, and confirm the destruction of natural objects, particularly under conditions of restricted access to areas affected by hostilities.

- Geographic Information Systems (GIS) provide spatial analysis of environmental data and its integration into a unified information model. GIS enable the mapping of environmental risks, the identification of high-risk zones, and the comprehensive assessment of environmental damage, which is of essential importance for both administrative decision-making and law enforcement purposes.

- Artificial intelligence (AI) and automated analytical systems ensure the processing of large volumes of environmental data, forecasting environmental risks, and detecting anomalous changes in environmental conditions. Overall, these technologies enhance analytical accuracy and the objectivity of assessments of environmental consequences.

- Digital environmental platforms and databases form the informational foundation of the environmental governance system by ensuring the accumulation, systematization, and exchange of environmental data between state authorities, international institutions, and scientific organizations.

The conditions of armed conflict significantly increase the importance of digital monitoring technologies as instruments for the legal documentation of environmental offenses, the recording of environmental damage, and the formation of evidentiary bases for subsequent legal response. The legal status of digital data is defined as a set of procedural norms governing the procedures for their collection, recording, verification, and evaluation. Under national law, such data are recognized as electronic evidence provided that the criteria of relevance, admissibility, and reliability are satisfied.

International practice confirms the growing role of digital technologies in the documentation of environmental crimes, particularly in areas affected by armed conflicts. Satellite data are widely used by international organizations to assess the scale of environmental damage and to prepare analytical reports.

At the same time, the key challenges remain the verification of digital information, ensuring its authenticity, and the absence of unified international standards for the assessment of digital environmental evidence.

At present, the legal regime of digital monitoring is still in the process of active formation and requires further institutional and regulatory elaboration. Despite the active implementation of digital environmental monitoring technologies and the growing role of nature-based solutions in climate change adaptation policy, Ukraine currently lacks a comprehensive legal mechanism for the integration of digital environmental

control systems, nature-based approaches, and response mechanisms to environmental consequences of armed conflict. This significantly complicates the timely detection, documentation, and assessment of environmental damage, reduces the effectiveness of state environmental control, and creates risks to environmental security under conditions of armed threats and climate change.

An important role in shaping modern environmental policy is played by the adaptation of national legislation to European legal standards. Scholarly literature emphasizes that the environmental policy of the European Union is based on the principles of sustainable development, the integration of environmental requirements into all areas of public policy, the precautionary principle, and the ecosystem approach, thereby forming a comprehensive model of legal regulation of environmental protection [17, p. 245]. In this context, provisions concerning the necessity of harmonizing Ukraine's environmental legislation with EU law and implementing European governance approaches in the field of environmental security are of particular importance.

At the same time, contemporary conditions demonstrate the insufficiency of traditional mechanisms of environmental control under conditions of armed threats [20, p. 90]. A significant number of territories remain temporarily inaccessible for direct environmental inspections, which complicates the timely documentation of environmental offenses and the assessment of environmental damage. This situation necessitates recourse to international legal standards of environmental protection, which define the basic principles of environmental governance in armed conflict situations, establish limits of permissible conduct for states, and form the legal basis for international responsibility for large-scale environmental harm.

International legal standards of environmental protection constitute a system of principles and norms aimed at the protection of the natural environment at the global level. Their foundation is formed by the provisions of international humanitarian law, in particular the Geneva Conventions and Additional Protocols, which prohibit causing widespread, long-term, and severe damage to the natural environment during armed conflicts. An important role is also played by international environmental conventions, which enshrine the principles of prevention, precaution, and sustainable development. These instruments impose on states the obligation to prevent transboundary environmental harm, ensure the rational use of natural resources, and guarantee effective environmental protection.

Particular importance is attached to the activities of international organizations, primarily the United Nations system and its specialized agencies, which develop approaches to the assessment and documentation of environmental damage in armed conflict settings. In this context, a gradual shift can be observed towards an expanded interpretation of international environmental offenses, including the concept of ecocide as a potentially independent international crime. Overall, international legal standards of environmental protection form the normative foundation for regulating environmental relations under conditions of wartime risks and serve as

a basis for holding perpetrators accountable for environmental harm.

The concept of environmental security within the national security system is based on its understanding as one of the key elements of protecting the vital interests of the state, society, and the individual. It presupposes the establishment of such an environmental condition in which ecological risks are minimized and a safe living environment is ensured. Environmental security is of an intersectoral nature and is closely interconnected with economic, energy, social, and military security. The disruption of ecological balance directly affects state stability, public health conditions, and the resilience of economic systems. At the normative level, this concept is enshrined in the Constitution of Ukraine, environmental protection legislation, and strategic national security documents, where environmental security is defined as a state policy priority. Under conditions of armed threats, its significance increases substantially, as hostilities directly affect natural resources, infrastructure, and the environmental safety of the population. Overall, this necessitates the integration of the environmental component into the system of state strategic and defense planning.

The full-scale war in Ukraine has demonstrated the limitations of traditional mechanisms of environmental control, as a significant number of territories remain inaccessible for direct environmental inspections. This complicates the timely detection, recording, and documentation of environmental damage.

In these conditions, the implementation of digital environmental monitoring technologies becomes of particular importance, as they enable remote observation of environmental conditions, prompt detection of changes in environmental indicators, and the formation of an objective evidentiary base regarding the consequences of armed hostilities.

Conclusion

The study has established that the environmental consequences of the full-scale war in Ukraine are systemic, complex, and long-term in nature, affecting all key components of the natural environment. Armed hostilities generate not only localized environmental disturbances but also cumulative effects manifested in the transformation of ecological balance, degradation of natural resources, and a reduction in the resilience of ecosystems to further anthropogenic and climate-related pressures.

Accordingly, digital environmental monitoring should be regarded as a key element of the contemporary environmental protection system, particularly under conditions of armed threats. Its further development should be aimed at the normative consolidation of the legal status of digital environmental data, the improvement of procedures for their use as evidence, and the integration of digital technologies into national and international environmental governance systems. The establishment of an effective mechanism of digital environmental monitoring constitutes a necessary prerequisite for ensuring state environmental security, enhancing the effectiveness of legal responses to the environmental consequences of war, and strengthening the system of international environmental legal order.

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MEDICAL SCIENCES

MODERN APPROACHES AND PROSPECTIVE DIRECTIONS FOR THE TREATMENT OF GOUT

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Abstract

Gout is one of the most common types of inflammatory arthritis, the development of which is directly related to impaired purine metabolism and the accumulation of sodium monourate crystals in the tissues. In recent years, the understanding of the pathogenesis of this disease, as well as approaches to its treatment, has changed significantly. If earlier the main emphasis was on eliminating acute pain syndrome, then modern rheumatology is focused on long-term control of uric acid levels and preventing the formation of crystal deposits.

The aim of the work is to analyze current scientific data on the molecular mechanisms of gout development, the role of genetic factors, new diagnostic methods and current therapeutic strategies. Particular attention is paid to promising areas of treatment, including biological therapy, selective urate transporter inhibitors and experimental biotechnological methods.

The paper summarizes the results of modern clinical studies and international recommendations regarding the treatment of patients with gout. The significance of the NLRP3 inflammasome, interleukin 1 β , URAT1 and ABCG2 transporters in the development of the disease is considered. The Treat to Target concept, the safety of xanthine oxidase inhibitors, and the features of the therapy of refractory forms of gout are separately analyzed.

The obtained data confirm that effective management of patients with gout requires an individualized approach, long-term control of hyperuricemia, and consideration of concomitant cardiometabolic pathology.

Keywords: gout, hyperuricemia, uric acid, NLRP3, urate-lowering therapy, Treat to Target.

Introduction.

Gout is one of the most common chronic inflammatory joint diseases in the adult population. The prevalence of this pathology is increasing every year, which is largely due to the aging of the population, the increase in the incidence of obesity, metabolic syndrome and chronic kidney disease [1].

The modern understanding of gout has moved far beyond the traditional notion of “a disease of excessive meat consumption.” Gout is now considered a systemic metabolic and inflammatory disease, the basis of which is the deposition of sodium monourate crystals in various tissues of the body. Crystal deposits can form not only in the joints, but also in the tendons, kidneys, soft tissues, and vascular walls [3].

Chronic hyperuricemia is accompanied by persistent low-grade inflammation, which negatively affects the cardiovascular system and kidney function. That is why modern approaches to the treatment of gout are based not only on controlling symptoms, but also on eliminating the pathogenetic mechanisms of the disease [20].

The aim of the work is to systematize current data on the pathophysiology of gout, the latest diagnostic methods, and promising areas of therapy in accordance with the principles of evidence-based medicine.

Analysis of recent studies and publications

Current understanding of the pathogenesis of gout includes the role of the NLRP3 inflammasome and IL 1 β in the development of inflammation.

Thus, the key link in the development of gouty arthritis is the accumulation of sodium monourate crystals in the tissues. After their phagocytosis by innate

immune cells, the NLRP3 inflammasome is activated, a multiprotein complex that responds to intracellular stress [3].

Activation of the inflammasome is accompanied by the conversion of inactive pro-IL 1 β into biologically active interleukin 1 β . This cytokine plays a leading role in triggering the acute inflammatory process in gout. Under its influence, the synthesis of pro-inflammatory mediators is enhanced, neutrophil migration occurs, and a typical clinical attack of arthritis is formed [15].

Neutrophils accumulating in the focus of inflammation not only support tissue damage but also participate in further limiting the inflammatory response by forming extracellular neutrophil traps. However, prolonged retention of sodium monourate crystals leads to chronic inflammation with the formation of tophi and progressive joint damage [4].

Genetic factors are also one of the main mechanisms of hyperuricemia.

The leading factor in the development of gout is a persistent increase in uric acid levels. In most cases, hyperuricemia occurs as a result of impaired excretion of urate, rather than excessive synthesis [1].

The URAT1 and ABCG2 transporters, which regulate renal and intestinal excretion of uric acid, are of great importance. Genetically determined changes in the function of these proteins can significantly increase the risk of developing gout even in the absence of significant nutritional disorders [16].

The enzyme xanthine oxidase plays a significant role in the synthesis of uric acid. That is why xanthine

oxidase inhibitors remain the mainstay of modern urate-lowering therapy [4].

The data obtained suggest that dietary factors are only an additional risk component, while genetic mechanisms largely determine the predisposition to develop the disease.

Recent studies confirm the importance of a number of inflammatory and metabolic markers in predicting the course of gout. One of the most promising is calprotectin, a protein secreted by activated neutrophils and macrophages.

Elevated calprotectin levels are associated with more crystal deposits and higher inflammatory activity even in the inter-attack period [5].

Other potential biomarkers are also being actively investigated, including IL-6, TNFSF14, GlycA, soluble E-cadherin, and urinary metabolomics [12].

Traditional uric acid testing is not always sufficient to confirm the diagnosis of gout, which is why instrumental diagnostic methods are becoming increasingly important.

Ultrasound examination allows to detect the characteristic sign of "double contour", which indicates the deposition of crystals on the surface of the cartilage.

Dual-energy computed tomography allows to determine the localization and volume of urate deposits precisely. The method is especially valuable in patients with tophaceous or atypical forms of gout [8].

Despite the high informativeness of DECT, ultrasound remains a more accessible method in everyday clinical practice.

The modern strategy for the treatment of gout includes:

1. Treat to Target Concept

Modern gout therapy is based on the Treat to Target principle, which involves achieving and maintaining a stable target level of uric acid [2].

The solubility threshold for sodium monourate is considered to be a concentration of approximately 6.8 mg/dL. Exceeding this level promotes crystal formation and disease progression.

The main therapeutic goals are:

- less than 6 mg/dL for most patients;
- less than 5 mg/dL for severe tophaceous gout.

The lower the uric acid level that can be maintained, the faster the crystals dissolve and the lower the risk of recurrent exacerbations.

To achieve the therapeutic goal, gradual titration of allopurinol or febuxostat doses is often necessary, and in some cases, combination therapy [2].

2. Xanthine oxidase inhibitors and safety issues

Allopurinol and febuxostat are the mainstays of urate-lowering therapy. However, their cardiovascular safety has long been a subject of debate.

The CARES trial [20] demonstrated a possible increased risk of cardiovascular mortality with febuxostat in high-risk patients. However, the FAST Trial [11] did not show a significant increase in mortality. Given the available evidence, allopurinol remains the first-line drug, especially in patients with concomitant cardiovascular disease [13].

Before prescribing allopurinol in certain populations, it is recommended to determine the HLA B*5801

allele, the carriership of which is associated with the risk of severe hypersensitivity reactions [13].

In patients with chronic kidney disease, therapy should be initiated with minimal doses followed by gradual titration under laboratory control.

Treatment of refractory gout is carried out with the help of:

1. Pegloticase. Pegloticase is a recombinant pegylated uricase that converts uric acid to the more soluble allantoin. It is used in patients with severe refractory gout and significant tophi [14].

Pegloticase therapy provides rapid and significant reductions in uric acid levels, but its efficacy may be compromised by the development of antibodies to the drug.

Combination therapy with pegloticase and methotrexate is increasingly being used to reduce immunogenicity. This approach has been shown to increase clinical response rates and reduce the risk of infusion reactions [14].

2. IL 1 inhibitors. Since IL 1 β is a key mediator of gouty inflammation, the use of drugs that block this cytokine has become a promising direction.

Canakinumab, a monoclonal antibody to IL 1 β , is able to effectively reduce the severity of inflammation and the frequency of attacks.

Anakinra, which is an IL-1 receptor antagonist, is used mainly in complex clinical cases when standard therapy is contraindicated or insufficiently effective [15].

Promising directions of therapy for gout are:

1. SEL 212. SEL 212 is a combined therapeutic system that combines pegylated uricase and immunomodulatory nanoparticles ImmTOR. The main goal of this technology is to reduce the formation of antibodies to the enzyme and prolong the therapeutic effect. The results of clinical studies demonstrate a sustained reduction in uric acid levels, a decrease in the frequency of exacerbations and better tolerability compared to traditional uricase therapy [17].

2. Selective URAT1 inhibitors. Promising new-generation drugs include AR882 and epaminurad. These drugs block the URAT1 transporter and reduce urate reabsorption in the kidneys. Clinical studies have shown their high efficacy in patients with chronic and tophaceous gout. The advantage of the new selective inhibitors is a better tolerability profile compared to previous uricosuric drugs [9].

3. Gene therapy. One of the most innovative areas is considered to be gene therapy aimed at restoring uricase activity. The possibility of using viral vectors or mRNA technologies for long-term expression of the enzyme and stable control of uric acid levels is being considered. Despite significant potential, these methods are still in the early stages of research [7].

Gout is often associated with other metabolic and cardiovascular diseases, the most important of which are type 2 diabetes mellitus, obesity, hypertension, chronic kidney disease, and atherosclerotic vascular lesions. The presence of such comorbid conditions significantly complicates the course of the disease and requires comprehensive interdisciplinary management of patients [20].

In recent years, sodium-glucose cotransporter type 2 (SGLT2) inhibitors have attracted considerable interest, and are mainly used in the treatment of diabetes mellitus. In addition to their hypoglycemic effect, drugs of this group have demonstrated the ability to influence purine metabolism and contribute to a moderate decrease in uric acid levels [10].

Clinical trials have shown that SGLT2 inhibitors are associated with a reduction in serum urate concentrations compared with placebo or other hypoglycemic agents. One possible mechanism for this effect is increased renal excretion of urate due to competitive inhibition of its reabsorption via the URAT1 and GLUT9 transporters in the proximal tubules. Additional roles may be played by changes in intrarenal hemodynamics and improved nephron function [8].

The practical significance of these effects is supported by real-world clinical evidence of reduced gout attacks in patients receiving SGLT2 inhibitors. The most significant benefit is seen in patients with a combination of gout, diabetes, and chronic kidney disease, as drugs in this group simultaneously provide nephro- and cardioprotective effects [19].

However, SGLT2 inhibitors cannot be considered as a stand-alone urate-lowering therapy. Their use should be evaluated only as an adjunct component of the complex treatment of patients with concomitant cardiometabolic disorders [12].

Modern research in the field of gout treatment is primarily aimed at overcoming the shortcomings of standard therapy, in particular, insufficient effectiveness in some patients and the development of adverse reactions. One of the most promising areas is considered to be the improvement of uricase therapy by creating combined biotechnological drugs [22].

An example of this approach is SEL-212, a combination of pegylated uricase and ImmTOR immunomodulatory nanoparticles. The main goal of this technology is to reduce the formation of neutralizing antibodies to the enzyme, which are the main cause of loss of efficacy of biological therapy. Data from phase II–III clinical trials demonstrate longer maintenance of low uric acid levels and a lower incidence of infusion reactions compared with traditional pegloticase therapy [18].

Despite the promise of such methods, safety concerns remain. The main risks include immune reactions, infusion complications, and the potential consequences of excessive uric acid lowering, which may be accompanied by oxidative stress. In addition, data on the long-term effects of long-term intervention in purine metabolism are still lacking [7].

Another promising direction is the development of new generation selective URAT1 inhibitors, in particular AR882 and epaminurad. These drugs provide a more pronounced reduction in urate levels by blocking their reabsorption in the kidneys. Compared with previous uricosuric agents, they are characterized by better selectivity and a more favorable tolerability profile [16].

However, the final assessment of the safety of these drugs requires further studies, especially regard-

ing their effects on renal function, the risk of nephrolithiasis, and use in patients with severe cardiovascular or metabolic diseases [19].

In parallel, experimental approaches related to gene therapy are actively developing. The main idea is to restore uricase activity using viral vectors or modern mRNA technologies. Although such methods have significant potential, they remain in the early stages of research due to the risks of uncontrolled gene expression and possible immunological complications [6].

Thus, further development of gout therapy depends not only on the creation of new molecules, but also on the accumulation of evidence of their long-term efficacy and safety. The use of biologics and recombinant enzymes has been an important advance in the treatment of severe gout. However, along with their high efficacy, these methods are accompanied by a number of complex problems related to the safety of therapy [21].

One of the main obstacles is immunogenicity - the ability of the drug to induce the formation of antibodies. The formation of anti-drug antibodies can not only reduce the effectiveness of treatment, but also contribute to the development of serious infusion reactions. Modern approaches involve the use of combination therapy with low doses of immunomodulators, which allows suppressing the excessive immune response and increasing the duration of the therapeutic effect [7].

An additional problem is the increased risk of infections due to the blockade of pro-inflammatory cytokines, primarily IL-1. Elderly patients, patients with chronic renal failure, and individuals with polymorbidity remain particularly vulnerable. Therefore, before prescribing biological therapy, a careful risk assessment, appropriate screening, and subsequent dynamic monitoring are necessary [6].

Conclusion. Despite significant progress in rheumatology, many aspects of gout remain unclear. One of the most controversial issues is the appropriateness of drug treatment of asymptomatic hyperuricemia. The available research results do not yet provide convincing evidence of a reduction in cardiovascular risk with early initiation of urate-lowering therapy.

Further development of the field is associated with the implementation of the principles of personalized medicine. It is expected that the choice of therapy in the future will be based not only on the clinical manifestations of the disease, but also on the genetic characteristics of urate transporters, immunological profile and functional state of the kidneys.

An individualized approach will allow selecting the most effective drug combinations and minimizing the risk of side effects. In the future, this may provide a transition from symptom control to full prevention of gout development and its complications at the molecular level.

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*Multi-profile hospital for active treatment - "Uni Hospital", Panagyurishte, Bulgaria*DOI: [10.5281/zenodo.20824356](https://doi.org/10.5281/zenodo.20824356)**Abstract**

Enteroviruses (EV) are a genus of the Picornaviridae family. About 70 serotypes have been isolated from humans. The name of this viral group comes from the place where they reproduce after entering the body - the intestines. They usually multiply in the lining of the gastrointestinal tract, where the infection may manifest subclinically or as a mild infection. In some cases, however, the virus spreads to various organs, where it causes severe disease. On the other hand, summer food poisoning is a microbial intoxication associated with the consumption of food contaminated with pathogenic bacterial microorganisms and their toxins, but viral food intoxications also occur. Summer food poisonings increase because warm weather accelerates the growth of microbes in perishable foods.

Keywords: Summer infections, children, complications, rehydration, strict hygiene.

Introduction.

Human enteroviruses include polioviruses, coxsackieviruses, echoviruses and new enteroviruses. Enterovirus infections are in most cases self-limiting, relatively mild diseases that last from 7 to 10 days, with the acute phase, when all symptoms are strongly expressed, usually lasting about 4-5 days^[4]. Humans are the only reservoir for enteroviruses. Carriers of the infection pose a danger to others from several weeks to 1-2 months after infection^[9,10,18]. Susceptibility is universal, but children and adolescents are mainly affected. Transmission occurs by various routes (most often fecal-oral), through consumption of contaminated water or food products, as well as with oral secretions of sick individuals. Less commonly, airborne droplets, as well as from the mother to the fetus (vertically)^[4,9,10,18]. The incubation period is 2-40 days. Recovery from infection leads to the development of life-long immunity^[9,18]. On the other hand, the most common food poisonings are due to the violation of basic hygiene standards and improper food storage are favorable factors for food contamination. Food is a good environment for the development of some pathogenic microorganisms and under appropriate conditions (high temperature and humidity) they multiply and cause food poisoning. The main causes of food poisoning are staphylococci, salmonellosis and colibacillosis. The toxins of some microbes such as staphylococci are resistant to boiling, which means that the risk of poisoning is high even with thermal processing. Most often, the transmission of salmonella toxicoinfection occurs when using meat, sausages, eggs, dairy products, ice cream and cakes contaminated with salmonella. Staphylococcal infection is caused by the formed staphylococcal enterotoxin. The main sources of this infection are humans (through the skin and nasopharynx) and animals suffering from mastitis - they contaminate fresh milk, and from there many dairy and confectionery products. A common source of staphylococcal infection is also contaminated foods - cakes, creams, ice cream, milk. Food contamination occurs upon contact with healthy asymptomatic carriers or patients with staphylococcal rhinitis or angina. Contamination of food products with colibacteria occurs mainly by humans through contaminated hands and food. Poisoning

can also occur after consuming foods that are not refrigerated, even though the appearance and taste of the food do not change - such foods include meat, eggs, and fish products. The source of coli-infection are sick and healthy carriers. The causative agent of botulism is a microorganism that forms spores and develops in an environment poor in oxygen - canned vegetables, sausages and fish. It is also often found in the soil, from where it gets into food, through unwashed vegetables. Usually the food looks spoiled, but it is possible that there are no changes and it is still infected. Botulinum toxin is believed to be the strongest natural toxin^[1,2].

Clinical picture.

The clinical course of EV infections.

Although many enterovirus infections are asymptomatic, some serotypes are inherently more pathogenic. The clinical course of enterovirus infections includes many clinical forms: "summer flu"; enterovirus exanthema; herpangina; "hand, foot, mouth" syndrome; pleurodynia; aseptic meningitis; encephalitis; paralytic disease; myocarditis and neonatal infections. The first four clinical forms occur most often in the form of epidemic outbreaks, each year one of them prevailing. While neuroinfections occur less frequently and generally have a benign course and usually end with recovery in 10-15 days.

In some cases, EV infections occur severely with high mortality, which is determined by the virulence of some serotypes of enteroviruses. Myocarditis and neonatal infections occur very rarely, but are very severe and usually end in death^[4,6,7,9,16-18].

Non-poliomyelitis EVs cause mild to severe inflammatory diseases in the central nervous system and respiratory tract. In most cases, those infected remain asymptomatic, but are involved in the spread of the infection - carrier status^[4,6,9]. The most common infections caused by non-poliomyelitis EVs occur as a flu-like illness - chills, headache, severe fatigue, general malaise, joint and muscle pain, and high fever that is difficult to control with medication. In some cases, vomiting, mild diarrhea, and abdominal pain are also observed. Therefore, these infections are called "summer flu"^[4,18]. 1-3 days later, a rash appears, starting on the face, spreading to the body and limbs, lasting from hours to several days. The nature of this enterovirus exanthema is polymorphic - spots, blisters, urticaria-like

skin changes, less often hemorrhages. The disease lasts 7-10 days and is caused by ECHO type 9 [4,9,18].

Clinical characteristics of food poisoning.

The most characteristic feature of food poisoning is their group nature, affecting multiple children who have consumed the same food. Symptoms of food poisoning usually appear two to six hours after consuming contaminated food and include fever and chills, nausea and vomiting, general weakness and fatigue, headache, abdominal cramps, and diarrhea that may contain blood. Food poisoning in most cases ends with recovery within a few days. In childhood, they are very dangerous and can lead to death. Coli-infection clinically occurs with colenteritis and is characterized by high fever, vomiting, diarrhea, dehydration and water-electrolyte disorders. Botulism is the most severe food poisoning and is often fatal^[1,2].

Diagnosics.

The diagnosis of summer viral and foodborne infections is based on the history of the disease, the characteristic clinical course and paraclinical examinations. In addition to the usual complete blood count, ESR and C-reactive protein (CRP), the following examinations are also performed:

- In severe cases of food poisoning, microbiological examination of vomited gastric contents and stool samples may need to be tested to identify the specific pathogen (such as Salmonella, Staphylococcus or E. coli).^[1,2]
- To diagnose the most common causes of viral gastroenteritis in childhood (rota, adeno-, astro- and noroviruses), a fecal sample is examined using rapid immunochromatographic tests.
- To diagnose EV infections, stool, throat secretions, and cerebrospinal fluid from patients are examined in the first days of the illness. Serological tests for the detection of antibodies are of no significant value, because specific antibodies for acute infection are formed slowly, in addition, a repeat test is required after 20 days, which will establish the presence of increasing levels of IgG antibodies^[4,9,18].
- Molecular methods are increasingly crucial^[6,16]. The RT-PCR method allows the detection of specific viral RNA, which proves the presence of the infection. RT-PCR is the most sensitive and widely used gold standard for diagnosing all human enterovirus infections – including polio, coxsackieviruses, echoviruses and newer strains such as EV-D68. It provides results much faster than traditional viral cell cultures and is more sensitive. Enteroviruses are cleared from the blood rapidly. PCR is very reliable for detecting viruses in cerebrospinal fluid (CSF) or respiratory specimens, but its diagnostic value decreases if tested too late in the infection. In some cases, stool testing (fecal PCR) is much more sensitive later in the disease. PCR for EV performed on throat swabs or feces is more sensitive than that performed on lumbar puncture^[6].

Treatment.

- Symptomatic treatment with analgesics, antiemetics and antipyretics is administered.
- Treatment of EV infections is nonspecific, supportive^[4,22]. In case of meningitis - symptomatic

treatment (intravenous immunoglobulins, corticosteroids and fluoxetine, suppressing the replication of EV B and D, but not A and C). In case of EV myocarditis, complications are prevented and treated - arrhythmias, pericardial effusions, heart failure^[9,18,22]. There is evidence that pleconaril reduces the severity of EV infections in newborns^[18].

- Although antibiotics are not usually used in viral food poisoning, they may be prescribed for specific bacterial infections. In the case of viral or bacterial gastrointestinal infections leading to dehydration, the main treatment is rehydration. The child should be given small, frequent sips of oral rehydration solution (ORS). Infants should continue to breastfeed or take formula as usual. Avoid giving the child milk, caffeinated drinks, or sugary fruit juices, which can worsen diarrhea, and withhold solid foods while the child is vomiting. Once the stomach has settled, slowly reintroduce bland foods using the BRAT diet (bananas, rice, applesauce, toast).

- In case of food poisoning adult antidiarrheal medications (e.g., loperamide or Pepto-Bismol) should never be given to children, as they can trap toxins in the body and prolong the illness.

- In cases of severe illness or severe dehydration, the patient should be referred for hospital treatment.

Conclusion.

The multiple antigenic types and mild course of enterovirus infections make vaccine development pointless (with the exception of polio vaccine). Unfortunately, benign encephalitis caused by EV has evolved in recent years and is characterized by a worse prognosis. For this reason, a vaccine against non-polio EV is being developed in China^[18]. Quarantine is not effective due to the high incidence of congenital infections and mass carriage in healthy individuals (17-46% during the summer months) [4,9,18,22]. The most important measures to prevent infectious diseases, whether viral or bacterial, are: Strict hygiene and washing hands as often as possible and drinking mineral or spring water, as tap water is associated with numerous gastrointestinal problems, so it is best to avoid it. Buying food from the street is risky. Buy food only from the grocery store, because all storage conditions are met there and their quality and origin are guaranteed. Canned food that is damaged, food with initial signs of spoilage or food that has not been refrigerated should not be consumed. It is important not to leave food warm for more than 3 hours in the summer, especially meat and dairy products, as they spoil faster, i.e. food products and ready-made foods should only be stored in refrigerated conditions. Correct thermal processing of food must be observed - do not consume semi-raw or undercooked meat, eggs and dairy products. After defrosting or warming, the dish should not be cooled or frozen again. Vegetables and fruits should be washed before consumption, as high temperature and humidity create good conditions for the reproduction of microorganisms both in food products and in the environment and favor the development of bacterial infections - food poisoning.

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Poisoning or intoxication is any ingestion of a substance that can cause a disease. Most often, childhood poisonings are observed up to the fifth year of life and are among the most common reasons for seeking medical help in pediatric emergency departments and represent a serious public health problem. Some of them are life-threatening and pose a serious challenge for pediatricians in emergency and toxicology departments and require rapid and targeted diagnosis and timely adequate therapeutic behavior, rapid assistance on the spot is crucial. In the emergency department of „Uni Hospital“, we often encounter incidents of various cases of poisoning in children, a fact that prompted me to write this article. Poisoning should be considered when a healthy child suddenly or rapidly develops symptoms of illness in the digestive, nervous, or cardiovascular systems, and objective examination does not reveal any signs pointing to another disease. The lack of complete and comprehensive information on the diagnosis of poisoning and algorithms for choosing therapy for certain combinations of symptoms leads to serious difficulties in prescribing detoxification therapy, loss of time and reduction in the effectiveness of prescribed pharmacotherapeutic regimens.

Keywords: Poisonings, childhood, complications, conclusions, therapeutic behavior.

Introduction

Acute poisonings are diseases caused by many and varied types of poisons, often starting suddenly or over a short period of time, often occurring severely and rapidly. Some of them are toxic gases that penetrate the body through the respiratory system, others are solid and liquid compounds and substances that penetrate the body through the digestive system, through the skin and superficial mucous membranes. A third type are poisons that are released by certain animals - snakes, fish, etc. - when bitten or stung. The most common causes of poisoning in childhood are drugs, cigarettes, plants, household, cosmetic and insecticidal preparations. One of the common problems in poisonings of children is the lack of data on the type and quantity of what the child has ingested. In pediatric medicine, acute intoxications are a frequent reason for admission to the pediatric emergency department (ED) and represent a significant public health problem[6]. Due to their developmental stage, behavior, and limited awareness of potential hazards, children are particularly vulnerable to toxic exposures. In adolescents, intoxications are more often intentional and can occur for a variety of reasons, ranging from recreational substance use to self-injurious behavior associated with psychological distress [8,9]. This age group typically has greater access to medications, alcohol, and drugs, which are often used as coping mechanisms in response to emotional vulnerability, social isolation, or underlying psychiatric conditions. [7][10,11] A physician's knowledge of the physiological effects of toxic substances is important for accurate diagnosis and effective treatment and care of patients with poisoning (Kovalenko et al. 2019).

Clinical characteristics and diagnosis of poisonings

The diagnosis of acute poisonings is based on a detailed history, physical examination and additional laboratory and instrumental examinations such as ECG, EEG, chemical toxicological analysis of lavage fluids, blood and urine [1, 2, 4, 17, 20]. In many acute intoxications, the clinical symptoms are very similar, which makes diagnosis difficult. Clinical manifestations depend on

the type of toxin, the amount and the time of exposure [16, 19]. Poisoning should be considered when a healthy child suddenly or rapidly develops symptoms of the digestive, nervous or cardiovascular systems, and objective examination does not reveal signs pointing to another disease. Young children may not be able to effectively communicate their symptoms or the substances they have ingested, a fact that hinders the diagnostic process, requiring health professionals to rely on physical examination, observation, and information from parents or caregivers. Also important are a detailed history of the presence of scattered tablets of one or more medications or if a package of a medication or other preparation is found in the place where the child was. Food poisoning is characterized by its group nature. In various drug intoxications, the most common symptoms include: CNS depression (unconsciousness, drowsiness, ataxia), gastrointestinal manifestations, CNS stimulation (confusion, agitation, tremor, seizures), visual disturbances, respiratory and cardiovascular symptoms. Characteristic signs pointing to certain poisons should also be sought - such as a specific breath odor, dilated pupils, seizures, impaired consciousness, etc. Specific odors are: alcohol, acetone, petroleum products, etc. Characteristic odors are: organophosphorus poisons (like rotten garlic), nicotine (tobacco), and hydrogen cyanide (like bitter almonds). [1, 2, 4, 5]

Therapeutic behavior in acute poisoning

When a patient with poisoning arrives at the emergency room, an adequate assessment of their general condition is first performed[2,12, 4, 20]. In critical patients, resuscitation is started, followed by decontamination [5]. The approach to poisoned patients should be systematic and include several steps: cleaning the entrance door of poison that has got into or on it (decontamination), elimination of the absorbed poison, administration of an antidote, protection of organs, symptomatic treatment, resuscitation and intensive therapy.[1,2,3]. The above measures are carried out in the following chronology:

I. Cleaning the entrance door

1. When the poison penetrates the respiratory system, the following measures are carried out:

- Rescuers must be wearing masks with oxygen devices and protective clothing.
- The poisoned person is immediately removed from the gassed environment.
- The seriously injured should be given an oxygen mixture to inhale.
- Outside the gassed area, if the patient is conscious, he/she should slowly inhale and exhale fresh air to reduce the concentration of the poisonous gas in the alveolar air in the lungs.
- In case of carbon monoxide poisoning, artificial respiration is performed.
- In case of poisoning with other gases that damage the respiratory tract and lungs, artificial respiration with motor procedures is not performed.

2. **In case of contact of the poison with the skin and accessible mucous membranes** of the victim, the following is done:

- Carefully remove the clothes from the victim and send them packaged for chemical disposal.
- The contact areas or the entire body are washed with water and soap - best under a shower.
- If the eyes are affected in the first minutes of intoxication, the latter are carefully subjected tangentially to a moderately strong stream of water and washed off the poison.

3. When the poison is taken orally

Inducing vomiting. It is undertaken in the first minutes by relatives or a doctor. It is achieved by irritating the pharynx with a finger or spatula, but provided that the child is adequate, conscious, and that the poison is not a corrosive substance. If the patient has ingested a poison with strong chemical burning properties (acids, bases and other similar substances), before inducing vomiting, he/she should be given 2 tea cups of fresh milk to drink, possibly mixed with the white of 1 or 2 eggs, or the egg white should be given mixed into an emulsion with 2 tea cups of water. In addition, in case of poisoning with strongly corrosive basic substances (sodium base, potassium base, calcium base, etc.), immediately after ingestion, a diluted vinegar solution or lemon juice can be given to drink. It is obtained by mixing 2 tablespoons of vinegar or the juice of 1 lemon with 1/2 l of water. These liquids form compounds with this type of poison (albuminates) and when they remain in the stomach and are vomited back, they will no longer exhibit their burning effect. In case of poisoning with fat-soluble substances such as pesticides, organic solvents, etc., taking fresh milk is contraindicated and dangerous, the same applies to consuming fatty foods immediately after ingesting the aforementioned poisons, because these foods facilitate the resorption of the poison into the blood. The USA National Poison Control Center guidelines do not recommend inducing vomiting after a patient has ingested activated charcoal (or this substance has been introduced into the stomach by a tube) as an antidote to poison, as inducing vomiting is highly discouraged in modern first aid for several reasons:

Exacerbation of exposure: In some cases, such as with corrosives or petroleum-based products, vomiting

can cause further burns to the esophagus, throat, and mouth, or lead to life-threatening pulmonary complications

Risk of aspiration of activated charcoal and/or the poison into the patient's lungs, which would lead to severe respiratory problems, lung damage or aspiration pneumonitis.

Reduced effectiveness, i.e., inducing vomiting can actually reduce the effectiveness of activated charcoal, as the charcoal must remain in the digestive tract to bind to toxins and prevent them from entering the bloodstream.

Gastric lavage (GL). It is indicated in case of ingestion of toxic or poisonous substances. This manipulation is performed with warmed saline solution or water, adding 2.5 g of table salt for every 1 l of it, so as not to develop as a complication hypotonic hyperhydration. These solutions are administered at a dose of 10 ml/kg body weight per cycle, with the maximum amount not exceeding 50-100 ml in infants, 150-200 ml in young children, and 250 to 350 ml in older children. **GL** is more effective the earlier it is performed, so it should not be postponed. Unjustified abstention from this procedure has led to the death of more than one child. Therefore, lavage is also performed in case of suspected poisoning, better an unnecessary lavage than a late one. Gastric probing is avoided when swallowing corrosive substances - acids and bases, due to the risk of iatrogenic perforation of the already severely weakened, necrotic and friable walls of the esophagus or stomach. **GL** has a good effect when administered promptly (up to 1 hour after ingestion of the poison), and is contraindicated in acute surgical abdomen, apnea, gastrointestinal bleeding, seizures or collapse until resolution, unconsciousness until endotracheal intubation, and in corrosive poisonings if more than 30 minutes have passed since ingestion due to the serious risk of airway aspiration, worsening of internal bleeding, and mechanical perforation of damaged organs. On the other hand, the American Academy of Clinical Toxicology and the European Association of Poison Control Centers and Clinical Toxicologists do not recommend routine decontamination of the gastrointestinal tract because of its association with life-threatening complications (e.g., aspiration pneumonitis/pneumonia, perforation of the esophagus or stomach, fluid/electrolyte imbalance).^[2,17]

II. Application of antidote and purgative medications

After gastric lavage, an antidote and purgative are introduced into the stomach. Activated charcoal is a universal and most commonly used antidote that absorbs a large part of the poisons^[15, 20]. At a dose of 1 g/kg body weight in children up to 1 year of age, and in older children 25 - 50 g, dissolved 1:8:10 with water, or 30 g, dissolved in 1 l of water, immediately after which vomiting is induced. It is important to apply it as early as possible after ingestion of the poison. Its administration should only be considered if the patient has ingested a potentially toxic amount of a poison that is known to be adsorbed by activated charcoal within one hour of ingestion^[17]. It is ineffective for acids, bases, alcohols, organic solvents, inorganic salts, metals, etc.

[5]. Activated charcoal is contraindicated in case of paralytic ileus, intestinal perforation and if an oral antidote has already been given [4]. Treatment with antidotes is strictly specific, their use is justified only if the poison is identified (Table 1). [3, 5, 16]

To accelerate the removal of the toxin-charcoal complex from the gastrointestinal tract, 15 min. later, laxatives are given to drink: magnesium sulfate in a

dose of 0.5 - 1 g / kg or 1/4 to 1/2 sachet (5-10 g) is dissolved in 150 ml of warm water and drunk at once - indicated for children over 6 years old. The effect occurs after 1-2 hours. Or castor oil is given at a dose of 0.5 - 1 g/kg, but the same is contraindicated for fat-soluble poisons, as it facilitates their resorption, in this case alternative laxatives are: liquid paraffin at a dose of 3 g/kg or mannitol 1 - 2 g/kg. [2].

Table 1.

Poisonings requiring immediate administration of an antidote [5].

Poison	Antidote
Carbon monoxide	The child is taken to fresh air or given pure oxygen. If possible he/she should be intubated or until then ventilated with a mask and Ambu
Opiates	• Naloxone in an initial dose of 0.01 mg/kg/s.c., i.m., i.v. or endotracheally (also serves as a diagnostic test), followed by iv infusion of 0.4 mg/h • Allylnormorphin (in the absence of naloxone) in a dose of 0.1 mg/kg/s.c., im or slowly i.v.
Methemoglobin-forming poisons	• Methylene blue – 1-2 mg/kg/i.v., slowly; the dose can be repeated after 2-3-4 hours
Benzodiazepines	• Flumazenil – 0.01 mg/kg/i.v., dissolved in saline solution (also serves as a diagnostic test). If there is no effect within 60 seconds, the same dose is repeated. Upon recovery from coma, after 15 min, i.v. infusion is started at a rate of 0.1-0.4 mg/h to a total dose of 2-3 mg. • Lipid emulsion in severe intoxication
Cholinesterase inhibitors (Organophosphorus compounds, tabun, sarin, soman)	• Atropine – slow i.v. at a dose of 0.05-0.1 mg/kg (serves as a diagnostic test); the maximum dose of 1-2 mg can be given every 5-10 min for sustained atropinization (tachycardia, slightly red and dry mucous membranes, dilated pupils) • Lipid emulsion in severe intoxication
Metoclopramide	• Diphenhydramine – Tabl. 25 mg po, amp. 50 mg, im, iv m, administration of 1-2 mg/kg – 2-3 times until effect.
Isoniazid	• Vitamin B6 – slowly, intravenously, in a dose equal to the isoniazid taken
Paracetamol	• N acethyl-cysteine – initial dose: 150 mg/kg, diluted in 5% glucose, infusion for 1 hour.
Beta blockers severe intoxication	• Glucagon: dose for children under 25 kg – 0.5 ml; dose for children over 25 kg – 1 ml • Intralipid 20% – 1.5 ml/for 5 min i.v., followed by continuous infusion 0.3-0.6 ml/kg 24 h, at a rate of 40 ml/h (1000 ml/24 h)
Calcium antagonists severe intoxication	• Calcium gluconate 10% – 1-2 ml/kg • Intralipid 20% – 1.5 ml/for 5 min iv, followed by continuous infusion 0.3-0.6 ml/kg 24 h at a rate of 40 ml/h (1000 ml/24 h)
Cyanides	• Hydroxycobalamin – infusion – 70 mg/kg for 15 min, in case of insufficient effect – repeated dose 35 mg/kg

III. Elimination of absorbed poison

The elimination of poison from the body is realized through methods of cleansing the tissues of the poison or its metabolites that have entered them. Such methods are forced diuresis and extracorporeal methods of detoxification [2, 15, 19].

1. Forced diuresis (FD). It is indicated for all exogenous noxies that are emitted through the kidney. It is a sufficiently effective method for eliminating poison from the blood and tissues. A prerequisite for its implementation is good circulation and healthy kidneys. It is achieved by intravenous infusion of fluids: ser. glucose, 10% glucose, 10% mannitol. In order to prevent the development of hypokalemia, 10 - 20 mmol / l of potassium should be added to each liter of these solutions. Infusion with 5% glucose solution is not undertaken

due to the risk of water intoxication. FD is performed under strict control of diuresis, electrolytes and cardiac function. Contraindications for its implementation are: renal failure, severe heart failure, cerebral and pulmonary edema. Fluids are infused at 20 ml/kg/hour during the first hours, then 10 ml/kg/hr or 200 ml/kg/24 hours, aiming to achieve a diuresis of about 4-6 ml/kg/hour, which means well-conducted depuration. In case of insufficient diuresis, furosemide is administered at 1 - 3 mg/kg i.v. [2,4,5]

2. Extracorporeal methods of detoxification

Absolute indications for extracorporeal methods of detoxification: severe poisoning with life-threatening symptoms; lack of other alternative treatment (e.g. effective antidote); very high and lethal concentrations of the poison in the blood. Contraindications for the use

of these methods are shock and hemorrhagic diathesis [2,4, 5].

The main extracorporeal methods used are:

□ Hemodialysis – for dialyzable poisons (alcohol, methanol, ethylene glycol, metformin, salicylates, etc.);

□ Carbohemoperfusion – suitable for liposoluble poisons with a high molecular weight and with significant binding to plasma proteins – e.g. barbiturates, methylxanthines, phalloid poisoning, etc.;

□ Plasmapheresis – effective for poisons with a high percentage of binding to plasma proteins. Modern devices allow its implementation through the peripheral venous route;

□ Peritoneal dialysis – a slow method, indicated for severely impaired hemodynamic indicators;

□ Exchange transfusion – a method suitable for infants and young children, for severe methemoglobin-forming toxins, for poisons causing severe hemolysis, for phalloidin poisoning, etc.

Conclusion

Rapid targeted correct diagnosis and timely therapeutic intervention in acute poisoning in childhood, especially prompt assistance on the spot, are crucial for the success of therapeutic measures, which reduces the risk of serious complications and death. The doctor's knowledge of the physiological effects of poisonous substances is important for accurate diagnosis and effective treatment and care of patients with poisoning. Inadvertent ingestion of household substances is particularly common among children under five years of age due to their fondness for and often unsafe storage of these substances. That is why extremely important to limit children's access to medicines and other toxic substances as much as possible.

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**MASKS OF RHEUMATOID ARTHRITIS: CLINICAL VARIANTS AND DIAGNOSTIC FEATURES
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assistant of the department of internal medicine***Heorhita K.M.,****Huz S.,****Dymitrash K.**DOI: [10.5281/zenodo.20824397](https://doi.org/10.5281/zenodo.20824397)**Abstract**

Rheumatoid arthritis (RA) is a chronic systemic autoimmune disease characterized by progressive inflammation of the synovial membrane of the joints, the development of erosive-destructive changes and extra-articular manifestations. The classic variant of the course of RA includes symmetrical damage to the small joints of the hands and feet, morning stiffness and gradual formation of deformities. However, in clinical practice, the disease often debuts atypically, masquerading as other rheumatological, infectious, neurological or degenerative pathologies. That is why the problem of "masks" of rheumatoid arthritis remains relevant in modern rheumatology.

Early diagnosis of RA is of fundamental importance, as the first months after the onset of the disease are considered a "window of therapeutic opportunity", when timely administration of basic therapy allows to slow down the progression of structural damage and improve the prognosis. However, atypical clinical variants often cause diagnostic errors and treatment delays.

Keywords: antibodies to cyclic citrullinated peptide, proinflammatory cytokines, rheumatoid factor, rheumatoid arthritis, atypical onset, seronegative arthritis, extraarticular manifestations, differential diagnosis.

Introduction

Rheumatoid arthritis is a chronic systemic autoimmune disease of unknown etiology, which is based on immunoinflammatory damage to the synovial membrane of the joints with the development of chronic proliferative synovitis and gradual destruction of joint structures. Modern ideas about RA have expanded significantly: today the disease is considered not only as a joint pathology, but as a systemic immunoinflammatory process with a wide range of clinical phenotypes. The prevalence of RA in the population is about 0.5–1%, and the disease is one of the leading causes of early disability and disability [9].

The classic form of RA is characterized by symmetrical involvement of the small joints of the hands and feet, morning stiffness, and progressive erosive processes. However, atypical forms of the disease are often encountered in clinical practice, in which joint symptoms are absent or mild in the early stages. In such cases, the clinical picture may resemble other diseases, which significantly complicates diagnosis [2].

A particular difficulty in clinical practice is the so-called "masks" of RA — atypical onsets and course variants in which classical symmetrical polyarthritis is absent or mild for a long time. Such forms can mimic infectious, oncological, neurological, pulmonary, cardiac, or other rheumatic diseases, which leads to a delay in diagnosis and late initiation of basic therapy [19].

Current recommendations from the European Alliance of Associations for Rheumatology and the American College of Rheumatology emphasize the need for early diagnosis of RA even in the absence of a typical clinical picture, taking into account serological, immunological, and imaging markers [22].

Clinical masks of rheumatoid arthritis include:

- **Seronegative rheumatoid arthritis** in which RF and ACCP remain negative. In such patients, the clinical picture often resembles seronegative spondyloarthritis, reactive arthritis, or osteoarthritis. The absence

of specific antibodies in the early stages complicates the verification of the diagnosis and delays the start of basic therapy. The main symptoms include: acute onset, asymmetric oligoarthritis, predominant involvement of large joints, absence or mild morning stiffness, fever, and systemic manifestations. Ultrasound of the joints, MRI of the hands, dynamic observation, and determination of anti-CCP are of diagnostic value [15].

- **Monoarthritis and oligoarthritis** can manifest as damage to one or more joints. Such a debut is often interpreted as traumatic injury, gout, reactive or infectious arthritis. The knee, radiocarpal or shoulder joints are most often affected. The lack of typical symmetry forms a false idea of a different nature of the disease. In such cases, synovial fluid analysis, determination of uric acid levels and instrumental methods of examination are important [8].

- **The polymyalgic variant of RA** in older patients may debut with severe pain in the shoulder and pelvic girdle, severe morning stiffness, reminiscent of polymyalgia rheumatica. In such cases, general symptoms dominate: weakness, subfebrile temperature, increased ESR and C-reactive protein. Arthritis of small joints may be absent or occur later. Unlike classical polymyalgia, RA later develops symmetrical arthritis of the hands, erosive changes, and positive anti-CCP [6].

- **Mask of osteoarthritis** in slow-progressing RA with a predominance of degenerative changes of the disease, patients complain of mechanical pain, and laboratory activity of inflammation is minimal. In such cases, only dynamic observation and detection of erosive changes allow to establish the correct diagnosis [11].

- **Fibromyalgia mask.** In some patients, pain syndrome prevails over objective signs of arthritis, which creates a similarity to fibromyalgia. Patients complain of diffuse pain, fatigue, sleep disturbances and depressive symptoms. At the same time, laboratory parameters may remain normal [3].

• **Febrile (septic) mask.** Sometimes RA debuts with prolonged fever, weight loss and a pronounced inflammatory syndrome, which can simulate: sepsis, infective endocarditis, tuberculosis, oncohematological processes. Such patients are often examined for a long time in infectious hospitals. A characteristic feature is the appearance of joint syndrome after several weeks or months [21].

Sometimes extra-articular manifestations of RA precede the development of the typical joint syndrome. Such manifestations include:

- **rheumatoid nodules;**
- **Lung involvement** – the most common pulmonary manifestations are interstitial lung disease, pleurisy, rheumatoid nodules, bronchiectasis. Of particular concern is RA-associated interstitial lung disease (RA-ILD), which may present with cough and shortness of breath in the absence of significant arthritis. Current guidelines emphasize the need for high-resolution computed tomography, pulmonary function tests, and a multidisciplinary evaluation involving a rheumatologist and a pulmonologist [10].

- **Vasculitis**, which manifests as purpura, skin ulcers, polyneuropathy, ischemic lesions, and damage to internal organs. In some cases, vasculitic manifestations are the first clinical sign of a systemic autoimmune process [17].

- **anemia of chronic inflammation;**

- **serositis;**

- **Neuropathies** in RA may include: tunnel neuropathies, cervical myelopathy, polyneuropathy, spinal cord compression in atlantoaxial instability. Sometimes patients are observed for a long time by a neurologist for cervical osteochondrosis, radiculopathy, neuropathic pain [24].

- **Palindromic rheumatism** as a prodrome of RA is characterized by short-term relapses of arthritis with complete inter-attack recovery. In a significant proportion of patients with positive ACCPs, palindromic rheumatism is considered a prodromal stage of RA. The modern concept of "pre-RA" suggests the possibility of early identification of high-risk individuals before the development of persistent synovitis [7].

- **Cardiac mask** in RA can lead to: pericarditis, myocarditis, accelerated atherosclerosis. Sometimes it is the cardiovascular symptoms that dominate the clinical picture [13].

In such situations, patients are observed for a long time by pulmonologists, cardiologists or neurologists without suspicion of rheumatoid arthritis.

The main reasons for late diagnosis are: the absence of typical symmetrical polyarthritis. Seronegativity, the predominance of systemic manifestations, similarity with other diseases [14].

Modern diagnosis of RA is based on the use of the ACR/EULAR 2010 criteria, which take into account: the number of affected joints, serological markers, acute phase indices, and duration of symptoms [20].

Of importance are [1]:

- rheumatoid factor (RF);
- antibodies to cyclic citrullinated peptide (ACCP);
- ESR;
- C-reactive protein.

ACCPs are characterized by high specificity (>95%) for RA and can be determined even before the clinical debut of the disease. However, negative results do not exclude early or seronegative RA [16].

Among instrumental diagnostic methods, radiography in the early stages has limited informative value. More sensitive methods are [23]:

- joint ultrasound;
- magnetic resonance imaging;
- power Doppler.
- CT of the chest for pulmonary manifestations.

These methods allow to detect synovitis, erosions and subclinical inflammation even before the appearance of radiological changes. It is the methods of modern imaging that have become key in the detection of atypical and preclinical forms of RA.

The ACR/EULAR 2010 classification criteria remain the basis for the early diagnosis of RA [8].

The diagnosis of RA is considered probable if the total score is ≥ 6 points according to the criteria: joint involvement, serological markers, acute phase indices, duration of symptoms [18].

Atypical forms of RA should be differentiated from [25]:

- osteoarthritis;
- psoriatic arthritis;
- reactive arthritis;
- gout;
- systemic lupus erythematosus;
- viral arthritis;
- fibromyalgia;
- Lyme arthritis.

Of particular difficulty are overlap syndromes and seronegative variants of the course [3].

Comprehensive analysis of clinical, laboratory and instrumental data allows to avoid diagnostic errors.

Conclusions

Rheumatoid arthritis is a clinically heterogeneous disease with a large number of atypical onsets and "masks". Atypical forms of RA significantly complicate early diagnosis and can lead to erroneous treatment. The greatest difficulties arise with seronegative, febrile, monoarthritic and extraarticular onset of the disease.

Modern approaches to diagnosis are based on a comprehensive analysis of clinical symptoms, serological markers and imaging methods. The concept of "pre-RA" and the implementation of modern EULAR/ACR recommendations open up opportunities for very early detection of the disease and timely appointment of basic therapy. Understanding the clinical "masks" of RA is of important practical importance for doctors of various specialties, since it is early diagnosis that determines the prognosis, quality of life of patients and the risk of disability.

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PEDAGOGICAL SCIENCES

METHODS FOR DEVELOPING ENGLISH VOCABULARY THROUGH BLENDED LEARNING

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Abstract

The rapid development of digital technologies has significantly transformed modern education, particularly in foreign language teaching. One of the most effective contemporary approaches is blended learning, which combines traditional face-to-face instruction with online and digital learning tools. This article examines methods for developing English vocabulary through blended learning and highlights the advantages of integrating mobile applications, interactive platforms, and classroom activities. The study emphasizes that blended learning creates flexible, engaging, and student-centered environments that improve vocabulary acquisition, retention, and practical usage.

Keywords: blended learning, English vocabulary, lexical skills, mobile applications, digital technologies, foreign language teaching.

Introduction

Vocabulary is one of the main components of language proficiency. A learner may know grammar rules well, but without enough words it is difficult to understand texts, express ideas, ask questions, or participate in conversation. For this reason, vocabulary development is a central part of English language teaching.

In traditional classrooms, vocabulary is often taught through explanation, translation, repetition, and memorization. Although these methods are useful, they are not always enough for long-term retention or active use. Many learners remember words for a short time, but later forget them because they do not meet the words in different contexts or use them regularly.

Blended learning offers a more effective solution. It combines face-to-face instruction with digital learning tools, allowing students to learn both in class and independently online. This method is especially useful for vocabulary development because it provides repeated exposure, interactive practice, visual support, and opportunities for self-paced learning.

The purpose of this article is to describe the main methods of developing English vocabulary through blended learning and to show how this approach improves motivation, retention, and communicative competence.

Theoretical Background of Blended Learning

Blended learning is an educational model that combines traditional classroom teaching with online or technology-based learning. In language education, it usually means that students learn some material in class with a teacher and continue practicing it at home or outside the classroom using digital platforms, applications, videos, or online exercises.

This model is effective because it brings together the strengths of both environments. In the classroom, students receive direct explanation, support, and feedback from the teacher. Online, they can practice repeatedly, review difficult words, and work at their own pace. As a result, learning becomes more flexible and personalized.

Why Vocabulary Needs Special Attention

Vocabulary is not simply a list of words. It includes meaning, pronunciation, spelling, usage, collocations, and grammatical behavior. A student must know not only what a word means, but also how to use it correctly in a sentence.

For example, learning the word “improve” means more than translating it. Learners should also know:

- how to pronounce it;
- what part of speech it is;
- what words it combines with;
- in what contexts it is used;
- how it differs from similar words.

Blended learning helps students learn vocabulary more deeply because words are presented in different forms and situations.

Methods for Developing Vocabulary through Blended Learning

1. Mobile Applications for Vocabulary Learning

Mobile applications have become an essential component of blended learning because they provide students with constant access to vocabulary practice outside the classroom. Unlike traditional paper-based exercises, mobile tools create interactive learning environments where learners can study independently, monitor their progress, and receive immediate feedback. Applications such as Quizlet, Duolingo, Memrise, Wordwall, and Anki are widely used in English language teaching due to their accessibility and variety of learning activities.

These applications contribute to vocabulary development by:

- improving memorization through spaced repetition;
- providing pronunciation models;
- supporting visual and auditory learning;
- increasing learner motivation through gamification.

For example, Quizlet enables learners to create customized vocabulary sets, practice spelling, complete matching activities, and participate in collaborative re-

view games. Memrise combines repetition with authentic pronunciation recordings from native speakers, while Duolingo introduces vocabulary through short contextual tasks and interactive challenges that maintain learner attention throughout the learning process.

In blended learning environments, teachers may assign vocabulary practice through mobile applications before classroom lessons. Students can familiarize themselves with target lexical items independently, which allows classroom time to focus on communicative activities, discussions, and practical application of vocabulary in meaningful contexts.

2. Interactive Classroom Activities

Although digital technologies play a major role in blended learning, face-to-face classroom interaction remains essential for effective vocabulary development. Classroom activities provide opportunities for learners to apply newly acquired words actively in communication rather than simply recognizing them during online exercises.

Interactive activities encourage deeper lexical processing because students must use vocabulary spontaneously while speaking, listening, reading, or writing. This active engagement strengthens productive vocabulary skills and helps learners become more confident language users.

One commonly used strategy is **role-play**. In role-play activities, students simulate real-life situations such as ordering food, conducting interviews, visiting a doctor, or discussing travel plans. Such tasks require learners to use thematic vocabulary in realistic communicative settings. Since vocabulary becomes associated with practical use rather than isolated memorization, retention improves significantly.

Debates and discussions also contribute to vocabulary expansion. When students express opinions, defend arguments, or react to classmates' ideas, they naturally practice academic and conversational vocabulary. These activities additionally develop critical thinking skills and fluency.

Project-based learning represents another effective classroom method. Students may prepare presentations, posters, digital reports, or research projects related to topics studied online. During project work, learners encounter vocabulary repeatedly while searching for information, organizing ideas, and presenting findings. Such repeated exposure strengthens understanding of lexical meaning and usage.

Vocabulary games are especially beneficial for maintaining classroom motivation. Activities such as word association tasks, guessing games, crossword puzzles, charades, and category competitions create dynamic learning environments where students practice vocabulary without excessive anxiety. Games also encourage participation from shy or less confident learners.

Teachers can further enhance vocabulary instruction by integrating **pre-class online preparation** with in-class collaborative tasks. For instance, students may study target words through digital flashcards at home and later participate in classroom storytelling activities using the same vocabulary. This connection between online preparation and classroom practice supports meaningful learning and contextual application.

Additionally, interactive classroom tasks improve pronunciation, collocation awareness, and grammatical accuracy because students receive immediate corrective feedback from both teachers and peers. Consequently, vocabulary learning becomes more comprehensive and communicatively oriented.

3. Multimedia Resources

Multimedia resources occupy an important place in blended vocabulary instruction because they expose learners to authentic language input and contextualized communication. Videos, podcasts, songs, films, animations, interactive presentations, and digital stories provide opportunities to encounter vocabulary in natural speech and realistic situations.

One of the greatest strengths of multimedia learning is **contextual support**. Learners often struggle to understand isolated vocabulary items because they cannot visualize how words function in real communication. Audiovisual materials solve this problem by presenting vocabulary together with gestures, emotions, settings, and visual clues. As a result, comprehension becomes easier and more memorable.

Video materials are particularly effective for vocabulary acquisition. Educational videos, interviews, documentaries, and short films allow students to hear pronunciation, observe intonation, and identify lexical usage in authentic contexts. Teachers can select videos related to thematic units such as education, technology, travel, health, or environmental issues. After watching, learners may complete comprehension tasks, summarize information, or discuss ideas using newly learned vocabulary.

Podcasts and audio recordings contribute significantly to listening-based vocabulary development. Exposure to different accents, speaking speeds, and communication styles improves learners' listening comprehension and helps them recognize vocabulary in continuous speech. Podcasts are especially useful for intermediate and advanced learners because they introduce natural expressions, idiomatic language, and discourse markers frequently absent from traditional textbooks.

Songs can also support vocabulary instruction by increasing emotional engagement and improving pronunciation awareness. Musical rhythm and repetition make lexical items easier to remember, while lyrics expose students to colloquial expressions and cultural references. Teachers may design gap-fill activities, lyric analysis tasks, or pronunciation exercises based on songs appropriate to learners' levels.

Digital storytelling is another valuable method in blended learning environments. Students may watch animated stories online or create their own digital narratives using target vocabulary. Story-based learning strengthens contextual understanding because words become connected to events, characters, and emotional experiences.

Multimedia resources additionally support differentiated instruction. Visual learners benefit from images and videos, auditory learners improve through listening activities, and kinesthetic learners engage through interactive tasks connected to multimedia con-

tent. Consequently, blended learning accommodates diverse learning preferences more effectively than traditional instruction alone.

Furthermore, multimedia materials increase learner motivation because they create more dynamic and authentic educational experiences. Students often perceive audiovisual content as more enjoyable and relevant than textbook-based vocabulary exercises, which positively influences participation and long-term engagement.

4. Collaborative Online Learning

Collaborative online learning is a fundamental aspect of blended education because it combines digital communication with cooperative knowledge construction. Through online interaction, students practice vocabulary actively while exchanging ideas, solving problems, and completing group tasks.

Platforms such as Google Classroom, Padlet, Moodle, Microsoft Teams, Edmodo, and collaborative Google Docs environments allow learners to participate in discussions and share learning materials beyond classroom walls. These tools extend vocabulary practice into continuous communication and encourage learners to interact in English more frequently.

One important advantage of collaborative online learning is **increased student participation**. In traditional classrooms, some learners may hesitate to speak due to anxiety or lack of confidence. Online environments often reduce psychological barriers because students have more time to formulate responses and participate at their own pace. Consequently, learners who are usually passive during face-to-face interaction may become more active contributors online.

Collaborative tasks also encourage **meaningful vocabulary use**. Students may work together to create glossaries, vocabulary posters, thematic presentations, or discussion forums related to lesson topics. During these activities, learners repeatedly encounter and apply target lexical items while negotiating meaning with peers.

Peer feedback plays a particularly important role in vocabulary development. When students review classmates' work, suggest corrections, or explain word meanings, they deepen their own understanding of lexical usage. This process promotes analytical thinking and increases awareness of spelling, collocations, grammar, and contextual appropriateness.

Digital discussion boards are especially useful for developing academic vocabulary. Teachers can assign debate questions, article responses, or reflective writing tasks that require students to use specific lexical items in context. Such activities strengthen productive vocabulary and improve written communication skills simultaneously.

Collaborative online learning additionally supports **intercultural communication**. Through virtual exchanges, learners may interact with students from different linguistic and cultural backgrounds. Authentic communication in international online environments motivates learners to expand vocabulary in order to express ideas more effectively.

For example, Padlet can be used to create shared vocabulary walls where students upload definitions, pictures, synonyms, antonyms, and example sentences.

Google Docs enables collaborative writing projects in which learners jointly edit texts and improve lexical accuracy. These activities transform vocabulary learning into a social and interactive process rather than an isolated individual task.

5. Gamification Techniques

Gamification has become one of the most effective strategies in blended vocabulary instruction because it transforms learning into an engaging and motivating experience. Gamification refers to the integration of game elements such as scoring systems, rewards, competition, challenges, and progress tracking into educational activities.

In vocabulary learning, gamified tasks encourage students to participate actively and practice lexical items repeatedly without experiencing boredom or excessive pressure. Educational platforms such as Kahoot, Quizizz, Baamboozle, Gimkit, and Wordwall are commonly used to create interactive vocabulary competitions and review exercises.

One of the primary benefits of gamification is **increased learner motivation**. Traditional vocabulary memorization may seem repetitive and monotonous, particularly for younger learners. Game-based activities create excitement and curiosity, encouraging students to engage with vocabulary more enthusiastically.

Competition can also stimulate **participation**. Team-based quizzes, timed challenges, and leaderboard systems motivate learners to improve performance and pay closer attention to vocabulary accuracy. At the same time, teachers must ensure that competition remains supportive and does not create excessive stress for weaker students.

Gamification additionally improves **concentration** and **memory retention**. Interactive tasks require learners to recognize, recall, and apply vocabulary quickly, strengthening mental associations and automatic word retrieval. Repeated exposure through games reinforces lexical knowledge more effectively than passive review methods.

Immediate feedback is another important advantage. Digital platforms instantly inform students whether their answers are correct, allowing learners to identify mistakes and correct misunderstandings immediately. Such rapid feedback supports self-regulated learning and helps teachers monitor vocabulary progress efficiently.

Gamified activities can also be **adapted for different proficiency levels** and learning goals. Beginners may complete matching games and picture-based tasks, while advanced learners participate in contextual quizzes, word formation challenges, or academic vocabulary competitions.

In blended learning environments, teachers often combine online gamified practice with classroom consolidation activities. For example, students may complete digital vocabulary quizzes at home and later participate in speaking tasks using the same lexical items during class discussions. This combination strengthens both receptive and productive vocabulary skills.

Advantages of Blended Learning in Vocabulary Development

Blended learning offers several important advantages for vocabulary acquisition because it combines traditional classroom instruction with digital technologies. This approach creates flexible and interactive learning environments that help students improve both receptive and productive vocabulary skills.

Flexibility

One of the main benefits of blended learning is flexibility. Students can study vocabulary anytime and anywhere using smartphones, tablets, or computers. Unlike traditional lessons that are limited by classroom time, digital platforms allow learners to review vocabulary at their own convenience. This continuous access to learning materials supports regular practice and independent study.

Individualization

Blended learning supports individualized instruction by allowing students to learn at their own pace. Learners can repeat difficult words, focus on specific topics, and complete additional exercises when necessary. Online applications often provide personalized feedback and progress tracking, helping students identify weaknesses and improve vocabulary more effectively.

In addition, blended learning accommodates different learning styles. Visual learners benefit from images and videos, auditory learners improve through listening activities, and kinesthetic learners engage through interactive tasks and games.

Increased Motivation

Digital technologies make vocabulary learning more engaging and enjoyable. Interactive applications, multimedia resources, online quizzes, and gamified tasks increase student motivation and participation. Features such as points, badges, leaderboards, and rewards encourage learners to practice vocabulary regularly.

Authentic materials like videos, podcasts, and online discussions also make learning more meaningful because students see how vocabulary is used in real communication.

Enhanced Retention

Blended learning improves long-term vocabulary retention through repeated exposure and contextual practice. Digital repetition systems, flashcards, and multimedia activities help learners review vocabulary regularly and strengthen memory.

Students also remember words more effectively when they encounter them in different forms such as videos, discussions, reading texts, and classroom activities. This combination of visual, auditory, and communicative practice supports deeper understanding and better recall.

Improved Communication Skills

Students first study vocabulary online and later use it in classroom discussions, presentations, role plays, and collaborative tasks. This process helps learners apply vocabulary actively in meaningful contexts.

Online collaboration platforms also provide additional opportunities for interaction, allowing students to practice writing and communication skills beyond the classroom environment.

Challenges of Blended Vocabulary Instruction

Despite its advantages, blended learning also presents several challenges that may affect vocabulary instruction.

Unequal Access to Technology

Not all students have reliable internet access or personal digital devices. Limited technological resources may reduce participation in online learning activities and create unequal learning opportunities.

Limited Digital Literacy

Some teachers and students may lack the technical skills necessary to use digital platforms effectively. Difficulties with educational technologies can slow down the learning process and reduce the effectiveness of blended instruction.

Distractions during Online Learning

Online learning environments may distract students because of social media, entertainment platforms, or unrelated internet content. Without proper guidance, learners may lose concentration during vocabulary practice.

Excessive Dependence on Technology

Overreliance on digital tools may reduce face-to-face interaction and communicative practice. Vocabulary learning requires real communication, teacher support, and collaborative activities that cannot be replaced entirely by technology.

Overcoming the Challenges

To overcome these difficulties, teachers should carefully choose accessible and user-friendly digital tools, provide clear instructions, and balance online learning with classroom interaction. Educational institutions should also support teachers through training programs and improve access to technological resources.

When implemented effectively, blended learning remains one of the most successful approaches for developing English vocabulary in modern language education.

Conclusion

Blended learning has become an effective and innovative approach to developing English vocabulary in modern language education. By combining traditional classroom instruction with digital technologies, teachers can create flexible, interactive, and learner-centered environments that support vocabulary acquisition, retention, and practical usage.

Various blended learning methods, including mobile applications, multimedia resources, interactive classroom activities, collaborative online platforms, and gamification techniques, contribute significantly to improving learners' lexical competence. These tools increase motivation, encourage independent learning, and provide repeated exposure to vocabulary in meaningful contexts.

In addition, blended learning helps students develop not only vocabulary knowledge but also communication, collaboration, and critical thinking skills. The integration of online preparation with classroom interaction allows learners to apply newly acquired vocabulary more confidently in speaking and writing activities.

Although blended learning may involve certain challenges, such as limited access to technology, digital

distractions, and insufficient technical skills, these difficulties can be reduced through careful lesson planning, teacher support, and balanced use of digital and traditional teaching methods.

Overall, the successful implementation of blended learning strategies can make vocabulary instruction more effective, engaging, and communicative, helping learners achieve higher levels of English language proficiency.

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PHILOLOGICAL SCIENCES

ТВОРЧЕСТВО ИЛЬДАРА АБУЗЯРОВА В ОЦЕНКЕ НАУЧНО-КРИТИЧЕСКОЙ МЫСЛИ

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THE WORKS OF ILDAR ABUZAROV IN SCHOLARLY AND CRITICAL RECEPTION

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Аннотация

В статье рассматривается творчество современного писателя Ильдара Абузарова в контексте литературоведческой и критической мысли. Анализируются особенности его поэтики, повествовательные стратегии, символика и философская проблематика. Особое внимание уделяется вопросам национальной и культурной идентичности, а также роли мифологических и интертекстуальных мотивов в произведениях автора.

Исследователи отмечают сложность и многогранность прозы Ильдара Абузарова, сочетание традиций русской и татарской литературы, использование архетипов, метафор и аллюзий. В статье также рассматриваются жанровые и стилистические особенности его произведений, элементы постмодернистской эстетики и формальные эксперименты автора. Делается вывод о значимости творчества Ильдара Абузарова для современной литературы и его высокой интерпретационной насыщенности.

Abstract

The article examines the works of the contemporary writer Ildar Abuzarov in the context of literary and critical thought. It analyzes the distinctive features of his poetics, narrative strategies, symbolism, and philosophical issues. Particular attention is paid to the problems of national and cultural identity, as well as to the role of mythological and intertextual motifs in the author's works.

Researchers emphasize the complexity and multidimensionality of Ildar Abuzarov's prose, which combines the traditions of Russian and Tatar literature and employs archetypes, metaphors, and allusions. The article also explores the genre and stylistic characteristics of his works, the elements of postmodern aesthetics, and the author's formal experiments. It concludes that Ildar Abuzarov's творчество occupies an important place in contemporary literature due to its rich interpretative potential.

Ключевые слова: Творчество, литературная критика, идентичность, символизм, мифология, постмодернизм, экзистенциальные аспекты.

Keywords: Creativity, literary criticism, identity, symbolism, mythology, postmodernism, existential aspects.

Введение: Литературный процесс конца XX – начала XXI века в России представляет собой многослойное и многогранное явление, где писатели стремятся осмыслить новые реалии, пересматривая прежние духовные ценности и социальные идеалы. Творчество Ильдара Абузарова, одного из значимых представителей современной русской литературы, в последние годы становится предметом исследования литературоведов и критиков. В условиях многополярности литературного процесса конца XX – начала XXI века, работы Абузарова привлекают внимание как пример сложного взаимодействия постмодернистских форм и реалистических мотивов. В данном исследовании представлен анализ современных научных трудов, посвящённых анализу творческого наследия Абузарова, с целью выявления ключевых тенденций в изучении его прозы.

Современная русская литература, развиваясь на фоне глобализации и постсоветского культурного кризиса, отличается стремлением к поиску

идентичности и новым способам осмысления реальности. В этом процессе важное место занимает проза как форма выражения быстрых изменений в обществе и личных переживаний героев. Абузаров в своих произведениях подчеркивает важность социальной и политической актуальности, погружая своих персонажей в повседневные, но глубоко символические ситуации, которые отражают острые проблемы современности.

Несмотря на использование постмодернистских приемов, его произведения обладают классическими чертами реализма. Главный акцент делается на человеческих характерах, где герои становятся выразителями времени. Например, его персонажи не просто сталкиваются с бытовыми проблемами, но и отражают общие социальные тенденции и дух эпохи, которые писатель постигает через призму личного опыта и творческого осмысления.

Современные литературные критики и исследователи, такие как Мария Ремизова [11, с. 44] и

Ирина Роднянская [12], обращают внимание на возвращение в русскую литературу элементов реализма, где постмодернистские стратегии служат средством передачи глубинных смыслов эпохи, а не просто игрой с формой. В этом смысле творчество Ильдара Абузярова можно рассматривать как пример соединения старых и новых традиций, где «постмодернизм» [8] используется для углубления реалистической интерпретации современности.

Творчество Ильдара Абузярова активно интегрирует восточные темы, что проявляется в его художественных произведениях через использование традиционных сюжетов, символики и философских мотивов Востока. Автор исследует культурное наследие и духовные практики восточных цивилизаций, внедряя их в повествовательные структуры своих произведений. Это выражается как в тематическом разнообразии, так и в стилистических особенностях, таких как лиризм, аллегоричность и внимание к деталям. В своих произведениях Абузяров демонстрирует глубокое понимание восточных культурных кодов и их влияние на личностное и общественное развитие, что позволяет читателям погрузиться в богатый и многогранный мир Востока. Взаимопроникновение восточной и европейской культуры отчетливо отражены в малой прозе Ильдара Абузярова.

Различные аспекты творчества И. Абузярова неоднократно становились объектом пристального изучения. До 2010-е годы прозу художника анализировали Аминев В.Р. в статье «Особенности организации субъектной сферы в произведениях русских и татарских писателей» [5], Ибрагимов М.И. в очерке «Национальная идентичность татарской литературы: современные методы исследования» [9]. В 2010-е - 2020 круг этих исследователей пополнили Дирк Уффельманн «Игра в номадизм, или Постколониальность как прием (случай Ильдара Абузярова)» [6], вопросами анализа поэтики произведений И. Абузярова в контексте современного литературного процесса занимались В.Р. Аминев, А.Н. Набиуллина в работе «Номинация как способ идентификации персонажа в прозе И. Абузярова» [3], Набиуллина А. Н., В.Р. Аминев ««Подпольный» человек в современной русскоязычной прозе (на материале произведений И. Абузярова)» [10]. Аминев В.Р., А.Н. Набиуллина «Жертвенность и жертвоприношение в прозе И. Абузярова: деконструкция мифологических сюжетов» [4].

В статье В.Р. Аминев «Особенности организации субъектной сферы в произведениях русских и татарских писателей» [5, с. 55-56] исследуется специфика субъектной организации в текстах, представляющих русскую и татарскую литературные традиции. Автор обращает внимание на различные формы взаимодействия между субъектом повествования и субъектом произведения, подчеркивая культурно-исторические и национальные особенности этих литературных процессов: «Смысловое композиционное развитие произведения основывается на соотношении двух планов: частного и общего, психологической конкретики и неких жизненных итогов, «завершающих» истин «родового», сверхиндивидуального порядка, раздумий о себе и

о мире в целом.» [5, с. 55-56] Данный аспект особенно интересен в контексте творчества Ильдара Абузярова, который активно использует элементы как русской, так и татарской культур, что находит отражение в организации субъектной сферы его произведений.

Аминев [5] рассматривает, как в татарской литературе субъектная сфера тесно связана с традициями устной народной словесности и эпоса, что способствует акценту на коллективное начало и тесную связь героя с родовым и этническим окружением. В произведениях Абузярова можно найти подобные черты, особенно в тех, где он обращается к теме культурной и национальной идентичности. Например, персонажи его произведений часто находятся в поиске своей этнокультурной принадлежности, что отражает общие тенденции татарской литературы, описанные Аминовой. Здесь важно отметить влияние татарской мифологии и фольклора, которые Абузяров органично вплетает в свои тексты, создавая многослойную субъектную сферу, где личное «я» переплетается с коллективным.

Таким образом, анализ статьи В.Р. Аминев в контексте творчества Ильдара Абузярова позволяет заключить, что субъектная сфера в произведениях последнего представляет собой сложное переплетение традиций русской и татарской литератур. Абузяров, как и многие современные писатели, ищет новые формы выражения этнокультурной идентичности, одновременно углубляясь в психологические аспекты личности, что делает его творчество актуальным для исследования в рамках современных тенденций русской и татарской литературы.

В своей статье «Национальная идентичность татарской литературы: современные методы исследования» [9] М.И. Ибрагимов исследует актуальные проблемы, связанные с формированием и сохранением национальной идентичности в татарской литературе. Автор подчеркивает, что ключевым аспектом этой литературы является её глубокая связь с историческими, культурными и религиозными традициями татарского народа, что оказывает значительное влияние на литературные стратегии современных писателей: «Национальное, этническое всегда будет в литературном тренде. Причины этого понятны: национальная самоидентификация невозможна без участия другого (в данном случае, другой национальной культуры), сопоставление своего мира с другим – основа идентичности. [9] В данном контексте творчество Ильдара Абузярова можно рассматривать как одно из ярких явлений, отражающих процесс поиска и осмысления национальной идентичности в условиях глобализации и постмодернистской литературной среды.

Ибрагимов акцентирует внимание на том, что для татарской литературы характерна тенденция к этнокультурному синтезу, когда в рамках одного произведения сочетаются элементы традиционного и современного, что позволяет сохранить национальные черты в условиях новых культурных вызовов: «Такая множественная идентичность героев Абузярова понятна и близка современному читателю, которому ежедневно приходится иметь

дело со множеством идентичностей и социальных ролей.» [9] Абузяров в своих произведениях также активно использует приёмы этнокультурного синтеза, совмещая в текстах элементы татарской мифологии, фольклора и современных постмодернистских форм. Как отмечают исследователи такие как Амниева В. Р. И Набиуллина А. Н. [3], Абузяров вплетает в свою прозу символику и мотивы, характерные для татарской культуры, при этом интерпретируя их в контексте глобальных вопросов самоидентификации и личностного поиска, что является примером отражения тенденций, описанных Ибрагимовым.

Также, Ибрагимов уделяет внимание вопросу языка как важнейшего компонента национальной идентичности. Вопрос сохранения и адаптации татарского языка в литературе приобретает особую значимость в условиях его частичного вытеснения русским языком. Абузяров, хотя и пишет свои произведения на русском языке, делает это, сохраняя в них татарские культурные коды, что создаёт уникальный феномен взаимодействия двух языковых систем. Как отмечает М.И. Ибрагимов, такие стратегии являются важным инструментом сохранения национальной идентичности, когда через произведения на другом языке передаются культурные смыслы и ценности родной культуры.

Ибрагимов также подчеркивает, что для современной татарской литературы характерна обращенность к проблемам самоидентификации в условиях глобализации, что можно наблюдать и в прозе Абузярова. Его герои часто оказываются в ситуации культурного и личностного кризиса, связанного с утратой или переосмыслением своих корней и традиций. Это соответствует общим тенденциям в современной татарской литературе, описанным Ибрагимовым, где писатели, отражая глобальные изменения, пытаются найти баланс между сохранением национальной самобытности и адаптацией к новым культурным условиям.

Таким образом, исследование М.И. Ибрагимова позволяет глубже понять художественные стратегии Ильдара Абузярова, которые находятся на пересечении традиционной татарской культуры и современных литературных тенденций. Абузяров, следуя описанным Ибрагимовым направлениям, стремится сохранить и актуализировать национальные особенности татарской литературы, одновременно предлагая их новую интерпретацию в условиях глобальных вызовов.

Статья Дирка Уффельманна «Игра в номадизм, или Постколониальность как прием (случай Ильдара Абузярова)» [6] представляет собой анализ постколониальных аспектов в произведениях Ильдара Абузярова, одного из ключевых представителей современной татарской литературы, пишущего на русском языке. Уффельманн рассматривает особенности постколониальной методологии в контексте произведений Абузярова, акцентируя внимание на концепции культурного номадизма и её значении в создании многослойного образа татарской идентичности. В этом контексте творчество Абузярова анализируется через призму постколониаль-

ной критики, что позволяет более глубоко осмыслить его тексты в условиях современной глобализации и этнокультурной неопределенности.

Уффельманн отмечает, что культурный номадизм, проявляющийся в произведениях Абузярова, связан с постоянным перемещением его героев между различными культурными, национальными и языковыми идентичностями. Такой подход можно рассматривать как постколониальный приём, который подчеркивает фрагментарность и множественность культурной принадлежности. Абузяров, по мнению Уффельманна, представляет собой писателя, который осознанно играет с постколониальными стратегиями, отказываясь от фиксированных идентичностей и подчеркивая гибридный характер своего культурного опыта: «Для самого Абузярова естественно относить себя к «нашей русской литературе», однако его «фирменный знак» на российском литературном рынке определяется сочетанием восточных мотивов с современными российскими реалиями.» [6] Это соответствует общим тенденциям постколониальной литературы, где доминирует идея множественности и гибкости идентичностей, что даёт возможность авторам отражать сложные процессы культурного смешения и преобразования.

Один из ключевых аспектов, на который указывает Уффельманн, заключается в использовании Абузяровым приёма «культурной игры» [6], где национальные и этнические коды постоянно меняются и пересматриваются. В этом контексте творчество Абузярова можно сравнить с другими представителями постсоветской литературы, стремящимися деконструировать и пересмотреть традиционные представления о национальной идентичности. Уффельманн подчёркивает, что Абузяров активно использует метафору номадизма как символа свободы от культурных и этнических ограничений, что позволяет ему создавать персонажей, чьи идентичности постоянно находятся в процессе формирования и изменения.

Важным элементом анализа Уффельманна является обращение к татарскому культурному контексту, который играет значительную роль в произведениях Абузярова. Однако, как отмечает Уффельманн, Абузяров не фиксируется исключительно на национальных аспектах, а стремится выйти за рамки узкой этнической идентичности, создавая многослойные тексты, где татарская культура сочетается с глобальными постмодернистскими формами. Это отражает тенденцию к космополитизму и номадизму, которые стали ключевыми темами в постколониальной литературе, в том числе и в творчестве Абузярова.

Таким образом, статья Дирка Уффельманна демонстрирует, что творчество Ильдара Абузярова можно рассматривать в контексте постколониальной теории, где номадизм выступает в качестве художественного приёма, позволяющего автору исследовать и переосмыслить вопросы культурной и этнической идентичности. Абузяров, используя постколониальные стратегии, создает тексты, в которых пересекаются различные культурные, языковые и национальные элементы, что делает его прозу

примером успешной интеграции локальных и глобальных литературных традиций.

В своей работе В.Р. Аминев и А.Н. Набиуллина «Номинация как способ идентификации персонажа в прозе И. Абузярова» [3] анализируется одна из центральных особенностей прозы Ильдара Абузярова – использование номинации (имён, прозвищ и наименований) как ключевого инструмента в создании персонажей и их идентификации. Авторы акцентируют внимание на том, как система именования героев выполняет важную художественную и концептуальную роль, отражая не только личностные черты персонажей, но и их культурную и социальную принадлежность. Рассмотрим основные положения статьи и их связь с общими тенденциями в творчестве Абузярова.

Авторы статьи подчеркивают, что номинация в прозе Абузярова носит не только традиционный характер, заключающийся в выделении индивидуальных характеристик героя, но и выполняет более глубокую семантическую функцию. Например, имена и прозвища часто отражают внутренний мир персонажа, его связь с культурным и национальным контекстом «мавр, факир, бербер» [3]. Ильдар Абузяров использует номинацию как средство создания многослойного текста, в котором имя может быть символом, метафорой или указанием на социальную роль персонажа. Это особенно ярко проявляется в рассказах Абузярова, где герои часто носят имена с глубокой символической нагрузкой, отражающей их внутренние конфликты или принадлежность к определённой этнокультурной группе: «Подобный способ номинации персонажа выполняет различные функции: выявляет его социальный статус и ролевое поведение» [3]

Примером служит использование татарских имен и наименований, что подчёркивает культурную идентичность героев и их связь с национальной традицией. Как указывают Аминев и Набиуллина, имена персонажей Абузярова нередко несут в себе информацию о культурных и религиозных ценностях, которые играют важную роль в развитии сюжета и мотивации героев. Например, имена героев часто отсылают к татарской или мусульманской традиции, что придаёт текстам дополнительную этнокультурную глубину.

Интересным аспектом анализа, предложенного Аминовой и Набиуллиной, является рассмотрение прозвищ как средства индивидуализации персонажей. В прозе Абузярова прозвища часто выполняют функцию неофициальной, но глубоко личностной характеристики героя, отражающей его статус в социуме или внутренние качества. Авторы статьи отмечают, что прозвища могут играть роль «второго имени», подчеркивая социальную функцию персонажа или его роль в коллективной идентичности. Важно, что прозвища в произведениях Абузярова нередко символизируют двойственность персонажа, его принадлежность к разным культурным мирам, что согласуется с общей постколониальной парадигмой, описанной в работах Д. Уффельманна [6].

Авторы также подчеркивают, что в прозе Абузярова имена и прозвища могут выступать как маркеры «гибридной идентичности» [3], характерной для многих героев, находящихся на пересечении различных культурных, этнических и религиозных систем. Этот аспект номинации связывает Абузярова с современными литературными тенденциями, ориентированными на поиск и переосмысление национальной и личной идентичности. В частности, произведения Абузярова часто рассматриваются как пример того, как через систему именования можно раскрыть сложные процессы культурного синтеза, характерные для постсоветской литературы.

Таким образом, исследование Аминев и Набиуллина демонстрирует, что номинация в прозе Ильдара Абузярова является не просто средством именования персонажей, но важным художественным инструментом, с помощью которого автор исследует и выражает сложные вопросы идентичности, культурной принадлежности и социального статуса. Использование имен и прозвищ в его произведениях позволяет создавать многослойные тексты, где каждый элемент несет в себе дополнительные смысловые значения, связанные с этнической, религиозной и культурной самобытностью персонажей.

Набиуллина А. Н. в статье «Подпольный» человек в современной русскоязычной прозе (на материале произведений И. Абузярова)» [10] проводит глубокий анализ одного из ключевых мотивов прозы Ильдара Абузярова – феномена «подпольного человека» [10]. Аделя Набиуллина рассматривает этот феномен через призму классической русской литературы, начиная с образа героя Ф. М. Достоевского, и показывает, как данная концепция трансформируется в произведениях Абузярова в контексте современных социальных и культурных реалий. Исследование автором данной темы актуально, поскольку Абузяров не только продолжает традиции русской литературы, но и вносит в них новые элементы, осмысленные через культурную и национальную идентичность.

Набиуллина А. утверждает, что в прозе Абузярова фигура «подпольного человека» воплощает внутренний кризис личности, который проявляется в условиях культурного и этнического разрыва: «Эти герои, по мнению общества, не могут жить в обществе, поэтому не только сами герои отгораживаются от внешнего мира, но и мир отвергает их. Рефлектирующие и легкоранимые герои И. Абузярова чувствуют свою ненужность и оттого всё сильнее укореняются в своём «подполье»» [10]. Подобные герои часто изображены как маргиналы, лишённые чёткой идентичности и находящиеся в постоянном поиске смысла. Они могут быть как социокультурными аутсайдерами, так и внутренне расколотыми персонажами, находящимися на грани самопознания и саморазрушения. Так, Набиуллина отмечает, что в произведении «О нелюбви. Роман с жертвой» [1] Абузяров использует образ главного героя, который находится в конфликте с окружающей действительностью и самим

собой, что позволяет говорить о возрождении архетипа «подпольного человека» в новом культурном контексте.

Автор статьи обращает внимание на то, что в современной русскоязычной прозе мотив «подполья» используется для демонстрации кризиса национальной идентичности. В случае с Абузяровым этот кризис связан с переходом от традиционных ценностей к современным формам самоидентификации. Набиуллина подчеркивает, что герои Абузярова находятся в состоянии постоянного метафорического «подполья» [10], когда они вынуждены скрывать свою внутреннюю сущность или сопротивляться общественным ожиданиям. Например, в произведении «Гламур в трущобах» [1] главный герой, по мнению Набиуллиной, испытывает глубокое отчуждение от окружающего мира, что символизирует его разрыв с национальной и культурной идентичностью. Этот феномен можно интерпретировать как продолжение темы «подпольного человека», который не может интегрироваться в социум.

Кроме того, Набиуллина выделяет, что для Абузярова ключевым становится осмысление этнической принадлежности героев через призму подпольного существования. Этнический аспект в данном случае играет двойственную роль: с одной стороны, герои осознают свою принадлежность к определённой этнокультурной группе (например, к татарской общине), но с другой - эта идентичность становится источником внутреннего конфликта. Как отмечает Набиуллина, в произведении «Гламур в трущобах» [1] главный герой также сталкивается с проблемой двойной идентичности: его русская фамилия и татарские корни становятся метафорой разделённой сущности, что усиливает его внутренний кризис и отчуждение. Такое изображение персонажей подчеркивает сложность их культурного самоопределения, что является одной из ключевых тем творчества Абузярова.

Набиуллина делает важное заключение о том, что феномен «подпольного человека» в произведениях Абузярова уходит от классического понимания героя-изгоя и приобретает новые черты, связанные с проблемами глобализации, культурного гибризма и этнической самоидентификации. Таким образом, «подпольный человек» в прозе Абузярова символизирует кризис идентичности, вызванный столкновением традиционного и современного миров, а также потерей этнической и культурной целостности.

Кроме этого, творчество И. Абузярова исследуется в монографии «Современный рассказ: содержательные векторы и повествовательные стратегии» [7] С.Э.Камиловой, которая анализирует произведения И. Абузярова в аспекте: «Статус автора, повествователя и героя в современном рассказе в контексте основных проблемно-тематических полей малой прозы». Монография представляет собой глубокое исследование актуальных тенденций современной литературы, особое внимание уделяя вопросам содержания и формальным стратегиям повествования.

Камилова С. Э. рассматривает произведения Абузярова в контексте жанра рассказа, отмечая, что

его творчество демонстрирует сочетание традиционных литературных элементов с новаторскими приемами повествования. Центральное место в его рассказах занимает тематическая глубина, охватывающая такие темы, как экзистенциальные поиски, духовные трансформации и культурные коды. Абузяров И., по мнению Камиловой С., умело балансирует между метафизической проблематикой и реализмом повседневной жизни, что придает его текстам многослойность и символическую насыщенность.

Особое внимание в монографии уделяется повествовательным стратегиям, используемым И. Абузяровым. Камилова С. подчеркивает значимость интертекстуальности в его произведениях, где прослеживаются отсылки к классической русской литературе, а также элементы восточной философии и суфизма: ««Мавр» И. Абузярова – современная «парабола» о человеческих ценностях, содержащая, как и традиции русской классической литературы» [7] Автор анализирует, как И. Абузяров переосмысляет классические повествовательные приемы, вводя новые формы нарратива, которые позволяют создавать у читателя эффект вовлеченности и интеллектуального напряжения.

Камилова С. акцентирует внимание на языковых особенностях прозы Ильдара Абузярова, подчеркивая его склонность к минимализму и лаконичности. В то же время его язык характеризуется выразительностью, насыщенностью метафорами и образами, что позволяет автору создавать мощное эмоциональное воздействие на читателя. Профессор отмечает, что именно через лаконичность и точность формулировок И. Абузяров достигает максимального драматического эффекта, заставляя читателя задумываться над каждым словом и смыслом текста.

Монография Камиловой Саодат Эргашевны представляет собой важный вклад в исследование современной русскоязычной литературы. Её анализ творчества Ильдара Абузярова открывает новые перспективы в понимании не только его художественного мира, но и общих тенденций развития рассказа как жанра в современности.

В следующей исследуемой работе, Аминева В. Р. «Жертвенность и жертвоприношение в прозе И. Абузярова: деконструкция мифологических сюжетов» [4] предлагается детализированный анализ одного из ключевых мотивов в творчестве Ильдара Абузярова – темы жертвенности и жертвоприношения. Автор статьи рассматривает эти темы через призму деконструкции мифологических сюжетов, подчеркивая, что Абузяров не просто использует мифологемы в своем повествовании, но активно переосмысляет их, вводя новые смысловые акценты.

Аминева В. Р. акцентирует внимание на том, что в прозе Ильдара Абузярова жертвоприношение не является однозначным актом, как это представлено в традиционных мифологических и религиозных текстах. Оно лишается своей сакральности и вместо этого приобретает многозначность, которая зависит от контекста, характеров и внутреннего мира героев. В статье подчеркивается, что в произведениях И. Абузярова жертвоприношение часто

связано с проблемами идентичности и духовного поиска, что позволяет автору деконструировать привычные мифологические конструкции и предложить новые трактовки древних сюжетов.

Аmineва В. Р. выделяет важную роль интертекстуальности в произведениях И. Абузарова, отмечая, что его проза тесно связана с мифологическими архетипами, которые в процессе повествования подвергаются трансформации: «Особенности функционирования мифологических сюжетов в прозе И. Абузарова раскрывают не только своеобразие творческого метода писателя, принципы его поэтики и стиля, но и характеризуют процессы самоидентификации, свойственные русскоязычной литературе в целом.» [4] Одним из примеров такой деконструкции является обращение И. Абузарова к образу жертвы, который становится символом не только страдания и самоотречения, но и осознания внутренней свободы и выбора. В этом контексте Аmineва В. Р. рассматривает, как автор трансформирует классические образы и мотивы, делая их частью более сложного философского размышления о природе человека, его месте в мире и его отношении к высшим силам.

Статья также предлагает анализ ключевых персонажей прозы И. Абузарова через призму их жертвенности. Аmineва В. Р. отмечает, что герои Ильдара Абузарова часто оказываются в ситуациях, где им приходится делать выбор между личной свободой и коллективной ответственностью, что подчеркивает парадоксальность жертвоприношения как акта. В этом контексте, по мнению Аmineвой В. Р., деконструкция мифологических сюжетов в творчестве И. Абузарова служит средством для постановки экзистенциальных вопросов о смысле жизни, роли судьбы и месте человека в мире.

Работа В. Р. Аmineвой представляет собой глубокое исследование мифологического измерения в прозе Ильдара Абузарова, демонстрируя, как автор работает с архетипами и символами, переосмысливая их в контексте современных реалий. Статья вносит значительный вклад в понимание творчества И. Абузарова, показывая его как писателя, который не только обращается к традициям мифа, но и активно их пересматривает, создавая новый тип повествования, насыщенный философскими и этическими размышлениями.

Заключение: Современные литературоведы отмечают, что одной из центральных тем в творчестве Абузарова является соотношение между реальным и вымышленным, что находит отражение в его использовании постмодернистских приёмов. Они подчеркивают важность интертекстуальности и цитатности в его произведениях, что является характерной чертой постмодернистской поэтики. Тем не менее, Абузаров использует эти приёмы не для деструкции смысла, а для его создания, что позволяет ему сохранять связь с реалистической традицией, воплощенной через глубокий анализ современных социальных и культурных реалий.

Таким образом, анализ современных научных статей показывает, что творчество Ильдара Абузарова представляет собой важное явление в русской

литературе XXI века. Оно объединяет в себе элементы постмодернизма и реализма, западной и восточной культурных традиций, создавая уникальный художественный синтез, способный глубоко отражать современность.

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СИМВОЛИКА В ПОВЕСТИ ЯВДАТА ИЛЬСОВА «ПЯТНИСТАЯ СМЕРТЬ»

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SYMBOLISM IN YAVDAT ILYASOV'S NOVELLA "THE SPECKLED DEATH"

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Статья посвящена анализу системы образов-символов в повести Явдата Ильясова «Пьяный звёздочёт». Рассматривается роль символики в раскрытии философской проблематики произведения, связанной с поиском истины, противостоянием знания и догмы, веры и разума, духовной свободы и общественных ограничений. Особое внимание уделяется интерпретации центральных образов-символов – звёздочёта, дороги, вина, белой вороны, книги, слова, света и тьмы. Исследуется их художественная функция в создании многослойного смыслового пространства повести. Анализ показывает, что символическая система произведения формирует авторскую концепцию человека как существа, находящегося между небом и землёй, знанием и верой, одиночеством и стремлением к духовному совершенству.

Сделан вывод о том, что Явдат Ильясов соединяет традиции восточной философии и притчевой литературы с гуманистическими идеями XX века, создавая оригинальную философско-художественную модель мира.

Abstract

The article analyzes the system of symbolic images in Yavdat Ilyasov's novella «The Drunken Stargazer». It examines the role of symbolism in revealing the philosophical issues of the work, including the search for truth, the conflict between knowledge and dogma, faith and reason, spiritual freedom and social constraints. Particular attention is paid to the interpretation of the central symbolic images—the stargazer, the road, wine, the white crow, the book, the word, light, and darkness. The study explores their artistic function in creating the multilayered semantic space of the novella. The analysis demonstrates that the symbolic system of the work shapes the author's conception of the human being as existing between heaven and earth, knowledge and faith, solitude and the aspiration for spiritual perfection.

The article concludes that Yavdat Ilyasov combines the traditions of Eastern philosophy and parable literature with the humanistic ideas of the twentieth century, creating an original philosophical and artistic model of the world.

Ключевые слова: повесть, русскоязычная литература, символ, композиция, образ, смысловой уровень.

Keywords: novella, Russian-language literature, symbol, composition, image, semantic level.

Явдат Ильясов – русскоязычный писатель, в произведениях которого ключевым принципом построения произведений служит включение образов-символов, организующих сюжетную канву. Ильясов выбрал для себя несколько устойчивых направлений: Историческая проза, охватывающая Среднюю Азию, Персию, древние государства региона. Повести и романы с ярко выраженной «приключенческой» и одновременно «историко-эпической» стилистикой. Элементы восточной философии, культурного наследия, мифологии и средневекового восточного мира включены в сюжетную ткань. Акцент на личности, бурных исторических событиях, культурной памяти и поиске идентичности региона – в каком-то смысле слияние региональной (башкирско-татарской/среднеазиатской) и советской литературной традиции.

Стиль Ильясова сочетает эпический размах и приключенческую динамику: исторические сцены, конфликты, войны, культурные столкновения. При этом присутствует глубина: обращение к мифу, к культурной памяти, к восточной философии

(например, в романе «Заклинатель змей»). Язык преимущественно русский, что делало его доступным для советской аудитории; тем не менее, в текстах ощущается влияние восточной традиции. Центральные персонажи часто стоят на перекрёстке исторических событий, что позволяет автору исследовать человека в истории, а не просто историческое событие. В художественной конструкции видно преемство от советской исторической прозы, но с заметным региональным (среднеазиатским/башкирским) колоритом.

Научный интерес к творчеству Явдата Ильясова в контексте национальной литературы в советский период акцентирует внимание на проблеме характера в историческом романе. Среди наиболее важных научных трудов можно выделить работы Варфоломеева И.П., Гареева Р.В., Красильникова Н.Н., Киреева В. и др. Так, при характеристике его исторической прозы, ученые выделяют их тематическое своеобразие и роль личности в исторической эпохе.

Повесть «Пьяный звёздочёт» Явдата Ильясова – одно из наиболее выразительных произведений советской историко-философской прозы конца XX века, входящее в цикл романов и повестей, посвящённых духовной истории Востока. Автор соединяет документальность исторического повествования, мифопоэтические мотивы и философскую аллегорию, создавая синтетическую художественную структуру, в которой образ-символ становится главным выразительным средством.

Повесть разворачивается в историческом контексте Средневекового Востока, где духовные искания, столкновение веры и знания, судьбы ученых и странников отражают вечные проблемы человеческого бытия. Через систему символических образов Ильясов раскрывает экзистенциальную идею: жизнь человека – это путь между верой и разумом, светом и тьмой, знанием и заблуждением.

Центральный образ повести – пьяный звёздочёт – является многоуровневым образом-символом, реализующим ключевую идею повести. Он соединяет в себе черты исторического персонажа (в образе легко угадывается черты Омара Хайяма – учёного, астронома, философа) и мифологического мудреца, изгнанного за дерзость мысли.

Звёздочёт – символ человеческого стремления к познанию и одновременно одиночества знания. Он «читает небо», ищет смысл мироздания, но его мудрость вызывает страх и неприязнь у окружающих. «От страха смерти я далёк: страшнее жизни, что мне приготовил рок...»¹. Эта реплика героя указывает на глубокий философский парадокс: знание освобождает, но и обрекает. Пьянство звёздочёта – не физическая слабость, а аллегория духовного опьянения знанием, оторванности от повседневной жизни. Образы-символы звезды / астрология / «пьяный звездочёт» раскрывают мотив судьбы, предначертания, научно-магического знания. Данные образы-символы сочетают рациональное (астрономия, расчёт) и иррациональное (предсказание жизни). Пьяный звездочёт – архетип пророка-края, врача души, который одновременно и осуждается обществом, и обладает зрением за пределы повседневности. Образ пьяного звездочёта показывает двойственность интеллекта: он может быть «опьянён» своей высотой и потому непригоден для мирской кухни, но именно это «опьянение» – источник подвижной истины. Астрологические детали рождения Омара (Солнце, Меркурий, Юпитер) метафорически закладывают у героя предназначение – быть носителем мысли и слова, отличающимся от окружающих.

Алкоголь трактуется в повести как символ бесконечного, неутолимого поиска, попытка уйти от абсурдности бытия. Дорога в повести – один из важнейших символов, объединяющих весь текст. Она имеет три смысловых уровня:

- реалистический – путь странника в Мекку;
- философский – путь человеческой души к истине;
- метафизический – движение по границе между жизнью и смертью, сном и пробуждением.

Рибат – приют для путников – превращается в символ мира, где встречаются разные типы человеческих судеб: нищие, праведники, имамы, странники. Это микрокосм, в котором герой осознаёт противоречие между верой и знанием: «Разве мы все – не временные постояльцы в этом мире, старом рибате нужды и бедствий?»²

Таким образом, мотив странничества становится не столько географическим, сколько экзистенциальным – путём души, блуждающей между светом звёзд и мраком человеческих страстей.

Образы-символы белая стужа, снег, холод, рибат выражают социальную пустоту, опасность существования, моральную «заморозку». Внешняя стихия становится отражением внутреннего – отчуждения, равнодушия, немилосердия общества. Рибат как приют бедных – место, где проявляется иерархическое презрение: «богатые/бедные», притворная благотворительность. Таким образом, холод – не только климатический фон, но и символ духовного холода, который угрожает теплу – человеческой поэзии, состраданию.

Мотив вина – один из древнейших в восточной поэзии, и у Ильясова он приобретает двойственное значение. С одной стороны, вино – это материальное опьянение, символ человеческих слабостей и греха; с другой – высший экстаз познания, духовное освобождение, сродни суфийскому опыту.

Пьянство звёздочёта – форма метафизического протеста против лицемерия и догматизма. Он пьян не от вина, а от чувства жизни, от познания неизбежности судьбы. Именно в этом смысле герой говорит: «Так будем пить! Ведь плащ порядочности нашей изодран, залатать его уже нельзя...»³ Это декларация внутренней свободы. Вино превращается в символ духа, противостоящего ханжеству и ложной святости.

Имам и чиновники в рибате изображены как носители обрядовой, мёртвой религии, противопоставленной живому духовному поиску звёздочёта. Они не способны к внутреннему откровению — их вера превращена в форму социального контроля.

Символы-образы: вино / «пьяный» мотив / стихотворство раскрывают оппозицию религиозной морали и поэтической свободы; средство ухода/бунта. Так, символ вина выступает и как укор (пьяный – грех), и как терапия для тех, кто бунтует против несправедливого мира. Пьяный звездочёт играет роль «позорного прорицателя», жизнь которого – пример, как слово и искусство становятся

¹ Ильясов Я. Пьяный звездочёт// <https://ziyouz.uz/ru/index.php/2012-09-02-11-30-00/42-2012-09-02-10-17-21/971-2012-09-26-16-19-57>

² Ильясов Я. Пьяный звездочёт// <https://ziyouz.uz/ru/index.php/2012-09-02-11-30-00/42-2012-09-02-10-17-21/971-2012-09-26-16-19-57>

³ Ильясов Я. Пьяный звездочёт// <https://ziyouz.uz/ru/index.php/2012-09-02-11-30-00/42-2012-09-02-10-17-21/971-2012-09-26-16-19-57>

«неприличными». Поэзия и вино – средства освобождения от социальной маски; они показывают возможное измерение подлинности.

Таким образом, между звёздочётом и имамом разворачивается символическая драма разума и догмы, вечного конфликта между свободной мыслью и авторитарным знанием.

Ильясов, следуя традиции восточной философии, не противопоставляет их полностью, но показывает, что истинная вера возможна лишь через сомнение.

В финале звёздочёт находит на дороге замерзающую белую ворону – редкий и глубоко символический образ. Белая ворона – символ инаковости, духовной избранности и одиночества. Она – зеркало самого героя, отвергнутого обществом, но несущего в себе искру истины.

Он спасает птицу, как бы спасая самого себя – ту часть души, которая ещё способна чувствовать. Этот эпизод становится знаковым моментом нравственного очищения, символом возвращения к жизни.

Белая ворона – это душа поэта, выживающая среди холода мира, символ надежды и искупления.

Свет звёзд, огонь костров, белый снег – все эти образы создают символическое пространство пограничья. Свет – знание, истина, но он ослепляет и замораживает; тьма – невежество, но она хранит тепло человеческой души.

Через систему этих контрастов Ильясов выстраивает барочную модель мира, где истина познаётся через противоречие, а гармония возможна лишь на грани разрушения.

Само имя героя – звёздочёт, человек, глядящий вверх, – противопоставляется миру, живущему «вниз», к земле.

Его предназначение – смотреть в небо, но наказание – жить среди тех, кто смотрит в грязь. Это архетипический конфликт между духовным и земным началом. Звёзды, к которым он стремится, – символ недостижимого идеала, истины, вечности. В этом смысле повесть Ильясова становится притчей о человеке, изгнанном из мира за то, что он слишком много видел.

Повесть «Пьяный звёздочёт» – философско-символическое произведение, где каждый образ имеет многослойную структуру. Звёздочёт, дорога, вино, ворона, огонь, свет и тьма – это не просто детали сюжета, а универсальные символы духовного поиска, выражающие философию автора: человек живёт между небом и землёй, между верой и сомнением, и в этом – его трагическая и великая суть. Ильясов соединяет восточную притчевость с гуманистической философией XX века, создавая художественный миф о мудреце, который ищет истину не в небесах, а в собственной душе.

В повести мотив книги и связанная с ним метафорика слова выступают центральным инструментом авторской семантики: они не только описывают интеллектуальное избранничество героя, но и

функционируют как активная сила, способная воздействовать на социальную реальность. В выбранной секции – эпизодах в рибате, сцене с туркменами и ранних эпизодах детства Омара – книги, ворона и само слово образуют тройственную символическую систему, в которой знание предстаёт одновременно как свет, угроза и «заклинание». Цель данного текста – развернуть этот мотив в полноформатный академический анализ: показать, как текст организует представление книги как опасного и спасительного начала, как слово конструирует межсубъектные трансформации и как образ вороны komponует семантику инаковости и провидения.

В повести книга появляется в материальной форме – «кирпичи» в узле повозки – и в виде акта чтения, который производит эффект на слушателей. Материальность книги подчеркнута в сцене разбойников: хозяин разворачивает узел, «и на дорогу с деревянным стуком посыпались темные кирпичи»⁴. Такой образ приковывает внимание – книга выступает не как лёгкая идея, а как тяжёлый, осязаемый предмет. Намёк на «кирпичность» знания говорит о его той самой весомости, которая может «сломать» поверхность повседневности; но одновременно он подчёркивает и непонимание: для туркмена это не золото, а «бруски», не имеющие рыночной цены.

Важно, что автор не ограничивает книгу ролью пассивного репозитория. Книга действует – через чтение она становится действенным словом. Омар, произнося аят из Корана или читая Евклида, не просто демонстрирует память: чтение в его исполнении производит эмоциональную трансформацию у слушателя. Реакция туркмена – «его охватила непонятная тревога... он почувствовал слабость в ногах» – фиксирует факт: слово работает как заклинание, меняющее телесное состояние. Это подтверждает метафору «заклинателя» (в названии повести) – не как буквальное управление змеей, а как способность слова поворачивать волю и чувства.

В традиции символики слово нередко сопрягается со светом. Здесь тоже знание описано как «свет учености», который «слабым отблеском» отражается в «тёмных глазах степняка». Свет метафорически обозначает просветление и одновременно – опасность: тот же свет может «ожечь» привычные ориентиры. Туркмен, привыкший к грубой логике силы, воспринимает чтение Омара не как тривиальную демонстрацию, а как вмешательство в его структуру ощущений: слово нарушает его «гармонию» насилия. Отсюда – тревога, отступление агрессии, изменение замысла лидера шайки (он отпускает хозяина с вещами).

Эта двойственность – спасение и угроза – проявляется и в другом поле: религиозный дискурс и книжность сталкиваются с институтом морали в рибате. Имам осуждает нищего, который «ходил в мечеть» лишь для добычи коврика; купец осуждает

⁴Ильясов Я. Пьяный звёздочёт// <https://ziyouz.uz/ru/index.php/2012-09-02-11-30-00/42-2012-09-02-10-17-21/971-2012-09-26-16-19-57>

поэзию как «женское занятие». В такой среде слово/книга становятся «неприличными»: они нарушают порядок и метафизическую «комфортность» доминирующей повседневности. Следовательно, книга в тексте – потенциальный разрушитель общественного согласия, а потому представляет угрозу для тех, кто извлекает свою стабильность именно из этого согласия. Это и объясняет враждебность: не к книге как таковой, а к тому, что книга освещает и ставит под сомнение.

Появление белой вороны – не случайный декоративный штрих. В культурной символике ворона часто репрезентирует двусмысленность: вестник, предвестник беды или, напротив, медиум знания и памяти. Здесь ворона акцентирует статус Омара как «инакового», как того, кто не принадлежит к общему потоку. Описание: «На повороте ему попалась замерзающая птица... она встрепенулась!... Разглядел: ворона. Редкая ворона. Белая»⁵ – подчеркивает незаурядность встречи. Белизна вороны – парадокс: символ традиционно тёмный в неожиданном белом окраске – усиливает эффект инаковости и делает птицу своеобразным аурическим знаком.

Функционально ворона выполняет несколько ролей. Во-первых, она выступает как каталитический знак: её спасение Омаром – первый акт внимания к иной, уязвимой жизни; таким образом он показан как тот, кто способен сострадать к «отвергнутым». Во-вторых, ворона метафорически отражает ситуацию книги: так же как белая ворона – нечто редкое и непонятное, так и знание Омара – «неподходящая» пища для большинства. Наконец, ворона работает как предшественница событий: в фольклорной традиции встреча с необычной птицей иногда предвещает судьбу, и в тексте рождение пророческого начала у Омара подкрепляется именно такими символическими сигналами.

Образы-символы книги / знания / ворона (белая ворона) обозначают свет учёности, её уязвимость и незнакомость для немногих. Символ книги – объект возвышения (Евклид, геометрия) и повод конфликта. Ворона (особенно белая ворона) – знак инаковости, исключительности, предвестника: она привлекает внимание, обозначая «необычность» героя. Так, знание в мире изображено как тяжёлый, «тёмный кирпич», непонятный многим (туркмен сжёг бы книги в Мерве). Тем не менее знание действует как «свет», заражающий даже грубую натуру (Ораз ощущает смутную тревогу перед чтением Омара) – это ключ к возможной трансформации.

Чтение у автора – это не только демонстрация памяти; это акт общения, попытка преобразовать зрителя. В сцене с туркменами результатом чтения становится кратковременная гуманизация насильника: он отпускает семью Ибрахима, оставляет мешок зерна, и от него исходит пожелание «Станешь большим человеком». Здесь слово воздействует на нравы и решения; читатель (туркмен) добровольно пересматривает своё поведение. Это – одна сторона

власти слова: демонстрировать возможность переосмысления и санкционировать иное действие.

Тем не менее власть слова сопряжена с риском. Чтение Омара вызывает именно тот «необычный» эффект, который делает его потенциально опасным для общества, где доминируют практики силы и экономической выгоды. Поэтому общество стремится исключить или принизить слово (насмешки, осуждение, клеймо «пьяный звездочёт»). Иначе говоря, власть слова равнозначна вызову: быть услышанным – значит выставить себя на конфликт и угрозу.

Приметы выбора читаемых текстов у автора не случайны. Омар читает и Коран, и Евклида: сочетание священного и научного символизирует синтез веры и разума. Это важно: автор не сводит слово к одной доминанте (ни к религии, ни к науке). В сцене с туркменом Омар доказывает, что чтение Корана и знание Евклида могут ужиться в одном сознании – и именно это делает его исключительным: он объединяет духовность и рациональность. Такие сочетания служат аргументом против тех, кто считает знание «чуждым» или «еретичным».

В исследуемой повести книга, ворона и слово образуют единую семантику, в которой знание предстает как активное, конфликтное и трансформирующее начало. Книга – тяжёлая, материальная, но также и исполняющая функцию «заклинания», которое может менять телесность и поведение. Ворона маркирует героя как инакового и подготавливает читателя к знаковому статусу Омара. Чтение же демонстрирует, что слово способно пересечь границы социальной стигмы, но риски, связанные с этим пересечением, велики: общество, структурирующееся вокруг порядка, экономической выгоды и ритуала, склонно маргинализировать тех, кто нарушает его правила.

Таким образом, в повести книга – не нейтральный предмет; она – активная сила, средство преобразования и одновременно опасность для статуса. Омар – тот, кто через слово может «усмирять змей» – то есть влиять на воплощённые в людях страсти; но его сила не гарантирует победы: повесть оставляет вопрос открытым, демонстрируя и надежду, и трагизм поэта/учёного в мире, который не всегда готов принять свет знания.

Образ Голе-Мохтар олицетворяет воплощённую поэзию/красоту, уязвимую и маргинальную. Её образ – контраст между пленяющей красотой и нищетой; она одновременно вдохновляет Омара и демонстрирует цену артистической жизни. Голе-Мохтар – символ поэтической мечты; её падение и голод подчёркивают, что краса и искусство не могут выжить в мире, где ценится сила и имущество.

Туркмен (Ораз) в повести символизирует «дикую» / грубую силу, этнографический образ диалектики «варварства» и человечности. Образ-символ туркмена представляет угрозу (грабёж, насилие) и одновременно способен быть тронутым

⁵ Ильясов Я. Пьяный звездочёт// <https://ziyouz.uz/ru/index.php/2012-09-02-11-30-00/42-2012-09-02-10-17-21/971-2012-09-26-16-19-57>

светом знания – его реакция на чтение Омара символична: жестокость и возможность восприимчивости. Автор не однозначен – туркмен не «зло» в чистом виде; он – носитель другой культуры, в которой также есть травма (история грабежа, угнетения). Его перемена подсказывает, что слово/книга могут «усмирить» даже «змею» грубо.

Символ молитвенного коврика, имама, религиозной риторики трактуется как институциональная религия, лицемерие, каноны. Данные религиозные фигуры в повести часто выступают как символ социального порядка, который оправдывает неравенство (имам осуждает нищих, купец презирает звездочёта). Религия в повести изображается двояко: как утешение и одновременно как механизм конформизма и социальной стабилизации, препятствующий свободе мысли.

Повесть строит конфликт между стихиями жизни – знанием и словом, холодом общественного мракобесия и теплом поэзии/человечности – через систему символов: звезды и астрология (судьба, пророчество), белая стужа и рибат (социальная нищета и моральная спячка), книги и ворона (свет учёности и её «чуждость» в жестоком мире), образ музы и «скоморохов» (искусство как искра жизни). Заголовочный мотив «заклинателя змей» (хотя в данном фрагменте явного акта заклинания змей ещё нет) функционирует как метафора силы слова/музыкальной речи, которая может усмирить или пробудить опасное – общественное невежество, агрессию, страх. Главный герой – ребёнок Омар – помещён между этими полюсами и становится медиумом (потенциальным «заклинателем»), способным привлечь и изменить «змею» общества – страх, грубость, варварство – через книгу, память и поэзию.

Интересным для понимания смысла повести Явдата Ильясова является прием взаимодействия образов-символов. Так, противопоставление «холод – тепло» реализуется через взаимодействие образов стужи и рибата, которые противостоят огню

творчества (поэзии), теплу межличностного сострадания. Омар – носитель внутреннего огня, который в мире встречает холод.

Антиномия образов знания и сила реализована через синтез символов книги и слова, которые действуют как «заклинание» против грубой физической силы. Именно здесь понятие «заклинателя змей» раскрывается метафорически: не музыкант укрощает змей, а слово/речь – общественную агрессию.

Образы-символы в повести раскрываются посредством художественных приемов: контрастные эпитеты и повторения, сцены «интермедий», метафоризация предметов

- Контрастные эпитеты и повторения (например, возобновление мотивов холода, повторы «аллах, аллах») усиливают ощущение суровости и ритуала.

- Сцены «интермедий» (рибат – микрокосм общества) работают как аллегорические панели: в одном месте собраны все классы и судьбы, что делает взаимодействие символов более плотным.

- Метафоризация предметов (зеленая чалма как символ статуса святого, книги как «кирпичи») переводит бытовые предметы в идеологические маркеры.

Таким образом, символика в повести Явдата Ильясова «Пьяный звездочет» реализует философскую проблематику, отражающую философию автора: человек живёт между небом и землёй, между верой и сомнением, и в этом – его трагическая и великая суть. Ильясов сочетает восточную мудрость притчи с гуманистическими идеями XX века, создавая художественный миф о мудреце, находящем истину не на небесах, а в глубинах собственной души.

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FEATURES OF 20TH-CENTURY RUSSIAN LITERATURE: ISSUES IN PERIODISATION

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Важное отличие русской литературы XX века от литературы предшествующего столетия состоит в том, что вопросы периодизации данной литературной эпохи до сих пор остаются открытыми и требуют осмысления и с теоретической точки зрения, и в контексте изучения истории русской литературы в высших учебных заведениях.

Abstract

A key distinction between 20th-century Russian literature and that of the preceding century lies in the fact that questions regarding the periodisation of this literary era remain unresolved to this day and require further analysis, both from a theoretical perspective and in the context of the study of Russian literary history in higher education institutions.

Ключевые слова: история, литература, период, литературное направление, поэтическое течение, проза, жанр, роман.

Keywords: history, literature, period, literary movement, poetic movement, prose, genre, novel.

Важное отличие литературы XX века от литературы предшествующего столетия состоит в том, что она не имела нормальных объективно обусловленных факторов развития. Три ветви русской литературы – литература метрополии, потаенная и литература русского зарубежья – связывает не только то, что все это единая русская литература, в рамках которой появлялись замечательные произведения, и что никто из писателей не был застрахован от превратностей исторической судьбы, но и то, что у них общие корни, обусловившие как явления традиционной эстетики, так и авангардные литературные направления.

Многообразие литературных группировок 20-х годов соответствовали достаточно разнообразным явлениям в русском зарубежье. Свои аналоги западничества и славянофильства (подчас несопоставимые по качеству и характеру) были и остаются и в литературе метрополии, и в эмигрантской. Когда в литературе метрополии стали очевидными унификация и обезличивание основного массива литературы, разнообразие все-таки сохранялось благодаря ярким индивидуальностям: М. Горькому, М. Булгакову, А. Платонову, А. Толстому, Ю. Тынянову, М. Зощенко, М. Шолохову, А. Ахматовой, О. Мандельштаму, Б. Пастернаку, А. Твардовскому, хотя не все они участвовали в текущем литературном процессе. В связи с этим возникает один из основных проблемных вопросов периодизации истории русской литературы XX века: проблема изучения потаенной и возвращенной литературы, существовавшей в 20-50-е годы параллельно с официальной литературой метрополии, но ставшей доступной для интерпретации широкого круга русскоязычных читателей в 60-80-е годы. Вместе с тем с 60-х годов XX века усложняется картина литературного процесса, обусловленная взаимодействием военной,

деревенской, городской, исторической прозой, громкой и тихой лирикой, поэзией бардов и таких поэтов, как И. Бродский.

Таким образом, помимо вопросов о хронологических рамках истории русской литературы XX века: начало и конец (1890-1990), о внутреннем членении на значимые периоды: трети, половины (1890-1920, 1930-1950, 1960-1990, первая и вторая половина XX века), существенное значение имеет применение методологии анализа, поскольку каждый период отличается от предыдущего и эстетическим контекстом, и культурной ситуацией, формально-содержательными особенностями.

На вопрос «Что же такое «новая русская литература»?» существуют различные ответы. Однако многие отмечают, что «для уяснения судьбы русской литературы не только ушедшего XX века, но и наступившего XXI века 1920-е годы остались ключевыми» [1, с. 348], «генетически всего ближе мы к литературе 20-х – начала 30-х гг.: тогда начиналось то, свидетелями конца чего нам суждено быть» [6, с. 235]. В свою очередь, указанный исследователями период неразрывно связан с тенденциями Серебряного века, который на современном этапе вызывает особый научный интерес. Так, ученые считают, что Серебряный век обозначает художественный и духовный расцвет, по времени связанный с началом XX века. Н. Осипова определяет Серебряный век как «понятие скорее метафорическое <...> потому обладающее множеством разночтений как в смысловом, так и хронологическом плане» [3, с. 376]. Определение границ Серебряного века представляется очень расплывчатым, особенно на его исходе. Безусловно, границы раздвигаются, если принять во внимание феномен эмиграции, опиравшейся на традиции Серебряного века, или творческий импульс ряда художников,

продолжавших писать в новых исторических условиях (Б. Пастернак, А. Ахматова, О. Мандельштам, М. Цветаева, Д. Андреев). Изучение творчества последних требует специфического подхода, позволяющего учитывать ряд объективных исторических факторов: невозможность своевременно публиковаться по цензурным причинам, искусственно созданный культурный вакуум, в котором оказались писатели, общественное и политическое давление. Все это создало в русской литературе беспрецедентную ситуацию – произведения подобных авторов стали неотъемлемой частью всего литературного процесса XX века по времени написания, опубликования и интерпретации.

При этом русская литература XX века разнообразно и метафорично отразила «чудовищный потрясающий век», вместивший огромное количество «событий, насильственных смертей, изобретений, катастроф, идей» .5, с. [90]. В связи с этим остро стоит вопрос о периодизации русской литературы XX века. Бесспорно, выделение периода, получившего название «Серебряный век», хотя хронологические рамки довольно подвижны (1890–1910, 1892–1921, 1892–1917), литературы 20–30-х, 40-х, 50-х, 60–80-х годов XX века. Так, В.Н. Крылов отмечает: «Русская литература (и шире – искусство) за неполных три десятилетия, начиная с 1890-х годов и заканчивая 1910-ми годами, издавна рассматривается как самостоятельный, новаторский период. По сравнению с другими, ранее известными этапами, период конца XIX – начала XX века отличается особым масштабом качественных трансформаций: происходит столкновение традиций классического реализма и новой картины мира, получившей воплощение в модернизме» [2, с. 4]. Поэтому автор считает, что «Серебряный век не только разделяет, но и связует две культурные парадигмы: подводит итог тенденциям литературы XIX века и намечает черты художественности XX века» [2, с. 4], тем самым обосновывая правомерность курса «История русской литературы конца XIX – начала XX веков». На наш взгляд, актуальным представляется тот факт, что этот период завершает историю русской классической словесности и подготавливает переход к изучению русской литературы XX века. Этот процесс начался с выступления Д.С. Мережковского «О причинах упадка и новых течениях современной русской литературы» (1892) и закончился в 1921 году в связи со смертью А. Блока и расстрелом Н. Гумилева. Хотя в начале 1920-х годов все еще организовываются такие поэтические объединения, как Серапионовы братья (1921–1929), ЛЕФ (1922–1929), конструктивизм (1923–1930), ОБЭРИУ (1927–1931) и существуют остатки относительной литературной свободы: «еще возможны были отдельные литературные и театральные выступления, еще писатели и поэты не были собраны в Союз писателей с единым для всех методом социалистического реализма, еще само понятие «литературной группы» не воспринималось как однозначно антисоветское. Тем не менее, серьезно усиливалось давление цензуры, практически стали невозможны публикации, в газетах появились по-

громные рецензии на те или иные явления культурной и литературной жизни» [4, с. 185]. Ключевым в данном контексте является последнее объединение, поскольку оно наглядно иллюстрирует переход к следующему периоду истории русской литературы XX века: разделение на официальную и потаенную литературу.

Философский роман 1930–1950-х гг., в частности, философия человека и природы в прозе М. Пришвина, концепция мира и человека в прозе А. Платонова в контексте русской философии, метафизика и реальность в романе М. Булгакова «Мастер и Маргарита», философская проблематика антиутопии Е. Замятина «Мы»; сатирические романы И. Ильфа и Е. Петрова «Двенадцать стульев», «Золотой теленок»; исторический роман А. Толстого «Петр Первый»; романы Б. Пастернака «Доктор Живаго», М. Шолохова «Тихий Дон» создают тематическое, жанровое, стилистическое многообразие прозы 1930–1950-х годов.

В эстетике 1940–1950-х гг. на первый план выдвигается нормативность, принцип унификации в идеологической и литературной политике. Выходит Постановление «О журналах «Звезда» и «Ленинград», оказавшее трагическое влияние на творчество М. Зощенко, А. Ахматовой и других писателей. Начинается дискуссия о положительном герое и теории бесконфликтности.

Ситуация «конца века», «смены эстетических координат», обусловила отражение в литературе таких актуальных вопросов современности, как: экологические проблемы, наркомания, разгул преступности. В частности, репрезентация национальной аксиосферы представлена в произведениях В. Астафьева и Ч. Айтматова, которые иллюстрируют индивидуальный подход к проблеме. В. Астафьев указывает на такие вечные ценности, как любовь в произведении «Пастух и пастушка», и пытается вскрыть сущность такого явления, как «озверение» народа в романе «Печальный детектив». Ч. Айтматов в произведении «И дольше века длится день...» заостряет проблему исторической памяти, используя образ Манкурта, и романе «Плаха» акцентирует внимание на эсхатологических мотивах, используя условно метафорическую образность.

Таким образом, мы считаем, что вопрос периодизации истории русской литературы XX века непосредственно связан с выбором концепции анализа художественной литературы, поскольку методология значительно обогатилась за счет взаимодействия литературоведения с культурологией, философией, психологией и даже естественнонаучными дисциплинами. Категориальный аппарат, используемый при изучении художественного текста и исследовании явлений литературного процесса, включает такие термины, как «культурная парадигма», «герменевтический круг», «развивающаяся система», «аксиология искусства» и другие. В частности, мы предлагаем изучать историю русской литературы XX века следующим образом: 1890–1920-е годы в свете культурной парадигмы, 1930–1950-е – с применением системного подхода и 1960–1990-е – в аксиологическом аспекте.

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FOLKLORE AND MYTHOLOGICAL SYNTHESIS IN TAGAI MURAD'S STORY «TARLAN»

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В статье рассматриваются особенности повести Тагая Мурада «Тарлан». В качестве предмета исследования определен образ главного героя – создателя дастана о коне, носителя особого типа народной памяти. Наиболее полно герой раскрывается на фоне фольклорных традиций, в частности, традиций «низкого» героя, характерного для сказок. Мифопоэтический план повести проявляется в особом синтезе творческого, природного и личностного начала.

Abstract

This article examines the features of Tagay Murad's novella "Tarlan." The subject of the study is the image of the protagonist – the creator of a dastan about a horse, a bearer of a special type of folk memory. The hero is most fully revealed against the backdrop of folklore traditions, particularly the tradition of the "low" hero, characteristic of fairy tales. The mythopoetic aspect of the novella manifests itself in a unique synthesis of creativity, nature, and personality.

Ключевые слова: повесть, «низкий» герой, сказка, былина, фольклорные традиции, дастан.

Keywords: story, "low" hero, fairy tale, epic, folklore traditions, dastan.

Идейно-тематическое своеобразие повести «Тарлан» определяется системой отношений между двумя ключевыми образами. Человек и конь предстают перед читателем в их нерасторжимой связи. Обратим внимание на ряд устойчивых фольклорных мотивов, имеющих отношение к сказке и былина, а также к комплексу архетипических представлений о мире. Главный герой повести – типичный «низкий герой», которого Е. М. Мелетинский обозначил, как «не подающего надежд». Такой герой, как правило, «занимает низкое положение, плохо одет, презираем окружающими, на вид ленив и простоват, но неожиданно совершает героические подвиги либо получает поддержку волшебных сил и достигает сказочной цели» [4, с. 179-180].

Данный тип героя исследователь относит к «сугубо демократическому» и характерному для волшебной сказки. Для восточных сказок характерен «лысый паршивец». «Эта колоритная фигура, – пишет М. Е. Мелетинский, – встречается не только в волшебных сказках, но и в анекдотических и особенно часто в новеллистических» [4, с. 179-180]. Данный тип героя изначально не подает надежд и часто «обездвижен» в прямом и переносном смысле, он лежит на печи, в грязи или золе. Тип «лысого паршивца» может быть заявлен не только как «никчемный человек», но и как «обездоленный» [4, с. 179-180]. Пассивность и чудачество не мешают «низкому» герою найти счастье, когда оказывается, что «дурак-то был умным» [4, с. 191]. За «низкой» внешностью часто скрывается «высокая» сущность героя [4, с. 194].

Наиболее полно противоречивость характера «фольклорного чудака» раскрывается благодаря анекдотическим элементам. Как отмечает исследо-

ватель, введение анекдотических мотивов позволяет «достигнуть диалектического единства возвышенного и комического» [4, с. 191]. Востребованность данного типа героя у писателей и читателей обусловлена и такими чертами, как терпение, покорность, тяготы жизни, которые преодолеваются «не силой разума и деяния, а покорностью судьбе и терпением» (М. Горький, статья «О дураках и прочем»). Примечателен и тот факт, что писатели-романтики, обращавшиеся к фольклорным традициям, рассматривали «низкого» героя, как «героя пассивного, наивного, непосредственного, близкого к природе» [4, с. 191].

Е. М. Мелетинский отмечает противоречивость авторских трактовок «низкого» героя, а также то, что при этом остается неизменной его актуальность для совершенно различной среды в культурном, историческом и общественно-политическом аспектах. В повести Тагая Мурада на первом плане мотив одиночества, отчужденности преодолеваемый родством душ между героем и его конем, природным и творческим союзом.

Главный герой повести Тагая Мурада – Зиядулло. Он с детства имел физический дефект, получив прозвище «плешивый». Отсутствие волос делает героя несчастным: «У всех, у кого была плешь, заново выросли кудри. Только моя голова ослепительно блестела. Ни одного волоска не выросло. Сами врачи удивлялись, сказали, мол, редчайший случай». Горе героя практически безгранично: «Люди прозвали меня плешивым. Дескать, Зиядулла-плешивый! О, Всевышний! Поначалу от стыда до самых ушей горел. Чувствовал себя глубоко несчастным. Но со временем прозвище «плешивый» перестало меня задевать. Свыкся я со своим несчастьем» [5, с. 8].

Такая форма простого человеческого смирения свидетельствует об особой организации внутреннего мира героя. Он «свыкся с несчастьем», что в данном случае означает «переродился» в новом облике. Прозвище герой стал воспринимать как имя. Герой даже злился на тех, кто не называл его Зиядулло-плешивым. Обращение по фамилии – товарищ Курбанов – Зиядулла-плешивый воспринимает как насмешку. Он сердится на почтальона, который обращается к нему официально – товарищ Курбанов. Процесс переименования открывает новое качество в герое: он принимает жизнь такой, какая она есть и вместе с этим чувством личного смирения он принимает мнение окружающих о себе. Отметим также, что «людская молва» не меняет героя, но добавляет в его облик и жизнь трагические ноты мотивы вынужденного одиночества и непонимания. Герой не отвергает толпу, так как народная стихия – это его естественная среда и сам он, прежде всего, народный певец, создатель дастанов.

Ситуация может быть рассмотрена двояко. Прозвище «плешивый» демонстрирует принадлежность героя к фольклорному материалу. Это так называемый тип дурака или юродивого, побиваемого, страдающего от людской молвы и несправедливости, но терпеливо сносящего все невзгоды. Отметим, что такой герой не теряет присутствия духа и отличается особой мудростью (в речь героя включены афоризмы), его смирение – это особая форма понимания и приятия мира. Не случайно, что повествование ведется от первого лица, в манере доверительной беседы. Рассказывая о своем образе жизни герой словно взывает к человеческому в человеке, напоминая о главном и святом для каждого. К читателям он обращается, как к братьям, родственным душам, взывая к братской любви и памяти рода человеческого.

Большую роль играет тот факт, что Зиядулло – человек творческий. Он играет на старой домбре (струнный, щипковый, музыкальный инструмент – *Е.К.*) и исполняет дастаны (эпическое произведение в фольклоре и литературе – *Е.К.*): «Домбра моя зазвучала, а я, глядя на бесконечную гряду холмов, на растекающееся по холмам стадо, на беспрестанно щебечущих на горных вершинах птиц и на белые клубящиеся облака, пел дастаны. Дастаны эти пели еще наши деды на праздниках в долгие зимние вечера – один умолкнет, другой подхватывает. Многие из тех стариков уже нет в живых. Так, как пели они, никто уже не споет. Мы же берем своим зычным голосом» [5, 1, с. 9].

В 9 главе Зиядулло-плешивого как лучшего пастуха пригласили для записи радиоочерка. Корреспондент Рихсиев оказывается полной противоположностью пастуха, исполнителя дастанов и народного философа Зиядулло. Диалог наполнен сатирическим пафосом, предвещающим последующий трагический исход событий: «– Дело вот в чем, товарищ Курбанов, я о вас радиоочерк напишу. – А что такое, уважаемый корреспондент, радиоочерк? – Что? Ну и ну! Вот тебе на, товарищ Курбанов. Есть такой публицистический жанр! В этом жанре прославляют героев, понятно? – Вот как? Ну и хорошо. А я-то подумал, это что-то нехорошее. Но не

стоим мы того, уважаемый корреспондент. – Это уж мы сами придумаем, как сделать из вас достойного человека, товарищ Курбанов. Все в наших руках. Вот вам бумага, пишите. Что, и ручки нет? Это уже не порядок...» [5, с. 17].

Корреспондент сам «проговаривает» историю жизни пастуха. Обратим внимание на то, что в момент создания псевдо-биографии неоднократно используется отрицание: «– Нет уж пишите. Еще напутаете, наговорите все, что в голову взбредет, а мне потом мучиться, монтировать. Нет. Пишите: «Солнце, распуская свои позолоченные косички, подняло голову из-за горизонта...». Нет, зачеркните. Художественную часть напишу сам. Вам это не под силу...» [5, с. 18]. Умалая творческие возможности пастуха, корреспондент-функционер даже не слышит слов уникального дастана, который, пройдя сквозь века, вновь зазвучал в новом обрамлении уже благодаря Зиядулло-плешивому: «– Уважаемый корреспондент, не знаю, слышали вы или нет, но я и дастаны сочиняю. – Ага, вот как? – Забочусь о том, чтобы песни и сказания дедов остались в памяти. И домбра у меня есть. – Ага. «Зачем свое мне прятать мастерство? Ведь в мир иной не заберешь его?» Алишер Навои! – Долгих вам лет! Я заволновался. Взяв домбру, запел свой дастан...» [5, с. 19]. Зиядулло не слышит равнодушия и даже презрения в разговорном «ага» корреспондента. Он хочет спеть уникальный «лошадиный дастан», приоткрыть завесу над отдельными моментами восточной жизни. Творчество для него – мост между современностью и древностью.

Обратим внимание на творческую лабораторию писателя, который параллельно с созданием текста работает над художественной концепцией. Писатель не останавливается на том, что его герой связан с фольклорными традициями. Его цель – показать глубину восприятия человеком этих традиций. Философия улака, старинной восточной игры, складывается в повести из нескольких мотивов. Первый – героический мотив, в котором запечатлен момент возвращения богатырского духа и силы. С помощью игры писатель моделирует определенную систему отношений. Первые 4 главы повести (всего их 85 – *Е.К.*) – герой обретает свой статус в обществе. В детстве он получает прозвище, которое становится его настоящим именем, таким образом, устанавливается система отношений «герой-общество».

Через мотив сна, символизирующий романтику и таинство отношений между мужчиной и женщиной, устанавливается система отношений «герой-семья». Эта часть жизни героя проходит перед читателем как одно мгновение. Мгновение в данном случае противопоставлено Вечности. Данный прием с искажением временного пути нужен писателю для того, чтобы показать наиболее значимый план – процесс самоидентификации героя. «Лошадиный» дастан, о котором говорит Зиядулло, становится его собственной жизнью. Через него раскрывается мудрость прошлых веков, осуществляется процесс соединения героя с народной памятью или традицией. Автору удастся не просто зафиксировать одну из восточных традиций (улак),

но и показать ее, как органичную часть сознания восточного человека. В трагикомичном диалоге корреспондента и пастуха скрыта идея о сложном взаимодействии жанров прошлого и настоящего – народного героического эпоса и производственного очерка. А также о подмене одного другим. Очерк, основываясь на фактах, фиксирует происходящее в настоящем. Полотно героического эпоса сосредоточено на моменте, когда прошлое переходит в настоящее по линии вечных ценностей. В повести упоминается эпос «Алпамыш», что можно отнести к подтексту, «подводному течению» произведения.

Судьба легендарного богатыря связана с образом коня. Жизнь и подвиги человека неотделимы от мира природы и шире – Вселенной. Ситуация в повести складывается таким образом, что, в самом герое соединяются черты сказочного «низкого» героя и былинного богатыря, совмещаясь с процессом создания индивидуального мифа. В соответствии с формулой А.Ф. Лосева, «миф есть в словах данная чудесная личностная история» личность трансформируется на фоне исторических событий. Факт «чудесного» имеет отношение к перерождению человека в человека-коня. «Конь – не только как бы побратим батыра (иногда тот так его и называет), – отмечает Липец, – их объединяют узы кровного, а как более поздняя замена – молочного братства» [2, с. 125].

В образах человека и коня важен момент проживания одной жизни на двоих. Родство душ героев соединено с ответственностью за жизнь друг

друга. В финале повести конь бросается на защиту своего хозяина, заслоняя его от неминуемой гибели. В этот момент и сам герой начинает постигать философию «лошадиного» дастана. Он слагает песнь своему коню, признавая их кровное родство, что является примером «чуда» как неотъемлемой части мифологической ситуации. Заявленная в статье проблема поэтики повести Тагая Мурада требует более обстоятельного изучения. В связи с чем представляется интересным ряд вопросов, касающихся внутреннего мира героя, его творческого сознания, которое расслаивается в зависимости от сказочных и былинных элементов. Текст «лошадиного» дастана в структуре повести формируется на фоне судьбы героя, исторических событий, традиций,

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THE THEME OF ART IN S. P. BORODIN's PROSE

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В статье была рассмотрена специфика прозы С.П. Бородин на примере романов «Дмитрий Донской» и «Андрей Рублев». Были отмечены наиболее перспективные направления в исследовании прозы писателя. Три периода творчества С. П. Бородин связаны со средневековой тематикой и образом Андрея Рублева. В статье были рассмотрены возможности реконструкции образа иконописца с помощью романа «Дмитрий Донской» и черновых материалов романа «Андрей Рублев».

Abstract

The article examines the specifics of S. P. Borodin's prose on the example of the novels «Dmitry Donskoy» and «Andrey Rublev». The most promising directions in the study of the writer's prose were noted. Three periods of the S. P. Borodin's work are associated with the medieval theme and the image of Andrei Rublev. The article considers the possibilities of reconstructing the icon painter's image with the help of the novel «Dmitry Donskoy» and the draft materials of the novel «Andrey Rublev».

Ключевые слова: роман, тема, мотив, проза С. П. Бородин, образ Андрея Рублева.

Keywords: novel, theme, motive, prose by S. P. Borodin, image by Andrey Rublev.

Одним из наиболее перспективных направлений современного бородиноведения является проведение сравнительно-сопоставительного анализа романов «Дмитрий Донской» и «Андрей Рублев». Сведения о последнем сохранились в виде черновых материалов в архиве писателя (фрагменты, заметки). Замысел «Андрея Рублева как части исторического романного цикла не был реализован полностью, но сама «рублевская» тема прослеживается на всех этапах творчества и может быть идентифицирована как лейтмотивная.

В творчестве С.П. Бородин мы выделяем три периода: 20-30-е годы – «амировский» период, характеризующийся первыми литературно-этнографическими поездками писателя в Самарканд и Бухару, публикацией очерковой прозы, романов в новеллах «Последняя Бухара» и «Египтянин» в русле ориенталистики 30-х годов. Сохранившиеся в архиве писателя дневниковые записи 20-х годов содержат указания на «рублевскую» тематику. Речь идет о пасхальном мотиве. Второй период – 40-50-е годы – московский или средневековый, который характеризуется интересом писателя к культуре и литературе Древней Руси, образам Дмитрия Донского, Сергия Радонежского и Андрея Рублева, публикацией романа «Дмитрий Донской» (1940), а также ряда произведений, показывающих интерес писателя к христианскому культурному коду и образу Андрея Рублева.

Так, в очерке «У Заутрени» (1942) не только появляется уже отмеченный пасхальный мотив, но и сам писатель раскрывается через новый псевдоним – Андрей Стрешнев. В этот же период было создано несколько киносценариев, что для писателя было важной составляющей творческого процесса («Дмитрий Донской», «Андрей Рублев»).

Для выяснения концептуальной значимости «рублевской» темы наиболее плодотворным является реконструкция романа «Андрей Рублев» посредством совмещения сохранившихся черновых фрагментов с романом «Дмитрий Донской», где, в частности, показаны детские годы Андрея Рублева и первые шаги в творчестве. Обратим внимание на то, что третий период творчества («ташкентский») С.П. Бородин – 50-70-е годы, который был ознаменован работой над романом-эпопеей «Звезды над Самаркандом» должен был завершиться романом «Белый конь», в одном из отрывков которого вновь появляются и пасхальный мотив, и образ иконописца. Характеризуя творчество С.П. Бородин с точки зрения специфики прозаического дискурса мы выделяем метатекстуальный план, который одновременно является самостоятельным метароманным образованием (текст над текстом) и комментарием (текст о тексте) к произведениям писателя.

Говоря об образе Андрея Рублева в творчестве С.П. Бородин следует учитывать три аспекта: 1. смена жанровых приоритетов: психологизм замещает историзм; 2. традиция «героя эпохи» в русской литературе XIX века; 3. тема искусства и образ творческой личности в русской литературе XIX и начале XX веков – для данного аспекта является актуальным создание индивидуально-авторского мифа в соответствии с формулой «миф есть в словах данная чудесная личностная история» (А.Ф. Лосев) [4]. Образ Андрея Рублева художественно и концептуально связан с Дмитрием Донским и Сергием Радонежским. Именно в слиянии этих образов С.П. Бородин продемонстрированы возможности взаимодействия нескольких планов – исторического, культурного, религиозного и собственно творческого, индивидуального.

В одном из высказываний В.О. Ключевского о личности Сергея Радонежского как феномене, имеющем непреходящее, надвременное значение читаем: «Есть имена, которые носили исторические люди, жившие в известное время, делавшие исторически известное жизненное дело, но имена, которые уже утратили хронологическое значение, выступили из границ времени, когда жили их носители. Это потому, что дело, сделанное таким человеком, по своему значению так далеко вышло за пределы своего века, своим благотворным действием так глубоко захватило жизнь дальнейших поколений, что с лица, его сделавшего, в сознании этих поколений постепенно спадало всё временное и местное, и оно из исторического деятеля превратилось в народную идею, а самое дело его из исторического факта стало практической заповедью, заветом, тем, что мы привыкли называть идеалом. Такие люди становятся для грядущих поколений не просто великими покойниками, а вечными их спутниками, даже путеводителями, и целые века благоговейно твердят их дорогие имена не столько для того, чтобы самим не забыть правила, ими завещанного. Таково имя преподобного Сергея; это не только назидательная, отрадная страница нашей истории, но и светлая черта нашего нравственного народного содержания» [3, с. 64-65]. Путь, указанный В.О. Ключевским, прошёл и Андрей Рублёв со своей «Троицей»: от исторической личности – к народной идее, от исторического факта – к идеалу. В этой схеме суть механизма создания мифа, сама логика мифа.

В формировании бородинского мифа об Андрее Рублеве важную роль играет символика круга и идея преодоления силой индивидуального таланта общей ситуации герметизма. Созданная в рамках древней традиции, «Троица» Андрея Рублева является многоплановым текстом, в процессе прочтения которого открывается многоплановость личности самого творца – иконописца, живописца, поэта, философа и мыслителя. Для прозы С.П. Бородин одним из лейтмотивных элементов является полет творческой мысли (птичий полет), похожий на росчерк кисти или пера. Творчество и Традиция соотносятся как горизонталь и вертикаль. Взаимодействие осуществляется по модели «город-башня». Выстраиваемый в горизонтальной плоскости город символизирует жизнь человека, основанную на взаимодействии между несколькими поколениями. На этом фоне закономерного течения жизни выделяется вертикальное, спиралеобразное выстраивание, символизирующее собой стремление ввысь, в небесную, божественную сферу (Творец, Мастер). Образ творца в прозе С.П. Бородин имеет свое обозначение – «Мастер птиц».

Благодаря «рублевской» теме становится очевидным значимость живописного экфрасиса (произведение искусства в произведении искусства) в творчестве С.П. Бородин. Сам писатель увлекался живописью, оставлял рисунки на полях рукописей, общался с художниками (Волков, Глазунов, Ходасевич-Леже) и обладал особым художественным даром «живописного», орнаментального письма.

Образ Андрея Рублева выкристаллизовывается в ситуации преемственности поколений. В романе «Дмитрий Донской» происходит встреча двух творцов – Кирилла и Андрея, которая становится знаменательной для совсем юного художника. Писатель делает акцент и на том, что именно у древнего зодчего Кирилла «рождается» будущий иконописец Андрей Рублев: «Словно ожидая чего-то, он медлил. Но обошёл всё – нигде ни следа. Нехотя пошёл обратно в город. Когда перелез через вал, меж груд золы мелькнула белая рубаха. – Эй! Никто не откликнулся. Увидел – осьмилетний мальчонка, белокурый, бледный до синевы, хватаясь тонкими пальцами за скользкие чурачи, карабкался от него прочь. Одним прыжком Кирилл его догнал и взял за плечи: «Ну, куда ж ты? И тотчас пригнулся от боли: острые зубы до крови вонзились в руку... Дичась, мальчик долго не откликался, но Кирилл чувствовал, как под его ладонями понемногу успокаивается и ручнеет этот светлый зверёк. Он взял его за руку и повёл за собой» [2, с. 220]. Обратить внимание на образы руки и золы. Рука наделена способностью карать или, напротив, защищать и связана с Богом, «...символ Бога в христианской Троице» [5, с. 315]. В аспекте «Троицы» речь может идти об образах Бога-Отца и Сына Бога. В символику круга данного иконописного полотна включена идея целостности и преемственности. Далее, мальчик появляется из золы или пепла. Возникает ассоциация с образом волшебной птицы феникс, символизирующей Воскресение Иисуса Христа [1, с. 224]. Белый цвет – «символ невинности, света, радости, чистоты, девственности, славы, веры, святости, жизни и души. В белое был одет Христос после Воскресения...» [1, с. 30]. Кульминация рождения сына – слова Кирилла: «–Ну нет. Он мне кровный сын: руку-то прохватил до крови! – Тебе вот и дети сами валяются... (в разговоре с Климом – Е.К.) – А и у меня сын. Вчерась нашёл. Андреем звать. –Что ж, иной найденный теплей кровного возрастает... (в разговоре с Овдотей – Е.К.)» [2, с. 221-222].

Неожиданно для себя получив по воле судьбы сына, Кириллу открывается возможность спасения и духовного роста, хотя полного осознания этого ещё нет. Речь идёт о спасении через творчество. Кирилл становится воином лишь по необходимости, призвание же его – это творчество: «Кирилл взял с затапа уголёк и сел за стол. От него отодвинулись и стены и Рязань. На белой крышке стола сияло тёплое море, в небе летели белые птицы, а между морем и небом он мыслил диковинный терем, и уголь в быстрых пальцах создавал тот терем на белых досках стола. Возникла витая арка ворот, проглянули, словно удивлённые, глаза-окна. И, как брови, над ними навис карниз» [2, с. 233]. Мальчика привлекает работа Кирилла: «Мальчик стоял позади, белый, босой, тоненький, как свеча. Зачарованными глазами он смотрел на рисунок Кирилла». Тот ещё не понимает, насколько талантлив Андрей. Пока Кирилл спал, Андрей закончил его рисунок: «Сперва он хотел гневно кинуться к одеялу и вытащить грешника, но, всмотревшись, подивился: широкие простенки меж окнами были заполнены какими-то склонёнными людьми, цветами и птицами.

Мальчик не успел дорисовать: обронённый уголёк валялся на краю стола. Но окна, соединённые рисунком, сливались в широкий пояс вокруг всего терема, и верх словно висел в воздухе, приподнятый стеблями цветов и крыльями птиц. – Да глянь-ко, какой ты мастер! – приласкал Кирилл Андрея... Ты мне помощник будешь» [2, с. 233-234]. Творческое начало только пробуждается в Андрее. Окончательно оно оформляется благодаря Кириллу, который принимает решение переправить мальчика в обитель к Сергию Радонежскому.

Подводя итоги, отметим, что для современного бородиноведения приоритетной исследовательской стратегией является привлечение новых контекстуальных сфер для извлечения новых смыслов, а также формирование теоретической базы с учетом специфики текста (поэтика живописного экфра-

сиса, метапоэтика). Актуальным является исследование проблемы периодизации творчества С.П. Бородин и специфики каждого из периодов с привлечением новых архивных материалов.

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SOCIAL SCIENCES

TO THE HISTORY OF THE STUDY OF THE SHAHRUKHIYA SETTLEMENT (ARCHAEOBOTANY AND PLACES OF WORSHIP)

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Abstract

The focus of this study is on Shahrukhiya settlement through the lens of archaeobotanical materials and sacred sites. The analysis of plant remains identified during archaeological excavations enables the reconstruction of not only population's nutritional habits and agricultural production systems, but also the way humans engaged with the environment during the medieval period. Particular attention is paid to the study of sacred places and places of worship located on the territory of the settlement and its surroundings. The socio-anthropological study of these places makes it possible to identify the characteristic features of the religious life of the local population, trace the synthesis and development of pre-Islamic and Islamic traditions, and determine the role of sacred spaces in shaping the cultural landscape of the region. A comprehensive approach, combining archaeobotanical, socio-cultural data contributes to a more complete understanding of the development of Shahrukhiya settlement as a major medieval center of Central Asia, as well as reveals the relationship between economic activity and the spiritual culture of its inhabitants.

Keywords: Shahrukhiya archaeological site, Central Asia, medieval city, sociocultural anthropology, archaeobotany, sacred places, ritual practices, cultivated plants, cereal crops, weed flora.

The archaeology of medieval cities in Central Asia has long remained an “archaeology of elites”, focusing primarily on fortifications, monumental architecture, ornaments, and numismatic materials, while the plant component of their cultural layers received comparatively little scholarly attention. The development of archaeobotany has unexpectedly shifted focus to some of the most fundamental aspects of past societies: what people ate, which crops they cultivated, which kinds of herbal plants were employed for the treatment, and how they coped with droughts and crop failures. By employing archaeobotanics, scientists obtained insights into the “invisible” urban life - the everyday practices and subsistence strategies of ordinary people. At the same time, archaeobotanical evidence can shed light not only on economic activities and daily life but also on the ritual and religious practices of local communities.

A particularly illustrative example combining archaeobotanics and sociocultural anthropology is provided by the archaeological site of Shahrukhiya, which constitutes a unique case study for investigating the interaction between plants, people, and cultural practices in medieval Central Asia.

Methods

The study employs retrospective, historical, and comparative methods of analysis.

Discussion

There was once an amazing city on the territory of the modern Akkurgan district⁶. In eastern written

sources it is known as Benaket. During the X–XIIth centuries, it was one of the most prosperous and beautiful urban settlements of the Tashkent Oasis. However, at the beginning of the XIIIth century, the city was completely devastated during the Mongol invasion (Bartold, 1963, p. 484).

This archaeological site has been mentioned repeatedly in medieval itineraries, geographical essays, and historical chronicles. It is located approximately 80 km southwest of Tashkent, on the elevated right bank of the Syr Darya river near the confluence of the Karasu channel, one of the ancient branches of the Akhangaran river. The site represents the ruins of one of the largest urban centers of the Tashkent Oasis. For several centuries, the city functioned as an important military, commercial, and economic center closely linked to the caravan trade. The settlement survived until the early eighteenth century and is identified with Benaket - Shahrukhiya (Buryakov and Bogomolov, 2009, pp. 82–84). Therefore, Benaket-Shahrukhiya-Sharqiya are all names of the same settlement.

According to historical sources, during the 1370s–1390s Amir Timur, having consolidated his rule over Transoxiana, initiated the reconstruction of cities and settlements destroyed by the Mongols, as well as building new fortresses. (Buryakov, 1983, p. 62; Alimov, 2005, p. 22).

From the earliest accounts, the city was surrounded by legends and incredible rumors. One of the

⁶ Akkurgan district is an administrative district of Tashkent Region, Uzbekistan

legends says that the city was so densely built that the goat jumped onto the roof of one house reached Toytepa⁷ without touching the ground. According to local belief, the place where the goat first landed later became a sacred site known as Shamorkari-Avliya (modern Shamirkori Avliyo), accompanied by a sacred grove.

Another legend tells of a prolonged siege by countless armies of invaders. The city appeared on the verge of collapse: siege engines had breached the walls, fires raged within the settlement, yet the defenders continued to resist, pouring boiling pitch upon the attackers and showering them with stones and arrows. Suddenly, all ceased. No defenders were visible on the walls. The invaders broke through the gates and entered the city, but it was empty; no one was there. Reaching the banks of the Syr Darya, they witnessed the last defenders disappearing into underground passages beneath the riverbank. According to legend, anyone who attempted to follow them never returned. These underground tunnels are said to extend for great distances, even passing beneath the Syr Darya itself. Such underground labyrinths do indeed exist and form a complex network beneath the city. Early investigators attempted to trace their routes. Other legends say that the labyrinths and caves were dug by tigers or tell of immense treasures hidden by the townspeople and submerged in the river during times of danger. A further cycle of legends is associated with a sacred place and elm grove located on the northern outskirts of the site.

Some researchers argue that the original name of the early city remains unknown. However, turkic sources from the period of the Turkic Khaganate mention a locality called Kangu Tarband, identified as a frontier point of the khaganate. It is possible that this reference pertains to the present site. At that time, the Syr Darya was also known as the Kang River, while tarband meant “crossing” or “passage.” Thus, Kangu Tarband may be interpreted as “the crossing over the Kang River.” The later name Benaket may derive from a transformation of this term, appearing in early Arabic itineraries and geographical essays, where ben represents a shortened form of tarband (“crossing”) and ket means “city.”

Another group of researchers associates the name of Shahrukhiya with Shahrukh, the son of Amir Timur. According to historical accounts, in 1392 Amir Timur, returning from a military campaign, recognized the strategic importance of the location, restored the city, and granted it to his youngest son Shahrukh. Consequently, the settlement became known as Shahrukh-shahr (“the city of Shahrukh”), later evolving into Shahrukhiya.

Subsequently, when the city came under Shaybanid rule, it was also referred to as Sharqiya (“Eastern”) (Kastan’ev, 1913; Buryakov, 1978, p. 11).

The Syr Darya delta was characterized by plant communities typical of Central Asian riverine ecosystems, including moisture-loving trees and shrubs. Its flora included such species as cattail (*Typha*), reed (*Phragmites*), sedge (*Carex*), willow (*Salix*), poplar (*Populus*), and Turanga poplar (*Populus diversifolia*), meadow vegetation and grasses. All of them remain widespread in the region today.

Weed plants are commonly encountered in archaeological deposits together with cultivated cereals, indicating a greater role for artificial irrigation. Among the most common weeds identified in the archaeobotanical assemblage are amaranth (*Amaranthus* sp.), lamb’s quarters (*Chenopodium album*), barnyard grass (*Echinochloa crus-galli*), millet (*Panicum* sp.), sedges (*Carex* sp.), reed grass (*Phragmites australis*), and narrow-leaved cattail (*Typha angustifolia*). This reflects the intensity of agricultural exploitation: the more intensively croplands and pastures were utilized, the greater the proportion of ruderal flora.

The study revealed a significant archaeobotanical assemblage consisting primarily of cereal crops, which formed the basis of the diet and constituted a key element of food security. Legumes, oil-crops, nuts, fruits, and grape were also identified, indicating a highly developed horticultural and possibly viticultural tradition. However, most of the recovered plant remains consisted of carbonized grains of bread cereals represented by two principal species: barley (*Hordeum vulgare*) and wheat (*Triticum aestivum* L.), whose abundance confirms their leading role in the local economy.



Pic. 1 Carbonized barley grains from Shahrukhiya settlement

⁷Toytepa is one of the major districts (administrative centers) of Tashkent Region, Uzbekistan.



Pic. 2 Carbonized wheat grains from Shahrukhiya settlement

The significance of barley alongside wheat is further supported by several characteristics of this crop. These include its high tolerance to arid conditions, its ability to grow on poor soils, and its earlier maturation compared to most other cereals. Furthermore, barley served as an important fodder crop for animals. The importance of barley, alongside wheat,

The legume assemblage is represented primarily by lentil (*Lens culinaris*) and *Vicia sativa* L., the latter is a weed contaminating lentil fields.

Analysis of the weed spectrum revealed the presence of white goosefoot (*Chenopodium album*) and amaranth (*Amaranthus* sp.). Representatives of the genus *Chenopodium* are the most abundant category of archaeobotanical remains among ruderal and meadow plants and have been identified at the overwhelming majority of archaeological sites across Central Asia (Spengler, Maksudov, F., et al. 2018; Spengler, R. N. 2019, p.215-227).



Pic.3 Seed of lamb's quarters (*Chenopodium album*) from Shahrukhiya settlement.

(*Chenopodium album* is an annual herbaceous plant belonging to the family *Amaranthaceae* and is commonly classified as a ruderal species)

It should be noted that ash pits, hearths, and *badrabs* (refuse pits) are among the most promising contexts for archaeobotanical sampling. Such contexts are often associated with ritual activities at ancient settlements. Most plant remains are preserved primarily in a carbonized form.

Fruit and legume remains are frequently discovered in the vicinity of religious sites, including mosques and mazars (Islamic shrines). This allows them to be interpreted as possible components of ritual offerings, in which the fruits of the earth symbolized gratitude for a good harvest. Consequently, the presence of such remains in sacred contexts suggests that part of agricultural production may have been used not only for subsistence purposes but also in religious ceremonies, reflecting the close interconnection between economic and spiritual spheres of life in the medieval city. One of the most vivid examples of such a sacred context is the site of Shamorkori Avliya.

In late May 1913, Collegiate Assessor I. A. Kastanye was travelling under the scorching sun in a cart hired in Yanaqurghan, eagerly anticipating his first encounter with the ruins of Shahrukhiya. Suddenly, to his

astonishment, he beheld what appeared almost miraculous - a mirage amidst the barren landscape covered with sparse vegetation. Rising unexpectedly was a sacred grove of ancient elm trees (karagach), visible from several versts away. As he approached Shahrukhiya, the structures of the sacred place gradually came into view, enclosed, like the grove itself, by a mud-brick wall. Large stork nests were visible in the trees. Adjacent to the grove stood the ruins of the Mosque of Abdullah Khan (the most of its walls had already collapsed, leaving only a small section with an arch intact by then. Near the mosque ruins was a low, single-chambered mazar constructed of fired brick. It was adorned with animal horns, strips of cloth, and horse tails (bunchuk). All these features were surrounded by large shade-giving trees forming part of the sacred grove known as Shamorkori Avliyo or Shamar-kara-Auliyo (Kastan'e, 1913).

Among the local population, including inhabitants of more distant areas, the locality of Sharkiya remains well known owing to the mazar of Shamorkori Avliyo and its sacred grove. Pilgrims undertaking ziyarats visit the site not only from neighbouring settlements but also from other regions of Uzbekistan (Jizzakh, Zaamin, Parkent, and Pskent), as well as from southern Kazakhstan (Sairam and Shymkent) and Khujand.



Pic. 4 Shamorkori Avliyo. The Sacred Grove

It is therefore unsurprising that numerous legends have developed around the mazar of Shamorkori Avliyo. According to one tradition, the site—comprising both the mazar and the grove—received its name from two saints who sacrificed a ram or goat there (according to I. A. Kastan'e), while the animal itself subsequently acquired sacred status. The trees of the grove were believed to have sprung from the blood of the sacrificial animal scattered upon the ground. Significantly, until relatively recently, when animals—particularly roosters or hens—were sacrificed, their blood was deliberately poured onto the roots of a tree or into a hollow within its trunk. Ritual practices performed at the shrine were relatively simple and characteristic of Central Asian *ziyarat* traditions: circumambulation of the sacred space, petitions addressed to the saint, prayers and blessings at the mazar, animal sacrifice (typically a ram or rooster), followed by the preparation of pilaf and, less frequently, *shurpa*. Some pilgrims also lit candles along the pathway leading to the shrine entrance.

In the 1980s and 1990s, the shrine frequently attracted people seeking healing, particularly women suffering from infertility. While the full cycle of *ziyarat* rituals was performed, in some cases the blood of the sacrificial animal—most often a bird, such as a white or red rooster or a white hen—was applied to the face, breasts, and abdomen of the afflicted woman. Children's faces were likewise anointed with the sacrificial blood. In certain instances, particularly in cases of skin diseases or when an individual was believed to be affected by sorcery or the evil eye, a black hen was offered as a sacrifice.

Notably, Shamorkori Avliyo is regarded as the senior saint among the avliyo of the region. Numerous elements of the associated legends point to a more ancient, pre-Islamic foundation of his cult. These include his manifestation in the form of a serpent or a white goat, his command over wild animals, and his possession of sacred powers connected with both the underworld and the granting of health and fertility. Even his present name, Sho-Mir-Kori, appears to represent a later reinterpretation of the earlier designation Shamor ("wind"). This suggests that the veneration of a wind

deity and related beliefs may once have been widespread among the populations inhabiting the Syr Darya basin.

Speaking of plant assemblages from cultic complexes, it is possible to identify a group of plants that were not typically associated with everyday consumption, suggesting instead their ritual significance, either as offerings or as components of ceremonial practices. Plant remains recovered from the mosque and mazars include species that are absent from domestic deposits, such as fragments of floral bouquets. Certain plant remains demonstrate a clear distinction between domestic and ritual use. Grapes, for example, in domestic areas are usually represented mainly by crushed seeds, whereas in cultic contexts—presumably associated with offerings—whole bunches or intact seeds are found. Similarly, cereal crops are commonly found in residential areas in the form of threshed grains, while sacred contexts contain complete ears of wheat, *harmala* (*Peganum harmala*) (Pak, pp. 55-56), or unprocessed wheat grains. This implies that the same plant species could fulfill both utilitarian and ritual functions depending on the archaeological context.

A complex of ritual plants has also been identified, including juniper, pistachio, cannabis, cereal crops, and fruits. These remains may reflect a variety of ceremonial practices, in which aromatic plants were likely used for rituals of incense burning, whereas fruits and cereals probably served as offerings.

Conclusion

The research of Shahruckhiya settlement is a crucial aspect of studying Central Asia's historical and cultural heritage. An analysis of the history of archaeological research demonstrates that Shahruckhiya was a significant political, economic, and cultural center of the region, whose development reflected key processes in medieval history. Archaeobotanical data are especially valuable for the reconstruction of the settlement's past. The analysis of plant remains enables the reconstruction of local economic activities, agricultural organization, irrigation systems, dietary practices, and the relationship between humans and their surroundings. Archaeobotanical materials indicates a well-developed

agricultural system and the efficient use of natural resources, which ensured the long-term sustainability of the urban center. Equally important is the study of sacred sites associated with Shahrukhiya and its surrounding territory. Cult structures, mausoleums, and pilgrimage places reflect the spiritual life of the local population, religious beliefs, and the processes of sacral landscape formation. Investigation of these structures provides deeper insight into the interrelations between the urban environment, religious practices, and the cultural memory of local communities. Thus, an integrated analysis of archaeological, archaeobotanical, and historical-religious data significantly expands our understanding of Shahrukhiya's role in the history of the region. A multidisciplinary approach enables a more comprehensive reconstruction of the natural, economic, and spiritual environment of the medieval city, while also emphasizing the need for further research and preservation of this unique cultural heritage site.

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TECHNICAL SCIENCES

METHODS FOR DAMPING ELECTROMECHANICAL LOW-FREQUENCY OSCILLATIONS IN POWER SYSTEMS

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Abstract

The interconnection of power systems for parallel operation and the formation of power system interconnections lead to a change in the nature of the stability problem and can significantly affect the conditions for using inter-system electrical connections due to the occurrence of low-frequency oscillations that threaten the stable operation of such interconnections. The article proposes the author's list and reviews methods for damping low-frequency oscillations of operating parameters that have been successfully applied in practice in power systems and power unions.

Keywords: low-frequency oscillations, damping methods, PSS, FACTS, HVDC.

Introduction

The ongoing integration processes in the global electricity sector have led to the creation of large-scale power systems. Such power systems connect a large number of different types of power sources for parallel operation and supply electricity to a large number of consumers. Ensuring the stability of power system operations is a key requirement for their functioning, as disruptions to their stable operation can pose a threat to human life and result in significant economic losses. At the same time, in recent years, numerous incidents have been recorded in power systems across Europe, Asia, and the Americas, caused by the occurrence and subsequent amplification of low-frequency electromechanical oscillations with frequencies usually not exceeding 1 Hz:

- China (2012–2013) – frequencies around 0,31 Hz and 0,63 Hz [1];
- USA, WECC (2017–2018) – frequency around 0,4 Hz [2];
- Kazakhstan (2020) – frequency around 0,35 Hz [3];
- Ireland (2021) – frequencies around 0,08 Hz [4];
- India (2023) [5].

Low-frequency oscillations constantly occur in power systems or power grids. This is caused by the acceleration or deceleration of the rotors of synchronous machines, which depends on the imbalance between the input mechanical power and the output electrical power of these machines when consumption in the power system changes. These low-frequency oscillations can be observed in the graphs of power flow changes along power transmission lines connecting synchronous generators to consumer substations. At the same time, the presence of low-frequency oscillations in a power system does not always lead to a loss of stability.

Identification of dangerous low-frequency oscillations in terms of power system stability

According to Lyapunov, the stability of any system in the absence of input disturbances can be determined by the sign of the real part of the roots of the first equation of the system (1) at any equilibrium point:

$$\begin{cases} \Delta \dot{x} = A \cdot \Delta x + B \cdot \Delta u \\ \Delta y = C \cdot \Delta x + D \cdot \Delta u \end{cases} \quad (1)$$

where:

x – vector of state variables (consisting primarily of the system's state parameters: rotor angles, angular velocities, electromotive forces etc.);

u – vector of control inputs;

y – vector of output signals, which reflect the result of the control inputs;

A – state matrix;

B – control matrix;

C – output matrix;

D – feedforward matrix.

The first equation of the system (1) will have Z solutions of the form corresponding to the dimension of the square state matrix A [6]:

$$Z_i = K_i \cdot e^{\lambda_i t}, \quad (2)$$

where:

K – complex amplitude;

λ – eigenvalue of matrix A ;

t – time;

n – dimension of matrix A ;

$i = 1 \dots n$.

The presence of complex-conjugate eigenvalues λ indicates the presence of oscillations in the system. In this case, the eigenvalues can be expressed as

$$\lambda = \sigma \pm j\omega, \quad (3)$$

where:

ω – angular frequency of oscillations (rad/s);

σ – the system's stability against oscillations with frequency ω (s⁻¹).

When assessing the threat posed by low-frequency oscillations in terms of the stability of the power system, the damping ratio is the most informative parameter among the various low-frequency oscillation parameters:

$$\xi = \frac{-\sigma}{\sqrt{\sigma^2 + \omega^2}}. \quad (3)$$

Given the importance of the damping factor for low-frequency oscillations in power systems, the following types of low-frequency oscillations are distinguished:

- $\xi > 0$ – damping low-frequency oscillations, whose amplitude decreases over time under the current operating conditions of the power system (relatively safe low-frequency oscillations);
- $\xi = 0$ – non-damping low-frequency oscillations with a constant amplitude (dangerous low-frequency oscillations);
- $\xi < 0$ – non-damping low-frequency oscillations with an amplitude that increases over time (very dangerous low-frequency oscillations).

In the context of ensuring the stability of the power system, special attention should be paid to damping sustained oscillations.

Methods for damping low-frequency oscillations in power systems

The author's analysis of the scientific and technical literature makes it possible to propose the following list of methods for damping low-frequency oscillations that pose a threat to the stability of power systems:

- flexible alternating current transmission systems (FACTS);
- high-voltage direct current (HVDC) systems;
- energy storage units (ESU);
- changing the settings of the automatic excitation controllers of synchronous generators;
- power system stabilizers (PSS).

FACTS devices are systems for series, parallel or combined connection, whose parameters can be adjusted quite rapidly using power electronics.

Examples of FACTS for series connection include Thyristor Controlled Series Capacitor (TCSC) and Static Series Synchronous Compensator (SSSC). The effectiveness of FACTS for series connection, in terms of significantly improving the damping of low-frequency oscillations, has been confirmed by research results on Brazilian power system where such devices installed at the Imperatriz and Serra da Mesa substations made it possible to change the damping of the 0.2 Hz low-frequency oscillation from negative to positive, which were observed in the “North–South” section following a sudden 300 MW reduction in power generation at the Tucuruí hydroelectric power plant in the Northern Power System of the Brazilian IPS [7]. Graphics of active power flow fluctuations in this section with the FACTS unit at the Imperatriz substation turned off and with the FACTS unit turned on are shown in Fig. 1. In both cases, the load on the “North–South” interconnection prior to the occurrence of the specified disturbance was 500 MW.

Examples of FACTS for parallel connection include Static Var Compensator (SVC) and Static Synchronous Compensator (STATCOM). The significant improvement in low-frequency oscillations damping in the power system resulting from the use of FACTS has been confirmed, in particular, by calculations performed on a model of the Eastern USA power system [8], where, as a result of a three-phase short circuit

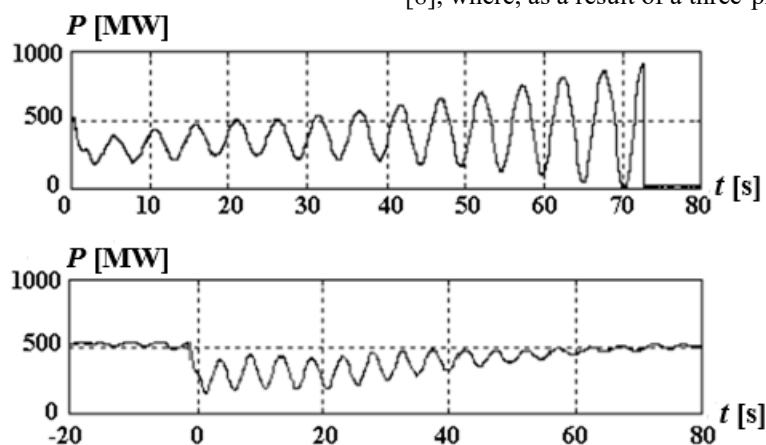


Figure 1 – Active power low-frequency oscillations in the Brazilian power system without and with the series FACTS unit

lasting 0,083 s at the North Nashville substation, low-frequency oscillations with a frequency of approximately 0,6 Hz were observed. The graphics of active power fluctuations at unit №2 of the Gallatin power

plant in the absence of FACTS on the busbars of this power plant and in the presence of parallel connected FACTS with a capacity of 8 MVar and 50 MVar are shown in Fig. 2.

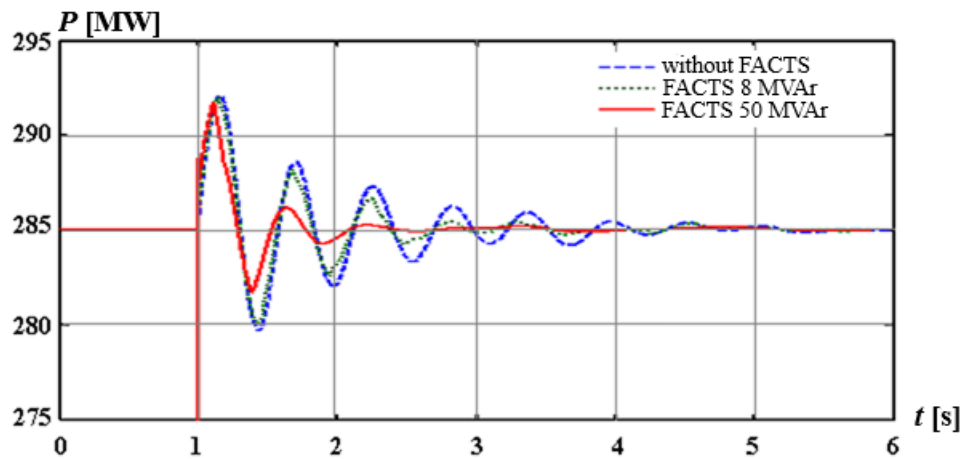


Figure 2 – Active power low-frequency oscillations in the Western USA power system without and with the parallel FACTS unit

Examples of FACTS for combined connection include Unified Power Flow Controller (UPFC) and Convertible Static Compensator (CSC). The significant impact of UPFCs on damping low-frequency oscillations in power systems has been confirmed by the results of

studies conducted on model of the Nigerian power system [9]. Figure 3 shows graphics of deviations in active power flow from pre-fault values preceded the occurrence of an unstable three-phase short circuit on one of the power transmission lines of the Nigerian power system without and with the UPFC.

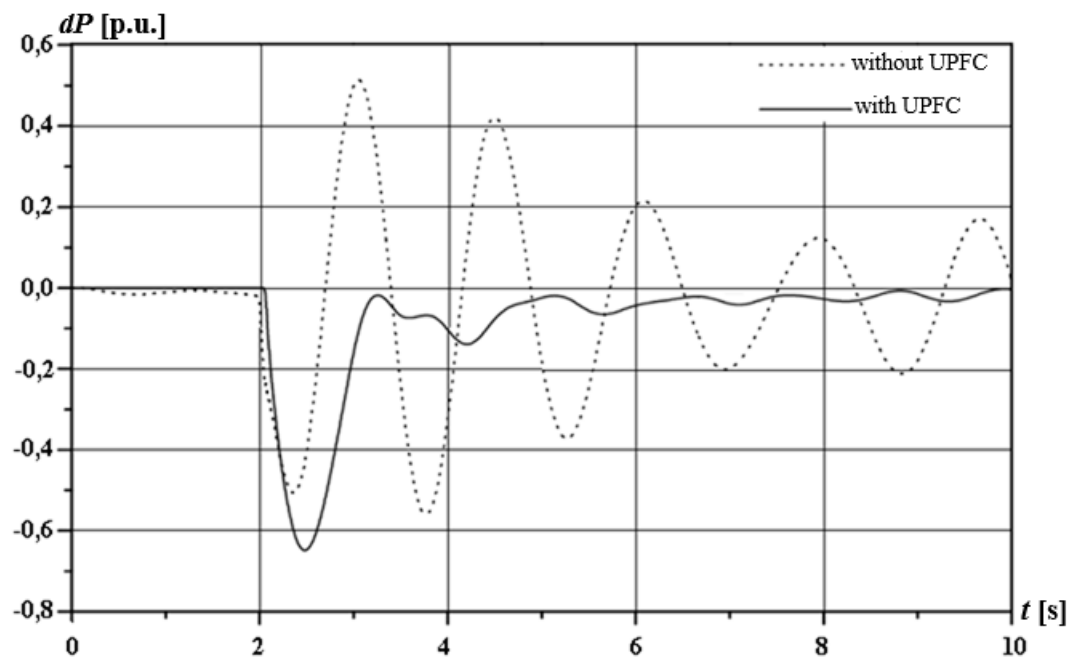


Figure 3 – Active power deviation low-frequency oscillations of power transmission line in the Nigerian power system without and with the UPFC unit

The improved damping efficiency of low-frequency oscillations in the presence of HVDC systems has been confirmed by research results on power system models and examples of their application in real power systems. In particular, the use of a bipolar HVDC link with a nominal voltage of ± 500 kV in the Southeast Power System of the Mexican power system between the Temascal and MMT substations made it possible to change the damping of low-frequency oscillations with a frequency of about 0.5 Hz from negative to positive, which were observed in the “North–South”

section during an emergency outage of the 400 kV power line between the PDB and TEH substations [10]. Graphs of voltage modulus oscillations on the busbars of the Temascal substation in the absence of an HVDC link and with an HVDC link present in two operating modes are shown in Fig. 4.

The improved effectiveness of damping low-frequency oscillations using energy storage units (ESU) has been confirmed by the results of studies conducted using test

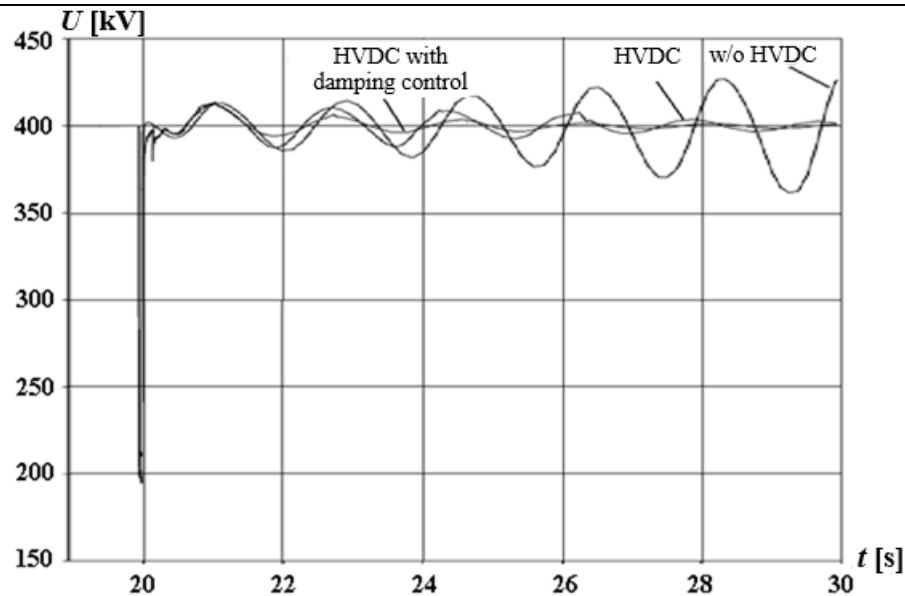


Figure 4 – Voltage module low-frequency oscillations at the Temascal substation in Mexico's power system without and with HVDC interconnection

models of power systems. In particular, for the test model of a four-machine IEEE 2-area benchmark system, the use of energy storage devices made it possible to change the damping of low-frequency oscillations with a frequency of about 0,5 Hz, which arose in the

230 kV interconnection, from negative to positive [11]. The graphics of active power flow oscillations across the interconnection in the absence of ESU and using ESU with different control methods are shown in Fig. 5.

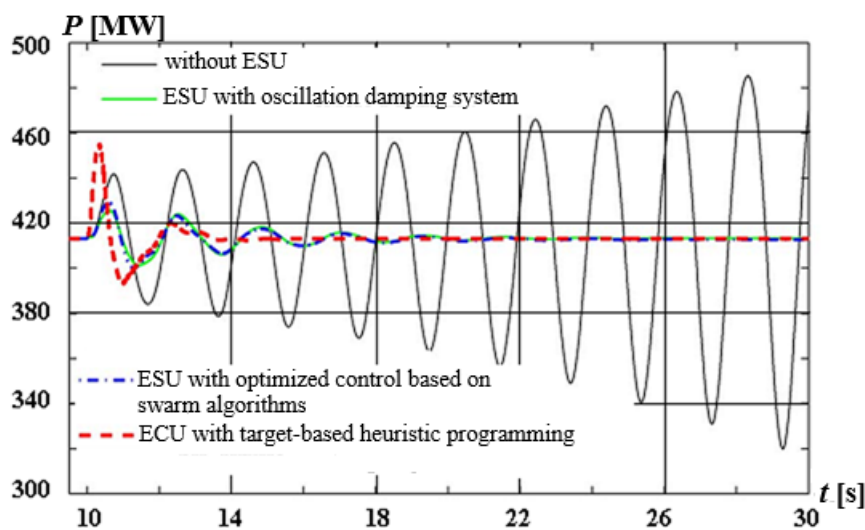


Figure 5 – Active power low-frequency oscillations in IEEE 2-area benchmark system with and without ESU

The effectiveness of damping low-frequency oscillations by adjusting the settings of the automatic voltage regulators of synchronous generators is demonstrated using a model of a four-machine test power system, for which reducing the voltage gain coefficients in

the automatic voltage regulator (AVR) from 200 to 10 made it possible to change the damping of low-frequency oscillations with a frequency of about 0,65 Hz, which arose in the interconnection, from negative to positive (Fig. 6) [12].

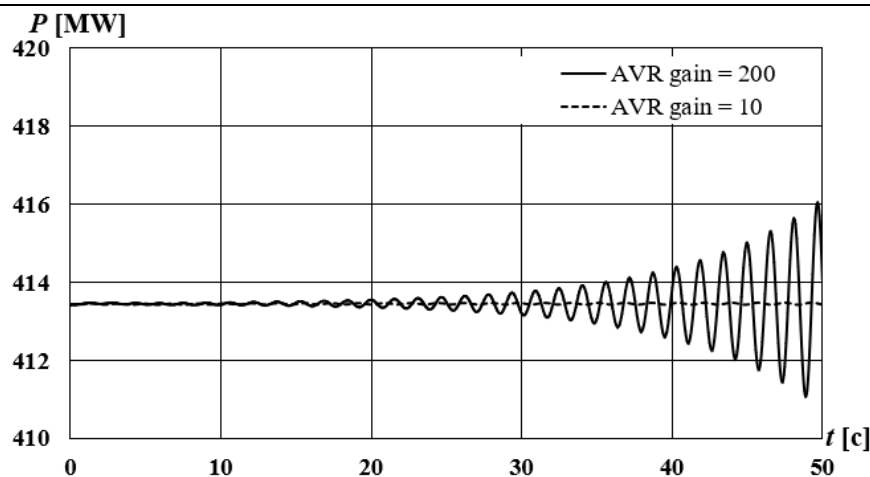


Figure 6 – Active power low-frequency oscillations damping improvement via decreasing gain coefficients of synchronous machines AVR

The primary function of PSS is to improve the damping of the low-frequency oscillations of generator rotors by regulating their excitation using auxiliary stabilizing signals, which are generated based on input signals of active power, angular velocity, frequency, or their deviations from a specific reference value. Currently, PSS is the most widely used method for damping low-frequency oscillations in electric machines. The effectiveness of their application in terms of improving low-frequency oscillations damping in power systems has been confirmed by the results of a series of studies conducted both on test models of power systems

and in real power systems. In particular, for the Brazilian Southern Power System the installation of four PSSs made it possible to significantly improve the damping of low-frequency oscillations with a frequency of approximately 1,2 Hz, which arose in the power system as a result of a sudden 5% increase in the input mechanical torque of the gas turbine connected to the Barracao substation busbars. The graphics of the rotor angular speed oscillations of the Salto Osorio hydropower plant generating unit with the PSSs deactivated in the Southern Power System of the Brazilian IPS and during their operation in two modes are shown in Fig. 7 [13].

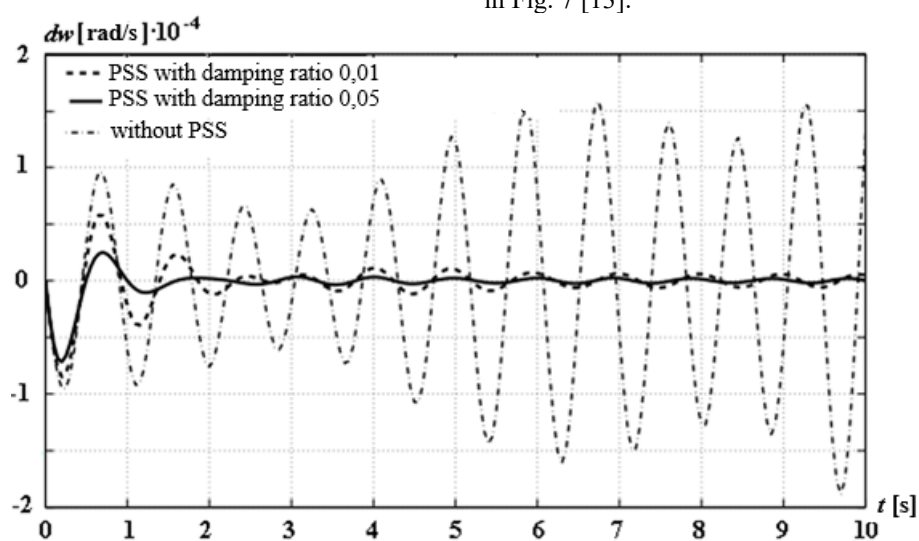


Figure 7 – Rotor angular speed low-frequency oscillations damping without and with PSS

Conclusions

This article examines the issue of damping low-frequency oscillations in operating parameters that pose a threat to the stability of power systems, proposes a list of methods for damping these oscillations, and provides examples of how these methods are applied in practice. The selection of the proper method for damping low-frequency oscillations from the list provided should be based on an analysis of the structure of the power system and the parameters of the equipment within it that can affect the damping coefficient of these oscillations.

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SELECTION OF THE FEEDER WIRE CROSS-SECTION CONSIDERING VOLTAGE DROP LIMITATIONS

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Abstract

The development of electrical networks is driven, amongst other things, by the need of the connections of the new consumers and sources of electrical energy to existing networks. This process is most active in low- and medium-voltage electrical networks, due, in particular, to the contracted capacity of consumers and the installed capacity of distributed energy sources.

During the design phase for connecting of the new power facilities to existing low- and medium-voltage electrical networks, an important task is selecting the cross-section of the wires or cables for the new feeders. In most cases, the selection of the wire or cable cross-section is based on the permissible current, followed by verification against the permissible voltage drop, which usually requires the calculation of steady-state operating parameters of the electrical network. This article discusses an approach to selecting the cross-section of feeder wires and cables in low- and medium-voltage networks, which makes it possible to avoid the need for such calculations and significantly simplifies the selection procedure.

Keywords: wire cross-section selection, low-voltage network, medium-voltage network, permissible voltage drop, permissible current.

Introduction

At present low-voltage (up to 1 kV) and medium-voltage (up to 35 kV) electrical networks are undergoing active expansion. This process is driven by the need of connection both new consumers and new sources of electrical energy, in particular distributed renewable

energy sources. Most power facilities of these types are connected to existing power networks using radial schemes. Such schemes involve connection of the new feeders either to branches of power lines or directly to substation busbars (Fig. 1).

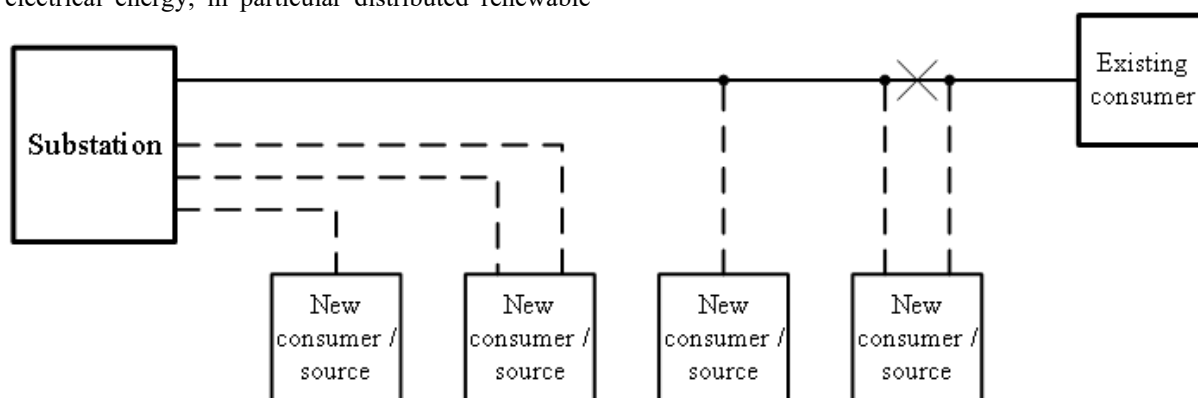


Figure 1 – Wiring diagrams for consumers and energy sources in low- and medium-voltage electrical networks

The cross-section of wires and cables for new feeders is generally selected based on the permissible current rating, followed by a check by the permissible voltage drop [1]. This approach, at the stage of verifying the suitability of the selected cross-section in terms of permissible voltage drop, requires the calculation of the steady-state operating parameters of the electrical network to which the connection is being made. At the same time, during the feasibility study or preliminary calculations, information on the parameters of the existing electrical network may be incomplete or inaccurate,

which complicates the performance of the aforementioned verification. In such situation the approach to selecting the cross-section of the feeder wire or cable based on compliance with the requirements of regulatory documents regarding the permissible voltage drop on the feeder can be used. Using this approach significantly reduces the volume of calculations.

The principles of the proposed approach

It is known that the voltage drop across the power transmission line in the low- and medium-voltage electrical network shown in Fig. 2 can be determined as [2]:

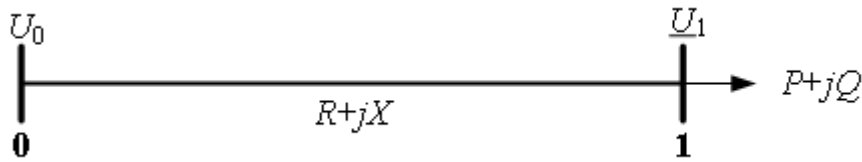


Figure 2 – Feeder of electrical network

$$\underline{U}_1 = U_0 - \left[\left(\frac{P \cdot R + Q \cdot X}{U_0} \right) + j \left(\frac{P \cdot X - Q \cdot R}{U_0} \right) \right] = U_0 - (\Delta U' + j \Delta U''), \quad (1)$$

where:

U_0 – voltage at the beginning of the feeder (real number);

$\underline{U}_1$ – voltage at the end of the feeder;

$\Delta U'$, $\Delta U''$ – feeder active and reactive voltage drop components;

P , Q – consumer's active and reactive power;

R , X – feeder resistance and reactance.

It can be shown that for low- and medium-voltage electrical networks the effect of the reactive component of the voltage drop $\Delta U''$ on the magnitude of the voltage at the end of the feeder is very small. Therefore for such networks this voltage drop component can be neglected and (1) can be simplified:

$$U_1 = U_0 - \frac{P \cdot R + Q \cdot X}{U_0} = U_0 - \Delta U'. \quad (2)$$

Low-voltage case

For low-voltage electrical networks wire or cable reactance per unit length can be taken as 0,08 Ω/km [3], which is equal in values to the resistance per unit length of the aluminum 300 mm² in cross-section wire or cable or to the copper 240 mm² in cross-section wire or cable. Furthermore, in such networks, the consumed active power is usually 3 times or more greater than the consumed reactive power. Thus, for the low-voltage networks $P \cdot R \gg Q \cdot X$ so $Q \cdot X$ component in (2) can be neglected and (2) can be written as:

$$\Delta U' = \frac{P \cdot R}{U_0} = \frac{P \cdot \rho \cdot L}{U_0 \cdot S}, \quad (3)$$

where:

ρ – specific resistance of the wire material or cable conductor;

L – feeder length;

S – required wire or cable cross-section.

The maximum permissible voltage drop in feeders $\delta U_{\max}$ for low-voltage electrical networks is regulated by the standard [1] and is known. So the required wire or cable cross-section S can be obtained as:

$$S = \frac{P \cdot \rho \cdot L}{U_0 \cdot \Delta U'}, \quad (4)$$

where $\Delta U' = \delta U_{\max}$.

Based on the calculated value, a larger standard wire or cable cross-section should be selected. The wire or cable cross-section determined in this way complies with the standards regarding permissible voltage drop, but must also be checked for permissible current I_{perm} :

$$I_{\text{perm}} \geq \frac{\sqrt{P^2 + Q^2}}{\sqrt{3} U_0}. \quad (5)$$

Medium-voltage case

For medium-voltage electrical networks wire or cable reactance per unit length often is equal or bigger than the resistance per unit length, so $Q \cdot X$ component

in (2) cannot be neglected. Equation (2) can be written in per unit length resistance r_0 and reactance x_0 as:

$$\Delta U' = \frac{P \cdot r_0 + Q \cdot x_0}{U_0} \cdot L. \quad (6)$$

In (6) r_0 and x_0 values are unknown and cannot be directly calculated from (6). Per unit length reactance can be written as:

$$x_0 = f \cdot \mu_0 \cdot \left(\ln \left(\frac{\sqrt{\pi} \cdot D_{GM}}{\sqrt{S}} \right) + \frac{\mu_r}{4} \right), \quad (7)$$

where:

f – electrical network nominal frequency;

D_{GM} – the geometric mean distance between phase wires or cables of the feeder;

μ_0 – vacuum magnetic permeability;

μ_r – the relative magnetic permeability of the wire material or cable conductor.

Taking (3) and (7) into account equation (6) can be rewritten as:

$$\Delta U' = \frac{P \cdot \frac{\rho}{S} + Q \cdot f \cdot \mu_0 \cdot \left(\ln \left(\frac{\sqrt{\pi} \cdot D_{GM}}{\sqrt{S}} \right) + \frac{\mu_r}{4} \right)}{U_0} \cdot L, \quad (8)$$

where $\Delta U' = \delta U_{\max}$ (for medium-voltage electrical network $\delta U_{\max}$ value can be taken, for example, from standard [4]).

An analytical solution to equation (8) in general form requires the use of the complicated Lambert's W-function; it is therefore simpler to solve it for specific values of the variables. Based on the calculated value, a larger standard wire or cable cross-section should be selected. The wire or cable cross-section determined in this way complies with the standards regarding permissible voltage drop, but must also be checked for permissible current I_{perm} with (5).

Conclusions

An approach for determining the cross-sectional area of feeder wires or cables with reference of the requirements of standards regarding permissible voltage drop is proposed. An advantage of the proposed approach is that there is no need to calculate the steady-state operating parameters of the electrical network during the cross-sectional area determination stage. Furthermore, the main calculation expressions of the proposed approach are not tied to regional parameters or standards. This makes it possible to apply the proposed approach to determine the cross-sections of feeder wires or cables in electrical networks in any country in the world.

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OVERLOADING PROBLEM OF THE MAIN ELECTRICAL NETWORK OF THE MULTI-APARTMENT BUILDINGS AFTER POWER SUPPLY RESTORATION FOLLOWING A PROLONGED POWER CUT

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Abstract

At present frequent and prolonged power cuts of electricity consumers are a unique phenomenon in the electrical networks of technologically advanced power systems. At the same time, such power cuts have been occurring in Ukraine since 2022 and continue to this day. The causes of these power cuts are the destructive effects of military action on electricity infrastructure, both in terms of generation and the transmission and distribution of electricity.

The deficit of active power generation in Ukraine's Interconnected Power System (IPS) necessitates the forced disconnection of some consumers in order to maintain the active power balance and keep the voltage frequency at 50 Hz. Given the significant duration of periods with a deficit in active power generation, scheduled power cut-off schedules were introduced in Ukraine to meet the basic electricity needs of the people, under which each group of consumers has electricity supply during specific time slots throughout the day. At the same time, the people's adaptation to these power cut schedules and the specific operating patterns of certain groups of domestic electrical appliances have led to the problem of overloading the main electrical wiring in multi-apartment buildings. This phenomenon is common for all densely populated cities in the country and creates the conditions for a very large number of faults to occur simultaneously in the main electrical networks of such buildings.

In this article the author sets out his view on the causes of this problem and possible ways of addressing it.

Keywords: multi-apartment building, main electrical network overloading, power cut, power supply restoration.

Introduction

Since 2022 the people of Ukraine has been facing frequent and prolonged power cuts caused by damage to power stations, substations and power transmission lines resulting from military destruction. The deficit in electricity generation within Ukraine's IPS has necessitated the implementation of mechanisms to forcibly restrict consumption in order to maintain the balance of active power and to keep voltage frequency at 50 Hz. For this purpose, six rounds of power cuts were established in the IPS of Ukraine, comprising two sub-rounds each, with a total scheduled load of approximately 6000 MW. Based on these, scheduled power cut timetables were introduced, under which each group of consumers receives electricity only during specific time slots throughout the day.

The total daily duration of periods with electricity supply during the winter of 2025–2026 was often reduced to 2...3 hours, which created significant problems in ensuring the normal daily life and activities of the population.

In order to provide a normal way of life during power cuts, the Ukrainian people has begun actively implementing projects aimed at achieving energy self-sufficiency for households. For private households such projects involved the installation of petrol or diesel generators and low-power (up to 10 kW) solar power stations with hybrid inverters and storage batteries. For flats in multi-storey buildings such projects involved the installation of charging stations or grid-connected inverters with storage batteries.

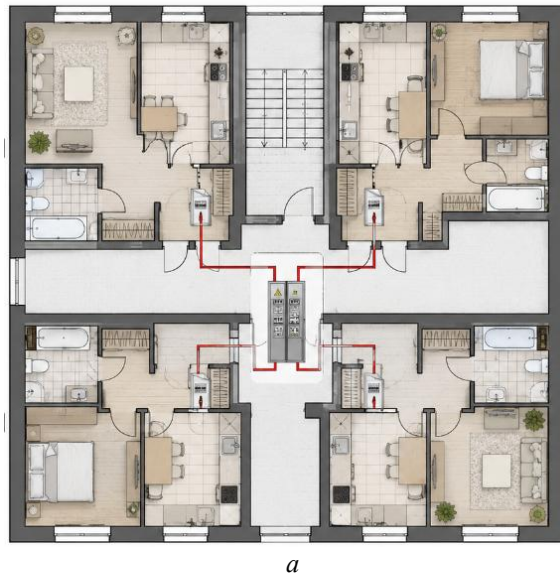
According to data from the World Integrated Trade Solution portal import into Ukraine of static converters, which include inverters, amounted to \$115,1 million in 2022, \$200,5 million in 2023, and \$362,9

million in 2024 [1]. This allows us to estimate the total number of imported devices at approximately 400 000 ... 500 000 units. Given the growth trend in imports of static converters, it can be stated that a total of 650 000 ... 750 000 devices were imported into Ukraine during the period 2022–2025. Taking into account the proportion of inverters in the total volume of imported static converters and the distribution of urban and rural populations in Ukraine, it can be stated that at least 300 000 inverters with a rated power of up to 6 kW are currently being used in conjunction with storage batteries to provide backup power supply to flats in multi-storey buildings. The number of charging stations with a capacity of up to 5 kWh and a charging power of up to 3.5 kW used in flats in such buildings can be estimated at approximately the same figure.

During power cuts from the external grid as part of scheduled power cuts the batteries connected to the hybrid inverters and charging stations batteries gradually discharge supplying electricity to consumers. Once power supply from the external grid is restored hybrid inverters and charging stations switch to battery charging mode adding the charging power to the power consumption of other household appliances. Given the charging power of typical domestic charging stations and domestic inverters in the initial moments after the restoration of power supply from the external grid situations arise in the main electrical networks of multi-apartment buildings where power is transmitted in excess of design capacity, which leads to the emergency shutdown of such networks due to the tripping of a fuse or circuit breaker, which will result in the interruption of the power supply to all consumers on that network.

Analysis of the causes of emergency power cuts in the main electrical networks of apartment buildings following the restoration of power supply

Typical designs for apartment buildings in Ukraine's major cities include 5-storey, 9-storey and 16-storey residential buildings.



For 9-storey buildings the design specification for the energy source used for cooking is natural gas; therefore the contracted electrical connection capacity for each flat in such a building is 5 kW (single phase). There are usually 4 or 6 flats per floor in such buildings. For a building with 4 flats per floor power is supplied via single main line (Fig. 1a); for building with 6 flats per floor power is supplied via two main lines (Fig. 1b).



Figure 1 – Power supply diagram for the flats on a floor of a typical 9-storey building

For 16-storey buildings the design specification for the energy source used for cooking is electricity; therefore the contracted electrical capacity for a flat in such a building is 10 kW (single phase). There are usually 6 or 7 flats per floor in such buildings. For a building with 6 flats per floor power is supplied via two main lines; for building with 7 flats per floor power is supplied via three main lines.

Therefore, the maximum load on the main supply line will be 12 flats with a contracted power of 5 kW per phase for a typical 9-storey building, and 16 flats with a contracted power of 10 kW per phase for a typical 16-storey building.

For typical 9-storey buildings the cross-section of the main aluminium busbar is 50...70 mm² with a permissible current of 165...210 A; for typical 16-storey buildings the cross-section of the main aluminium busbar is 120...150 mm² with a permissible current of 300...355 A [2].

In condition of the a stable power supply from the external grid the total load from the flats on each phase of the main line $P_{ph\ fl}$ can be calculated as follows [3]:

$$P_{ph\ fl} = P_0 \cdot N, \quad (1)$$

where:

P_0 – the estimated specific electrical load per dwelling (flat), which is determined using a table based on the assumed level of electrification and the number of flats connected to that section of the electricity network;

N – the number of dwellings (flats) connected to the line.

According to Table 6.1 [3] for a typical 9-storey building $P_0 = 2,36$ kW and for a typical 16-storey building $P_0 = 3,05$ kW, therefore total load from the flats on each phase of the main line according (1):

$$P_{ph\ fl}^9 = 2,36 \cdot 12 = 28,32 \text{ kW};$$

$$P_{ph\ fl}^{12} = 3,24 \cdot 16 = 51,84 \text{ kW}.$$

The phase current in the main line, caused by the load from the flats, can be determined as:

$$I_{ph\ fl} = \frac{P_{ph\ fl}}{U_{nom} \cdot \cos\varphi}, \quad (2)$$

where:

U_{nom} – nominal voltage of the main line of the building (for Ukraine $U_{nom} = 230$ V);

$\cos\varphi$ – power factor for flat by the Table 6.5 [3] (for a typical 9-storey building $\cos\varphi = 0,96$, for a typical 16-storey building $\cos\varphi = 0,98$).

Thus the phase currents in the main line for the typical buildings:

$$I_{ph\ fl}^9 = \frac{28,32}{0,23 \cdot 0,96} = 128,3 \text{ A};$$

$$I_{ph\ fl}^{16} = \frac{51,84}{0,23 \cdot 0,98} = 230,0 \text{ A}.$$

An analysis of the results shows that in condition of the stable electricity supply the main circuits in typical buildings are not overloaded.

If the power supply is restored following a prolonged outage, the power required to charge the battery of a hybrid inverter or charging station is added to the typical loads; the presence of such equipment in flats is not provided for in the standard [3].

In this case, the total load from the flats on each phase of the main line will be:

$$P_{ph\ fl} = (P_0 + P_{ch} \cdot k_d) \cdot N, \quad (3)$$

where:

P_{ch} – charging active power of the charging station or the hybrid inverter;

k_d – share of apartments with installed charging stations or hybrid inverters.

For charging stations the typical charging power is 1,5...3,5 kW, for single-phase hybrid inverters – 3,5...6,0 kW. The results of the calculation of the total

load per phase on the main line from the flats and the phase current of the main line for different charging powers of the charging station and inverter, for different proportions of flats with installed charging stations or hybrid inverters for typical 9-floor and 16-floor buildings are shown in Table 1 and Table 2.

Table 1

Total load per phase and phase current of the main line from the flats of the typical 9-floor building

P_{ch} , kW	$P_{ph\ fl}$, kW / $I_{ph\ fl}$, A				
	$k_d=10\%$	$k_d=20\%$	$k_d=30\%$	$k_d=40\%$	$k_d=50\%$
1,5	30,1 / 136,4	31,9 / 144,6	33,7 / 152,7	35,5 / 160,1	37,3 / 169,0
3,0	31,9 / 144,6	35,5 / 160,9	39,1 / 177,2	42,7 / 193,5	46,3 / 209,8
4,5	33,7 / 152,7	39,1 / 177,2	44,5 / 201,6	49,9 / 226,1	55,3 / 250,5
6,0	35,5 / 160,9	42,7 / 193,5	49,9 / 226,1	57,1 / 258,7	64,3 / 291,3

Table 2

Total load per phase and phase current of the main line from the flats of the typical 16-floor building

P_{ch} , kW	$P_{ph\ fl}$, kW / $I_{ph\ fl}$, A				
	$k_d=10\%$	$k_d=20\%$	$k_d=30\%$	$k_d=40\%$	$k_d=50\%$
1,5	54,2 / 240,6	56,6 / 251,3	59,0 / 261,9	61,4 / 272,6	63,8 / 283,2
3,0	56,6 / 251,3	61,5 / 272,6	66,2 / 293,9	71,0 / 315,2	75,8 / 336,5
4,5	59,0 / 261,9	66,2 / 293,9	73,4 / 325,8	80,6 / 357,8	87,8 / 389,7
6,0	61,4 / 272,6	71,0 / 315,2	80,6 / 357,8	90,2 / 400,4	99,8 / 442,9

In Table 1 and Table 2 yellow color indicates that the permissible current has been exceeded on the main supply line with a cross-section of 50 mm² for a typical 9-storey building and 120 mm² for a typical 16-storey building, red color indicates an exceedance of the permissible current in the main line with a cross-section of 70 mm² for a typical 9-storey building and 150 mm² for a typical 16-storey building.

An analysis of Table 1 and Table 2 shows that problem with overloading of the main distribution lines in apartment buildings arise even when hybrid inverters with a charging capacity of 4,5 kW or higher are installed in 20% of the flats in the building, and charging stations with a charging capacity of 1,5 kW – for 50% of the flats in the building. Given the previously cited data on the number of inverters and charging stations imported into Ukraine, the results obtained indicate the risk of widespread incidents involving the disconnection of main power lines in apartment buildings and power cuts to consumers.

Recommendations for preventing emergency power cuts to the main lines of apartment buildings following the restoration of the electricity supply

In order to prevent emergency power cuts on the main supply lines of apartment buildings the author recommends implementing the following measures:

1) Inform the public of the need to avoid situations where charging stations or hybrid inverters are operating in charging mode alongside other high-power electrical appliances (electric hobs, boilers, heaters, irons, etc.).

2) Recommend that manufacturers importing charging stations and hybrid inverters into the country reduce the charging current in the factory settings to half of the maximum permissible value.

3) Recommend that energy supply companies install smart meters with the ability to remotely change settings and limit electricity consumption, which will enable them to temporarily disconnect consumers whose electricity consumption exceeds a certain limit.

Conclusions

It has been established that the main cause of emergency power cuts to the main supply lines of apartment buildings in Ukrainian cities following the restoration of power from the external grid is currently the widespread use by the public of charging stations and hybrid inverters with rechargeable batteries, the charging mode of which is characterised by high power consumption. With a view to reducing the number of such outages the author recommends the implementation of a series of preventive measures.

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DOI: [10.5281/zenodo.20824602](https://doi.org/10.5281/zenodo.20824602)**Abstract**

The article examines architectural solutions used in the design of scalable next-generation ETL platforms under conditions of increasing data volume, velocity, and heterogeneity. It is shown that the transition from monolithic models to modular, microservices-based, and event-driven architectures is driven by the need to ensure horizontal scalability, fault tolerance, manageability, and data quality. The study analyzes the theoretical foundations of ETL platform design, modern architectural approaches, and key mechanisms for ensuring reliability, including orchestration, autoscaling, streaming processing, data quality control, and observability. It is concluded that an effective ETL platform should be viewed as a distributed and manageable environment combining technological flexibility, resilience, and cost efficiency.

Keywords: ETL platforms, scalability, data architecture, microservices architecture, streaming data processing, fault tolerance, data orchestration.

Introduction

Amid the rapid growth in data volume, variety, and generation speed, the architecture of extract, transform, and load platforms has become strategically important for the stable operation of digital ecosystems. While early corporate analytics relied mainly on centralized and relatively static data integration systems, such approaches are increasingly insufficient today. Increasing data sets, expanding cloud and hybrid infrastructures, the shift to streaming, and increased reliability requirements have created the need for rethinking traditional ETL (Extraction, Transformation, Loading) design principles. Scalable, flexible, manageable, and robust architectural solutions have thus emerged as key concepts.

Modern ETL platforms are no longer limited to data transfer between systems; they function as distributed software and infrastructure environments embedded in enterprise data management. Their effectiveness depends not only on the performance of individual components, but also on the ability of the overall architecture to adapt to changing workloads, support parallel

processing, maintain data consistency, and reduce failure risks. In this regard, special scientific interest is focused on the analysis of architectural models used in the development of the next generation of ETL platforms, such as monolithic, modular, microservices, and event-driven models.

The purpose of this study is to analyze the architectural models used in the development of scalable next-generation ETL tools, as well as the key mechanisms used for their efficiency, reliability, and flexibility.

Main part. Theoretical and technological foundations of building scalable ETL platforms

In general, an ETL platform is a software and architectural complex designed to extract data from heterogeneous sources, transform it according to predefined logic, and subsequently load it into target repositories, analytical data marts, or operational systems (fig. 1).

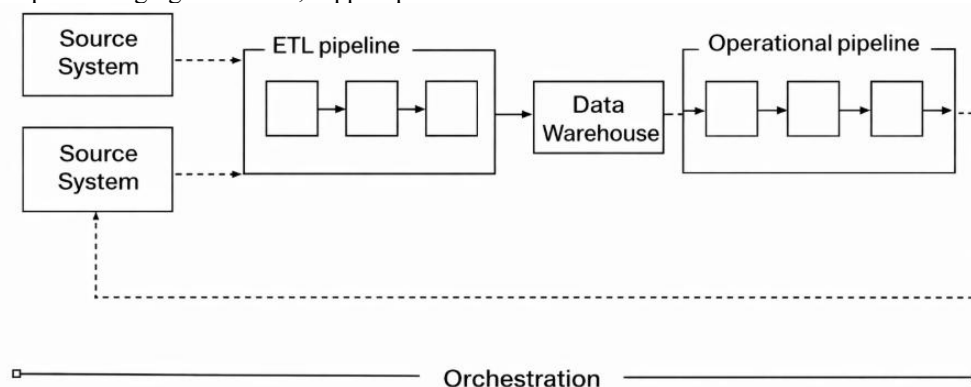


Figure 1. General architecture of an ETL platform [1]

In the modern context, ETL is no longer limited to scheduled linear batch processing; it functions as a distributed environment that must coordinate multiple data sources, support different processing modes, and remain manageable under continuously growing work-

loads [2]. For this reason, next-generation ETL platforms are increasingly viewed as part of a broader data management ecosystem, in which architectural properties are no less important than the functional capabilities of individual components.

The shift toward scalable ETL architectures is primarily driven by the changing scale of the digital environment. In addition, based on the Worldwide Global DataSphere Forecast (2024-2028) report by IDC, it is projected that the total global data created, captured, replicated, and consumed is expected to be 393.9 ZB by 2028, almost triple that of 2023. As data are distributed in cloud, edge, enterprise, and streaming environments, centralized integration approaches become less efficient, and horizontal scaling, distributed storage, and high-speed processing become critical for ETL platforms [3].

Under these conditions, the theoretical understanding of ETL platforms requires identifying the features that distinguish modern scalable solutions from traditional integration systems. While early ETL focused mainly on correct data transfer and load automation, contemporary platforms are defined by architectural properties that support distributed operation. These include horizontal scalability, support for multiple processing modes, loose coupling, flow manageability, observability, and built-in data quality control. Systematizing these characteristics helps clarify the technological nature of next-generation ETL platforms and provides a basis for further analysis of their architectural models (table 1).

Table 1.

Key characteristics of next-generation scalable ETL platforms

Characteristic	Description	Architectural significance
Distributed design	Data processing is performed across multiple interconnected services and infrastructure components rather than within a single execution node.	Enables high-volume data handling and reduces dependence on the limits of an individual server.
Horizontal scalability	Performance is increased by adding nodes, containers, or service instances instead of only expanding a single machine.	Supports workload growth without fundamental redesign of the platform.
Support for multiple processing modes.	The platform supports batch, near-real-time, and streaming scenarios all in one environment.	Broadens the applicability of ETL pipelines for analytical and operational workloads.
Modular structure	Extraction, transformation, loading, orchestration, monitoring, and validation are separated into relatively autonomous components.	Simplifies the maintenance, scaling, and evolution of the platform.
Loose coupling	Components interact through standardized interfaces, queues, or event-driven mechanisms.	Improves fault isolation and facilitates the integration of new sources and services.
Observability	The platform provides monitoring of execution states, resource utilization, pipeline behavior, and data anomalies.	Increases transparency of operations and accelerates fault detection and diagnosis.
Built-in data quality control	The validation rules, schema checks, consistency checks, and error handling are all integrated into the pipeline.	This ensures the reliability of the transformed data, reducing the possibility of error propagation into the target systems.

Therefore, the next-generation ETL platform should be viewed not as a collection of extraction, transformation, and loading procedures, but as an architecturally organized distributed system capable of operating reliably under growing workloads and increasing digital complexity. These characteristics demonstrate that the ETL architecture of today is no longer driven by the operations involved, but by the ability to facilitate scalability, manageability, reliability, and data quality.

Architectural approaches to the design of next-generation ETL platforms

In the context of ETL platforms, an architectural approach can be understood as a stable model for organizing components, data exchange channels, orchestration mechanisms, and scaling tools that determines system behavior under growing workloads, an increas-

ing number of data sources, and more complex processing scenarios [4]. For next-generation platforms, this issue is especially important, since ETL no longer functions as a local batch-loading tool but as a distributed digital infrastructure combining batch, near-real-time, and streaming scenarios in cloud or hybrid environments.

While the functional purpose remains the same, i.e., to extract, transform, and load the data, the way the components of the architectures interact, the way the workload is distributed, the way failure is handled, and the way the data flows are managed differ in various architectural models. Therefore, comparing architectural approaches makes it possible to identify those that best meet the requirements of the modern digital environment, including the rate at which the data is updated, the integration of the data sources, and the reliable operation in the distributed environment (table 2).

Table 2.

Main architectural approaches to the design of next-generation ETL platforms [5, 6]

Architectural approach	Description	Advantages	Limitations
Monolithic	All core ETL functions are implemented within a single unified system.	Simplicity of initial implementation, centralized control, lower complexity at early stages.	Limited scalability, high component interdependence, and difficulties in isolating failures and introducing changes.
Modular	ETL processes are divided into separate functional modules with limited autonomy.	Increased flexibility, easier maintenance, and selective scaling of subsystems.	Requires coordination between modules and standardization of interfaces.
Microservices-based	ETL functions are implemented as independent services with their own lifecycle.	High scalability, independent deployability, and improved fault isolation.	Increased operational complexity, as well as higher orchestration, monitoring, and DevOps needs.
Event-driven	Data processing is based on the concept of event streams, message queues, and asynchronous interactions.	Support for near-real-time processing, loose coupling, and high flexibility.	More complex consistency management, state handling, and end-to-end traceability.
Hybrid	Combines multiple architectural approaches within a single platform.	Flexibility in handling diverse workloads and a balance between scalability and stability.	More difficult architecture design, integration, and maintenance of system coherence.

The comparison illustrates that the development of next-generation ETL tools is accompanied by a gradual shift toward more flexible and distributed architectures, moving away from centralized and tightly coupled models. While monolithic architectures are applicable in limited and stable scenarios, modular, microservices-based, and event-driven architectures are more appropriate in scenarios with growing workloads, various data sources, and complex processing scenarios. Nevertheless, the choice of architecture depends on various factors, such as data and processing characteristics, as well as organizational maturity, which is why hybrid architectures that leverage the best features of each approach within a single integration tool are becoming increasingly relevant.

Overall, current trends in the development of architectural solutions for high-performance ETL platforms are associated with increasing distribution, the growing role of event-driven models, deeper integration of orchestration and observability, and the shift toward hybrid architectures that combine batch and streaming processing within a unified environment. Platform decomposition into autonomous services capable of scaling independently according to workload profile is becoming increasingly important, while transport and orchestration layers are gradually turning into core elements of the entire ETL environment. At the same time, the importance of architectural solutions focused on fault tolerance, processing reproducibility, data quality control, and cost-efficient use of infrastructure resources is increasing, reflecting the transition of ETL from a set of technical procedures to a fully developed high-load digital platform.

Key mechanisms for ensuring the scalability and reliability of ETL platforms

The scalability and reliability of next-generation ETL platforms depend not only on the choice of architecture, but also on a set of engineering mechanisms that enable the system to adapt to growing workloads, isolate failures, preserve data integrity, and maintain predictable recovery time. In distributed environments, these properties must be ensured simultaneously at the computational, transport, orchestration, and data quality levels. Therefore, ETL platforms should be analyzed not only in terms of their overall architecture, but also through the specific technical mechanisms that provide elasticity, fault tolerance, and operational stability [7].

The first key mechanism is **horizontal scaling of computational components**. In modern ETL tools, increasing performance is not done by increasing the capacity of a single node but instead done by adding multiple instances of parallel services. This is the same idea behind the Kubernetes Horizontal Pod Autoscaler, which scales the number of replicas of a Pod based on certain metrics. In ETL, this is important because there are usually varied loads in stages such as ingestion, transformation, validation, and loading. As a result, architectural resilience depends on the ability to scale bottlenecks rather than the entire system.

The practical importance of autoscaling is confirmed by modern cloud data platforms. For example, Google Cloud Dataflow is a fully managed service for batch and streaming data processing, supporting autoscaling for both types of pipelines. It can scale up to 4,000 workers per job, and petabytes of data are regularly processed. For ETL platforms, this shows that horizontal scaling is no longer experimental but a standard operating mode, improving both throughput and cost efficiency.

The second important mechanism is the **decomposition of processing through message brokers and streaming buses**. By introducing an intermediate transport layer between data producers and consumers, the platform can absorb load spikes, decouple component lifecycles, and reprocess data without blocking the entire pipeline. In this context, delivery and processing guarantees are especially important. For example, Apache Kafka provides durable event storage in topics and supports exactly-once processing semantics, which allows scalable ETL pipelines to avoid unnecessary duplication and preserve result consistency during retries, intermediate failures, and asynchronous execution.

The importance of the transport layer is also demonstrated by vendor benchmarks. In Google Cloud Managed Service for Apache Kafka, increasing producer batch size from 1 KB to 10 KB raised throughput from 48,049 to 160,694 messages per second while reducing latency from 608 to 171 ms. Similarly, increasing consumer fetch size from 10 KB to 500 MB improved throughput from 2.7 to 60 MB/s [8]. Although these results are environment-specific, they highlight a key point: ETL performance depends not only on compute capacity, but also on proper configuration of buffering, batching, and parallel data exchange.

The third mechanism is **fault-tolerant processing through checkpointing, replay, and exactly-once or at-least-once delivery policies**. This is essential for streaming ETL platforms, where even a short failure

under high input rates can cause data loss or duplication. For example, Google Cloud Dataflow officially supports exactly-once record processing while maintaining low latency. In practice, this means that ETL reliability depends not only on infrastructure redundancy, but also on processing semantics that allow safe re-execution without compromising data integrity.

Operational reliability is closely linked to formally defined availability targets. For example, Google Cloud Dataflow specifies a Service Level Agreement with a Monthly Uptime Percentage of at least 99.9%. Although an SLA does not guarantee faultlessness of a particular pipeline, it does define an important engineering principle for next-generation ETL tools: these tools must be designed for continuous operation, where failures are considered normal and must be automatically recoverable. This suggests that these tools should be equipped with retry mechanisms and be capable of resuming execution from partial failures.

The fourth key mechanism is **mature task orchestration**. Unlike traditional schedulers, modern orchestrators coordinate dependencies between pipeline stages, manage retries, separate control and execution logic, and provide observability of DAG processes. The practical importance of this layer is supported by industry data: according to The State of Airflow 2025, 47.9% of respondents already consider Airflow to be business-critical (fig. 2).

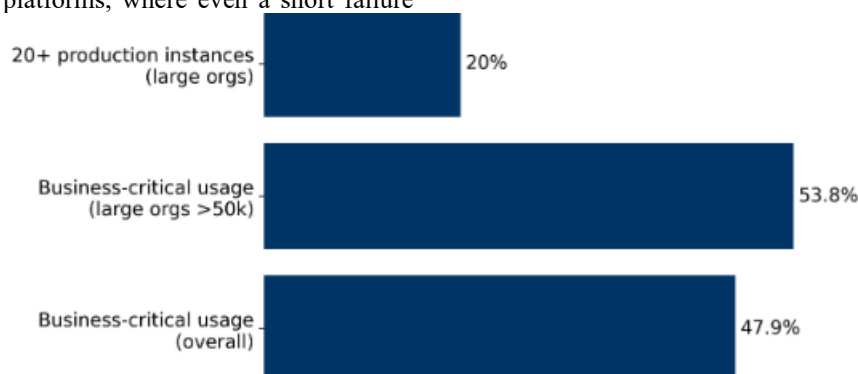


Figure 2. Airflow adoption in business-critical and large-scale production environments [9]

These indicators show that the orchestration layer has evolved into a fully critical subsystem of large ETL platforms rather than merely a supporting interface for task execution.

The fifth mechanism is platform **observability and data quality control**. According to Precisely (2025), 76% of organizations have already implemented formal observability programs for data quality and pipelines. At the same time, the dbt Labs 2025 report shows that 38% of teams plan to increase investments in data quality and observability, while 56% of respondents explicitly identify data quality as a problem. This is particularly important for ETL platforms, where, as the number of sources and transformations grows, failures may appear not as system outages but as “silent” data degradation, including staleness, missing values, duplicates, schema violations, and data drift. Therefore, ETL reliability should be understood

beyond infrastructure availability and include the system’s ability to detect quality deviations in a timely manner.

Thus, the scalability and reliability of next-generation ETL platforms are ensured by a combination of interrelated mechanisms, including horizontal scaling, automatic resource allocation, streaming transport layers, exactly-once semantics, mature orchestration, and advanced observability [10]. Recent studies show that it is the integration of these mechanisms, rather than the isolated use of any single tool, that enables ETL platforms to maintain performance, correctness, and manageability under increasing data sources, more complex transformations, and the transition to near-real-time processing.

Conclusion

Architectural solutions for next-generation scalable ETL platforms are shaped by key technological shifts, including the rapid growth of data volume and velocity, the adoption of cloud-native infrastructures,

the expansion of streaming processing, and increasing data quality requirements. In this context, traditional monolithic ETL models lose effectiveness, while modular, microservices-based, and event-driven architectures offer greater scalability, flexibility, and resilience for modern distributed environments.

At the same time, the efficiency of an ETL platform as a distributed environment depends not only on architecture but also on the maturity of underlying engineering mechanisms such as horizontal scaling, dynamic resource allocation, streaming transport layers, reliable processing semantics, and so on. Hence, the next generation of ETL platforms should be designed as distributed and managed environments, where flexibility is combined with reliability, reproducibility, and efficiency.

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СОВРЕМЕННЫЕ ПОДХОДЫ И ТЕОРЕТИЧЕСКИЕ ОСНОВЫ МОДЕЛИРОВАНИЯ КАЧЕСТВА ВОЗДУХА С ИСПОЛЬЗОВАНИЕМ МЕТОДОВ ГЛУБОКОГО ОБУЧЕНИЯ И ПРОСТРАНСТВЕННО-ВРЕМЕННЫХ МОДЕЛЕЙ

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MODERN APPROACHES AND THEORETICAL FOUNDATIONS OF AIR QUALITY MODELING USING DEEP LEARNING METHODS AND SPATIO-TEMPORAL MODELS

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Аннотация

В статье рассматриваются современные подходы к моделированию качества атмосферного воздуха с использованием методов глубокого обучения и пространственно-временных моделей. Актуальность исследования связана с необходимостью повышения точности прогнозирования загрязнения воздуха в условиях роста экологических проблем в крупных городах. Анализируются возможности применения нейронных сетей, включая LSTM и CNN, для обработки экологических и метеорологических данных. Рассматриваются преимущества пространственно-временных моделей, позволяющих учитывать влияние климатических, географических и антропогенных факторов. Отмечается, что использование методов искусственного интеллекта способствует повышению эффективности систем экологического мониторинга и поддержки принятия решений в области охраны окружающей среды.

Abstract

This article examines modern approaches to modeling ambient air quality using deep learning methods and spatiotemporal models. The relevance of this research stems from the need to improve the accuracy of air pollution forecasts amid growing environmental challenges in major cities. The article analyzes the potential applications of neural networks, including LSTM and CNN, for processing environmental and meteorological data. The advantages of spatiotemporal models, which allow for the consideration of the influence of climatic, geographical, and anthropogenic factors, are examined. It is noted that the use of artificial intelligence methods contributes to improving the effectiveness of environmental monitoring systems and decision support in the field of environmental protection.

Ключевые слова: качество воздуха, глубокое обучение, пространственно-временные модели, экологический мониторинг, искусственный интеллект, прогнозирование загрязнения воздуха.

Keywords: air quality, deep learning, spatiotemporal models, environmental monitoring, artificial intelligence, air pollution forecasting.

Загрязнение воздуха оказывает негативное воздействие на здоровье человека, особенно детей, пожилых людей и людей с уже имеющимися заболеваниями. Длительное воздействие загрязненного воздуха может привести к респираторным и сердечно-сосудистым заболеваниям, раку легких и другим проблемам со здоровьем. Несмотря на усилия правительств по снижению загрязнения, качество воздуха в некоторых районах остается плохим.

В настоящее время все больше внимания уделяется проблемам загрязнения воздуха, чтобы гарантировать, что качество воздуха не превышает

допустимых уровней. По данным Всемирной организации здравоохранения, 92% населения мира подвергается воздействию загрязняющих веществ в концентрациях, превышающих уровни, считающиеся вредными для здоровья [1]. Загрязнение воздуха является глобальной проблемой в странах с различным этническим составом населения и в развивающихся странах [2]. Сегодня более 90% населения мира дышит воздухом, концентрация которого превышает допустимые уровни. Организация

Объединенных Наций определила загрязнение воздуха как одну из главных угроз для здоровья человека и планеты [3].

Состояние воздуха напрямую влияет на здоровье людей и благополучие городов. Промышленный рост, увеличение трафика и высокая концентрация жителей в мегаполисах ухудшают экологию. Поэтому критически важно точно отслеживать и предсказывать уровень загрязнения. Традиционные методы моделирования, опирающиеся на физику и статистику, не всегда справляются со сложными взаимосвязями между погодой, источниками выбросов и их распространением во времени и пространстве. Однако, благодаря развитию искусственного интеллекта, особенно глубокого обучения, появляются более точные и гибкие модели для прогнозирования качества воздуха.

Традиционные подходы к оценке и предсказанию состояния атмосферы, опирающиеся на статистические выкладки и физические модели, часто демонстрируют низкую точность из-за высокой изменчивости и нелинейности процессов загрязнения. Это стимулирует рост интереса к технологиям искусственного интеллекта, в особенности к методам глубокого обучения, которые эффективно выявляют скрытые закономерности в массивах данных и учитывают пространственно-временные аспекты распространения вредных веществ. Значимость настоящего проекта продиктована потребностью в создании интеллектуальной платформы для мониторинга качества воздуха, обеспечивающей своевременную оценку загрязненности и заблаговременное оповещение граждан об опасных экологических условиях. Применение нейросетевых архитектур и моделей, учитывающих пространственно-временные связи, открывает перспективы для существенного повышения точности прогнозов и их адаптации к меняющейся городской среде. Следовательно, создание таких интеллектуальных систем является ключевым направлением научных исследований, направленным на улучшение экологической обстановки, повышение осведомленности общества и поддержку управленческих решений в сфере защиты окружающей среды.

В настоящее время используют современные методы анализа временных рядов, машинного обучения и обработки больших данных для эффективности в оценке и предсказании состояния атмосферы. В рамках исследования предполагается проведение сравнительного анализа различных моделей, выбор оптимальной архитектуры, а также оценка точности прогнозов с использованием метрик качества (MAE, RMSE и др.). Особое внимание уделяется интерпретируемости моделей и возможности объяснения полученных результатов. Глубокое обучение представляет собой класс методов машинного обучения, основанных на многослойных нейронных сетях, способных автоматически извлекать сложные признаки из больших объемов данных. В задачах моделирования качества воздуха данные методы демонстрируют высокую эффективность за счет способности учитывать нелинейные зависимости и скрытые закономерности. Сверточные нейронные сети применяются для анализа

пространственных данных и карт загрязнений, так как они эффективно обрабатывают двумерные и многомерные структуры. Рекуррентные нейронные сети и их модификации ориентированы на анализ временных рядов и позволяют моделировать динамику изменения концентраций загрязняющих веществ во времени. Использование глубоких нейронных сетей снижает зависимость от ручного выбора признаков и повышает точность прогнозирования.

Основная задача данного исследования заключается в тщательном сопоставлении и отборе наиболее результативных и понятных для интерпретации алгоритмов прогнозирования на основе сравнения с эталонными моделями, часто используемыми в специализированных соревнованиях по анализу временных рядов. Чтобы гарантировать практическую ценность полученных прогнозов, в качестве обучающих выборок применяются высококачественные данные, зафиксированные сенсорными устройствами. Фокус на задачах экологического мониторинга обеспечивает релевантность выводов для решения реальных прикладных проблем. Ключевую роль в совершенствовании систем оценки состояния атмосферы играют такие параметры, как температура, атмосферное давление, роза ветров и уровень осадков, поскольку они напрямую определяют процессы образования, распространения и накопления вредных примесей в воздухе. Осознание механизмов этого воздействия позволяет реализовывать адресные меры, включая регулирование промышленных выбросов и транспортную политику, что способствует эффективному снижению загрязненности. Внедрение данных факторов в алгоритмы прогнозирования помогает принимать обоснованные управленческие решения. При этом следует отметить, что применение нейронных сетей часто затрудняет выявление конкретных причинно-следственных связей между отдельными переменными и получением явной математической зависимости.

Основное внимание будем уделять следующим основным вкладам: предложение стандартного процесса использования методов машинного обучения для обеспечения справедливого сравнения производительности, введение интерпретируемых методов ХАИ для прогнозирования качества воздуха и комплексный анализ факторов, влияющих на качество воздуха.

Выбор данных. В сокращении набора данных Kaggle применяется комплексная коллекция экологических измерений, включая PM2.5, которая представляет собой аэрозольные частицы размером 2.5 мкм или меньше и оказывает значительное воздействие на качество воздуха [5]. В данном случае PM2.5 является зависимой переменной, а также присутствуют 16 независимых переменных, включая No (номер), year (год), month (месяц), day (день), hour (час), PM10, SO2, NO2, CO, O3, TEMP (температура), PRES (давление), DEWP (температуру точки росы), gain (указывает на выпадение осадков), wd (направление ветра) и WSPM (скорость ветра).

Измерения PM2.5 имеют большое значение для здоровья человека, поскольку эти частицы могут проникать в легкие и вызывать отрицательные последствия для организма [6]. Существует корреляция между уровнем PM2.5, изменениями давления и содержанием загрязнителей, связанных с метеорологическими факторами. Эти факторы могут оказывать прямое влияние на распространение загрязнителей, химический состав и климатическую стабильность, что, в свою очередь, влияет на уровни качества воздуха [7].

Анализируя все различные параметры окружающей среды, можно получить более подробное представление о динамике качества воздуха, особенно в контексте температуры воздуха. Рассмотрение таких факторов дает возможность лучше понять взаимосвязи и влияние различных параметров на качество воздуха. Анализ временных рядов имеет несколько преимуществ при оценке качества воздуха, делая его важным инструментом для исследователей и экологических менеджеров. Использование моделей временных рядов дает возможность обнаружить скрытые тренды, сезонные закономерности и циклическое поведение данных о качестве воздуха. С помощью этих моделей аналитики могут выявлять и интерпретировать повторяющиеся закономерности, возникающие со временем, а также понимать сложные взаимосвязи между различными загрязнителями воздуха. Таким образом, комплексное понимание такой временной динамики — ключевое для эффективного управления окружающей средой, разработки политики и применения целевых стратегий вмешательства для смягчения загрязнения воздуха.

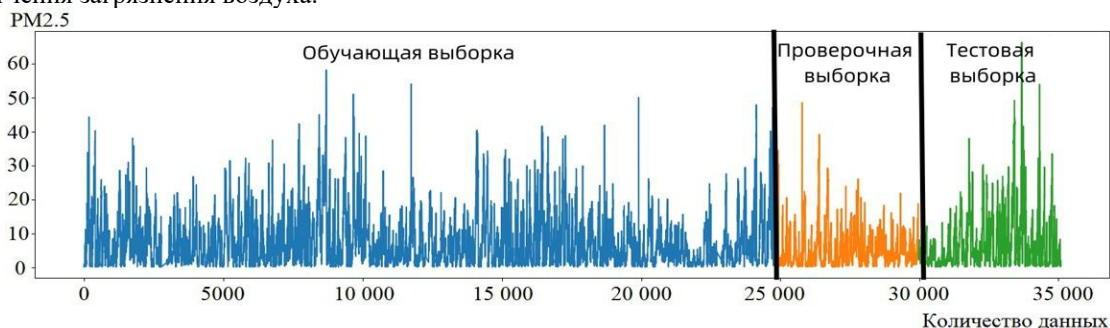


Рис. 1. Распределение данных

2. Модели прогнозирования в приложениях временных рядов.

2.1. Основные методы. В настоящее время структуры нейронных сетей и ансамблевых моделей широко применяются в различных приложениях. Поэтому важно выбрать представительные модели в этих структурах для всестороннего сравнительного анализа прогностических моделей. В качестве модели нейронной сети выбираем искусственные нейронные сети (ANN), рекуррентные нейронные сети (RNN), двунаправленные рекуррентные нейронные сети (Bi-RNN), двунаправленные долгосрочные нейронные сети с короткой памятью (Bi-LSTM) и двунаправленные блокирующие рекуррентные единицы (Bi-GRU). Ансамблевые модели включают алгоритмы бустинга и бэггинга; выбираем LightGBM, XGBoost и

Применение моделей позволяет интегрировать передовые техники машинного обучения и технологии XAI, улучшая интерпретируемость и прозрачность анализа качества воздуха. Включение методов, таких как SHAP, дает возможность исследователям определить наиболее влиятельные признаки в процессе принятия решений моделей, что приводит к лучшему пониманию базовых данных и взаимосвязей, которое способствует доверию к моделям со стороны заинтересованных сторон и позволяет принять данные ориентированных подходов в управлении окружающей средой. Более того, непрерывное развитие методов моделирования временных рядов способствует повышению точности и надежности прогнозов качества воздуха, дополнительно усиливая их применимость и ценность в данной области.

В рамках настоящего исследования конкретный момент времени служит границей между обучающим и тестовым наборами данных вместо произвольного случайного выбора. Такой подход более отвечает внутренней логике временных рядов. Примерно 70 % элементов выделены для обучающего набора данных. Учитывая различные пропорции отсутствующих значений для разных видов данных, можно обеспечить достаточное количество признаков при прогнозировании концентрации частиц PM2.5 в качестве целевой переменной для данного исследования (рис. 1). Установив разумную границу, пропорции обучающего набора данных, тестового и валидационного наборов данных определены как 70, 15 и 15 % соответственно.

Оба типа моделей — ансамблевые методы и нейронные сети — принципиально решают задачи посредством последовательной декомпозиции, а не через разделение всего пространства данных сложными границами, как это реализовано в методах опорных векторов или логистической регрессии. Алгоритмы на основе деревьев выполняют итеративное разбиение пространства признаков по различным критериям с целью максимизации информационного выигрыша. Нейронные сети функционируют схожим образом, хотя данный процесс менее очевиден: каждый нейрон отвечает за определённую область пространства признаков с возможным перекрытием областей активации, активируясь при поступлении входных данных в соответствующую область.

При этом нейронные сети формируют модели на основе вероятностного подхода к разбиению пространства признаков, тогда как методы, основанные на деревьях решений, используют детерминированный механизм. Эффективность обоих классов моделей во многом определяется глубиной архитектуры, поскольку её элементы соответствуют различным сегментам пространства признаков.

В рамках настоящего исследования в качестве объектов анализа выбраны модели LightGBM, ANN, RNN, Bi-RNN, Bi-LSTM и Bi-GRU. Для экспериментов применяется версия LightGBM, использованная победителями соревнования M5, поскольку она характеризуется повышенной адаптивностью к сложным структурам признаков и обеспечивает более высокую точность прогнозирования по сравнению со стандартной реализацией модели.

Light GBM. Light Gradient Boosting Machine (LightGBM) — это усовершенствованная версия алгоритма градиентного бустинга на деревьях решений (GBDT), характеризующаяся превосходным качеством работы в различных задачах машинного обучения, особенно с большими наборами данных и сложными пространствами признаков. В ней применяется метод на основе гистограмм для построения и разделения деревьев решений, что уменьшает использование памяти и вычислительную нагрузку путем дискретизации непрерывных значений признаков в дискретные блоки. В результате LightGBM эффективнее обрабатывает большие наборы данных по сравнению с традиционными реализациями GBDT. Ещё одна отличительная характеристика LightGBM — это стратегия Exclusive Feature Bundling (EFB), которая использует разреженные структуры данных для идентификации взаимоисключающих признаков и их объединения, что эффективно уменьшает размерность набора данных. Это позволяет избежать «проклятия размерности» и ускоряет процесс обучения без потери предсказательной способности модели.

LightGBM предлагает две инновационные стратегии роста деревьев: Leaf-wise и Depth-wise для улучшения производительности модели. Подход Leaf-wise разделяет узлы дерева с наибольшей дельтой функции потерь, в то время как метод Depthwise способствует сбалансированному развитию дерева. Предоставление этих альтернативных подходов позволяет пользователям выбрать соответствующую стратегию роста в зависимости от конкретной задачи и вычислительных ограничений. Как исследователи, так и практики могут получить выгоду от преимуществ LightGBM, особенно при работе с обширными и высокоразмерными наборами данных. Версия M5 LightGBM относится к хорошо оптимизированной реализации, использующей тщательный подбор признаков для извлечения высококачественной информации из данных.

ANN. Artificial Neural Network (ANN) — это основная архитектура машинного обучения, которая моделирует сложные закономерности в данных, имитируя структуру и функцию биологических

нейронов. ANN применяются в задачах распознавания образов, обработки естественного языка и кластеризации

RNN, LSLM, GRU. Recurrent Neural Network (RNN) — это специализированная нейронная сеть, разработанная для работы с последовательными данными путем включения рекуррентных связей, что позволяет сохранять информацию на протяжении временных шагов [9].

➤ RNN достигает значительной производительности в таких задачах, как обработка естественного языка, анализ временных рядов и распознавание речи.

➤ Long Short-Term Memory (LSTM) — это продвинутая модификация RNN, которая использует механизмы гейтов для регулирования потока информации и устранения проблемы затухающего градиента, характерной для глубоких RNN. Внутренние вентили — входной, забывания и выходной — в LSTMs позволяют лучше понять долгосрочные зависимости и сложные шаблоны в последовательностях, что улучшает производительность в задачах машинного перевода и генерации текста.

➤ Gated Recurrent Unit (GRU) — еще одно расширение RNN, упрощающее архитектуру LSTM с использованием вентиля обновления и сброса для регулирования потока информации [10]. Оно предлагает сбалансированный компромисс между выразительностью LSTM и простотой стандартных RNN, достигая конкурентоспособной производительности при сниженной вычислительной сложности в таких задачах как анализ тональности и моделирование последовательностей.

Bi-RNN, Bi-LSLM, Bi-GRU. Двухнаправленные рекуррентные нейронные сети (Bi-RNN), двухнаправленные долгосрочные нейронные сети с короткой памятью (Bi-LSTM) и двухнаправленные блокирующие рекуррентные единицы (BiGRU) являются передовыми архитектурами машинного обучения, которые расширяют возможности рекуррентных нейронных сетей (RNN) путем обработки последовательных данных в направлениях вперед и назад одновременно. Захватывая зависимости от предыдущих и будущих входов одновременно, данные модели достигают превосходной производительности в задачах обработки естественного языка, распознавания речи и анализа временных рядов.

Рассмотрим двухнаправленные долгосрочные нейронные сети с короткой памятью

➤ Bi-RNN расширяют стандартные RNN с отдельным обратным слоем, который обрабатывает последовательности ввода в обратном порядке. Скрытые состояния прямого и обратного слоев объединяются на каждом временном шаге, обеспечивая комплексное представление последовательности ввода.

➤ Bi-LSTM и Bi-GRU — это варианты Bi-RNN, включающие специализированные ячейки памяти для решения проблемы затухающего градиента, часто возникающей при использовании глубоких RNN. LSTM использует механизмы управления, включая входные, забывающие и выходные вентили, для регулирования потока информации

между временными шагами, тогда как GRU упрощает этот процесс с помощью вентиля обновления и сброса. В результате Bi-LSTM и Bi-GRU предлагают улучшенную способность к обучению долгосрочных зависимостей и сложных шаблонов в последовательностях, что в конечном итоге приводит к более точным и надежным моделям для различных задач машинного обучения.

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