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ВЫСОКИХ ТЕХНОЛОГИЙ

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ԲԱՐՁՐ ՏԵԽՆՈԼՈԳԻԱՆԵՐԻ ՏԵՂԵԿԱԳԻՐ
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ANTIMICROBIAL POTENTIAL OF "KAVALGINE" CLAY BASED NOVEL PREPARATION FOR PROPHYLACTIC SKIN CARE

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Abstract

The demand for novel antimicrobial preparations is high in medicine, veterinary, agriculture, etc. However, numerous classical preparations derived from steroids, oligo-/macro- cyclic lactones, and antibiotics possess notable disadvantages: adverse effects on human health, the potential for ecological risks, etc. Moreover, the increase of antibiotic concentrations in environment escalates the multi-drug resistance problem. Therefore, the need of innovations in that scope, and particularly, the search for alternative new natural preparations is very actual.

The current paper discusses "Kavalgine" new preparation, developed using natural components: highly mineralized clay obtained during the table salt mining; propolis, laurel essential oil and other bioactive additives. Its effect was successfully tested on model strains of various opportunistic pathogens: *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Salmonella enteritidis*, and *Staphylococcus aureus*.

Keywords: highly mineralized clay sediments, propolis, antimicrobial effect, laurel essential oil, opportunistic pathogenic bacteria, skin health prophylactics.

Introduction

The development of a new, improved antimicrobial and anti-inflammatory preparation is a highly relevant topic in light of the current situation. This urgency arises due to the multiple drawbacks associated with conventional antibiotics used in medicine and other fields. Classical antibiotics often lead to various harmful side effects, reduced efficacy, allergies, and other undesirable consequences [1,2]. In this regard, the elaboration of novel safe skin care preparations and ointments, which are based on natural materials is especially important. That is one of the prospective strategies for the development of treatment preparations by the combination of inorganic mineral components from the natural sources (clays and non-clay minerals, etc.) with some organic plant and animal sourced substances of target effects, such as like propolis, plant essential oils, waxes and also fungi bioactive components, etc. [3,4].

For centuries, natural clay has been utilized as a traditional remedy for its anti-inflammatory properties. Its beneficial effects on the skin have been recognized and documented throughout history. Ancient civilizations like the Egyptians employed clay for treating wounds and addressing digestive issues [5]. The application of clay in medicinal practices extends to various traditional systems such as Ayurveda, Traditional Persian and Chinese medicine, etc. [6,7]. During the last decades, the use of clay in diverse fields of

medicine, cosmetology, and healthcare has witnessed a steady increase. Different types of clay with varying chemical compositions can be found depending on their geographical origins. These mineral-rich substances have long been employed for the treatment of skin infections, as evidenced by numerous studies conducted in recent decades [8]. Clay has the ability to bind to certain metals, including toxic heavy metals, thereby preventing their absorption by the body's organs such as the skin, stomach, and intestines [9]. French green clay, rich in Fe-smectite, is renowned for its healing properties against conditions like Buruli ulcer, a necrotizing fasciitis caused by *Mycobacterium ulcerans* [10]. Hence, clay is recognized for its anti-inflammatory capabilities. Additionally, apart from its anti-inflammatory effects, clay is known to improve digestion, enhance the immune system, and promote skin health [11, 12].

Propolis is also known for its wide application in various branches of traditional medicine in many countries. It is a resin-like substance produced by bees that has antimicrobial properties and other valuable bioactivities. Bees initially use propolis to protect their hives from pathogens. In human civilization propolis are being used for medicinal purposes for centuries. It has some antibacterial, antifungal, and antiviral properties, making it an effective natural remedy for fighting against infections [13, 14]. Propolis can be used to treat a wide range of pathological conditions, including sore throat, colds, flu, and even cancer [15]. It is also a natural source of antioxidants, which can help to protect the body from oxidative stress and inflammation. The mechanisms of its effect are defined by the interactions of phenolic and other compounds, including pinobanksin, pinocembrin, and galangin with cells. Moreover, the antibacterial activity is attributed to its active compounds, such as like the aromatic compounds, especially caffeic acid, lactones. and flavonoids. In addition, propolis has a bactericidal activity which able to inhibit the cellular division such as like to damage the cell walls of bacteria, and to suppress the protein synthesis. Pinocembrin is the component of propolis that demonstrates the antibacterial activity against some strains of Streptococcus spp. and other pathogenic bacteria [16-20]. Artepillin C, p-coumaric acid, 3-phenyl-4-hydroxycinnamoyl cinnamic acid are bale to decrease the activity of bacterial glycosyltransferase in some pathogenic bacteria, such as like Helicobacter pylori. Another one important component of propolis is apigenin. Apigenin is one of the most common flavones aglycones, a natural antioxidant with anti-inflammatory and anti-carcinogenic properties [21, 22]. Propolis also serves as a component of painkillers and preparations for the symptomatic treatment and the supporting therapy medicines of various diseases such as like: neuritis, neuralgia, osteochondrosis, radiculitis, arthropathy and other inflammatory diseases of the musculoskeletal system [23, 24]. Based on the considered literature data about the positive influence of clay and propolis on health in general, “Kavalgine” composition was elaborated in our laboratory, as a combination of highly mineralized clay, propolis and essential oil of laurel. In current paper the antimicrobial effect of “Kavalgine” ointment is studied.

Conflict Setting

Due to the decrease of efficiency of classical antibiotic therapy for the treatment of various infections the actuality of usage of alternative antimicrobials, such as like plant oils

and various natural extracts as well as inorganic salts and mineral compounds is being increased. That is why the studies of natural mineral clay sediments-based preparations are started to be more actual world around. And this is very important especially in scopes of cosmetology, dermatology and preventive prophylactic therapy. In these regards, the main purpose this research was to study the antimicrobial properties of new "Kavalgine" preparation against the range opportunistic pathogens of human, including the test-cultures of most dangerous opportunistic pathogens, such as like *Pseudomonas aeruginosa* and *Staphylococcus aureus*, which are well-known by the multi-drug resistance.

Materials and Methods

The name of preparation is coming from Armenian word “kav”, what means “the clay”. "Kavalgine" is elaborated as the combined effect ointment, consist of inorganic and organic active components of absolutely natural source. Inorganic ingredient of it is the major part and it is based on highly mineralized clay, which was obtained from the side product sediments of table salt production process (from Avan rock salt mine of RA). The initially isolated highly mineralized clay-sediments contain about 30 various micro- and macro-elements [25]. The detailed description of Cavalgine includes the following: alcohol solution of propolis, bay leaf esencial oil, clay Dimexidum in the following ration wt.%: 20% alcohol solution - 7.5-9.5; bay leaf esential oil - 0.5-2.0; Dimexidum - 7.5-9.5 and clay - the rest [26].

The organic components of “Kavalgine” are essential oil of laurel and the natural bee product propolis. Also, it contains Dimexide (dimethyl sulfoxide or DMSO) which was used as an additive to improve skin tissue permeability [27]. All these compounds are added to enhance anti-inflammatory, pain-relieving and antimicrobial target effects of the ointment.

For qualitative evaluation of antibiotic-resistance of the selected microbial strains, there were used the sterilized by autoclaving solid selective media, based on beef-extract agar with addition of 50 mcg/mL content of appropriate antibiotic. The following antibiotics were used in selective m In this research for in vitro microbiological experiments, 10 strains of human Gram-negative and Gram-positive opportunistic pathogens from the National Collection of Microorganisms of Microbial Depository Center (MDC), “Armbiotechnology” Scientific and Production Center (SPC) of the National Academy of Sciences of the Republic of Armenia (NAS RA) were used. The following bacterial strains were selected as objects for tests: *E. coli DH5α S. enteritidis 5170 K. pneumonia 5244 St. aureus 5233 P. aeruginosa 5249 P. aeruginosa 9056 S. maltophilia 9289 P. fluorescens 9134 P. putida 9235 P. geniculate 9340.* All the mentioned bacterial strains were cultivated on liquid Luria-Bertani medium (LB) and solid nutrient L-agar cultural media (1.8%-agar) due to the generally accepted methodologies, using 60 mm diameter Petri dishes [28].

edia: Pcn/Penicillin; Amp/ampicillin, Amx/amoxicillin, Amc/augmentin (representatives of aminopenicillins of β-lactam antibiotics), Cfx/cefixime, Cro/ceftriaxone (representatives of I and III generations cephalosporins of β-lactam antibiotics), Kan/kanamycin, Stp/streptomycin, Cip/ciprofloxacin (representatives of aminoglycoside antibiotics), Cam/chloramphenicol (of amphenicol antibiotics) and Azm/azithromycin (from azalides of macrolides antibiotics), produced by “Asteria”. The cultivation on appropriate

selective media was carried out by streaking technique, using 60 mm diameter Petri dishes, at 37 °C (in contribution to the optimum conditions of the studied bacterial strain), under aerobic conditions [29]. For the assessment of antimicrobial activity of "Kavalgine" ointment, two methods were used. The preliminary screening of "Kavalgine" effect was carried out by the method of mixing ointment with the cultural media inappropriate concentrations. After the solidifying of the obtained mixture, the microorganisms were cultivated on it by the stacking method. Also, for the antimicrobial effect assessment the method of wells and was applied. For that purpose, 1.8%-agar containing MPA (meat peptone agar) cultural media was poured into Petri dishes (60 mm diameter). Then the sterile glass cylinders were placed in a center of each of Petri dishes. Separately the mixtures of appropriate microbial strain overnight cultures (~108 CFU) and the molten 0.7% agar containing MPA at 37 °C, were prepared in sterile test tubes. On surface of solidified 1.8%-MPA cultivation media in each of Petri dishes, the mentioned mixture was added as the second layer, around the placed glass cylinders. After the solidifying of second layer, the glass cylinders were carefully taken off for the obtaining od wells. In each of obtained well 1.2 mg of testing ointment was added.

For each strain the experiment was carried out in two ways: with UV-sterilized (4 min upon the λ = 254 nm UV light) ointment samples and without the UV-sterilization. As a control in all the experiments, which were carried out, the sterile water and DMSO appropriate quantities were added instead the testing "Kavalgine" ointment [30, 31]. for a comparable quantification of a qualitative analyses of "Kavalgine" ointment effect on the studied microorganisms the digital analysis of results was performed by ImageJ software [32]. The statistical assessment was based on the fact that all the experiments were carries out in 5 series of 3 repeats for each probe. MS Excel was used for data analysis of "Kavalgine" antimicrobial effect evaluation. The data of growth inhibition zones are given in mm (table 1, fig. 1-2), SEM (Standard Error of the Mean) were ± 0.23-0.37. Significance was tested by applying Student t-test and estimated as p-value less than 0.05.

Research Results

The results of antimicrobial resistance tests of bacteria which were used for this research are presented in tab. 1 and fig. 1.

During all the experiments, it was noted non-significant inhibition of growth of all the tested bacterial cultures. Only in case of *K. pneumonia 5244*, after 24 hours, a thin sterile rim 6 mm wide was formed around the well, which indicates a slight antibacterial effect. After 3-4 days of experiment in *K. pneumoniae 5244* sample, the width of the sterile rim was reached 5 mm. In *P. aeruginosa 5249* and *P. aeruginosa 9056* samples, the rims were 1.5 mm and 1.2 respectively. For the rest of the samples: *E. coli DH5α, S. enteritidis, St. aureus 5233, S. maltophilia 9289, P. fluorescens 9134, P. putida 9235, P. geniculate 9340* the mean of the measured width was 1 mm.

The obtained results indicate the lower intensity of "Kavalgine" ointment antimicrobial effect on the mentioned bacteria growth. Throughout the experiment, in all the cases of unsterilized ointment, the contamination with very small colonies of an undefined contaminant microbes was observed. That indicates the absence of a significant antimicrobial

effect not only in relation to the tested cultures, but also to the contaminant. In case of sterilized ointment samples, contamination was not observed. All the control samples have demonstrated the absence of notable antimicrobial effect of DMSO on the research strains of bacteria.

Table 1

Antibiotic-resistance of human opportunistic pathogenic bacterial strains.
S – sensitivity, R – resistance; C – control, "+" – growth of strain in full surface of petri dish (d = 60 mm) on nutrient agar cultural media with addition of appropriate quantity of sterile water; antibiotics: Pcn - penicillin, Amx - amoxicillin, Amp- ampicillin, Amc - augmantine, Cfx - cefixime, Cro - ceftriaxone, Cam - chloramphenicol, Cip - ciprofloxacin, Stp - strepromycin, Kan- kanamycin

Bacterial strain	Antibiotics										C
	Pcn	Amx	Amp	Amc	Cfx	Cro	Cam	Cip	Stp	Kan	
E. coli DH5α	S	S	S	S	S	S	S	S	S	S	+
S. enteridіdis 5170	S	S	S	S	S	S	S	S	S	S	+
P. aeruginosa 5249	R	R	R	R	R	R	R	S	R	R	+
K. pneumonia 5244	R	R	R	R	R	S	R	S	S	S	+
St. aureus 5233	R	R	R	R	R	S	R	S	R	R	+
Rh. javanica 1002	R	R	R	R	R	R	R	R	R	R	+
B. thuringiensis 849	R	R	R	R	R	R	R	S	R	S	+
Br. laterosporus 200-4	S	S	S	S	R	S	S	S	S	S	+

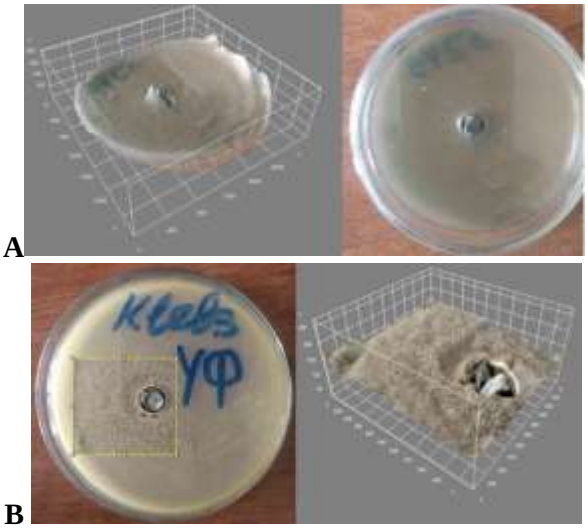

Fig. 1 Photography of "Kavalgine" antimicrobial activity observation *in vitro* and digitizing of it
A – *P. aeruginosa 5249*; B – *K. pneumonia 5244*.

According to the presented data, the majority of them are multi-drug resistant or pan-drug resistant. The results of antimicrobial activity of «Kavalgine» preparation against the ten common opportunistic pathogens of human are presented in tab. 2 and fig. 2.

During the experiments with UV sterilization and with the sterilization by UV light, it was found out that there is no differences between the collected data. Thus, the sterilization has no impact on an influence of preparation. It can be assumed that in the absence of a

pronounced antibacterial effect, the healing effect of the ointment may be caused by the effect of organic components (wax, etc.) of propolis on the skin. It is also possible to assume a regeneration-stimulating effect of clay and other mineral components on the skin. Probably, the considered ointment beneficial effect is caused by all the natural additives combined presence influence, due to their improving of antimicrobial properties of the clay basic component. Thus, the beneficial effect of «Kavalgine» ointment on the skin is probably prognosed [33].

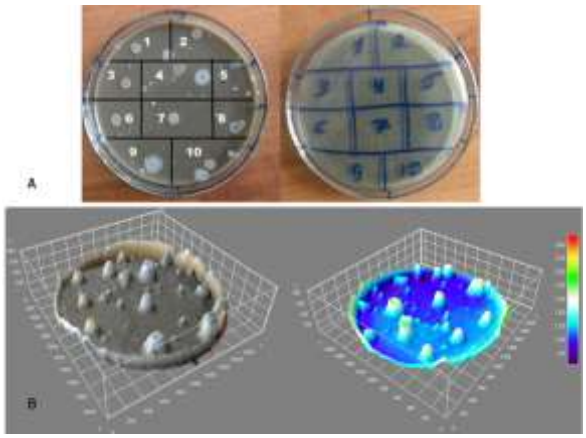

Fig. 2 «Kavalgine» antimicrobial effect on opportunistic pathogens

A. "Kavalgine" (without UV sterilization) effect on microbes: 1 – *E. coli DH5α*, 2 – *S. enteritidis 5170*, 3 – *K. pneumonia 5244*, 4 – *St. aureus 5233*, 5 – *P. aeruginosa 5249*, 6 – *P. aeruginosa 9056*, 7 – *S. maltophilia 9289*, 8 – *P. fluorescens 9134*, 9 – *P. putida 9235*, 10 – *P. geniculate 9340*; B – Results digitizing by thermal imaging.

Table 2

Antimicrobial activity of "Kavalgine" against the opportunistic pathogens

"+" – the presence of growth and the absence of antimicrobial effect on all the diameter of Petri dish (d = 60 mm); "C+" – Positive control on nutrient agar cultural media without any antimicrobial compound; C_{water} – control with sterile water; C_{DMSO} – control with sterile DMSO.

Bacterial Strain	Effect of "Kavalgine" without UV sterilization	C+	C_{water}	C_{DMSO}
E. coli DH5α	1 mm	+	+	+
S. enteritidis 5170	1 mm	+	+	+
K. pneumonia 5244	5 mm	+	+	+
St. aureus 5233,	1 mm	+	+	+
P. aeruginosa 5249	1.5 mm	+	+	+
S. maltophilia 9289	1 mm	+	+	+
P. fluorescens 9134	1 mm	+	+	+
P. putida 9235	1 mm	+	+	+
P. geniculate 9340	1 mm	+	+	+
P. geniculate 9056	1.2 mm	+	+	+

For the comparison of propolis and its mixture in consistence of "Kavalgine" preparation, the activity of it was separately tested upon the same conditions by the same methods which were mentioned above on same ten bacterial strains. In case of application of well method, to propolis on the first day, a sterile rim with 1 mm wide was formed around the well on samples of *K. pneumonia 5244.* After 48 hours of experiment, in the samples of *St.*

aureus 5233 1 mm wide rim was formed. In sample of *K. pneumonia 5244* the rim was enlarged up to 1.5 mm. In case of usage of method of adding the propolis in cultural media, only in case of UV-sterilized samples the growth suppression of *K. pneumonia 5244* (after 24 hours of experiment) and *S. maltophilia 9289* (after 48 hours of experiment) were noted. According to the literature data propolis containing preparations have a positive effect on wound and sport trauma healing [34, 35].

Therefore, based on the obtained results, «Kavalgine» new preparation might be also recommended as a preparation for increasing of wound healing processes intensity, especially for usage in sport medicine.

Conclusion

The elaborated «Kavalgine» preparation, which is originally based on mineral-reach clay sediments and the bee product propolis have demonstrated not so emphasized antimicrobial activity. The maximal effect was noted for strains *K. pneumonia 5244, S. maltophilia 9289, P. aeruginosa 9056, P. aeruginosa 5249, St. aureus 5233.* The experiments with propolis have demonstrated the similar results. In general, the use of clay and propolis as a natural anti-inflammatory treatment for overcoming antimicrobial resistance against pathogens offers a safe and effective alternative to conventional medicine.

These natural remedies have been used for centuries and have been shown to have a wide range of therapeutic properties. By incorporating clay and propolis into your daily routine, you can help to reduce inflammation, boost your immune system, and promote overall health and wellness. Probably, the main target of “Kavalgine” effect is cellular growth of host-organism and the signification of general immune status of it.

Probably, the considered ointment beneficial effect is caused by all the natural additives combined presence influence, due to their improving of antimicrobial properties of the clay basic component. Thus, «Kavalgine» new anti-inflammatory preparation is recommended for further in vivo experiments and the clinical research for deeper understanding the mechanisms of its effect, which were demonstrated during the *in vivo* experiments.

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ՄԱՇԿԻ ԿԱՆԽԱՐԳԵԼԻՉ ԽՆԱՄՔԻ ՀԱՄԱՐ «ԿԱՎԱԼԳԻՆ» ԿԱՎԱՅԻՆ ՀԵՆՔՈՎ ՆՈՐ ՊԱՏՐԱՍՏՈՒԿԻ ՀԱԿԱՄԱՆՐԷԱՅԻՆ ՆԵՐՈՒԺԸ

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Նոր հակամանրէային պատրաստուկների պահանջարկը մեծ է բժշկության, անասնաբուժության, գյուղատնտեսության և այլ ոլորտներում: Այնուամենայնիվ, ստերոիդներից, օլիգո-/մակրո-ցիկլիկ լակտոններից և հակաբիոտիկներից ստացված բազմաթիվ դասական պատրաստուկներ ունեն զգալի թերություններ. բացասական ազդեցություն մարդու առողջության վրա, էկոլոգիական ռիսկեր և այլն: Ավելին, հակաբիոտիկների կոնցենտրացիաների աճը շրջակա միջավայրում սրում է բազմակայունության հիմնախնդիրը: Ուստի այս ոլորտում նորարարությունների անհրաժեշտությունը և մասնավորապես այլընտրանքային նոր բնական պատրաստուկների որոնումը շատ արդիական է:

Հոդվածում քննարկվում է բնական բաղադրիչներ՝ կերակրի աղի արտադրության ընթացքում անջատված բարձր հանքայնացված կավի, պրոպոլիսի, դափնու եթերայուղի և այլ կենսաակտիվ հավելումների կիրառմամբ մշակված «Կավալգին» նոր

պատրաստուկը: Դրա ազդեցությունը հաջողությամբ փորձարկվել է տարբեր պայմանական պաթոգենների մոդելային շտամների վրա: *K. pneumonia, P.aeruginosa, S. enteritidis* և *S. aureus*:

Բանալի բառեր. բարձր հանքայնացված կավե նստվածք, պրոպոլիս, հակամանրէային ազդեցություն, դափնու եթերայուղ, պայմանական պաթոգեն բակտերիաներ, մաշկի առողջության պրոֆիլակտիկա:

АНТИМИКРОБНЫЙ ПОТЕНЦИАЛ НОВОГО ПРЕПАРАТА НА ОСНОВЕ ГЛИНЫ «КАВАЛГИН» ДЛЯ ПРОФИЛАКТИЧЕСКОГО УХОДА ЗА КОЖЕЙ

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Спрос на новые антимикробные препараты высок в медицине, ветеринарии, сельском хозяйстве и др. Однако многие классические препараты на основе стероидов, олиго-/макроциклических лактонов и антибиотиков имеют ряд недостатков: негативные для здоровья последствия, потенциальные экологические риски и т.д. Более того, увеличение концентрации антибиотиков в окружающей среде усугубляет проблему мультирезистентности. Поэтому потребность в инновациях в этой области и в частности, поиск альтернативных новых натуральных препаратов весьма актуальны.

В данной статье рассматривается новый препарат «Кавалгин», разработанный с использованием натуральных компонентов: высокоминерализованной глины, полученной при добыче поваренной соли, прополиса, эфирного масла лавра и др. биоактивных добавок. Его действие было успешно протестировано на модельных штаммах разных условных патогенов: *K. pneumonia, P. aeruginosa, S. enteritidis* и *S. aureus.*

Ключевые слова: высоко-минерализированные осадки глины, прополис, антимикробный эффект, масло лавра, условно-патогенные бактерии, профилактика здоровья кожи

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EXTRACELLULAR EXPRESSION OF THE ALPHA-AMYLASE GENE FROM BACILLUS AMYLOLIQUEFACIENS MDC1974 STRAIN USING BACILLUS SUBTILIS RIK1285 CELLS

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Abstract

The alpha-amylase gene from *Bacillus amyloliquefaciens* MDC1974 strain was molecularly cloned into the *E. coli*/*B. subtilis* pBE-S shuttle vector and subsequently expressed extracellularly by the recipient strain *Bacillus subtilis* RIK1285, which exhibited low protease activity. As a result of optimizing fermentation conditions, a secretion of alpha-amylase with an activity of 1400 units per mL was achieved.

Keywords: *Bacillus amyloliquefaciens, α-amylase, extracellular expression, E. coli/B. subtilis shuttle vector*

Introduction

α -Amylases (E.C. 3.2.1.1.) are starch-degrading enzymes that hydrolyze the internal α -1,4-O-glycosidic bonds of polysaccharides preserving the α -anomeric configuration of the products. Most α -amylases are metalloenzymes that require calcium (Ca^{2+}) ions for their activity, structural integrity, and stability. They belong to the glycoside hydrolase enzyme family 13 (GH-13) based on amino acid sequence similarity [1]. Amylases are one of the most important industrial enzymes, which are widely used from the conversion of starch into sugar syrups to the production of cyclodextran for the pharmaceutical industry. They account for 30% of the world production of enzymes [2].

The α-amylase GH-13 family is classified within the GH-H clan of glycoside hydrolases, which also encompasses the GH-70 and GH-77 families. This clan constitutes the largest family of transferases and isomerases, represented by more than 30 different enzyme

forms [3-5]. These enzymes include endoamylases, exoamylases, debranching enzymes, and transferases [5].

In numerous studies, conservative sites of the primary structure of α-amylases, as well as their domain and spatial structures, and catalytic mechanisms, have been extensively investigated [6].

T.M. Soghomonyan

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α-Amylases are ubiquitous enzymes produced by plants, animals, and microbes, where they play a significant role in carbohydrate metabolism. Amylases derived from plants and microbes have been utilized as food additives for centuries. For instance, barley amylases are crucial in beer production, while fungal amylases are commonly employed in various food processing applications. Despite their wide distribution, microbial-origin amylases, particularly from bacteria and fungi (such as *B. subtilis*, *B. stearothermophilus*, *B. licheniformis*, and *B. amyloliquefaciens*), are predominantly used in industry due to their cost-effectiveness, ease of production, and adaptability to modification and optimization of the production processes [4, 7-8].

In the application processes of α-amylases, determining the optimal temperature and pH for their activity, as well as assessing their heat stability, are crucial factors. Based on these parameters, the search for and characterization of new α-amylases represent ongoing biotechnological challenges [4, 9-10].

The impact of Ca^{2+}, Mg^{2+}, Mn^{2+}, Zn^{2+}, Fe^{2+}, and other metal ions on the activity of α-amylases has been investigated in numerous studies [4, 8].

The substrate specificities of amylases for soluble starch, amylose, amylopectin, glycogen, maltodextrin, cyclodextrins, and other substrates have been investigated in many modern studies [11-12]. The quest for new α-amylases capable of hydrolyzing raw starch (in technologies utilizing them, the energy-intensive stage of starch gelatinization is bypassed) is one of the pressing issues in modern biotechnology [13-15].

Conflict Setting

The demand for α-amylases with diverse physiological and biochemical characteristics across different industries drives the purposeful search for enzymes with novel attributes using recombinant technologies [16-19] and enzyme engineering [20-21]. For instance, through point mutagenesis involving the deletion of amino acids arginine 179 and glycine 180 of the α-amylase from *B. stearothermophilus*, a recombinant enzyme with enhanced properties (such as increased heat resistance, capacity to function at low pH, and reduced calcium dependency) was successfully generated and characterized [22]. Furthermore, by optimizing the signal peptide of the α-amylase from *B. stearothermophilus* and enhancing the expression of the corresponding chaperone, it became feasible to achieve the overexpression of the secreted enzyme (at a level of 9200 units/ml) [23].

Therefore, the acquisition and characterization of recombinant alpha-amylase-producing strains and enzyme variants with novel, enhanced attributes are currently significant issues. These enzymes find widespread use in the processing of starch-containing raw materials, and ongoing efforts in this direction are essential to meet the demands of biotechnological industries.

The objective of this study is to molecularly clone the α-amylase gene of the *B. amyloliquefaciens* MDC1974 strain into the *E. coli*/*B. subtilis* pBE-S shuttle vector, express the recombinant enzyme extracellularly, and characterize it. Previously, our working group has achieved some success in researching this enzyme. Specifically, we were able to amplify the amylase gene from the complete bacterial genome (selected based on the analogy of the 16S ribosomal RNA gene of both our and host strains) and characterize the corresponding enzyme [24]. Additionally, a phylogenetic analysis of the *B. amyloliquefaciens* MDC1974

strain was conducted based on the 16S ribosomal gene sequence, and the enzyme was further characterized in detail [25].

Materials and Methods

The source of the α-amylase gene used in this study was B. amyloliquefaciens MDC1974 strain, which was provided by the microbial depository center of SPC "Armbiotechnology". The B. subtilis RIK 1285 strain, known for its low protease activity, was utilized as the host for expression vector. The E. coli Top10 strain from Invitrogen was employed for the initial transformation and propagation of the expression vector. The pBE-S shuttle vector from Takara Bio served as the vector for cloning and extracellular expression of the recombinant α-amylase gene.

Bacterial strains were stored either on meat peptone broth agar plates at 4°C or in meat peptone broth supplemented with 50% (v/v) glycerol at -45°C. *E. coli* or *Bacillus* strains were cultured on a Sanyo rotary shaker at 150 rpm, maintained at 37°C for *E. coli* and 33°C for *Bacillus*, respectively, in Luria-Bertani (LB) medium (composed of 1% peptone, 0.5% yeast extract, and 0.5% NaCl). When necessary, LB medium was supplemented with ampicillin at 100 μg/ml for *E. coli* or kanamycin at 10 μg/ml for *B. subtilis*. Overnight bacterial cultures were also grown in LB medium for DNA isolation purposes.

DNA from the *B. amyloliquefaciens* strain MDC1974 was purified using the Monarch Genomic DNA Purification Kit following the manufacturer's instructions. For the Gibson assembly method, the following primer pairs were utilized to clone variants of the target alpha-amylase gene, with and without the signal peptide, into the shuttle pBE-S vector:

For the variant with the signal peptide:

- Forward primer: amy1974_pBE-S_NdeI_F GCCGGTGCACATatgattcaaaaacgaaagcggacag
- Reverse primer: amy1974_pBE-S_XbaI_R ATGGTGATGTCTAGAttatttctgaacataaatggagacggacc

For the variant without the signal peptide:

- Forward primer: amy1974_pBE-S_NdeI_sig_F GCCGGTGCACATATGgtaaatggcacgctgatgcagta
- Reverse primer: amy1974_pBE-S_XbaI_R ATGGTGATGTCTAGAttatttctgaacataaatggagacggacc

PCR amplification of the alpha-amylase gene was conducted under the following conditions: Initial denaturation: 95°C for 2 min; Cycling: 30 cycles of denaturation at 95°C for 30 sec, annealing at 57°C for 30 sec, extension at 72°C for 2 min; Final extension: 72°C for 5 min.

DNA electrophoresis was conducted using a 0.8% agarose gel (Agarose I™, VWR® tablets) in 40 mM Tris-Acetate-EDTA buffer, pH 8.0, with the gel run at 100 volts for 35 minutes. DNA bands were visualized using "Millipore" GelRed® nucleic acid stain. NEB's TriDye™ 1 kb Plus DNA ladder was employed as a reference for agarose gel sizing.

Cloning was conducted using the Gibson ligation method [26]. Initially, the pBE-S vector was double-digested with NdeI and XhoI restriction enzymes following the manufacturer's instructions provided by NEB (New England Biolabs). In the subsequent step, cells of *E. coli* Top 10 were transformed using the heat shock method with pBE-S_amy1974sig and pBE-S_amy1974 vectors synthesized (directly from the cloning reaction mixtures). Transformed colonies were selected from colonies growing on ampicillin in LB medium using the colony PCR method. Plasmids were isolated using the QIAprep Spin

Miniprep kit from QIAGEN following the manufacturer's instructions and stored at -20°C until further use. (Link to the QIAprep Spin Miniprep kit: https://www.qiagen.com/us/products/discovery-and-translational-research/dna-rna-purification/dna-purification/plasmid-dna/qiaprep-spin-miniprep-kit)

B. subtilis RIK 1285 strain cells were transformed using the obtained pBE-S_amy1974sig and pBE-S_amy1974 vectors, resulting in the generation of B. subtilis RIK 1285_amy1974sig and B. subtilis RIK 1285_amy1974 strains. Transformations were conducted following the manufacturer's instructions (https://www.takarabio.com/documents/User%20Manual/3380/3380_UM.pdf) provided by "Takara Bio," with certain modifications. The method involves inducing bacterial cells to enter the stage of sporulation through starvation, which coincides with the stage of competence for cell transformation [27].

The selection of fermentation media for recombinant amylase strains was made from 5 fermentation media with the same synthetic composition but different organic nitrogen sources. The synthetic composition of the environments had the following percentage composition: glucose: 1, starch: 1, $(NH_4)_2SO_4$: 0.3, NH_4Cl: 0.2, KH_2PO_4: 0.5, $MgSO_4$: 0.025. The media also contained 40 mg/l of L-lysine and L-tryptophan and 10 mg/l of kanamycin. In addition to the above composition, the T1 medium contained 1% peptone and corn extract each, T5 medium - 1% peptone and yeast extract, T6 medium - 1% tryptone and yeast extract, T7 medium - 1% soybean meal and yeast extract, and T8 medium contained 2 percent yeast autolysate. In the experiments studying the effect of the presence of own signal peptide and the intensity of aeration on amylase output, T9 medium was used, which differed from T8 in that glucose was replaced by sucrose (in order to avoid possible catabolic repression). And in experiments studying the effect of kanamycin on amylase output, T9 medium without starch was used. An overnight culture was grown in LB medium at 33°C on a rotary shaker (140 rpm). The overnight culture (seed material) was introduced into the fermentation medium in a volume of 5%. The fermentation was provided in cotton-stoppered 500 mL wide-mouthed flat-bottomed flasks containing 20 mL each of growth medium (33°C, 220 rpm).

Enzyme activity secreted in the culture fluid was determined by estimating the number of reducing groups formed during starch hydrolysis using Sumner's 3,5-dinitrosalicylic acid (DNS) reagent method [28] with Miller's modification [29]. The reaction medium in the final volume (0.2 mL) contained 1% (w/v) starch, 50 mM acetate buffer at pH 6.0, 1 mM $CaCl_2$, and the required amount of enzyme preparation. After 10 minutes of incubation at 55°C, 1 mL of DNS reagent was added, followed by 15 minutes of incubation in a boiling water bath. Subsequently, 1 mL of 20% Segnet salt solution (sodium-potassium tartaric acid salt) was added. The optical absorption of the solutions was measured at a wavelength of 546 nm.

One unit of enzyme activity was defined as the amount of enzyme that catalyzed the formation of 1 μmol of reducing groups in one minute under the specified conditions. The amount of protein was estimated using the method of Groves and Davis [30].

Research Results

The pBE-S shuttle vector utilized in this study is depicted in Fig. 1a. It encompasses the kanamycin and ampicillin resistance sites, the ColE1 and pUB origins, as well as the aprE promoter and signal peptide of the subtilisin protease.

The results of the amplification of the amy1974sig and amy1974 variants of the α-amylase gene of *B. amyloliquefaciens* MDC1974 strain are depicted in Fig. 1b. The process of cloning the amy1974 version of the same gene is illustrated in Figure 1c. Cloning of target genes into

the shuttle vector was accomplished using Gibson's assembly method. For this purpose, the quantities of the linearized vector and the amplified gene introduced into the reaction mixture were calculated: 0.03 and 0.06 picomoles per 10 µl of the reaction mixture. An alpha-amylase gene cloning reaction was then conducted using NEBuilder® HiFi DNA Assembly Master Mix at 50°C according to the manufacturer's instructions provided by NEB. The manufacturer's recommended 15-minute incubation was extended to 40 minutes. As a result, pBE-S_amy1974sig and pBE-S_amy1974 vectors with and without the signal site, respectively, were obtained.

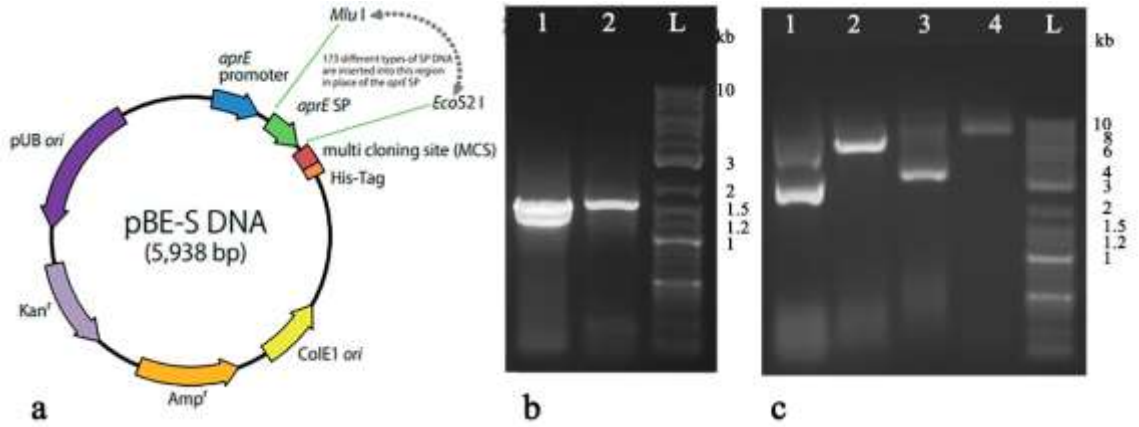

Fig. 1 Molecular cloning process of α-amylase gene of *B. amyloliquefaciens* MDC1974 strain.

(a) - Structural diagram of pBE-S vector. (b) - Flowchart for amy1974 (1) and amy1974sig (2) gene amplification. (c) - Flowchart for amy1974 gene cloning: (1) - pBE-S vector, (2) - pBE-S vector cut with XbaI restrictase, (3) - pBE-S_amy1974 vector, (4) - pBE-S_amy1974 vector cut with XbaI restrictase. In images (b) and (c), DNA ladders are represented by (L).

Transformation of *E. coli* Top 10 cells was employed to select, propagate, and obtain working quantities of the constructed targeting vectors. Transformed colonies were selected from colonies growing on ampicillin in LB medium using the colony PCR method. The transformation efficiency, defined as the total number of colonies per microgram of vector, was found to be 1.5x10^7 and 2.1x10^7 for pBE-S_amy1974sig and pBE-S_amy1974 vectors, respectively.

To obtain an alpha-amylase-secreting strain-producer, *B. subtilis* RIK 1285 strain cells were transformed with pBE-S_amy1974sig and pBE-S_amy1974 vectors propagated in *E. coli* cells. Given that the *B. subtilis* RIK 1285 strain has auxotrophy towards lysine and tryptophan amino acids, the casamino acids recommended by Takara Bio were replaced by L-lysine and L-tryptophan at 40 mg/L each during the stage of obtaining competent cells of that strain.

According to the method, circular plasmid is added to the competent cells and slowly shaken for 90 minutes on a rotary pendulum. Many experiments conducted by us have indicated that transformation occurs only after shaking for 90 minutes and leaving it in static conditions for another 60 minutes. Under these conditions, the efficiency of natural

transformation of the competent strain with pBE-S_amy1974sig and pBE-S_amy1974 vectors was 2.5x10^2 and 2.1x10^2, respectively.

Active transformants carrying pBE-S_amy1974 vectors lacking their own signal peptide gene were utilized to select the composition of the fermentation medium. The media utilized had a constant inorganic salt composition, including the carbon/nitrogen ratio, and contained different sources of organic nitrogen at the same 2% concentration. Considering that the target amylase gene is regulated by the subtilisin protease expression system (the inducibility of this system has no available information), isolated sources of peptides were tested in the study.

The obtained results are depicted in Fig. 2a. It is evident from the figure that T7 and T8 environments provide significantly higher enzyme activity compared to other environments. The volumetric activity of amylase in T8 medium at 48 hours reaches an absolute value of 740 units/ml.

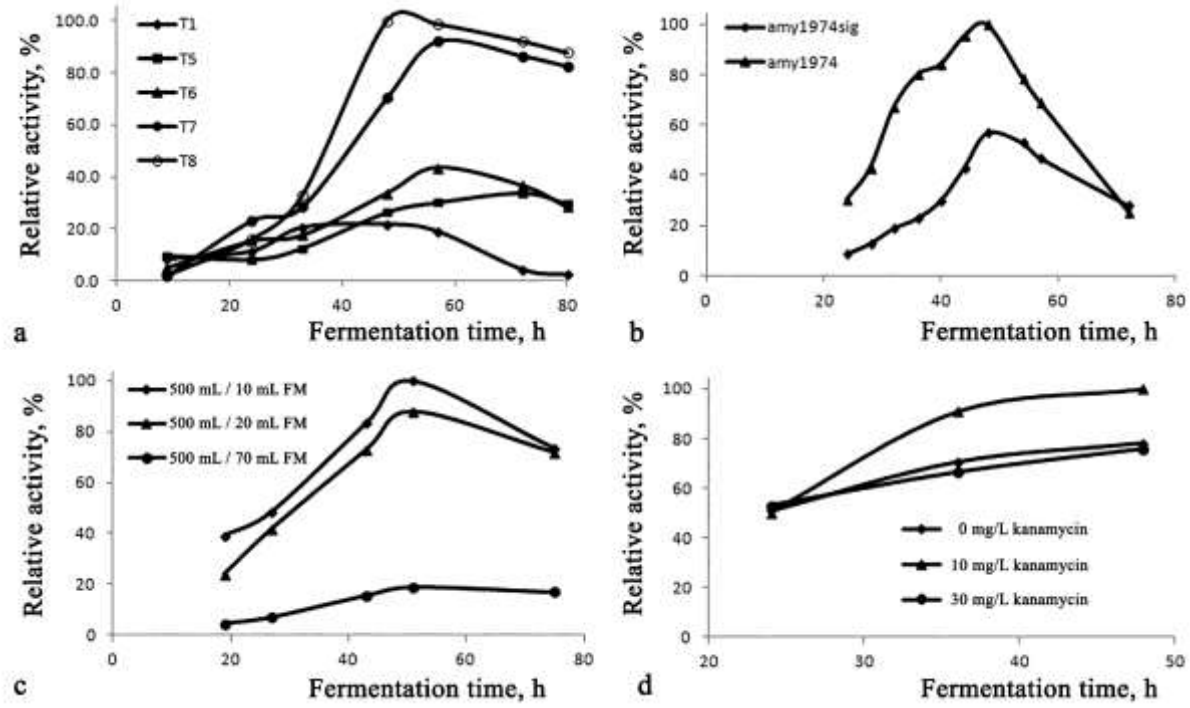

Fig. 2 Dependence of α-amylase expression of *B. amyloliquefaciens* MDC1974 strain.

(a) – on the nature of the nitrogen source of the fermentation medium, (b) – on the presence of its own signal peptide in the cloned gene, (c) – on the intensity of aeration of the fermentation medium and (d) - on the concentration of kanamycin in the medium.

(a) – 100% activity corresponds to Amy1974 volumetric activity of 740 units/ml, (b) – 100% activity corresponds to Amy1974 volumetric activity of 1100 units/ml, (c) – 100% activity corresponds to Amy1974 volumetric activity of 1300 units/ml, (FM: fermentation medium) (d) – 100% activity corresponds to a volumetric activity of Amy1974 of 1410 units/ml.

Additionally, it can be observed from the results that in all investigated environments, the maximum enzyme activity is observed near the 48th hour, gradually decreasing later.

Furthermore, it is evident from Fig. 2a that, under other equivalent conditions, the tryptone-based medium (containing relatively larger peptides) has an advantage over the peptone-based medium. In the subsequent parts of the study, the T8 medium based on yeast autolyzate, which provides maximum expression of the enzyme, was selected as the basis.

Fig. 2b illustrates the expression of amylase depending on the presence of its own signal peptide in the cloned gene. The results obtained demonstrate that in the presence of the own signal peptide (where signal peptides from the vector and the amylase gene are simultaneously present in the amplified gene), the expression of the enzyme decreases by about two times. This decrease could be attributed either to the complexity of processing two different signal peptides in the same secretion system, or to the activation of different secretion systems by the host organism for different enzymes.

Fig. 2c illustrates the dependence of alpha-amylase expression on aeration intensity. The obtained results indicate that the intensity of aeration substantially enhances the expression of recombinant alpha-amylase of B. amyloliquefaciens MDC1974 strain, reaching 1300 units/ml at the 51st hour in the case of 10 ml fermentation medium in a 500 ml flask.

Fig. 2d depicts the dependence of alpha-amylase expression on kanamycin concentration. In the presence of 10 mg/L kanamycin in the medium, 1410 units/ml of amylase activity is observed at 48 hours. In the absence of kanamycin and with 30 mg/L kanamycin, more than 75% of this activity is maintained, indicating the high segregation and structural stability of the pBE-S vector-based expression system, as evidenced by Takara Bio.

Conclusion

Through cloning by Gibson's assambly method, a stable and high-activity secretory alpha-amylase strain-producer of *B. amyloliquefaciens* MDC1974 strain was successfully obtained utilizing the pBE-S vector from "Takara Bio", with some characteristics of the enzyme synthesis studied. Moving forward, the plan involves introducing the 173 signal peptides from "Takara Bio" into the resulting system and obtaining multiple more active strains of amylase through the selection of active variants.

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BACILLUS AMYLOLIQUEFACIENS MDC1974 ՇՏԱՄԻ ԱԼՖԱ-ԱՄԻԼԱԶԻ ԳԵՆԻ ԱՐՏԱԲՋՋԱՅԻՆ ԷՔՍՊՐԵՍՈՒՄ *BACILLUS SUBTILIS* RIK1285 ԲՋԻՋՆԵՐԻՑ

Տ.Մ. Սողոմոնյան
ՀՀ ԳԱԱ «Հայկենսատեխնոլոգիա» գիտաարտադրական կենտրոն

Bacillus amyloliquefaciens MDC1974 շտամի ալֆա-ամիլազային գենը մոլեկուլային մակարդակում կլոնավորվել է *E. coli*/*B. subtilis* pBE-S մաքոքային վեկտորում և արտաբջջային ձևով էքսպրեսվել ցածր պրոտեազային ակտիվությամբ *Bacillus subtilis* RIK1285 ռեցիպիենտ շտամից: Ֆերմենտման պայմանների օպտիմալացման արդյունքում ստացվել է արտազատվող ալֆա-ամիլազի 1400 միավոր/մլ ակտիվություն։

Բանալի բառեր. *Bacillus amyloliquefaciens,* α-ամիլազ, էքսպրեսում արտազատմամբ, *E. coli*/*B. subtilis* մաքոքային վեկտոր

ВНЕКЛЕТОЧНАЯ ЭКСПРЕССИЯ ГЕНА АЛЬФА-АМИЛАЗЫ ИЗ ШТАММА BACILLUS AMYLOLIQUEFACIENS MDC1974 С ИСПОЛЬЗОВАНИЕМ КЛЕТОК BACILLUS SUBTILIS RIK1285

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Ген альфа-амилазы штамма *Bacillus amyloliquefaciens* MDC1974 был клонирован на молекулярном уровне в *E. coli*/*B. subtilis* pBE-S челночный вектор и экспрессован внеклеточно из штамма-реципиента *Bacillus subtilis* RIK1285 с низкой протеазной активностью. В результате оптимизации условий ферментации была достигнута секреция альфа-амилазы с активностью 1400 ед./мл.

Ключевые слова: *Bacillus amyloliquefaciens*, α- амилаза , экспрессия с секрецией, *E. coli*/*B. subtilis* челночный вектор

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TRANSITION FROM SOCIALISM TO A MARKET ECONOMY: ASSESSMENT OF ECONOMIC CONSEQUENCES IN THE REPUBLIC OF ARMENIA

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Abstract

The main geopolitical and regional phenomenon of the early 90s of the 20th century and the first two decades of the 21st century was the transition from the socialist system (socialism) to free market relations. The transition from socialism to free market relations (capitalism) in about 30 countries of the world was carried out in conditions of greater uncertainty, as a result of which several countries made this transition quite quickly and with

small socio-economic costs, and some countries went through a rather difficult path, paying for it high economic and social cost. In these countries, the situation in the labor market was especially difficult, which was accompanied by a high degree of social vulnerability and poverty of the population. The article examines the experience of the Republic of Armenia in the transition from socialist to free market relations, the authors compare the growth rates of the two most important macroeconomic indicators of the long socialist period with the corresponding macroeconomic indicators of the period of independence of the republic.

Keywords: gross public product, national income, GDP, net national income, economic policy, absolute growth rate, average annual growth rate.

Introduction

The transition from the socialist economic system to the market system, as evidenced by the experience of the former socialist (communist) countries, significant economic, social, and political changes, and the "cost" associated with this transition can vary from both internal and external factors and circumstances. The starting point of the transition economy, the pace of the transition and society's readiness to ensure this transition, the collective will of the people to make political and legal decisions supporting it, the speed and intensity of implementing reforms for the transition to new relations, the methods and means of external support, etc., are important for this process.

This transition has some regularities, the main ones being:

- Economic disturbances. The transition from a centrally planned economy to a market economy can lead to short-term economic disruptions. State enterprises need to be privatized or restructured, which may lead to job losses and low efficiency in the short term;
- New infrastructures and establishment of institutions. Building the necessary infrastructure and institutions to support a market economy, such as financial markets, legal frameworks, regulatory bodies, and protection of property rights, may require substantial investment;
- Social security networks. The introduction of social safety nets to vulnerable groups, such as the unemployed or people living in poverty, is necessary to mitigate the impact of the transition and social tensions and to ensure social stability during the transition period
- Education and training. Investment in education and training programs to equip the workforce with the skills needed for a market economy can be critical to long-term success, but may require upfront investment.

Overall, while the transition from socialism to market relations may entail significant costs and challenges, successful reforms can lead to long-term economic growth, increased economic efficiency, and improved living standards. The specific costs and benefits of transition will depend on the unique circumstances and choices of each country in the process.

Observing the new concept of the state, Nobel laureate in economics J. Tirole notes that the choice of socio-economic formation is not the choice between the state and the market, as both supporters of state intervention in the economy and its opponents often try to

present. The state and the market are complementary to each other, not mutually exclusive. The market needs regulation, government, competition, and incentives.

The state no longer provides large-scale jobs in the public sector, as it was before, and is not engaged in the production of goods and services through state-owned enterprises. The state has been transformed, first of all, into a regulator, whose new role is to define the rules of the game, and the state's intervention is necessary to overcome market collapses, not to replace market forces. The state takes responsibility where the market is insufficient: the state ensures healthy competition, regulates the activities of monopolies, controls the financial system, defines responsibility for environmental protection, protects people from health threats and risks of accidents, ensures real equality of opportunities, redistributes income through taxation [1].

Specialists studying economic reforms based on the example of transitional economies (including the Republic of Armenia) note that the ideal model of the economic structure for solving various problems of the society provides for the use of levers of state regulation, which is carried out through several functions. Apart from the imperative of solving the primary economic problems of the state (legal provision, protection of competition, production of public goods, stabilization of the macroeconomic situation), the state today directly manages the shares considered state property or commercial organizations considered fully state property.

In all countries where a planned economy previously existed and which are currently proceeding with the construction of market relations, the selection of the regulatory toolkit is more complicated, as it is necessary to choose the most effective means for the given reality from the range of existing levers.

Economic levers are important tools in the implementation of economic policy in any country [2].

The study of the theoretical achievements of Soviet economics and its contribution to mainstream economics has been widely discussed by economists to understand the application of the laws and patterns of economics in various societies. D. Rodrik, in particular, notes that economic principles (adequate leverage, property rights, sound monetary system, non-deficit budget) are universally valid, but due to differences in the institutional environment of different countries, their impact on economic policy is different in different periods. Therefore, different policies implemented in different countries can be composed (combined) of the same set of economic principles. Here, the idea of the universal application of the principles of the basic teaching of economics and the idea that the types of policies applied can differ significantly according to countries and periods are very successfully substantiated. D. Rodrik emphasized how unacceptable it is, based on economic principles, to draw similar conclusions about economic policies without taking into account the institutional conditions and level of development of countries, which can decisively determine the success or failure of a specific policy.

One of the first areas of Soviet experience in economic analysis was growth statistics. In particular, both economists and the US government considered the officially published statistical data to be too high, which was the reason for a deeper study of the issue and

recalculation of the growth indicators. That work was started by K. Clark and continued by A. Bergson and his students, among whom were also specialists of the US Central Intelligence Service. The main task of the researchers was to develop data on the evaluation of the economic growth of the USSR, which would be more reliable than those officially published. The results of this research made a significant contribution not only to the economic history of the USSR but also to the basic teaching of economics. In particular, it was revealed that when calculating economic growth rates, differences can be observed between the Paasche and Laspeyres indices.

In addition, researchers looked at the role of institutions in determining the rate of economic growth. Although foreign economists long ago studied the role of institutions in individual markets (monopoly) and on price formation and production volumes in those markets, the role of national institutions and their impact on macroeconomic growth rates were not emphasized. The work of A. Bergson and others, which emphasized the role of national institutions in ensuring growth rates, later became one of the most important parts of economic theory.

The study of such problems of Soviet economic policy as economic administration, economics of property rights, economics of the informal sector, and economics of "famine" also contributed to enriching the theory of modern economics with these solutions.

In general, Soviet economics was not only an anthropological study of developing economies, dealing with countries on the "periphery" of the world economic system, but these studies made a significant contribution to the theory of economics. Due to the study of the economies of the Soviet countries and based on the experience of transition economies, the debate about the universal applicability of economic laws developed. In particular, it was shown that in many cases (for example, in the case of indirect taxation, the rule of inverse elasticity) there are types of economically efficient policies that are acceptable to all. In other cases, the types of economically effective policies can vary dramatically across countries and over time, depending on the institutional environment [3].

Market relations are characterized as relations of a special type of economic organization when there are no intermediate managers, planners, or other administrative institutions between producers and consumers, which are called to regulate the activities of producers and consumers. The direct opposite of the market is the authoritarian system. It is applied between the producers and the consumers themselves, dictates its terms to them, and directs their activities with the help of administrative instructions and directives. These orders, in the form of centralized product release plans, directly concern producers, who in turn determine consumer behavior.

If in the conditions of the market economy, certain rules and regulations are established automatically, without "outside" intervention, then the authoritarian economy seeks to impose a strict order from above, thereby eliminating competition between producers and consumers. Although competition leads to some undesirable phenomena, it is nevertheless a sufficiently effective means of stimulation for increasing personal initiative, entrepreneurship, and public work productivity. In any case, the market economy based on competition has proven its advantages compared to alternative ways of organizing the public

economy [4].

Currently, there are more than 200 states in the world, which differ from each other in many features. And in the panorama of these differences, those states, whose economies and state management systems were more effective, were more successful. Especially nowadays, in increasing the longevity of the state and the well-being of the population, when the globalization and economic integration of the world economy deepens and develops, more than ever, the role and importance of both individual states and their economic and political unions increases. In other words, the viability and efficiency of the modern state are based on the development and implementation of both short-term and strategic plans and policies of the country's economic policy [5].

Many new books have been and will be written on the state, its functions, and especially on economic policy [6,7,8,9,10].

Ricardo Hausmann, Director of the Center for International Development, Kennedy School of Government, Harvard University: The article “Economic Development and the Accumulation of Know-how” states that economic development depends on the accumulation of knowledge. In the course of economic development, societies gain the ability to produce more and more complex goods. This means that the other side of the coin of individual specialization is the fact that production requires teamwork and cooperation between more and more people. Economic growth theory has long emphasized the importance of something called technical progress, but what it is and how it grows is not well understood. Technical progress is based on three separate aspects: tools, or embodied knowledge, recipes, or blueprints, or codified knowledge, and know-how, or “tacit” knowledge. Transferring “tacit” knowledge, or know-how, is more difficult and generally takes longer than transferring “objective” knowledge. Such know-how can only grow at the societal level with increasing specialization of individuals. Individuals have a limited capacity to acquire knowledge and skills because life is limited and learning takes time. As knowledge and know-how expand, each individual must have a smaller and smaller share of the total knowledge [11].

Tom Palmer, Deputy Director of the Cato Institute, "The Morality of Capitalism. In the foreword of the Armenian translation of the book "What Your Professors Won't Tell You About", he stated: "Like capitalism, socialism was based on motives, but instead of positive motives that motivate people to create value through peaceful cooperation, socialism's motives created a broken, inefficient, deficit-inharmonious, greedy, mutual-respect system that eventually collapsed".

Socialism failed to "provide space" for human creativity and voluntary cooperation. Free markets work because they are based on positive motivations that motivate people to create value not only for themselves, but also for consumers, workers, investors, suppliers, and society as a whole" [12].

Conflict Setting

The purpose of this article is to show the economic consequences of the transition from socialist relations to a free market economy and the quantitative characteristics of the policies implemented in the Republic of Armenia during that time. That problem was solved

in 1994-2023 through the calculation of the economic growth (both absolute and average annual growth) realized by different RA governments during the period. That indicator was the basis for evaluating the effectiveness of the government's activities during the transition period.

Research Methodology

The professional terms used in the article have the following content, which were used and are used in the relevant periods. Thus, the gross social output is calculated as the difference between gross output and intermediate consumption (when calculated at market prices). According to another calculation formula, gross public product is the sum of gross national product calculated at basic prices and net taxes on products (minus subsidies), as well as net taxes on imports (minus subsidies). Among the gross domestic product (GDP) estimation methods, the income calculation method was used, according to which the GDP consists of wages of employees, net taxes on products (minus subsidies), net taxes on imports (minus subsidies), gross profits, and gross revenues.

For the Soviet period, the index of produced national income was used. When calculating the indicators of economic growth of the third republic of Armenia, both the GDP and the net national income index were used, which is closer to the produced national income index. The relationship between these used indicators is as follows: the domestic product (gross, at market prices) is calculated as above and if to this amount of GDP is added the initial incomes received "from abroad" (including wages of workers, income from property) the initial incomes transferred "from abroad" (-), including wages for hired workers and income from property. As a result of the operation, the balance of initial incomes or the gross national income is obtained, from which if we subtract the consumption of fixed capital, we will get the net balance of initial incomes or the net national income. If we add to the latter the current transfers received "from abroad" and subtract the current transfers transferred "abroad", we will get the net national disposable income. Currently, the mentioned methodology is the basis of the system of national accounts.

Research Results

Regardless of the economic system of the society, the socioeconomic development of the country is characterized by the help of many indicators, in which an important place is allocated especially to the macroeconomic indicators. In turn, the main place among the macroeconomic indicators belongs to the indicators of economic growth assessment and calculation, because this indicator best characterizes both the socio-economic achievements of the society and the shortcomings and omissions in the economic policy. The main macroeconomic indicators characterizing the development progress in the socialist (Soviet) society were mainly two: the gross social product and the national income. The latter had two dimensions of measurement: produced and used. According to this the produced national income most accurately characterizes the economic potential of the given republic and the level of well-being of the population. The national income is the main indicator that was divided into consumption and accumulation funds, and the consumption fund was mainly

used for the payment of the population's work and public consumption funds (free education, health care, organization of recreation, etc.). In other words, the consumption fund was used for increasing the welfare and living standards of the population, and the accumulation fund was mainly used for the expansion of production, modernization, and increase of fixed capital as well as working capital. It is also important to note that both gross social output and national income indicators were used not only to characterize and evaluate economic growth but also to define the effectiveness of that development. If the gross social result included not only the size of the national income but also the depreciation of the main funds, then the national income indicator more objectively characterized the funds allocated to the population for socio-economic development and their size. From this point of view, it is extremely important that both in the short term and even in the long term, the indicators of the growth and increase of the national income have a progressive growth and increase rate about the growth and indicators of the gross social output. Such a requirement concerning the mentioned macroeconomic indicators characterizes that the expenses realized within the state are used more efficiently.

The data given in Tab.1 characterize the growth rates of the gross public product and national income of the ASSR in 1965-1980, at comparable prices.

It follows from the data in Table 1 that in 1965-1980 The gross public product and the produced national income of ASSR had high rates of both growth and surplus. Thus, in 1980, compared to 1965, the growth rate of the gross social product was 317.6%, and that of the produced national income was 328.2% (the progressive growth rate of the produced national income compared to the gross social product was 1.03 which means that the unit expenditure in the economy provided an increase of 1.03 units of national income). 1965-1980 The growth rate of the gross public product of ASSR was 317.6% or 21.2% on average per year, and the produced national income was 328.2%, and 21.9%, respectively. In the mentioned period (1965-1980), the increase of the gross social output was 217.6% or the average annual increase was 14.5%, and the national income was 228.2%, and 15.2% respectively. The indicated indicators are not only impressive in the sense of their magnitudes but also seem insurmountable in comparison with the indicators of the current period, which proves the existence of the economic potential and huge capacities of the production base of Soviet Armenia, as well as the high efficiency of the formation of those opportunities and the management of their use.

Whatever made possible the country's opportunities for economic growth and raising the standard of living of the population.

It should be noted that if in 1970, compared to 1965, the growth rate of the gross public product of the ASSR was 161.7%, and that of the produced national income was 157.8%, then these indicators in 1975 compared to 1970 are 228.1% and 229.9%, respectively, and in 1980 compared to 1975, 139.1% and 142.6%, respectively.

To have a more complete understanding of the socio-economic situation of the country, it is also important to study the indicators of average annual growth of macroeconomic indicators. It should be noted that according to the data in Table 1, the average annual increase of the gross social output in 1980 compared to 1965 was 14.5%, the

produced national income was 15.2%, compared to 1970, in 1980 respectively 9.7%, 10.8%, in 1980 compared to 1975, respectively 7.8%, 8.5%, then in 1976-1980 respectively: 6.8% and 7.6%. Although it is obvious that according to the chronological order, the indicators of the average annual increase of both the gross social output and the produced national income tend to decrease, they continued to remain high thereby ensuring the high growth and increase rates of the economy of the Socialist Republic of Armenia.

Table 1

Growth rates of gross public product and national income of ASSR 1965-1980, at comparable prices [13]

Years	Gross public product	National income (produced)
with percentages relative to 1965		
1965	100	100
1970	161.7	157.8
1975	228.4	229.9
1976	244.8	247.1
1977	261.7	264.9
1978	281.1	289.3
1979	299.1	309.6
1980	317.6	328.2
with percentages relative to 1970		
1970	100	100
1975	141.3	145.7
1976	151.4	156.6
1977	161.9	167.8
1978	173.9	183.2
1979	185.1	196.0
1980	196.6	207.8
with percentages relative to 1975		
1975	100	100
1976	107.2	107.5
1977	114.6	115.2
1978	123.1	125.7
1979	131.0	134.5
1980	139.1	142.6
with percentages over the previous year		
1976	107.2	107.5
1977	106.9	107.2
1978	107.4	109.2
1979	106.4	107.0
1980	106.2	106.0

For comparison, Tab. 2 shows the growth rates of the gross domestic product and net national income of the Republic of Armenia in 2008-2022, at current prices.

From the data in Tab. 2, it follows that in 2022, compared to 2008, the GDP growth index (calculated in Armenian drams) was 238.3%, 167.3% in US dollars, and the net national income (2008-2021) 176.9% and 113.6%, respectively. The rate of progressive growth of net national income about GDP in 2008-2021. was calculated in AMD 0.90 and expressed in USD 0.95, respectively. From this, it becomes clear that one of the most important patterns of the development of the economy of the Republic of Armenia, the progressive coefficient of

the growth rate of the net national income has been violated by the growth rate of the GDP, which is a significant loss compared to the corresponding indicators of Soviet Armenia. This proves that both the economic potential of the Republic of Armenia, as well as the opportunities to raise the standard of living of the population have become smaller and the economy has been managed worse. As a result of all this, the effectiveness of the socio-economic development of the republic has noticeably deteriorated.

Table 2

Growth rates of gross domestic product and net national income of the Republic of Armenia in 2008-2022, at current prices [14,15,16]

Years	Gross domestic product		Net national income (produced)		AMD/USD exchange rate
with percentages compared to 2008					
	million AMD	million US dollars	million AMD	million US dollars	
2008	100	100	100	100	100
2013	127.7	95.4	127.5	136.4	133.9
2018	168.6	106.8	159.9	174.2	157.9
2019	183.4	116.8	173.8	189.7	157.0
2020	173.2	108.4	158.3	172.9	159.8
2021	195.9	119.0	176.9	113.6	164.6
2022	238.3	167.3	-	-	142.4
with percentages compared to 2013					
2008	100	100	100	100	100
2013	127.7	95.4	127.5	136.4	133.9
2018	132.1	106.8	125.5	127.7	117.9
2019	108.7	122.5	136.3	139.1	117.3
2020	94.5	113.7	124.2	126.7	119.4
2021	113.1	124.8	111.7	65.7	123.0
2022	121.6	175.5	-	-	106.4
with percentages compared to 2018					
2018	100	100	100	100	100
2019	82.3	114.6	108.7	108.9	99.5
2020	71.5	106.4	99.0	99.2	101.2
2021	85.6	116.8	89.1	51.4	104.3
2022	92.1	164.3			90.2
in percentages compared to the previous year					
2018	108.13	108.08	106.5	173.1	100.06
2019	108.75	109.32	108.7	108.9	99.47
2020	94.48	92.83	91.1	91.1	101.78
2021	121.59	109.78	111.7	65.7	103.02

Note: Tables 2, 3, and Figure 1 were compiled and calculated by the authors.

Note that in 2008-2021 The average annual GDP growth rate was 6.9% expressed in AMD, and 1.4% in dollars, and the national income was 5.5% and 2.6%, respectively.

If we were to compare the gross social output and GDP of Soviet Socialist Armenia and the Republic of Armenia, as well as the corresponding indicators of the correspondingly produced national income and net national income in the long-term segments, the picture is as follows: 14.5%, 15.2% for the ASSR, and 6.9%, 5.5% for the RA, in other words, the average annual increase of the GDP in the Republic of Armenia is the average of the gross social output of the indicator of the Socialist Soviet Republic of Armenia 2.10 and 2.76 times the annual rate. The study of the objective and subjective reasons for the low efficiency of economic management should become the subject of interest not only of economists but also of political scientists, as well as people with other professions. It is especially necessary to understand the shortcomings and mistakes that were made during socio-economic development, to eliminate them and not to make new mistakes.

Table 3

The main periods of the economic history of the Republic of Armenia in chronological order (according to the current governments) 1994-2022

Stages of economic policy according to chronology	Periods	Absolute GDP growth per capita over the entire period, %		Average annual growth rate of GDP per capita during the period, %	
		million AMD	million USD	million AMD	million USD
12.02.1993-04.11.1996	1994-1996	260.1	158.9	86.7	52.9
01.03.1998-30.05.1999 01.03.1997-28.02.1998 01.11.1996-28.02.1997	1997-1999	23.2	12.8	7.7	4.3
01.06.1999-27.10.1999 01.11.1999-30.04.2000	1999-2000	4.7	3.9	2.4	1.9
12.05.2000-25.03.2007	2000-2006	157.5	234.2	22.5	33.5
04.04.2007-09.04.2008	2007	18.4	43.9	18.4	43.9
09.04.2008-12.04.2014	2008-2013	36.6	2.1	6.1	0.3
13.04.2014-08.09.2016	2014-2016	5.7	-8.5	1.9	-2.8
13.09.2016-17.04.2018	2017-2018	8.5	8.5	2.8	2.8
08.05.2018	2018-2022	41.3	56.6	8.3	11.3

According to Article 146 (Status and Functions of the Government) of the RA Constitution: "The government is the highest body of the executive power. The government develops and implements the internal and external policies of the state based on its plan. The government carries out the general management of the bodies of the state administration system. The powers of the government are defined by the Constitution and laws. All the issues related to the executive power, which are not reserved for the state administration or other local self-government bodies, are under the jurisdiction of the government" [15].

According to Article 147 (Composition and Structure of the Government) of the RA Constitution: "The government consists of the prime minister, deputy prime ministers and ministers. The list of ministries and the procedure of the Government's activities are defined by the law on the Government's proposal. The number of deputy prime ministers cannot exceed three, and the number of ministers - eighteen".

The main periods of the economic policy of the Republic of Armenia in chronological order from 1994-2022 are presented in Tab. 3, and in Fig. 1 the main periods of the economic history of the Republic of Armenia are presented in chronological order in AMD from 1994-2022.

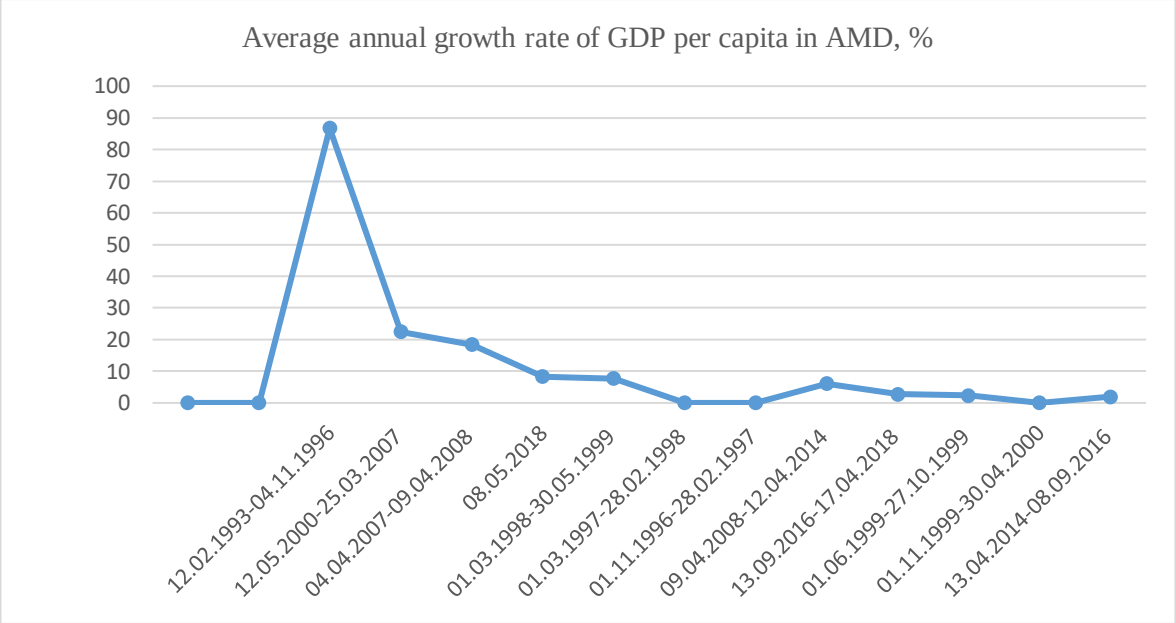

Fig. 1 The main periods of the economic history of the Republic of Armenia in decreasing order of the average annual growth rate of the GDP according to the AMD (according to the current governments) 1994-2022

It follows from the data in Tab. 1 that in 1994-2022 during the period, the absolute increase of the GDP per capita of the population during the entire period of the given government expressed in AMD was the highest in 1994-1996: 260.1%, the second place was recorded in 2000-2006: 157.5%, and 3rd place: 2018-2022: 41.3%.

Fig. 1 shows the main periods of the economic history of the Republic of Armenia in descending order of the average annual increase in GDP according to the AMD, in % from 1994-2022.

Conclusion

The transition from socialism to free market relations (capitalism) was carried out in each country with the presence of complex and difficult socio-economic and political conditions and circumstances. Accordingly, during that transition, the price of the transition was not evaluated and taken into account until the end, which led to the delay of the transition

period and the increase of uncertainty regarding the transition period. The criteria and deadlines for the end of that transition are also not clear, which leads to social tension and dissatisfaction in those countries, it is also obvious that the sign of the end of that transition in each country can be the higher values of the main macro-economic and living standard indicators of the population than they were at the end of the socialist society.

The transition of market relations in the Republic of Armenia was carried out in difficult and contradictory conditions, which was due to various types of force majeure circumstances (Karabakh 1st, 2nd wars, COVID-19, etc.). Accordingly, different governments have implemented this transition with different speeds and success. The success of that transition was evaluated and calculated by the absolute growth rate of economic growth and the average annual growth rate, which is how the success and speed of evaluating the activities of the RA governments in the period 1994-2022 was evaluated.

The RA government should clarify the transition to free market relations and its completion and propose more concrete steps and socio-economic policy scenarios to complete the transition successfully and without socio-economic upheavals.

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ԱՆՑՈՒՄԸ ՍՈՑԻԱԼԻԶՄԻՑ ՇՈՒԿԱՅԱԿԱՆ ՏՆՏԵՍՈՒԹՅԱՆ. ՏՆՏԵՍԱԿԱՆ ՀԵՏԵՎԱՆՔՆԵՐԻ ԳՆԱՀԱՏՈՒՄԸ ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅՈՒՆՈՒՄ

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XX-րդ դարի 90-ական թվականների սկզբից և 21-րդ դարի առաջին և երկրորդ տասնամյակում շարունակվող աշխարհա-քաղաքական և տարածաշրջանային երևույթներից հիմնականը եղել է անցումը սոցիալիստական համակարգից (համայնավարությունից) ազատ շուկայական հարաբերությունների: Սոցիալիզմից ազատ շուկայական հարաբերությունների (կապիտալիզմի) անցումը աշխարհի շուրջ 30 երկրներում իրականացվեց ավելի շատ անորոշությունների պայմաններում, ինչի հետևանքով մի շարք երկրներ այդ անցումը իրականացրեցին բավականին արագ և սոցիալ-տնտեսական ցածր ծախսերով, իսկ առանձին երկրներ այդ անցումը իրականացրին բավականին բարդ ճանապարհով՝ ինչպես տնտեսական, այնպես էլ սոցիալական բարձր գին վճարելով: Այդ երկրներում հատկապես ծանր էր վիճակը բնակչության զբաղվածության շուկայում, որն ուղեկցվում էր սոցիալական անպաշտպանության և աղքատ բնակչության բարձր տեսակարար կշռով: Հոդվածում քննարկվում է սոցիաալիստական հարաբերություններից ազատ շուկայական հարաբերությունների անցման Հայաստանի Հանրապետության փորձը՝ համադրելով սոցիալիստական երկարատև ժամանակահատվածի մակրոտնտեսական երկու կարևորագույն ցուցանիշների աճի տեմպերը հանրապետության համապատասխան ժամանակաշրջանի մակրոտնտեսական ցուցանիշների հետ:

Բանալի բառեր. համախառն հասարակական արդյունք, ազգային եկամուտ, ՀՆԱ, զուտ ազգային եկամուտ, տնտեսական քաղաքականություն, բացարձակ աճի տեմպ, միջին տարեկան հավելաճի տեմպ:

A.Kh. Markosyan, E.N. Matevosyan, M.A. Markosyan, G.A. Martirosyan
TRANSITION FROM SOCIALISM TO A MARKET ECONOMY: ASSESSMENT OF ECONOMIC CONSEQUENCES IN THE REPUBLIC OF ARMENIA

ПЕРЕХОД ОТ СОЦИАЛИЗМА К РЫНОЧНОЙ ЭКОНОМИКЕ: ОЦЕНКА ЭКОНОМИЧЕСКИХ ПОСЛЕДСТВИЙ В РЕСПУБЛИКЕ АРМЕНИЯ

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Основным геополитическим и региональным явлением начала 90-х годов XX столетия и первых двух десятилетий XXI века стал переход от социалистического строя (социализма) к свободным рыночным отношениям. Переход от социализма к свободным рыночным отношениям (капитализму) примерно в 30 странах мира осуществлялся в условиях большей неопределенности, в результате чего ряд стран осуществил этот переход достаточно быстро и с небольшими социально-экономическими издержками, а отдельные страны прошли довольно сложный путь, заплатив за это высокую экономическую и социальную цену. В этих странах особенно сложной была ситуация на рынке труда, которая сопровождалось высокой степенью социальной незащищенности и бедности населения. В статье рассматривается опыт Республики Армения в деле перехода от социалистических к свободным рыночным отношениям, авторы сравнивают темпы роста двух важнейших макроэкономических показателей длительного социалистического периода с соответствующими макроэкономическими показателями периода независимости республики.

Ключевые слова. валовой общественный продукт, национальный доход, ВВП, чистый национальный доход, экономическая политика, абсолютный темп роста, среднегодовой темп прироста.

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THE IMPORTANCE OF ECO-TOURISM DEVELOPMENT ON THE EXAMPLE OF SPECIALLY PROTECTED NATURE AREAS OF RA IN THE CONTEXT OF ECONOMIC DEVELOPMENT OF THE REGIONS

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Abstract

The article explores various aspects of the potential for ecotourism development within Armenia's Specially Protected Nature Areas (SPNA's). With growing global interest in sustainable travel practices, ecotourism presents a promising avenue for promoting conservation efforts while simultaneously providing socio-economic benefits to local communities. Armenia's SPNAs, characterized by their rich biodiversity and unique landscapes, offer an ideal setting for ecotourism initiatives, however, challenges such as inadequate infrastructure, limited visitor facilities, insufficient marketing strategies and absence of data analytics hinder the realization of ecotourism potential in SPNA's.

By capitalizing on the natural and cultural assets of SPNAs and adopting sustainable tourism practices, Armenia has the opportunity to establish itself as a leading ecotourism destination in the region, attracting environmentally conscious travelers and contributing to the country's socio-economic development.

The primary objective of the article is to assess the existing situation of the recent 5 years by providing respective data analysis, as well as highlight the gaps and opportunities, ultimately striving for a balanced and sustainable outcome both for affected communities and natural ecosystems.

Keywords: ecotourism, data deficiency, social conditions, affected community, stakeholders.

Introduction

Although certain state coordination units have been established in Armenia to oversee the development of ecotourism in RA SPNA’s effective tools and methodologies have not yet been developed through state funding. As early as 2015, units were created under the Ministry of Environment of the Republic of Armenia with the aim of supporting ecotourism development, including the Ecotourism Support and Development Department and the Ecotourism Information Center. These units collaborate with both domestic and international entities, facilitating the dissemination of information on tourism destinations throughout Armenia. However, interdepartmental cooperation with the RA Tourism Committee, subordinate to the Ministry of Economy remains insufficient. In some SPNA’s, tourist registration mechanisms are insufficient or not conducted, posing significant obstacles to obtaining quantitative data for measurement, analysis, and further strategy development. Furthermore, the level of ecotourism utilization in RA remains relatively low due to inadequate financial analysis of ecotourism revenue, which often presents greater financial potential with minimal capital investment requirements. This issue is compounded by the lack of data collection on ecotourism and, in many cases, insufficient consideration of environmental impacts of the tourism sector. The absence of a cohesive state program or strategy guiding the activities of tourist companies active in the regions further hinders the development of ecotourism in communities. Establishing such a program would orient tourism towards ecological principles, promote landscape recovery, preserve ethnic values, historical and cultural heritage, and actively involve communities in all the processes. Additionally, a well-developed and scientifically based ecotourism implementation system in one region could serve as a model for others. Analysis reveals that IUCN Category I reserves are more active in ecotourism development among the protected areas of Armenia compared to national parks and sanctuaries. However, under current legislation, reserves have the strictest conservation regulations, often lacking developed ecotourism routes and attractive destinations. This oversight neglects the potential of ecotourism as an alternative income source, leading to the continued exploitation of other ecosystem services and subsequent ecosystem disruption paired with sustainable revenue loss. In recent years, respective management plans have been established or updated in several protected areas of RA, mostly due to international grant resources, incorporating ecotourism development programs, creation of ecotourism routes and capacity building for SPNA management or community

members. However, the potential of ecotourism remains largely untapped, yielding less than 1 USD per hectare annually, despite a consistent rise in tourist numbers in Armenia since 2019.

Conflict Setting

The purpose of this article is to underscore the significance of data based decision making in the management process of Armenia's SPNA's with the aim of additional income generation from ecotourism, as well as contribute insights to the discourse on ecotourism development in protected areas. By emphasizing the importance of data-driven decision-making, the article seeks to highlight the potential for leveraging data analytics and evidence-based approaches to enhance the management and promotion of ecotourism in Armenia's SPNAs.

Overall, the article aspires to contribute valuable insights to the ongoing dialogue on ecotourism development in protected areas, advocating for a data-driven approach to decision-making that balances economic prosperity in communities with the preservation of natural & cultural resources.

Materials and Methods:

The research method involves a multi-faceted approach, incorporating data analyzing methods such as quantitative & comparable analysis. Initially, relevant data regarding the ecological, cultural, and economic aspects of Armenia's SPNAs were collected from various sources, including government agencies, non-governmental organizations, and academic institutions. Quantitative analysis techniques were then applied to assess the current state of ecotourism in SPNAs, including statistical analysis of visitor numbers, revenue generation, and resource utilization.

Research Results

The specially protected natural areas (SPNAs) of the Republic of Armenia constitute 13% of the territory and serve as habitats for 60-70% of endangered plants and animals registered in the Red Book of RA. Within Armenia, there are 3 state reserves, 4 national parks, 27 state reserves, and 232 natural monuments. Despite the significance of these SPNAs for biodiversity conservation and environmental education, there is currently no standardized system for tracking ecotourism statistics under the purview of the Tourism Committee of the Ministry of Economy. Instead, data collection is overseen by the Ministry of Environment of the Republic of Armenia, though this system lacks comprehensive data due to the absence of centralized entry/ticketing systems in many SPNAs, resulting in both accounting inaccuracies and significant revenue loss.

Moreover, our study revealed that approximately 90% of SPNAs do not calculate tourist loads or lack scientifically justified data regarding visitor numbers. This dearth of information hampers the formulation of annual tourism plans and inhibits the implementation of advance online ticket sales. Furthermore, many SPNAs lack developed websites or effective channels of communication that could serve as a marketing tool.

The collected data from SPNA's on their financial income from ecotourism activities for a period of 2019 -2022 was calculated, the results of which are detailed in the subsequent Fig. 1.

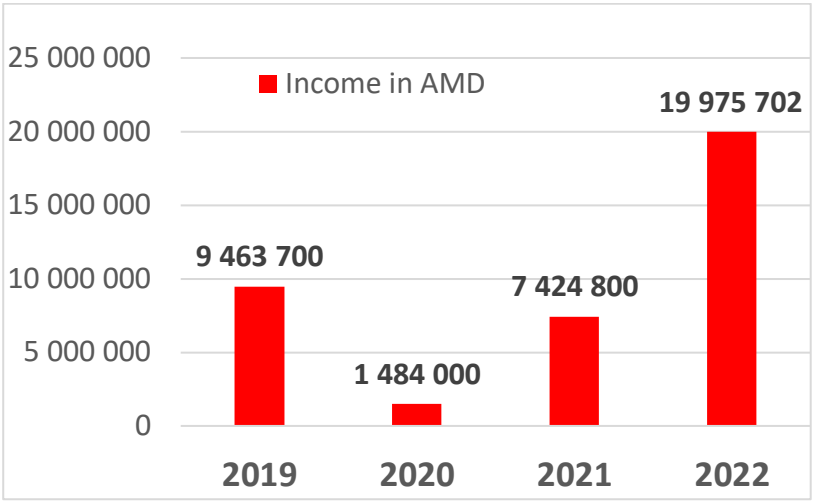

Fig. 1 The income of Armenia's SPNA's from ecotourism for a period of 2019-2022 (in AMD)

The data depicted in Fig. 1 indicate a substantial increase in revenue, with some instances of doubling or even tripling since 2019. This surge in revenue can be attributed to various factors, including the revision of management plans in certain SPNAs, the establishment of ecotourism routes, the implementation of access control measures, and the availability of guide services. However, it is noteworthy that the figures for 2020 show a decline, a trend likely influenced by the COVID-19 pandemic and concurrent military operations.

Despite the apparent growth in revenue, it is important to acknowledge potential limitations in the data's accuracy. Specifically, the high prices associated with ecotourism excursions across Armenia may skew the revenue figures, with costs averaging at a minimum of 35,000 Armenian Drams per person per day, including overnight stays. Moreover, while Armenia possesses considerable ecotourism potential and experiences increasing demand for eco-tours, the income generated from ecotourism within RA national parks remains notably lower compared to that of developed countries.

For instance, revenue from activities within American national parks averages at $40 per hectare, a substantially higher figure than observed in Armenia. Authors make a note that comparison of American & Armenian SPNA revenues is presented rather as an example of effective management and is not based on a detailed analysis of all underlying factors contributing to revenue generation.

To elucidate this discrepancy, a comparative analysis was conducted between the ecotourism incomes of the two most frequently visited SPNAs in 2022, juxtaposed against their respective areas. This comparison is aimed to assess the gross income generated per hectare and offers useful insights into the economic dynamics of ecotourism within SPNA's.

Table 1.

The highest incomes received by the two frequently visited SPNA's, 2022.

N	Name of SPNA	SPNA area (ha)	Generated income (in AMD)
1	Khosrov State Reserve	23, 213	6,384,800
2	Dilijan National Park	33,765	7,309,102

Hence, through a straightforward calculation, it is determined that the Khosrov Forest State Reserve yields AMD 275 per hectare, while the Dilijan National Park generates AMD 216 per hectare, a stark contrast to the revenues observed in the United States. Notably, in the American context, ecotourism is concentrated on only 10% of protected area territories, yet yields approximately $40 or roughly 16,000 AMD per hectare.

Despite this, given the critical role of protected areas in ecosystem preservation and ecotourism development for each state, concerted attention from governmental entities is imperative. Prompt responses to factors impeding the functioning of protected areas are essential to ensure their sustained operation.

When comparing the influx of tourists to the Republic of Armenia (RA) between 2019 and 2022 with the visitation rates of SPNA's during the same timeframe, it was discerned that in average only 1% of tourists have visited the SPNA's which is delineated in Tab. 1, illustrating the comparative percentage of eco-tourists for the years 2019 through 2022.

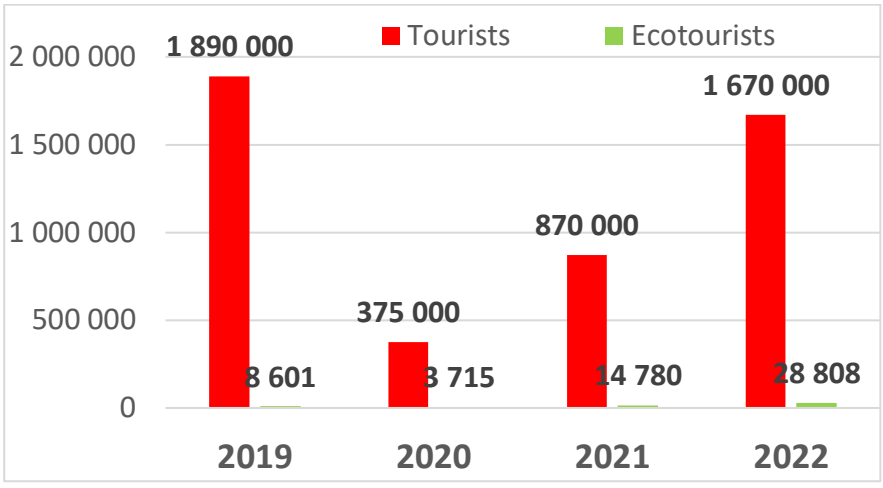

Fig. 2 The comparative analysis of tourists & ecotourists for a period of 2019-2022

Tab. 2 below provides a detailed comparison of tourists and eco-tourists visiting the Republic of Armenia (RA) from 2019 to 2022, presenting the absolute numbers for each year. This tabular representation offers a comprehensive overview of the proportions observed during the specified timeframe.

Table 2

The visiting dynamics of ecotourists during 2019-2022

Year	Tourists (in absolute number)	Ecotourists (in absolute number)	Percent Relation
2019	1,890,000	8,601	0,4%
2020	375,000	3,715	0,9%
2021	870,000	14,780	1,69%
2022	1,670,000	28,808	1,7%

As previously indicated, our analysis suggests that the actual number of eco-tourists visiting SPNA's is notably higher than the figures provided by state authorities. Over the past four years, there has been a discernible rise in the visitation rates of eco-tourists to SPNA's, increasing from 0.4% to 1.7%. Despite constituting a relatively modest percentage, it is noteworthy that a majority of eco-tourists allocate their time to exploring other natural and historical-cultural sites across the marzes of the Republic of Armenia. In contrast to tourists who tend to spend extended periods in Yerevan, the capital city, eco-tourists contribute significantly more to local communities and expend greater financial resources in the regions. Consequently, to foster community-based tourism initiatives, it is imperative to prioritize the further advancement of ecotourism, including the development and management of appropriate routes & capacity building.

It is obvious that the potential for ecotourism development is particularly promising in mountainous regions. Notably, the national parks of RA offer numerous and diverse ecotourism routes. For instance, the "Khosrov Forest" State Reserve features five main routes, while the "Dilijan" National Park boasts sixteen routes, and the "Sevan" National Park has four routes. However, it is notable that the majority of sanctuaries lack designated routes or have none developed. The tabulated data below presents pertinent information regarding the protected areas of the Republic of Armenia, underscoring that the ecotourism potential of most protected areas in the country remains untapped.

Currently, the activities of SPNA's require significant state attention, with the following aspects being particularly emphasized as per our view:

- Formulation and implementation of an ecotourism strategy tailored to each SPNA.
- Establishment of a centralized control system for SPNA's;
- Renovation and enhancement of infrastructures, equipment and accessories;
- Integration of trained ecotourism personnel into the workforce.

As previously mentioned, the establishment of well-designed eco-trails is a critical prerequisite for fostering ecotourism, necessitating careful planning and construction considerations, such as:

- Engagement of multidisciplinary specialists in the trail construction process, including botanists, zoologists and ecologists;
- Conducting comprehensive territorial studies to identify key stops along the route;
- Minimizing environmental disturbances during any type of activity;

- Removal of obstacles along the trail, while avoiding extensive deforestation and grass destruction/clearance;
- Preferential construction of eco-trails with curved designs to enhance appeal and interest for eco-tourists, while safeguarding vulnerable areas such as animal nesting sites and water bodies.

Table 3

The area & routes of RA SPNA's

SPNA name	Location	Area (ha)	N of routes	Distance (km)	Payment for entry /activity in AMD	
					RA citizen	Foreign citizen
					On foot/on horse	On foot/on horse
RESERVES Khosrov State Reserve	Ararat, Kotayk	23 213.5	5	93	F.3500 H.10000	F.5000 H.15000
Shikahogh	Syunik	12 137.1	11	278	F.3500	F. 5000
Erebuni	Yerevan	89.0	N/A	N/A	N/A	N/A
NATIONAL PARKS Sevan	Gegharkunik	147 455.0	4	4,4	-	-
Dilijan	Tavush	33 765.0	16	200,69	F.3500	F. 5000
Arpi Lake	Shirak	21 179.3	4	116,1	F.3500 H.10000	F 5000 H.12000
Arevick	Syunik	34 401.8	N/A	N/A	N/A	N/A
Akhnabad living park	Tavush	25.0	N/A	N/A	N/A	N/A
Arjatkhlenu	Tavush	40.0	N/A	N/A	N/A	N/A
Juniper thin forest	Gegharkunik	3 312.0	N/A	N/A	N/A	N/A
Gulagarak	Lori	2 576.0	N/A	N/A	N/A	N/A
Herher sparse forest	Vayots_Dzor	6 139.0	N/A	N/A	N/A	N/A
Jermuk forest	Vayots_Dzor	3 865.0	N/A	N/A	N/A	N/A
Sou grove	Gegharkunik	64.2	N/A	N/A	N/A	N/A
Aragats Alpine	Aragatsot	300.0	N/A	N/A	N/A	N/A
Banksy Pine	Kotayk	4.0	N/A	N/A	N/A	N/A
Goravan dunes	Ararat	95.99	N/A	N/A	N/A	N/A
Caucasian blackberry	Lori	1 000.0	N/A	N/A	N/A	N/A
Arzakan-Meghradzor	Kotayk	13 532.0	N/A	N/A	N/A	N/A
Gandzakari	Tavush	6 813.0	N/A	N/A	N/A	N/A
Getiki	Gegharkunik	5 728.0	N/A	N/A	N/A	N/A
Ijevani	Tavush	5 908.0	N/A	N/A	N/A	N/A
Margahovti	Lori	3 368.0	N/A	N/A	N/A	N/A
Yeghegnadzor	Vayots_Dzor	4 200.0	N/A	N/A	N/A	N/A
Goris	Syunik	1850.0	N/A	N/A	N/A	N/A
Vordan the red	Armavir	219.85	N/A	N/A	N/A	N/A

Boghakar	Syunik	2 728.0	N/A	N/A	N/A	N/A
Sev lich	Syunik	240.0	N/A	N/A	N/A	N/A
Khor Virap	Ararat	50.28	N/A	N/A	N/A	N/A
Hydrological of Hankavan	Kotayk	5 169.04	N/A	N/A	N/A	N/A
Jermuk hydrological	Vayots_Dzor	17 371.0	N/A	N/A	N/A	N/A
Zangezur	Syunik	25 870.64	-	97,2	-	-
Zikatar	Tavush	150.0	N/A	N/A	N/A	N/A
Khustup	Syunik	6946.74	1	44	-	-

In the "Travel and Tourism Development Index 2021" ranking, published in 2022, Armenia secured the 61st position among 117 countries. This index assesses tourism competitiveness by aggregating various indicators across three sectors: tourism regulatory environment, business environment and infrastructure, as well as human, cultural, and natural tourism resources. The ranking occurs biennially and encompasses both tourism-related datasets and survey responses. The findings concerning Armenia (RA) are deemed commendable, with notable advancements observed across several domains, particularly in price competitiveness, health and hygiene, and safety and security, where Armenia ranks 19th, 37th, and 19th, respectively. Progress is evident in visa acquisition and international accessibility, with ranking of 45th. Moreover, strides have been made in Information Communication Technology, with a ranking of 55th. However, indicators pertaining to air, land, and cultural resources, as well as business trips, remain underdeveloped, with Armenia positioned at 78th, 74th, and 85th, respectively. Despite possessing abundant natural resources, inadequate evaluation and utilization practices have resulted in a low ranking of 105th in natural resource assessment. Consequently, the utilization of recreational resources for tourism development is hindered, necessitating systematic approaches and comprehensive assessments rooted in precise calculations and data analysis, which in its turn justifies the findings of the authors in this article.

In conclusion, it is evident that ecotourism facilitates the redistribution of revenue to regions and remote villages, fostering their equitable development. Additionally, it contributes to the preservation of ethnic culinary traditions, cultural heritage, and employment generation. Hence, effective regulation of the sector necessitates the acquisition and synthesis of analytical data with proactive state involvement to enhance quantitative assessments for better decision making at all state levels.

Conclusion

The analysis conducted in this study sheds light on various facets of ecotourism potential within Armenia's Specially Protected Nature Areas (SPNAs). Despite the rich biodiversity and unique landscapes offered by Armenia's SPNAs, challenges such as inadequate infrastructure, limited visitor facilities, and insufficient marketing strategies hinder the realization of ecotourism potential. However, there is substantial scope for leveraging the natural and cultural assets of SPNAs to establish Armenia as a leading ecotourism destination in the region.

Key findings indicate a need for enhanced data collection and analysis to inform ecotourism strategies and decision-making processes. Current data deficiencies, particularly in tracking visitor numbers and revenue generation, underscore the importance of implementing centralized entry/ticketing systems and improving communication channels within SPNAs. Additionally, the disparity in revenue generation between Armenia and developed countries highlights the need for targeted investments and strategic planning to maximize ecotourism's economic benefits.

The study also reveals a growing interest in ecotourism among visitors, with a notable increase in the proportion of eco-tourists visiting SPNAs over the past four years. However, further efforts are required to capitalize on this trend and promote community-based tourism initiatives. Developing well-designed eco-trails, integrating trained personnel, and fostering interdepartmental cooperation are crucial steps towards realizing ecotourism's full potential in Armenia.

Suggestions

1. **Formulation of Ecotourism Strategies:** Develop tailored ecotourism strategies for each SPNA, focusing on sustainable tourism practices and community engagement.
2. **Centralized Control Systems:** Establish centralized control systems for SPNAs to streamline data collection, visitor management, and revenue tracking.
3. **Infrastructure Enhancement:** Invest in infrastructure upgrades, equipment, and facilities to improve visitor experiences and support ecotourism initiatives.
4. **Capacity Building:** Integrate trained ecotourism personnel into SPNA management teams to enhance service quality and environmental stewardship.
5. **Eco-Trail Development:** Prioritize the development of well-designed eco-trails in SPNAs, involving multidisciplinary specialists and minimizing environmental disturbances.
6. **Interdepartmental Cooperation:** Foster collaboration between relevant government agencies, including the Ministry of Environment and the Tourism Committee, to align ecotourism policies and initiatives.
7. **Data Collection and Analysis:** Strengthen data collection efforts to accurately track visitor numbers, revenue generation, and environmental impacts, enabling evidence-based decision-making.
8. **Promotion and Marketing:** Implement targeted marketing strategies to raise awareness of Armenia's ecotourism offerings and attract environmentally conscious travelers.
9. **Policy and Regulatory Framework:** Develop comprehensive policies and regulations to guide ecotourism activities, ensuring the sustainable management of SPNAs and equitable distribution of economic benefits.
10. **Community Engagement:** Engage local communities in ecotourism planning and decision-making processes, emphasizing the importance of preserving cultural heritage and natural resources for future generations.

    By implementing these suggestions, Armenia can harness its ecotourism potential to promote sustainable development, preserve biodiversity, and enhance the well-being of local communities at large.

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ԷԿՈԶԲՈՍԱՇՐՋՈՒԹՅԱՆ ԿԱՐԵՎՈՐՈՒԹՅՈՒՆԸ ՄԱՐԶԵՐԻ ՏՆՏԵՍԱԿԱՆ ԶԱՐԳԱՑՄԱՆ ՀԱՄԱՏԵՔՍՏՈՒՄ՝ ՀՀ ԲՆՈՒԹՅԱՆ ՀԱՏՈՒԿ ՊԱՀՊԱՆՎՈՂ ՏԱՐԱԾՔՆԵՐԻ ՕՐԻՆԱԿՈՎ

Ա.Ռ. Մկրտչյան[1], Ա.Գ. Հարությունյան[2], Գ.Ա. Մարտիրոսյան[3], Ժ.Մ. Միրզոյան[4]

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Քննարկվում են Հայաստանի բնության հատուկ պահպանվող տարածքներում (ԲՀՊՏ) էկոտուրիզմի զարգացման հիմնահարցեր ի դեմս էկոզոբոսաշրջության

զարգացման հնարավորությունների ու ռիսկերի՝ շեշտադրելով տվյալահեն որոշումների կայացման անհրաժեշտությունը:

Զարգացած երկրներում կայուն զբոսաշրջության նկատմամբ հետաքրքրության աճն ու զբոսաշրջային պահանջարկը գնալով աճում է, իսկ էկոտուրիզմը տարեցտարի գրավիչ ուղղություն է դառնում դեպի զարգացող լեռնային երկրներ՝ հանդիսանալով ոչ միայն բնության պահպանության համար լրացուցիչ եկամուտներ ապահովող տնտեսության ճյուղ, այլև սոցիալ-տնտեսական էական օգուտներ ապահովելով տեղական համայնքներին՝ ապահովելով համաչափ զարգացում:

Հայաստանի բնության հատուկ պահպանվող տարածքները, որոնք բնութագրվում են հարուստ կենսաբազմազանությամբ և եզակի լանդշաֆտներով, ունեն մեծ ներուժ էկոտուրիզմի զարգացման համար, ինչի արդյունքում կարող են ապահովել հավելյալ եկամուտներ, որոնք կուղղվեն բնական տարածքների պահպանության ծախսերին, սակայն ԲՀՊՏ-ներում կուտակված ինստիտուցիոնալ և կազմակերպչական խնդիրները, ինչպիսիք են սահմանափակ կարողությունները, անբավարար ենթակառուցվածքը, պլանավորման բացերը՝ պայմանավորված տվյալների վերլուծության, մարքեթինգային ռազմավարությունների, տարբեր շահառուների հետ համագործակցության բացակայությամբ, հնարավորություն չեն ընձեռում իրացնել ամբողջական ներուժը, այն դեպքում, երբ ՀՀ-ն կարող է դիրքավորվել որպես տարածաշրջանում էկոտուրիզմի առաջատար ուղղություն՝ նվազագույն ներդրումներով ապահովելով կայուն եկամուտներ:

Հոդվածի նպատակն է գնահատել ներկա իրավիճակը վերջին 5 տարիների ընթացքում՝ ԲՀՊՏ-ների համապատասխան տվյալների վերլուծության միջոցով, ինչպես նաև բացահայտել ոլորտի զարգացման հիմնական բացերն ու հնարավորությունները, ինչը կապահովի բնական էկոհամակարգերի ծառայությունների տրամադրումն ու տեղական համայնքների համաչափ զարգացումը:

Բանալի բառեր. էկոզբոսաշրջություն, կենսաբազմազանություն, սոցիալական պայմաններ, համայնք, շահագրգիռ կողմեր:

ЗНАЧИМОСТЬ РАЗВИТИЯ ЭКОТУРИЗМА НА ПРИМЕРЕ ОСОБО ОХРАНЯЕМЫХ ПРИРОДНЫХ ТЕРРИТОРИЙ РА В КОНТЕКСТЕ ЭКОНОМИЧЕСКОГО РАЗВИТИЯ РЕГИОНОВ

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Данное исследование рассматривает потенциал развития экотуризма в Особо охраняемых природных территориях (ООПТ) Армении. С растущим глобальным

интересом к устойчивым практикам путешествий экотуризм представляет собой многообещающий путь для продвижения усилий по сохранению природы, одновременно обеспечивая социально-экономические выгоды для местных общин. ООПТ Армении, характеризующиеся богатым биоразнообразием и уникальными ландшафтами, предлагают идеальные условия для развития экотуризма, однако вызовы, такие как недостаточная инфраструктура, ограниченные возможности для посетителей, недостаточные маркетинговые стратегии и отсутствие аналитики данных, мешают реализации потенциала экотуризма в ООПТ.

Путем максимального использования природных и культурных ресурсов ООПТ и принятия устойчивых практик туризма Армения имеет возможность позицинироваться в качестве ведущего экотуристического направления в регионе, привлекая экологически осознанных путешественников и способствуя социально-экономическому развитию общин страны. Основной целью является оценка текущей ситуации за последние 5 лет путем предоставления соответствующего анализа данных, а также выявление пробелов и возможностей, стремясь к сбалансированному и устойчивому исходу как для затронутых общин, так и для природных экосистем.

Ключевые слова: экотуризм, недостаток данных, социальные условия, община, заинтересованные стороны.

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A NEW ABRASIVE DISC DESIGNED FOR GRINDING GRANITE

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Abstract

The aim of the work is to develop a new effective design and material of the disc for abrasive machining of granite. The task was undertaken in order to shorten the time of the machining operation of surface grinding by ensuring a uniform post-machining surface roughness for a given cycle , shortening the time for a given grain group of abrasive segments. For the purpose of the task, an analysis of the effectiveness of the impact of the working surface of the disc of known geometric solutions and a new solution of the disc geometry was carried out. Recipes for material composition and technology for making prototypes of discs with a new geometry of abrasive segments were developed, for which laboratory tests were performed.

***Keywords*:** grinding wheels, mineral surface treatment, impact effectiveness, diamond wheels, surface roughness.

Introduction

Natural stone is a material with a large number of varieties characterized by individual physical, mechanical and functional properties, as well as the richness of colors and possible surface textures with diverse dynamics of utility patterns. Expectations are directed at new technological solutions that increase efficiency, increase quality, increase work safety and reduce machining costs. At present, according to publications [1, 2], there is a great interest in the world economy and an increase in the production of tools manufactured on the basis of synthetic diamond powders with synthetic binders. Historical use of diamond as an abrasive material for processing basalt and granite was made as early as Ancient Egypt, as evidenced by the traces of cuts in the stone on the buildings in Giza. Egyptian sources inform that 3000 BC in the kingdom of the pharaohs, grains of natural diamond called amodeus were used as an abrasive , and powder obtained from grinding nut shells was used for polishing [3,4]. In 1953, Platen B in Sweden performed the first diamond synthesis, also in 1953 Generall Eletric launched the industrial production of synthetic diamonds. In 1965, the production of synthetic diamonds was mastered in Russia. Since the 90s, in its technical development, China has become the largest producer of diamond powders in the world, which has contributed to the reduction of their production costs and the price of the diamond powder itself. At present, the dominant direction in the development of grinding wheel technology for surface finishing

works in the processing of granite are directions related to the dynamically developing research on the use of synthetic binders.

1. Granite surface treatment

Diamond tools for the surface treatment of stone slabs - granite, play a dominant role in the mechanization of grinding processes and performing supporting operations [1, 9]. The use of diamond tools for stone processing in Poland dates back to 1965. The beginnings of the development of the stone processing industry were related to the import of diamond tools, the leading role of which was played by Diamant Board from South Africa. At the end of the 70s of the last century, an important step in the development of abrasive tools production technology was the start of production of domestic diamond segments. The use of diamond tools brings certain benefits, which include: high efficiency, high quality of the product after machining. Optimum working parameters affect the efficiency, tool wear, and the quality of the machined surface, which, with the minimum number of disc passes over the workpiece, should ensure uniformity of the surface machining quality. The measure of the quality of granite slabs is the uniformity of roughness or the degree of polishing on the entire treated surface and the long-term preservation of the given texture features. The quality of diamond grinding discs depends primarily on the parameters set by the manufacturer, such as: disc diameter, dimensions and number of segments, their geometry, type, granulation and concentration of diamond, type and hardness of the binder. The quality of the tool segment is additionally expressed by the parameter of the holding force of the abrasive grain in the binder [15]. The main factors influencing the efficiency of grinding include the configuration of the arrangement of abrasive segments on the surface of the machining head. Material parameters of diamond segments, i.e. diamond powder granulation, diamond concentration in the abrasive segment, type of diamond powder, binder hardness and optimal kinematic parameters of work, were also considered as the leading factor of abrasive efficiency.

2. Grinding wheels with diamond abrasive on synthetic binders

Discs equipped with abrasive segments are used for the stone surface treatment process, examples of design solutions are presented in Tab. 1. In addition to the presented solutions for the construction of grinding wheels with diamond segments on a metallic bond, in the construction industry, when processing granite, solutions of discs with inserts of diamond segments on synthetic bonds, mounted on the base disc, are used.

From the analysis of the literature [12, 13] regarding the assessment of factors influencing the work of the abrasive wheel during surface treatment, a variety of relationships for the effective surface treatment process are indicated. In the first stage of the work, the need to check the behavior of the new geometries of the abrasive wheel was defined as the initial task. The purpose of determining the effectiveness of the abrasive impact, depending on the abrasive elements for the construction of the circular geometry of diamond disc segments on synthetic bonds, was to carry out calculations of the influence of variables - dimensions and arrangement of abrasive segments on the base surface of the disc. Based on the analysis of the literature [12, 13], a preliminary hypothesis was put forward, according to which the abrasive efficiency of the grinding wheel is expressed by the uniformity of the distribution of grain cracks on the workpiece after passing the wheel on the square of the base surface with a side equal to the diameter of the wheel (D).

Table 1

Known design solutions for abrasive discs for surface treatment of stone slabs [2, 10, 14].

Photography	Name	Diameter (mm)	Diamond powder granulation
	Plastic strips	100	#50
	Peel off Velcro	100	#50
		100	#100
	Type ZL-16K	100	#50

The segments arranged on the circular base surface of the disc may have various forms and may be arranged in various ways. This indicates the legitimacy of seeking to increase the abrasive efficiency in new constructions by rationalizing the parameters of the relationship between the geometric form and the size of the abrasive elements of the segments. These activities should be preceded by the calculation of the geometric effectiveness of the impact of the new geometrical shapes of the friction elements of the discs with their assessment and verification on the abrasive test stand, verified by the post-machining roughness distribution on the machined surface, when assessing the disc's impact area across the width of its impact diameter.

3. Modeling the geometry of a grinding wheel for processing granite

Modeling of the geometry of the grinding wheel for granite processing indicates a variety of occurring phenomena and modeling methods, including the analysis of tools for an effective surface treatment process. As the first research task, the need to calculate the indicators of the geometric effectiveness of the impact on the machined surface of round diamond segments was determined.

A useful tool for the geometrical analysis of the construction of discs with given construction parameters is a computer program developed at the Częstochowa University of Technology [13, 16], which allows modeling of machining tools for specific parameters of the disc operation. The starting point in the modeling of the disc structure according to the method is to check the influence of the working geometry of the tool during the movement on the effectiveness of the impact on the machined surface. The methodology is very useful in determining the abrasive efficiency of grinding wheels.

The modeling program allows you to take into account all types of movement by formulating the path of disc displacements. The characteristics of the disc motion path include determining the position of the disc center and its kinematic parameters (speed of translational and rotational motion) at the beginning and at the end of the next stage of motion. A detailed

description of the computer program for analyzing the effectiveness of the geometric impact of discs is described in publications [13, 16].

Conflict Setting

The aim of the work is to develop a new effective design and material of the disc for abrasive machining of granite.

Research Results

For the purpose of assessing the effectiveness of the impact of different disc geometry solutions, calculations were carried out and the effectiveness of the impact of the abrasive segments was compared, determining the value of the geometric impact efficiency (S_o) of the disc with a diameter of 100 mm, for 4 variants of the geometry of the rubbing segments as in Fig. 1-4, for each variant a disc with a diameter of 100 mm with an internal hole d = 15 mm, where 4 variants of abrasive segments were arranged on the full ring, assuming a kinematic load of ω = 960 rpm and a forward speed of V_p = 0.01 m/s. In the calculations, the effectiveness of the geometric impact S_g was determined , presented on the charts, for which the minimum, average and maximum geometric efficiency as well as the standard deviation index and the relative deviation index were determined.

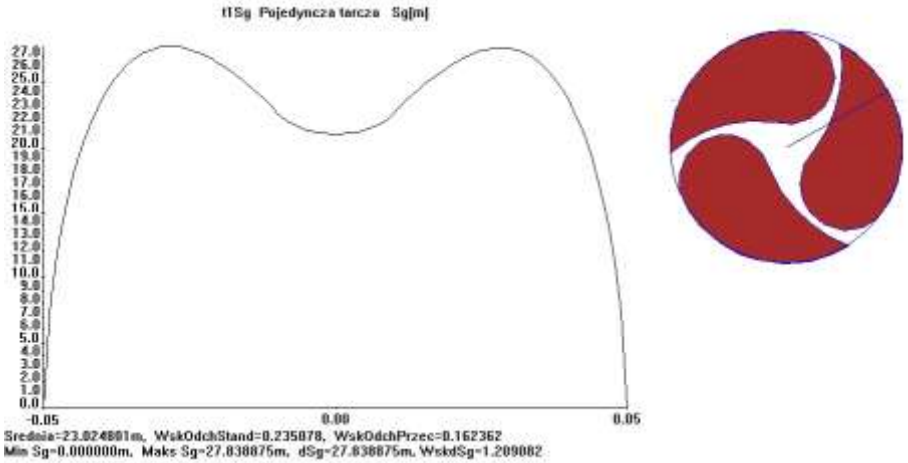


Fig. 1 Graph of the effectiveness of teardrop-shaped geometry on a 100 mm diameter disc

Graphs from the performed calculations of the geometric effectiveness of the impact of the rubbing surface of the segments against the machined surface indicate that the most effective solution in terms of the impact effectiveness has the variant as in Fig. 1, the graph S g in relation to the sensor lines $_{shows}$ high efficiency of the interaction of the working surface with the machined surface. It is intentional to point out that the round geometries of the segments of the diamond grinding wheels have an influence on the uniform distribution of the graph of the effectiveness of the action of round grinding wheels.

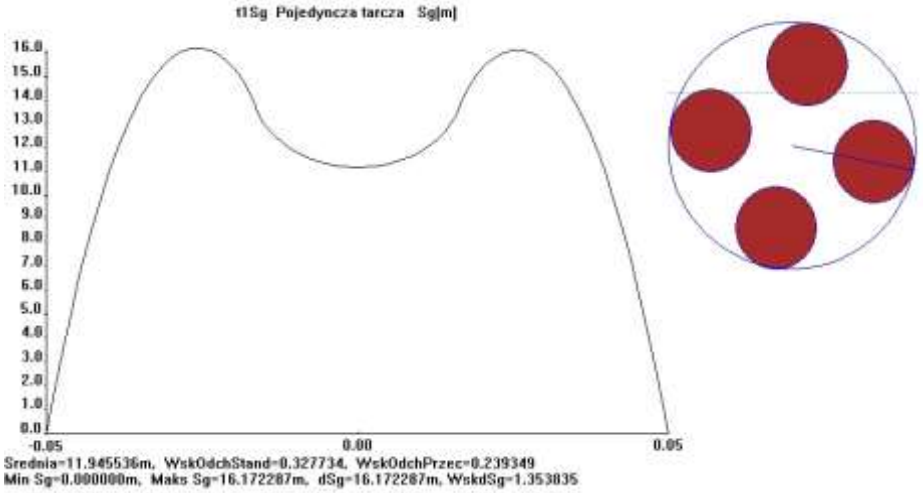


Fig. 2 Graph of the impact effectiveness of the geometry in the shape of circles arranged on a 100 mm diameter disc

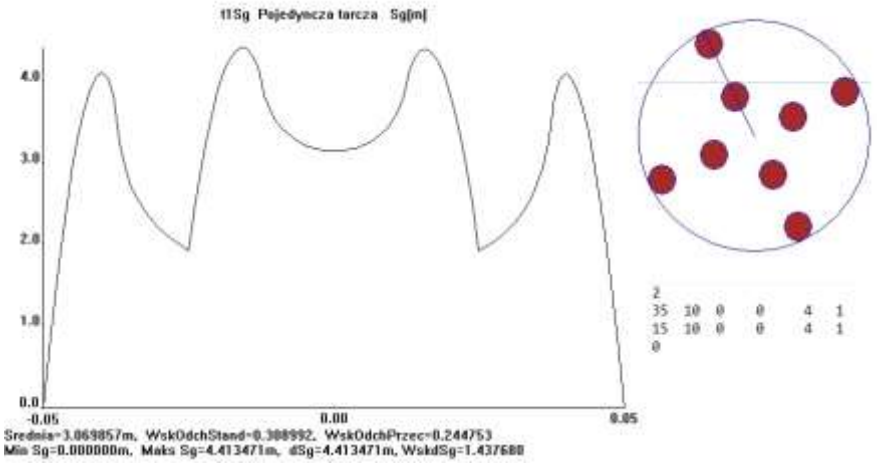


Fig. 3 Graph of the impact effectiveness of the geometry in the shape of circles arranged on a 100 mm diameter disc

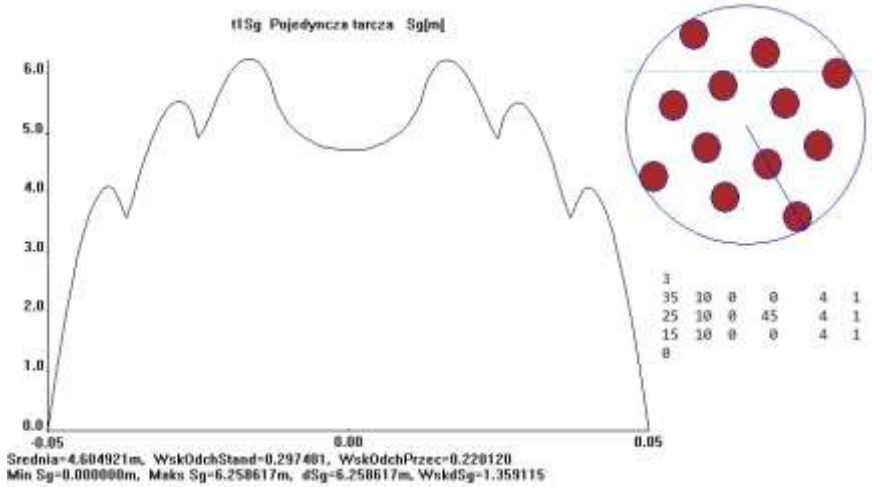


Fig. 4 Graph of the impact effectiveness of the geometry in the shape of circles arranged on a 100 mm diameter disc

Taking into account the technological conditions and economic efficiency, it is also advisable to conduct research in the field of shaping circular abrasive segments with their use to find rational relationships to increase the efficiency of the grinding process.

Evaluation of granite surface roughness after impact with discs

In the tests, the abrasive efficiency of the disc was checked in terms of the distribution of roughness after a trace left on the polished surface of a granite plate along the full diameter of the disc at a length of 10÷50 mm.

The measurement of the roughness distribution was determined from the center of the disc in 5 sections of 8 mm on the full length of the radius of the grinding disc, as in Fig. 5.

Fig. 5 Measurement of roughness distribution

After abrasive treatment were used in the assessment . Measurable parameters are used to assess surface roughness , such as:

R_a – mean authentic deviation of the profile from the mean line [μm],

Rz - the average height of the profile roughness in 10 points for the 5 highest and 5 lowest measuring points along the measuring length [μm] ,

R_{max} - the highest height of the measurement unevenness from the lowest point to the highest measurement point [μm],

The measurement of the profile after the work of the new disc design was carried out with an electronic measuring tool from Mitutoyo , type JS-21. The results of measuring the roughness of prototypes and known structures are summarized in Tab. 2 of the post-machining trace of new design and material solutions for grinding wheels for granite processing. The effect of the target was tested on 3 samples for each type of target. The impact of the abrasive process was carried out without the use of coolant for each disc for 30 s without the sliding motion.

The roughness measurements show that the original prototypes of grinding wheels have an even distribution of roughness in relation to industrial structures. Due to the lack of feed during the experimental tests of the impact of grinding wheels on the machined surface of a polished granite plate with an initial roughness of $R_a = 0.21$ μm , the depression left after the impact of the tested prototypes of the wheels was larger than industrial structures, which results in a high parameter of R_a .

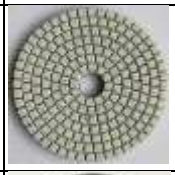
Table. 2

Shield type	Hardness [HLD]	S_g [m]	Ra [µm] _				
prototype of the shield with a polyester resin binder	560	15.66	3.43	3.55	3.59	3.58	3.60
prototype of the shield with epoxy resin binder	550	15.66	3.56	3.59	3.61	3.61	3.62
industrial construction of the disc on a polyester resin binder	630	13.55	3.28	2.33	2.25	2.29	1.07

The collective results of calculations of the average geometric effectiveness of the impact of the shields (PR1÷PR3 and Ak) along with the characteristic parameters of the geometric analysis are summarized in the Tab. 3.

Tab. 3

Collective results of calculations of the geometric mean effectiveness of the shields (PR1÷PR3 and Ak) along with the characteristic parameters of the geometric analysis [own study]

Lo.	Surface structure	Impact effectiveness indicators				The share of the geometry of the working surface of the disc structure	
		Set parameters n (rpm)	Average impact efficiency Sg (m)	Standard deviation index σ	Relative deviation index	Active segment area P_{as} [cm^3]	Total area of excavated material removal channels P_{ku} [cm^3]
PR1		660	11,310	0,305	0,221	58,20	19,51
PR2		660	11,867	0,319	0,253	59,15	18,56
PR3		660	13,560	0,253	0,153	59,71	18,00
Ak		660	15,655	0,338	0,245	41,76	33,60

Based on the results of the numerical tests and the collected key data on individual disc designs, i.e. the active surface of the segments and the total area of channels for the

removal of excavated material and the supply of coolant, it was found that the solution proposed by the author of the shape and arrangement of segments on the working surface has a higher geometric efficiency. impact by 13.38% from the PR3 shield, which has the highest parameter (S_g) among the analyzed industrial shields. Moreover, it should be noted that the mentioned shield (PR3) has the lowest standard deviation index ($\sigma = 0.253$) among all the analyzed cases. However, it is related to having the largest active surface of the segments, $P_{as} = 59.71$ cm^2. When analyzing the original solution (Ak), a slightly higher standard deviation index was noticed ($\sigma = 0.338$) in relation to the analyzed discs used in the stone industry (PR1÷PR3). This is correlated with having a lower active surface of the segments by an average of 41.33% compared to industrial machining discs, and at the same time a larger surface for removing the excavated material and supplying coolant during operation by an average of 55.63%. It should be noted that the standard deviation indicator itself in the analyzed case is not a key parameter for assessing the geometric effectiveness of the grinding wheel. The presented results from the numerical tests confirm the rational selection of the geometry of the working segments and their arrangement on the base surface of the abrasive disc.

Conclusion

The performed calculations of the geometric effectiveness of the interaction indicate the desirability of conducting further research for the geometry of the circular friction segments that fit into the teardrop surface.

Calculations of the effectiveness of the geometrical impact of discs with round segments show a high impact value, which was confirmed by the measurement of post-machining surface roughness, instrumental tests on five measurement sections, each 8 mm long, on the length of the disc radius D = 50 mm, for which a homogeneous roughness distribution was demonstrated, which is $R_a = 3.61$ μm , with synthetic diamond powder grains of grain size 40/45#, with 25% concentration of grain deposited in segments on a polyester binder with a hardness of 460 HLD.

The new construction and material solution of the grinding wheel has a more even distribution of post-machining roughness and has a higher effectiveness of impact compared to the currently used construction and material solutions in industry.

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ՆՈՐ ՀՂԿԱՄԱՇԻՋ ՍԿԱՎԱՌԱԿ ԳՐԱՆԻՏԻ ՀՂԿՄԱՆ ՀԱՄԱՐ

Պավել Ռայչիկ
Չեստախովայի տեխնոլոգիական համալսարան

Ներկայացված է գրանիտի հղկող մշակման նոր արդյունավետ կառուցվածքի և սկավառակային հղկամաշիչ նյութի մշակումներ: Խնդիր դրվել էր նվազեցնել մակերևույթի մեխանիկական մշակման ժամանակը: Առաջարկվել է սկավառակի երկրաչափական բնութագրերի նոր լուծում: Մշակվել է նյութերի բաղադրության և հղկող հատվածների նոր երկրաչափությամբ սկավառակների նախատիպի պատրաստման տեխնոլոգիա: Բերվում է լաբորատոր փորձարկումների տվյալների վերլուծություն:

Բանալի բառեր. հղկող սկավառակ, հանքանյութով մակերևույթիմշակում, ալմաստե սկավառակ, մակերևույթի խորդուբորդություն:

НОВЫЙ АБРАЗИВНЫЙ ДИСК, ПРЕДНАЗНАЧЕННЫЙ ДЛЯ ШЛИФОВАНИЯ ГРАНИТА

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Пердставлена разработка новой эффективной конструкции и материала диска для абразивной обработки гранита. Задача поставлена с целью сокращения времени механической обработки операции плоскошлифования за счет обеспечения

равномерной шероховатости поверхности. Предлагается новое решение геометрии диска. Разработана технология изготовления прототипов дисков с новой геометрией абразивных сегментов. Приведен анализ результатов лабораторных испытаний.

Ключевые слова: шлифовальные диски, минеральная обработка поверхности гранита, алмазные диски, шероховатость поверхности.

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INTRODUCTION OF THE LATEST TECHNOLOGIES IN MUSEUMS: CREATING AN ELECTRONIC ARCHIVE AND DATABASE

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Abstract

In the context of museum communication with visitors, the primary goal is interactive communication. Currently, the most relevant aspect is not the instrumental role of cutting-edge technologies, but rather their potential for enhancing traditional museums. Moreover, it is particularly intriguing to assess whether these technologies can fundamentally impact a conservative museum institution, open new horizons in virtual space, and attempt to envision the museum's future—undoubtedly closely tied to the overall course of cultural evolution. Introducing people to the museum, fostering their attachment, and making them regular visitors and friends of the museum remain steadfast objectives for its successful existence.
The presence of a museum in a social network makes both its virtual and real existence visible and tangible. Museums and their collections can be presented from a new perspective while preserving their individuality and relevance for a new audience. The application of innovative technologies and the implementation of automated systems significantly enhance the efficiency of solving tasks that museums encounter throughout their existence.

Keywords: digital archive, digital copies, features of the museum database, paper document fund, passport of the museum unit, survival strategy, relevance, network interaction.

Introduction

With the introduction of innovative technologies into our museum life, the creation of museum databases solves the overarching task of the existence of an architecture museum. The transformation of thinking, the entire modern way of life, a significant change in museum mentality require an urgent solution to the priority issue for museums - their «digitalization».

Our goal is not just to create an electronic archive, but a complete database of the museum. To create a database in a museum means to make it modern, competitive, relevant for visitors, capable of communicating with museums around the world «on equal terms». The museum's database is an interactive automated system that includes: search algorithms,

several catalogs (exhibition catalog, visitor reviews, inventory lists, etc.), the museum's website, pages on social networks, correspondence with partners, and so on [1]. The entire history of life and plans for the future of the museum - in the electronic database, as a guarantee of safe existence for many years.

There are various approaches to creating electronic museum archives and databases, as well as their application in practical tasks of managing museum collections and popularizing cultural heritage. It is no longer possible to ignore the fact that any museum must be represented not only in the real world but also in the internet space. How, where, on which platform, in what volume and sequence should this happen [2]?

Without a clear, universal survival guide or a definitive plan (specifying what modern museums should and shouldn't do), each museum has had to navigate this path independently. The transition from extensive paper archives to digital formats has been a significant undertaking. Museums have addressed old challenges, encountered new ones, and forged their own paths. Our architectural museum, the National Museum-Institute of Architecture named after A. Tamanyan, has developed a survival strategy and tactics through empirical methods. The experience gained from creating an electronic archive allowed us to draw several conclusions: Digitization Process: All information existing in paper form must be meticulously reviewed (including authorship, dates, etc.) and gradually digitized as we read and catalog paper files. To achieve this, we first need to establish a suitable Classifier for describing each storage unit and create a tree-like schema for systematic organization (structuring the distribution of objects into sections, subsections, etc.) [3]. Database Considerations: The database is a separate entity. How should we store information that is not suitable for public use on the internet? Should there be a separate online museum database? If so, which platform and resource should host it? Challenges in Automation: When implementing automated (or even simple electronic) systems for collection management, storage, and research, challenges often arise related to information structuring, standardizing terminology, and defining classification features. Transitioning to automated work does not merely involve transferring manual tasks to computers; it represents a different level of work with distinct tasks and objectives [4].

Conflict Setting

In every museum (and ours is no exception), there is a colossal volume of information accumulated and systematized by each department or individual employee according to their own understanding. The first step will be to compile a registry of all these disparate and diverse databases, assessing their volume and quality. Since the same information about an object (the same document) appears repeatedly at all stages and among all employees, or conversely, different information about the same object (several documents on one topic, etc.), it is quite evident that there is a desire to automate this process by creating a database.

Research Results

All information available in paper form must be verified and digitized step by step, as it is read and paper folders are taken into account. For this purpose, a Museum Unit Passport

has been developed – its identification card. This document contains all the necessary information about a specific exhibit for integration into the electronic archive, thereby uniting and regulating the work of all employees. Additionally, the passport contains and updates information obtained throughout its entire life. Thus, with the introduction of mandatory passportization for incoming and existing museum valuables, questions of identification, indexing, and integration into the museum's database, and consequently into the overall system of museum connections, are resolved. Digitized information can be distributed across files on each specific computer as needed [5, 6]. But how? Should jointly developed criteria and standards for filling out electronic documents exist among all employees? Similarly, how should the scheme for their storage and accounting in the common database be constructed through collaborative efforts? What goal should be prioritized when creating our museum archive's database? What are the priorities when translating museum collections into digital format [7]?

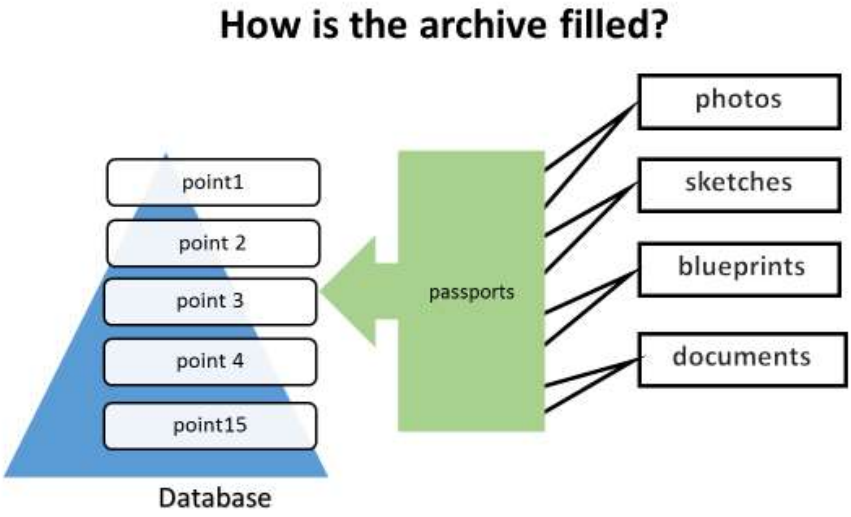

Fig. 1 The museum's digital archive administering algorithm.

In the first place, should we digitize what has already been identified? Or should we digitize new materials as they arrive? Or perhaps prioritize digitizing the paper materials that are in dangerously poor condition? Or focus on the most valuable ones? Who is the archive primarily created for, and for what purpose? Is it for students and researchers? For the museum's needs? To preserve collections? For users? For future generations? Is it for record-keeping or ease of searching for specific documents? Transparency and accessibility for a wide audience in the online space? Should the operator responsible for their «digitization» consider identifying new, unknown documents (i.e., research work), or should we refrain from addressing global tasks during the construction of the museum archive database [8]?

These questions were addressed by the museum during its work. Additionally, it became clear that when the structure of the museum archive database is clear, a tree is drawn, and a well-defined order of working with paper carriers (documents) is established, but without a carefully thought-out strategy for its filling, issues in future work cannot be avoided.

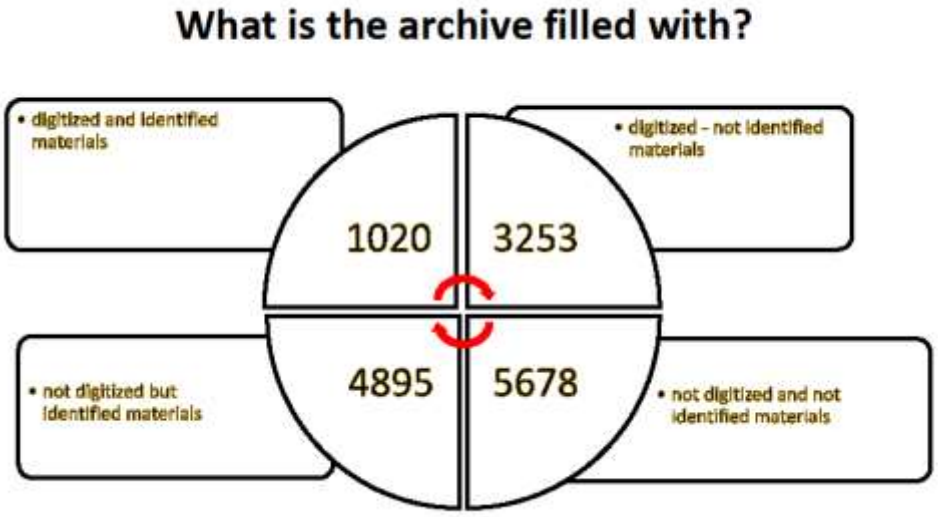

Fig. 2 Structure of the digital archive database of the museum.

Considering the above, work can be organized in such a way that the data input section from multiple operators is constructed like a large factory: each operator has their own specialization, and each operator enters or verifies their field in the database. However, it is crucial to organize everyone's work as a unified team with the goal of introducing consistent terminology, structuring information, and developing classification principles, among other things. In this context, extensive discussion within the museum team about terminology, description structures, and the acceptance of compromise decisions plays an important role—essentially, the «rules of the game» without which one would be at an impasse. Since the initial users of the automated accounting and storage system are museum employees, the chosen strategy for populating the database plays a significant role in the successful implementation of electronic document management.

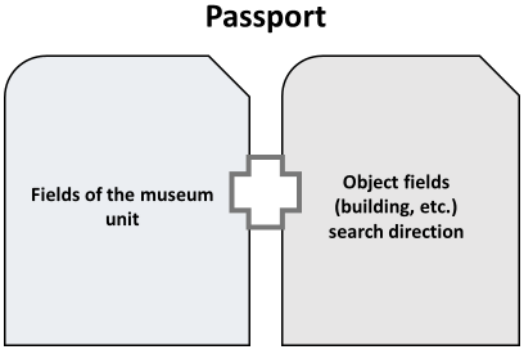

Figure 3. Passport of the museum unit.

Working within an automated system is based on the psychology of collective work. Information enters the database through various paths during different museum operations.

Consequently, it is sometimes impossible to determine who entered which information, where they obtained it from, and whether there is a likelihood of another colleague reusing the same material when adding it to the electronic archive.

Instead of scattered «individual» information, a shared information resource emerges—one whose quality depends on the efforts of all involved. Creating this resource requires increased responsibility from each person contributing information, but it also becomes a powerful motivating factor for enhancing scientific work efficiency and enables a greater number of researchers to engage in collection processing.

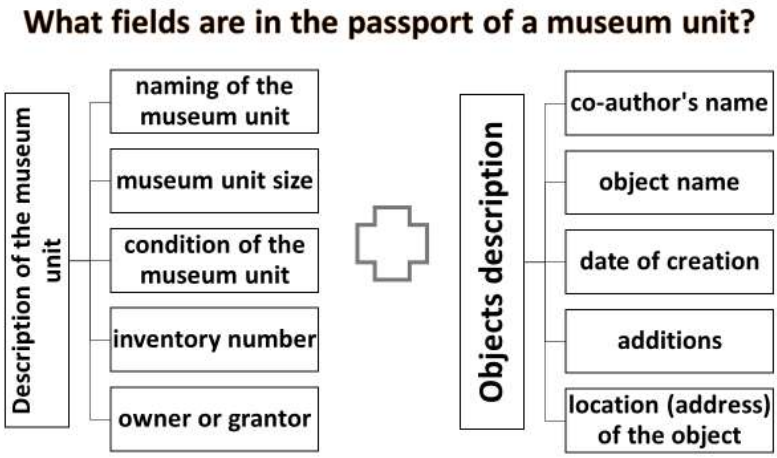

Fig. 4 Archive Organization Scheme in Accordance with the digital passports.

It is necessary to note another aspect related to the human factor. Until the database is more or less fully populated (the entire museum collection or at least a significant part of it), it cannot be effectively utilized. Thus, during the database population, museum staff face an additional burden, which is quite substantial, and the benefits of the new system are not immediately apparent. Nevertheless, if from the very beginning, employees work with a database-oriented mindset, and the entire team clearly understands that the conceptual capabilities of any information array, collected and systematized by a specific staff member, significantly increase when properly structured (and archived according to general standards) and integrated into a comprehensive network of relationships, many problems and errors can be avoided in the long term.

The uniqueness of a museum archive lies in its fleeting nature—it is as ephemeral as it is unique. The only known method to safeguard an archive from disappearing is to digitize it. In other words, a paper archive must inevitably have a digital, electronic alternative, especially considering the typical errors that occur during the creation of a museum database.

An electronic archive is not merely an electronic exhibition, a digital museum, or a repository of paper analogs. It represents an extension of possibilities—a modern approach to problem-solving, including those specific to museums.

For instance, electronic exhibitions can be created, which minimally correlate with the museum's database and operate autonomously. These could include interactive games or educational tests for children based on the museum's collection, without directly relying on the electronic archive. The scope of the electronic exposition depends on the specific goals set for it.

This endeavor is a long-term project that may span years, but it is essential. By associating registration numbers (passport numbers) with museum artifacts in the existing paper catalog and subsequently in the electronic catalog, we can predict that the application of such a unified identifier will expand not only within the inter-museum context but also at the national and international levels. This way, the museum won't need a separate registry of registration numbers for individual storage units.

For the second decade now, both national and international projects aimed at expanding access to cultural heritage for the population and specialists have been successfully emerging worldwide. There are numerous platforms, applications, projects, and similar initiatives with growing content and possibilities.

Are museums compelled to change in the modern world? Undoubtedly, we are evolving, but is it happening rapidly and strategically enough? Are all changes beneficial for museums? Yes, if a museum has a well-thought-out strategy for modification and modernization even before its inception [9].

At present, the most challenging task is not attracting visitors or gaining attention, but retaining it. On one hand, we are inherently non-competitive because we are museums! On the other hand, without representation in the online space, we become less competitive. However, this presents a dilemma.

By providing the same opportunity as, let's say, the film industry—enjoying our product without leaving home, sitting on the couch, and munching popcorn—we deprive ourselves of the chance to interact with visitors face-to-face.

Exaggerated expectations, consumer attitudes, and the widespread consumption of intellectual fast food lead to a reluctance to work on ourselves. Yet, visiting a museum is also a form of work—an overcoming of boundaries and stereotypes. Who willingly wants to labor upon entering a museum, treating it as a place of «recreation»?

«It is necessary to immerse ourselves in the digital flow to remain relevant with each generational shift» and not lose the existing audience while also capturing new ones. This ensures that we keep up with the mentality of a modern successful brand—an informational and cultural resource.

Any museum, even the smallest one open to visitors, should have a website—a «business card» with promotional information. In recent years, the face of a museum directed towards the open information space has become an increasingly significant factor. To compete and thrive in the modern world, it is crucial for a museum to have such an 'internet face. After all, most people turn to the internet when seeking information, including researching museums and exploring their collections.

In the future, the number of virtual museum guests will surpass the count of physical visitors, and a central role in the museum's public relations system may be occupied by «Internet relations» [10].

Conclusion

When considering a museum website or a Facebook page as a means of communication with the public, we address one of the most pressing museum challenges: the issue of «gallery

congestion». Prioritizing the creation of a digital archive becomes a key aspect of a contemporary museum's strategy. However, it is essential to understand that building an electronic archive is a long-term endeavor that requires time and effort. It is a minimum program. Transitioning to a fully functional database can take years, but it ensures survival.

The virtual museum website represents the face of the physical museum. Most people perceive us based on our online presence. Despite the experiences and practices of other museums, each institution adapts to the «new era» in its unique way.

Once again, defining the ultimate goal, tasks, and future strategy within the context of cutting-edge communication technologies is a top priority for modern museums. Now, a museum represented in the online space can seamlessly integrate into global platforms, media resources, virtual events, social networks, and mobile applications.

And importantly, the application of information technologies in creating a digital archive at the National Museum-Institute of Architecture named after A. Tamanyan undoubtedly strengthens the museum's brand in the market and fosters partnerships with online platforms and social networks. It makes architectural heritage more accessible and comprehensible to a wide audience, popularizes and preserves it for future generations, and contributes to education and research in this field.

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ԱՐԴԻ ՏԵԽՆՈԼՈԳԻԱՆԵՐԻ ՆԵՐԴՐՈՒՄ ԹԱՆԳԱՐԱՆՈՒՄ: ՏՎՅԱԼՆԵՐԻ ՇՏԵՄԱՐԱՆԻ ԹՎԱՅԻՆ ԱՐԽԻՎԻ ՍՏԵՂԾՈՒՄ

Ե.Է. Վարդապետովա
Ալեքսանդր Թամանյանի անվան ճարտարապետության ազգային թանգարան-ինստիտուտ

Թանգարանի և այցելուների շփման հարցում հիմնական նպատակը ինտերակտիվ հաղորդակցությունն է, և այսօր ամենաարդիականը ոչ թե նորագույն

տեխնոլոգիաների գործիքային դերն է, այլ ավանդական թանգարանի ներուժը բարձրացնելու համար դրանք օգտագործելու հնարավորությունը: Ավելին, հատկապես հետաքրքիր է գնահատել, թե արդյո՞ք նոր տեխնոլոգիաների կիրառումն ի վիճակի է հիմնովին ազդել պահպանողական թանգարանային հաստատության վրա, վիրտուալ տարածքում բացել նոր հորիզոններ, փորձել ներկայացնել թանգարանի ապագան, անկասկած, սերտորեն կապվելով մշակութային էվոլյուցիայի ընդհանուր ընթացքի հետ: Մարդկանց թանգարանի նյութերին ու աշխատանքներին ծանոթացնելը, հետաքրքրություն արթնացնելը և նրանց մշտական այցելուներ և ընկերներ դարձնելը անխոս թանգարանի հաջող գոյատևման գրավականն է:

Այսպիսով թանգարանի առկայությունը սոցիալական ցանցում տեսանելի և շոշափելի է դարձնում նրա և՛ վիրտուալ, և՛ իրական էությունը: Թանգարանը և նրա հավաքածուները կարող են ներկայացվել նոր տեսանկյունից՝ պահպանելով սեփական ինքնությունը և արդիականությունը նոր լսարանի համար: Նորարարական տեխնոլոգիաների կիրառումը և ավտոմատացված համակարգերի ներդրումը կարող են զգալիորեն բարձրացնել թանգարանի առջև ծառացած խնդիրների լուծման արդյունավետությունը, որոնց նա բախվում է իր կյանքի ընթացքում:

Բանալի բառեր. թվային արխիվ, թվային պատճեններ, թանգարանային տվյալների բազայի առանձնահատկություններ, թղթային փաստաթղթերի հավաքածու, թանգարանային միավորի անձնագիր, գոյատևման ռազմավարություն, ցանցային փոխազդեցություն:

ВНЕДРЕНИЕ НОВЕЙШИХ ТЕХНОЛОГИЙ В МУЗЕЕ. СОЗДАНИЕ ЭЛЕКТРОННОГО АРХИВА И БАЗЫ ДАННЫХ

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В вопросе коммуникации музея с посетителями основная цель – это интерактивная коммуникация, и на сегодняшний день наиболее актуальна не инструментальная роль новейших технологий, а возможности их использования для усиления потенциала традиционного музея. Более того, особенно интересно оценить, способны ли технологии принципиально повлиять на консервативный музейный институт, открыть новые горизонты в виртуальном пространстве, попытаться представить будущее музея, без сомнения, тесно связанное с общим ходом культурной эволюции. Познакомить людей с музеем, создать у них привязанность, сделать их постоянными посетителями и друзьями музея - одна из неизменных целей его успешного существования .

Т.о. присутствие музея в социальной сети делает зримой и ощутимой как виртуальную, так и реальную его ипостась. Музей и его коллекции могут быть

представлены в новой перспективе, сохранив при этом свою индивидуальность и актуальность для новой аудитории. Применение инновационных технологий, внедрение автоматизированных систем позволяет значительно повысить эффективность решения задач с которыми сталкивается музей на протяжении всей жизни.

Ключевые слова: цифровой архив, цифровые копии, особенности музейной базы данных, фонд бумажных документов, паспорт музейного подразделения, стратегия выживания, актуальность, сетевое взаимодействие.

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THE INFLUENCE OF THE NATIONAL MENTALITY ON THE MONUMENTAL WORKS OF SARGIS BAGHDASARYAN

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Abstract

Monumental art can have various manifestations. The sculptor's creative work is meant to give people an additional spiritual charge. Therefore, the responsibility of the artist towards the people is great, which expects from the artist emotional intensity, communication of high spiritual values. The high ideological and artistic qualities and the individual mastery of the sculptor are the main criteria for the creation of lasting creative values. In the article, it is justified that Sargis Baghdasaryan was able to successfully put the profile of the national mentality formed during the centuries-long struggle for existence of the Armenian people into the basis of his monumental sculptures and obtain works that do not lose their modernity going into the future.

Keywords: sculpture, monumental art, national mentality, society, worldview

Introduction

In the second half of the 20th century, the processes leading to globalization in the world, in terms of ensuring scientific and technical progress, although it provided noticeable results, nevertheless led to the integration of different peoples. This process can have particularly dangerous consequences for small nations, and the question arose in the direction of developing a way to preserve the national identity of the Armenian people, its culture and way of thinking. The mindset of the people is one of the main factors affecting the course of historical processes and reforms, which is especially important for the Armenian society. This issue was of particular importance for the Armenians living in the autonomous region of Nagorno Karabakh, which was part of Azerbaijan.

To solve this problem, it was necessary to assess the features of spiritual values that existed among Armenians living in the absence of political freedom, to find out how they affect people's social and individual life. In order to influence the formation of mentality, it was necessary to transfer from generation to generation and to consolidate the historically established, spiritual, ideological and cultural values of the Armenian people, to enrich them with universal values that fit into the moral perception.

A.A. Ohanyan

THE INFLUENCE OF THE NATIONAL MENTALITY ON THE MONUMENTAL WORKS OF SARGIS BAGHDASARYAN

The understanding of thinking gives the Armenian people the opportunity to understand their own essence, to learn their history and culture. The perception of thinking with all the richness of its manifestation is based on a broad basis of integration of many types of knowledge, and the sociological analysis of this phenomenon provides an opportunity to predict the behavior of the people and its individual representatives in different situations. Communicating the values of world culture is a necessary prerequisite for developing and developing one's own art directions, while imposing them to lead to serious consequences. In particular, they can affect an individual at a subconscious level, causing a change in worldview and behavior, disrupting the manifestations of national spiritual characteristics.

Art acts as a way for a person to understand and appreciate the world in which they live. In this area, a person's ideas about the world are most comprehensively reflected, which he perceives through his inherent systemic network of worldviews. Art provides a comprehensive understanding of a person's spiritual values. Consequently, art as a subsystem of culture occupies a key position in it, being its center, which captures the cumulative impact on all aspects of a person's life. Art creates artistic models of the relationship between the world and man, forms for the individual an image of a worldview that can preserve in cultural memory the way of life of a person at different stages of the development of civilization.

He forms and aesthetically develops the socio-cultural values that are transferred to the level of personal meanings of the individual, shapes his value orientations and encourages him to choose an ideal or develop it [2, 3].

The ideals that manifest themselves in solving practical problems, while at the same time regulating these processes, play the role of purposeful motivation in the activity of the individual.

Conflict Setting

The subject of the study is the way of thinking of the Armenian people, the characteristics of the influence of art on the formation of the Armenian worldview. Considering art as a tool for the formation of the mentality of the Armenian man, the task was to analyze the technologies used in the monumental works of the sculptor Sargis Baghdasaryan, with the help of which the content structure of the mentality of the Armenians living in Armenia and the Nagorno Karabakh Autonomous Region during the Soviet period was refined, laying the basis for the conservation of national values and public behavior within the expected geopolitical processes.

Research Results

The ideological possibilities of monumental sculpture are related to the visualization of images used by state propaganda. In propaganda, images are more effective than logical arguments. This is explained by the peculiarity of the individual's visual thinking. The monumental sculpture is perfect in this respect: it is both visual and pictorial [7].

In expansion to picking up proficient instruction, the sculptor learns life lessons, developing up to be a creative person. There can be no high-quality art without inventiveness; subsequently, a conveyor of the Creator's tall culture can help within the advancement of tremendous masterpieces. Standard thinking can diminish the impact of a monument that has

been within the works for a long time and cannot be expelled from an exhibition, such as a painting.

The study of mind originated in the twentieth century at the “Annals” Research Center, where the focus was not on leader actions or event descriptions, but on identifying all social links that have existed for as long as feasible. Proponents of this tendency investigate the mass perception of people within a certain age, the evolution of value systems across time, and the issue of historical memory [1].

Monumental sculpture is a type of fine art whose works, as a rule, are dedicated to significant historical events or erected in honor of great people. The characteristic features of monumental sculpture are large size (as a rule), unity of content, harmony with the architectural and spatial environment. A monumental sculpture can be a monument, a memorial, a statue, a bust or a rather large relief. Such works are usually created to be placed in a specific location to complement the architectural appearance of a building, plaza, square, street, etc. Monumental sculptures are integrated with the surrounding environment.

In this sense, Sargis Baghdasaryan departed from the generally accepted approach and created the ideological work of the monumental sculpture "We Are Our Mountains" (1967) in the belief that ordinary people create history (Fig. 1).

Fig. 1 ***Sargis Baghdasaryan's work "We Are Our Mountains"***

We are placing ordinary people at the epicenter. It should also be noted that monumental sculpture has always been ideologically linked to dominant political forces [8].

Therefore, the installation of a monumental sculpture "We are our mountains" on the territory of the NKAO, part of the Soviet Azerbaijan, can be seen as an unusual phenomenon and even an achievement for the Armenian people.

In this sense, if we compare the sculpture “We are our mountains” with the monumental work “Worker and a collective peasant” (Bela Mukhina) depicting the common

people making history" (1937), we can see that there is an obvious ideological difference (Fig.2).

Fig. 2 ***Vera Mukhina's work "Worker and a collective peasant"***

Vera Mukhina's work "Worker and a collective peasant" was so powerful, swift and possessed of extraordinary unity that it raised the monumental art of the world to unprecedented heights, and she herself experienced true creative inspiration, like the ancient "Icarus" and the joy of conquering heaven [10]. The sculptor, who depicted a young man and a girl with a hammer and sickle in their hands, was thought to personify the owners of the Soviet land - the working class and peasants. Until Mukhina, no one had ever achieved such versatility in monumental and decorative sculpture in the first half of the 20th century. Despite its monumentality, this composition is "light", actively penetrating the surrounding space and creating a unique aura around itself. In contrast to the work "Worker and a collective peasant" in which the talented Vera Mukhina disseminated the undeniable power of the Soviet state through the image of the working class and the simple peasantry, which underlies the ideological foundations of socialism. The monument reflects two people from Artsakh, an elderly husband and wife, who, with their appearance and features, symbolize not only the longevity of the people of Artsakh known all over the world, but also the longevity and eternity of Karabakh itself.

The hill on which the sculpture is placed without a pedestal is nothing more than a mountain that these two Artsakh citizens "grew up". They are also mountains, unshakable mountains of Artsakh, because their history stretches back more than a millennium. The human nature, which the sculptor conveyed in the views of these two Artsakh citizens, is also

simple and simple, as simple as everything genius is. There is calmness, wisdom and an unbreakable will to live in their own land. Broadly speaking, it is a look back at our own history, which spans centuries and is filled with struggles for the homeland and indigenous peoples [5]. According to Eleonora Nersisyan, the tufa work "We are our mountains" is a static, pyramid-like image of an ancestor with national features, a monolithic, unshakable figure of grandparents. Perhaps, it is the only monumental static work, conceived just like that and not in motion, which suggests not only that the couple is native and long-lived, but also that the rock-shaped people standing back-to-back like a mountain, symbolizing the permanence of the people, cannot be moved, as it is impossible to dislodge the mountain and the rock.

The complex monument "We are our mountains" became world famous. "Pravda" newspaper wrote that it is "the first monument in the world built in honor of longevity", because Artsakh is also considered the epicenter of the longevity of the planet Earth. Sargis Baghdasaryan answered the question "Do these figures have no legs?" "They exist, and they have put down deep roots in their land" [6].

Vera Mukhina is one of the few female sculptors in the history of monumental art who possessed an ideal sense of harmony, polished craftsmanship and a refined sense of space. Mukhina's talent is versatile. She mastered almost all genres of plastic art, from the monumental sculpture "The Worker and the Mistress" to miniature decorative statues and sculptural groups, sketches for theatrical productions, and art glass [10]. And can't the same be said about Sargis Baghdasaryan's sculptures? The problem of familiarizing the population with cultural values comes down to providing appropriate contact, if of course the individual is interested in the content of the work of art and has the ability to perceive it. To solve the problem of optimizing contacts of the cultural population, it is often necessary to apply a system of differentiated services, taking into account the diversity of interests of different groups of the population, as well as the level of their artistic training. In this respect, sculpture, in contrast to painting, has an obvious advantage, because they are usually placed in open spaces suitable for vision. Nature itself tells the sculptor what to do. opening our eyes in a mountainous, rocky country, we see faces, images, talking, sounding stones looking at us from the stones, mountains and rocks, we are enchanted by the natural creation, surrender to its magic and express our inner world through the material riches given by nature: stone, clay, copper, bronze, wakes up the emotions and ideas sleeping in the soul and mind. The sculptures of Sargis Baghdasaryan are not only images that attract the viewer: they are in movement, action, flight and running, with a deep revelation of character, biography, event.

The works of the sculptor are not only accurate, but also symbolic. Every work of Sargis Baghdasaryan bears the stamp of his handwriting, at the same time being distinguished in its type, expression, form and template, a template that has no boundary lines, is airy, as a madman escaping from a mad world "Loretsi Sakon" (bronze, decorative sculpture, Tumanian literary hero), the historical figure of "David Beck" releasing the reins of the fiery steed (rough copper), the decorative sculpture of "Meghedi" (aluminum, granite), the great poet and thinker Isahakyan, thoughtful on the paths of life, holding an inseparable cane on his back and walking without his help. the monument (bronze) in Yerevan. as if the master is one of those walking in the park who went for an ordinary walk... The statue of Hunan Avetisyan installed

in the city of Kapan is also in motion. the warrior goes with wide steps, unhesitatingly towards heroism... Sargis Baghdasaryan's sculpture "The Thinker" is placed in Carrara, Italy, where the sculptor's works have been exhibited and gained recognition, and the sandstone monument dedicated to the friendship of peoples is in Sopron (Hungary). The works of the famous Armenian sculptor are stored in the Tretyakov Gallery, the Museums of the Art of the Peoples of the East (Moscow), Lithuania, Tajikistan, and the National Gallery of Armenia. It is not surprising that the Armenian people have great masters of creation, it is surprising, no, it is astonishing and infuriating that such barbarians called Armenians raise their hands on national values, like the "Loretsi" statue placed in Tumanyan's park. They tried to steal the "Sakon" compositional sculpture several times, and then they smashed, broke the fingers and the harp of the harpist girl of the "Melody" sculpture, barbarism, which, unfortunately, is not a unique and random phenomenon in Armenia [6].

Meanwhile, monumental sculptures, as a rule, are dismantled or destroyed during global political changes, wars or revolutions. The "repression" of the monument is a ritual necessary for the visual and visual thinking of the masses, aimed at the overthrow of the heroes of the "unjust regime" [7]. Many similar cases took place in Artsakh after the 44-day war, when many sculptures were destroyed, particularly the statues of Vazgen Sargsyan and Hovhannes Tevosyan in Shushi. Similar manifestations of vandalism are found in many episodes of world history. In particular, the busts of the founders of the German Empire, Emperor Wilhelm I and Chancellor Otto von Bismarck, were also dismantled in Russia at one time [9]. Among Egyptian radical Islamists, calls are currently being made to destroy the pyramids as monuments to paganism [7].

Since the problems of culture are interconnected with the problems of national mentality, it is necessary to reveal the relationship between the concepts of "culture" and "mindset" for the Armenian person. From a sociological point of view, culture is a regulator of human behavior, a system of norms and values that regulates the behavior of a given human community. It is customary to distinguish two aspects of culture: semantic and functional.

In particular, the following features are specific to culture [2, 4].

1. Culture is a process of active human activity aimed at world perception and transformation. The reflection of the world in people's feelings, perceptions, ideas, in their individual and social consciousness constitutes the epistemological aspect of culture.
2. Culture is a set of material and spiritual values.
3. Culture is an important factor in the development of human personality and creative abilities (humanistic aspect of culture). Culture ensures the regulation of social relations of society and people's daily life (normative aspect of culture).

Art in the system of social relations, at the level of interaction between ideology, science, morality, politics, religion, gives an opportunity to reveal the features of the formation of the consciousness of an individual and different social groups and the ways of their possible change.

In the light of the systemic approach, art with its diversity of types and genres appears as a complex system of interconnected subsystems that are in dialectical interaction, including with different social systems.

A.A. Ohanyan

THE INFLUENCE OF THE NATIONAL MENTALITY ON THE MONUMENTAL WORKS OF SARGIS BAGHDASARYAN

A work of art is created within a genre. It is formed by the influence of the art school, the existence of which in turn is determined by the type of art. As levels of art function, it is customary to distinguish: 1. universal art, 2. national art, 4. individual art, other [2].

Sargis Baghdasaryan's art is markedly national, where the process of shaping the style by the sculptor goes from content to form with the preservation of the mentality of the Armenian people, when the content of the national character acquires materiality, which bears the emotional stamp of folk psychology. Sargis Baghdasaryan, bearing in himself the ethnic characteristics of the collective consciousness of the Armenian people, left a lasting mark on the cultural heritage of future generations with his monumental sculptures. Subjected to emotional and figurative transformation, the sculptor's works have provided the aesthetic and folklore traditions of the Armenian people, which in turn influence the consolidation of the ethnic characteristics of the social psychology of the society and stimulate the formation of nationalistic psychological reactions.

Difficulties in managing the processes of interaction of the population with cultural values are due to the peculiarities of the perception of works of art, the educational background of the individual, his competence in this type of art, as well as the qualitative characteristics of the cultural value. Thus, art is a real non-violent means of forming the national mentality and improving the inner world of people. Therefore, the use of art as a tool for shaping the spirituality characteristic of the national culture and the way of thinking of an individual is the most effective [2]. An individual who engages with art has a broader emotional capacity. Therefore, the influence of art on such an individual in order to form a way of thinking can be more effective.

Conclusion

Culture is a process of active human activity aimed at perceiving and changing the world. Questions of purposeful formation and transformation of individual mentality are the subject of continuous research. For the formation of the mental characteristics of the individual, effective methods and means of intervention should be sought, with the observance of moral standards and the unconditional supremacy of the rights of the individual over his own way of thinking. It is important to focus on the background characteristics of the environment in which the given society is located. Thus, it is possible not only to get arguments that point to the fundamental possibility of actively influencing the way of thinking, but also to reveal effective mechanisms of influence. Sargis Baghdasaryan was able to successfully put the description of the national mentality formed during the centuries-long struggle for existence of the Armenian people into the basis of his monumental sculptures and obtain works that do not lose their modernity going into the future.

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ԱԶԳԱՅԻՆ ՄԵՆԹԱԼԻՏԵՏԻ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ՍԱՐԳԻՍ ԲԱՂԴԱՍԱՐՅԱՆԻ ՄՈՆՈՒՄԵՆՏԱԼ ՍՏԵՂԾԱԳՈՐԾՈՒԹՅՈՒՆՆԵՐԻ ՎՐԱ

Ա.Ա. Օհանյան
Շուշիի տեխնոլոգիական համալսարան

Մոնումենտալ արվեստը ամենատարբեր դրսևորումներ կարող է ունենալ: Քանդակագործի ստեղծագործական աշխատանքը կոչված է լրացուցիչ հոգևոր լիցք հաղորդելու մարդկանց: Ուստի մեծ է արվեստագետի պատասխանատվությունը ժողովրդի հանդեպ, որը արվեստագետից ակնկալում է հուզական ինտենսիվություն, բարձր հոգևոր արժեքների հաղորդում: Գաղափարական և գեղարվեստական բարձր որակները ու քանդակագործի անհատական վարպետությունը մնայուն ստեղծագործական արժեքների կերտման հիմնական չափանիշն են: Հոդվածում հիմնավորված է, որ Սարգիս Բաղդասարյանը հայ ժողովրդի բազմադարյան գոյապայքարի ընթացքում ձևավորված ազգային մենթալիտետի նկարագիրը հաջողությամբ կարողացել է դնել իր մոնումենտալ քանդակների հիմքում և ստանալ դեպի ապագա գնացող արդիականությունը չկորցնող ստեղծագործություններ:

Բանալի բառեր. քանդակ, մոնումենտալ արվեստ, ազգային մենթալիտետ, հասարակություն, աշխարհայացք:

НАЦИОНАЛЬНЫЙ МЕНТАЛИТЕТ В МОНУМЕНТАЛЬНЫХ ПРОИЗВЕДЕНИЯХ САРКИСА БАГДАСАРЯНА

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Творческая работа скульптора призвана дать людям дополнительный патетический заряд, поэтому велика его ответственность перед народом, который ожидает от его произведений эмоционального накала, выражения выдающихся

духовных достижений. Высокие идеологические устои и художественный вкус, а также индивидуальное мастерство скульптора являются основным критерием создания непреходящих творческих ценностей. Саркису Багдасаряну удалось успешно отразить в своих монументальных скульптурах национальный менталитет, сформировавшийся в ходе многовековой борьбы за выживание армянского народа, воплотить его мощь и дух. Они не теряют своей актуальности и уверенно устремлены в будущее.

Ключевые слова: скульптура, монументальное искусство, национальный менталитет, общество, мировоззрение.

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ORGANIZING INFORMATION COLLECTION IN THE CONTEXT OF DISASTER: APPROACHES BEFORE, DURING AND AFTER EMERGENCIES

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Abstract

This article examines the challenges and strategies associated with collecting critical information during different types of disasters. The use of technology and specialized tools to collect data on various natural disasters, such as natural events, industrial accidents, and health crises, is examined. It also emphasizes the importance of cleaning this data to remove unnecessary information. It is shown that by mastering these data collection techniques, more informed decisions can be made and disaster management can be improved.

Keywords: emergency situation, man-made disaster, natural disaster.

Introduction

An important task for making decisions in a particular area is providing input data. As research shows, the data collected varies depending on the subject of the study. For example, they are different during man-made and natural disasters. A feature of man-made disasters is that they can occur as a result of a combination of several events or as a result of random accidents. The latter is difficult to predict. To eliminate them, regulatory measures are provided to reduce the likelihood of these events occurring.

Applying machine learning techniques to data analysis will provide the opportunity to identify patterns, trends and impacts of natural disasters (NDs) that may influence future actions.

Improving decision readiness of systems through pre-security data storage and processing is critical as it provides vital information for risk assessment, planning and early warning systems.

During emergency situations (ES), to support and respond to emergency situations, there is often a need for technologies for collecting and storing data in real time.

Post-security data analysis and long-term storage technology provides stakeholders with the necessary tools to analyze important information. This includes any emerging trends related to ES and by storing this information in a secure database system, society can learn from the mistakes of the past.

The use of a particular data collection and processing technology depends on the nature of the disaster.

As practice shows, the information received is accompanied by noise. Therefore, it is important to consider special methods by which this information is cleaned and only the part that is useful is retained.

The choice of hardware and software for organizing the receipt of information and its processing is important, and in this regard, the article provides their classification by purpose.

Let's consider the proposed technologies for collecting and storing the necessary data before, during and after ES [1].

Conflict Setting

The goal of the task is to propose an integrated approach to the classification of disasters for the simultaneous collection, purification and analysis of parameters characteristic of disasters.

Research Results

To organize data collection before ES, it is proposed to use complex tools such as sensor networks, which allow organizing constant monitoring of critical data. Environmental, medical, seismic, and environmental sensors can be used as sensors. Drones equipped with various types of sensors can be used to collect data. To organize the storage and appropriate processing of data for decision-making, it is necessary to select or develop software using elements of artificial intelligence, which will improve the quality of informed decision-making and proactive measures. Among other things, it is necessary to use software for remote sensing, environmental modeling and geographic information systems (GIS).

We divide ES into the following: Technogenic or anthropogenic, natural environmental disasters, Socio-economic crises compared to biomedical wars. Each type of ES has its own unique characteristics, which take different forms and pose specific challenges[2]. This means that it is necessary to have knowledge of how to properly collect and separate information in order to effectively manage various Ess[3].

The proposed structure of the technology for collecting data before a disaster is presented in Fig. 1.

Thanks to mobile apps, remote sensing tools, and Internet of Things (IoT) gadgets, such information can be collected, analyzed, and stored faster, thereby enhancing situational awareness for resource allocation as well as decision-making in dynamic environments. Mobile apps are user-friendly designed for both first responders and members of the public who would like to report cases or incidents, share

information in real time or request assistance in times of crisis, facilitating rapid data collection and transfer data.

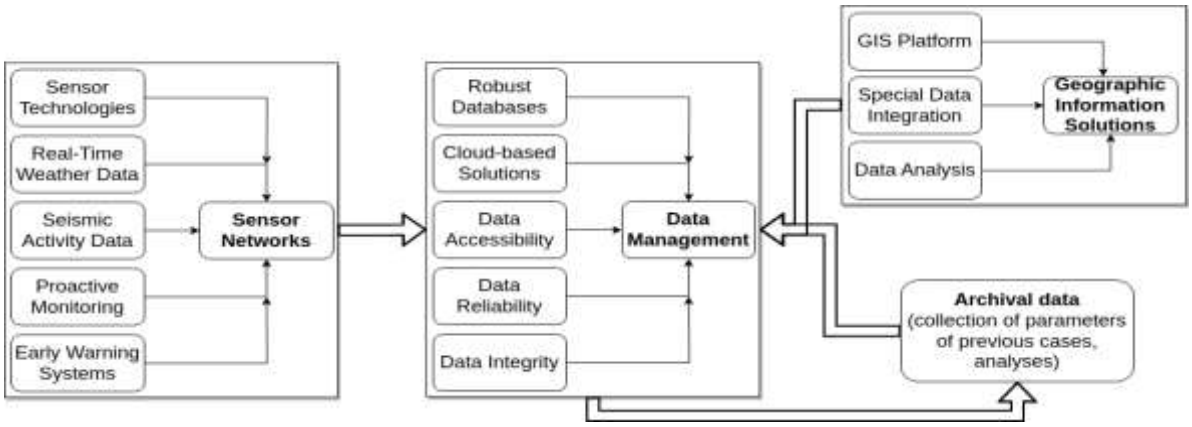

Fig 1 Pre-disaster technology structure

Remote sensing and imaging technologies are the application of high-resolution imagery or video from satellites, drones, and aerial surveillance to aid in damage assessment, resource allocation, or situational awareness [4].

The proposed structure of the technology for collecting data before a disaster is presented in Fig. 2.

Therefore, after a disaster occurs, it is necessary to use real-time data collection technologies, which leads to enhanced capabilities of emergency response services based on the acquired data that they need to effectively manage situations. This improves coordination among citizens who can exchange information among themselves and also seek help when needed. It is critical that remote sensing solutions provide visual evidence of resource destruction and deployment. In addition, these remote information collection devices are always on, providing important information about the environment and existing structures.

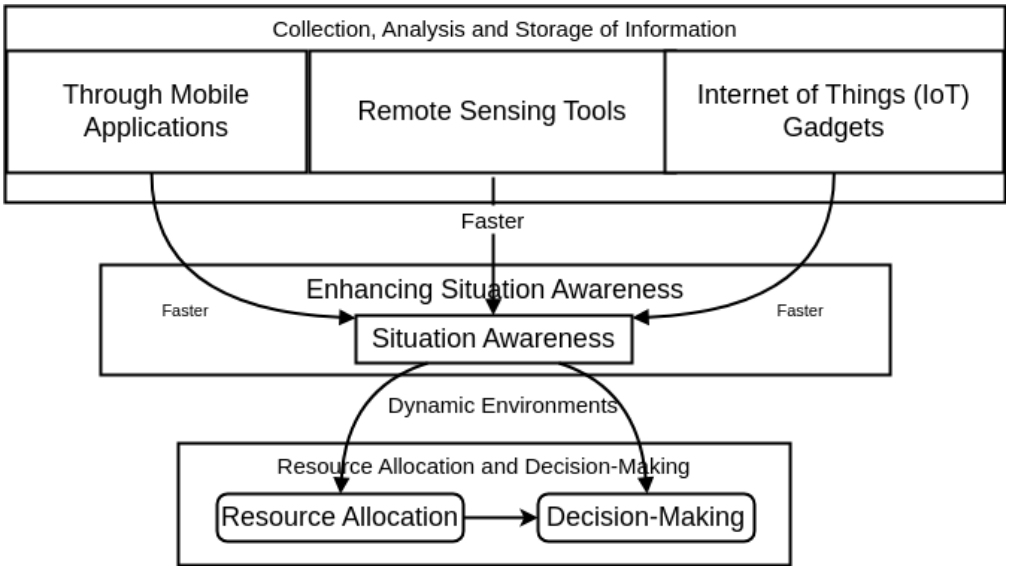

Fig.2 During disaster technology structure

In other words, through these techniques, awareness can be increased, thereby encouraging timely response, ensuring efficient allocation of resources, ultimately leading to improved disaster management and hence reducing its impact [5]. Archiving and saving data is important here. To protect critical information on disaster-related issues for subsequent research, it is important to use cloud-based redundant systems.

A structure for the technology for collecting data after a disaster has been proposed, which is presented in Fig. 3.

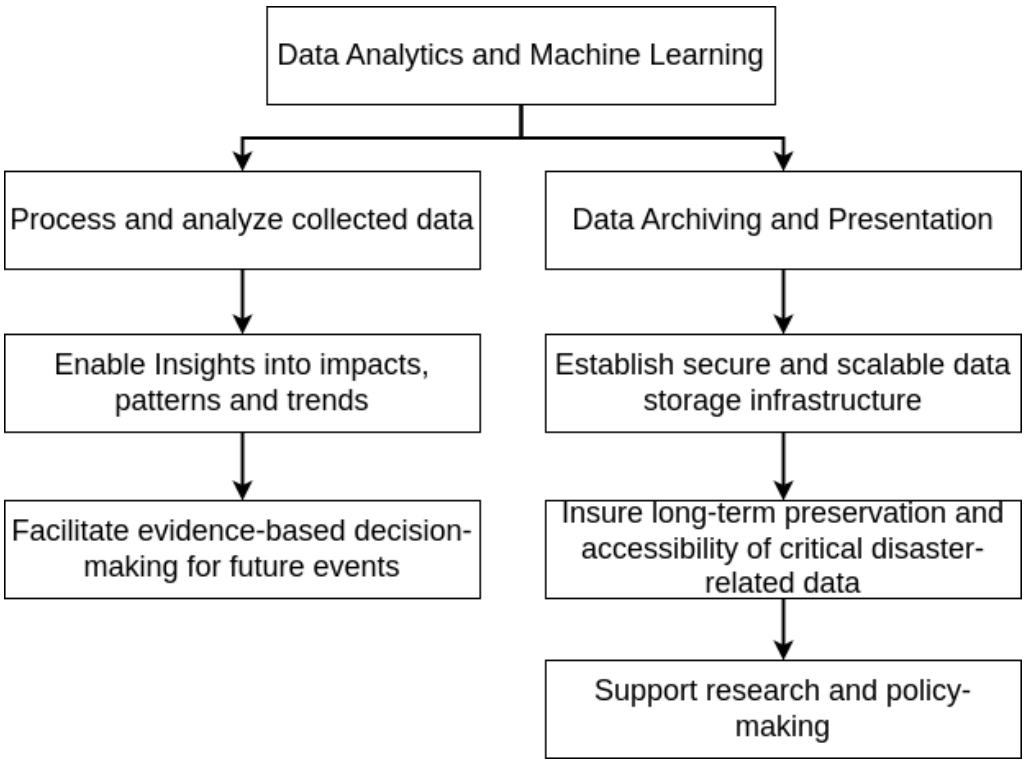

Fig 3 Post-disaster technology structure

We are dealing with different classes of disasters and, therefore, information.

We divide disasters into: man-made, natural environmental, socio-economic, biomedical and military disasters.

Disasters come in many forms, each with their own unique characteristics and challenges. This requires knowledge of how to effectively collect and separate information in order to manage the NDs that arise in all their diversity.

Technology, collection and processing equipment are given in Tab. 1.

Information collection focuses on tracking disease spread, hospital capacity, vaccine distribution and public health data.

In the field of ND management, there is nothing more important than accurate and reliable data. However, data collection sometimes suffers from what we call “information noise,” which refers to irrelevant or incorrect information that can distort the decision-making process. Given the importance of the task, various methods are

used to clean data and are required to be clear, reliable and not distracting during emergencies. For this purpose, the following classification of methods and mechanisms for cleaning data from information garbage is proposed.

Table 1.

Collection and Processing Equipment

Class ES	**Technology Collection of information**	**Collection information with ardware**	**Processing software Information**	**Hardware and software: processing information**
Technogenic or anthropogenic	Sensor networks Drones	Sensors - gas leaks - chemical spill - structural integrity Cameras and sensors	DBMS in real time	Geographic Information Systems (GIS)
Natural and ecological catastrophes	Meteorological monitoring data: Monitoring level of pollution	Sensors: - level of liquid in wells - seismometers - presence of radon - water quality - air quality	requires real-time data collection for early warning software systems remote sensing, software modelling of the environment. Forecasting the spread of pollution. Geospatial tools that help map and estimate ecological destruction.	Satellite systems Drones: To assess the impacts of ES
Biomedical and military catastrophes	Diagnostic Devices, Remote Patient Monitoring, Autonomous Ground Vehicles	Medical sensors for tracking trends in vital signs and spreading diseases. Special equipment for disease testing and sample analysis.	Electronic medical record software (EHR) for monitoring patient information. Software epidemiological modeling	High-Performance Computing (HPC) Clusters, Field-Deployable Servers, Data Analytics Platforms, Cybersecurity Solutions

Advanced filtering algorithms as data filtering algorithms help identify and remove outliers and anomalies or small deviations that do not correspond to expected values.

Follow strict validation as data verification and quality control's processes to combine high-quality data sets so that they meet predefined standards set by their owners, such as variable range checking, variable type checking, consistency checking.

When studying information, contextual analysis should always be understood in its situation, otherwise known as contextual analysis, where differences may arise. By taking into account the information around it, one can easily determine the existence or non-existence if any inconsistencies within it, thus discarding any extraneous details.

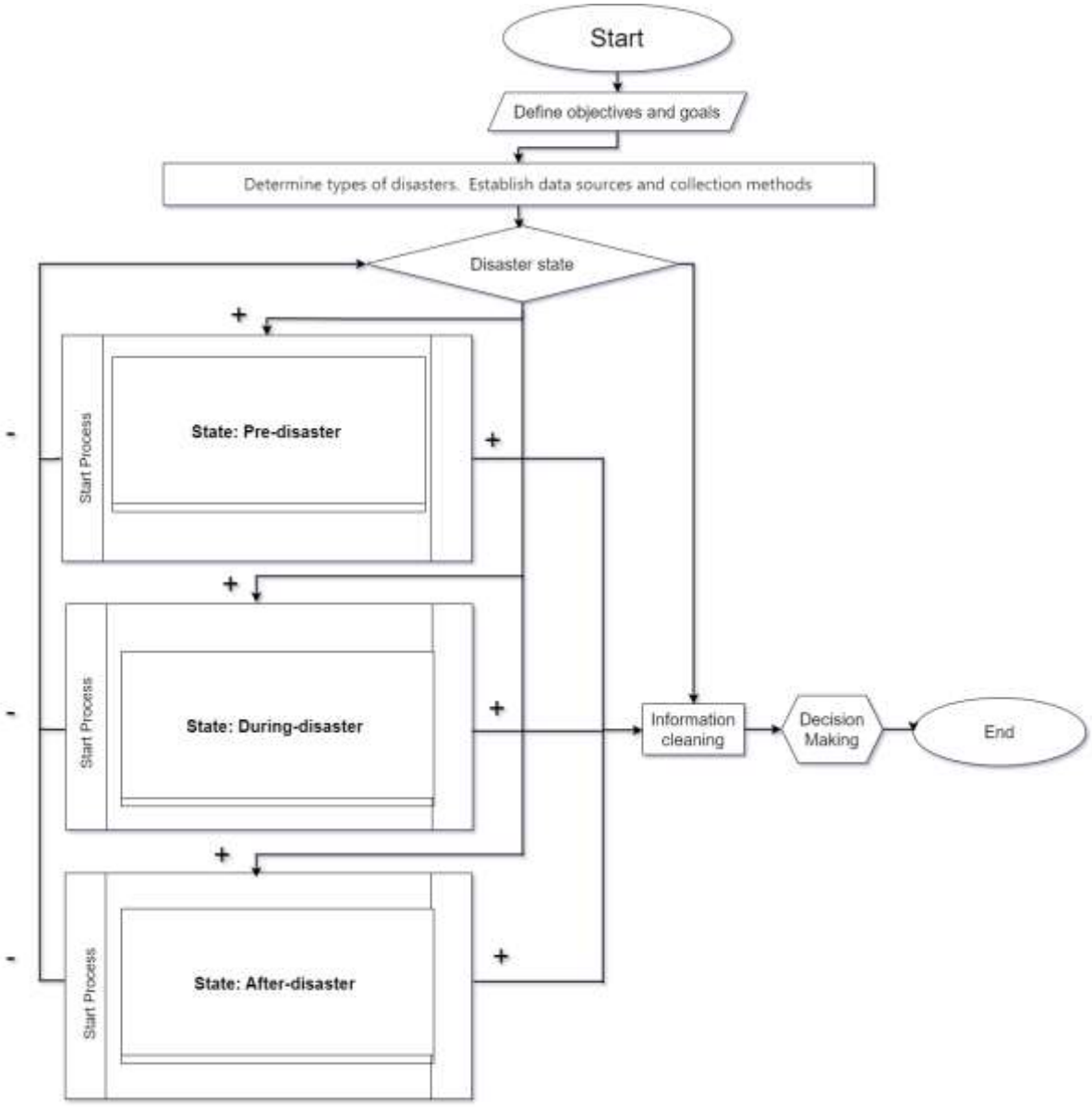

Fig 4 System's proposal structure from disaster state view point

In some cases, using crowdsourced data from various individuals or sources is useful in verifying that individual pieces of data have been entered correctly into the system. This is especially true for real-time data verification during natural disasters.

The use of machine learning algorithms in data analysis helps to identify patterns in information, as well as distinguish between relevant and irrelevant. These algorithms improve with use and become better at filtering out noise.

The noise can be determined by an expert familiar with the subject. Thanks to their knowledge in certain areas, they are able to distinguish between reliable and erroneous figures.

To check consistency or inconsistency, compare recent data obtained from current disaster management situations and historical records. Old records can serve as a criterion for determining the reliability of incoming facts.

Analyze metadata associated with data sources to determine how reliable and valid they are. Unreliable sources are always indicated by suspicious circumstances surrounding them, indicating potential sources of noise.

User feedback mechanisms are necessary to ensure quality processing of any form of data available on the Internet, either automatically or manually through human intervention processes to ensure timely correction before the situation worsens.

Combine multiple sources of information together, cross-checking their content using merging techniques; this will help check some information in different data sets if they are consistent, thereby completely removing background noise.

Establish control systems that monitor data quality over an extended period of time, thereby maintaining expected standards along the way to improve decision-making purposes. This makes it possible to immediately identify as well as correct any events leading to undesirable data quality in a given case where such problems arise unexpectedly within a short period of time, leading to unpleasant consequences for the desired results due to the incorrect definition of the time frame itself.

Below you can see Fig. 4, which presents the systematic proposal of the above process sequences within this work.

Conclusion

1. Based on an analysis of information collection technologies, recommendations are given for their use depending on the nature/class of the safety system and time (before, during and after disasters).

2. Structures of information collection technologies are proposed that increase the quality of decisions made.

3. The classification of filtering methods made it possible to organize the selection of the necessary mechanisms for “garbage cleaning” in the collected data.

4. Recommendations are given on the use of types of sensors when collecting information.

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ՏԵՂԵԿԱՏՎՈՒԹՅԱՆ ՀԱՎԱՔԱԳՐՄԱՆ ԿԱԶՄԱԿԵՐՊՈՒՄԸ ԱՂԵՏԻ ՀԱՄԱՏԵՔՍՏՈՒՄ՝ ԱՂԵՏԻՑ ԱՌԱՋ, ԸՆԹԱՑՔՈՒՄ, ՀԵՏՈ

Է.Տ. Հարությունյան
Հայաստանի Եվրոպական Համալսարան

Բերված են տարբեր տեսակի աղետների ժամանակ կարևոր տեղեկատվության հավաքագրման մարտահրավերների ու ռազմավարությունների ուսումնասիրությունների արդյունքները: Դիտարկված են տեխնոլոգիաների ու մասնագիտացված գործիքների օգտագործումը տարբեր աղետների վերաբերյալ տվյալներ հավաքելու համար, ինչպիսիք են բնական աղետները, արդյունաբերական վթարները և առողջապահական ճգնաժամերը: Կիրառելով տվյալների հավաքագրման առաջարկվող տեխնիկան, հնարավոր կլինի կայացնել հիմնավորված որոշումներ և բարելավել աղետների կառավարումը:

Բանալի բառեր: արտակարգ իրավիճակ, տեխնածին աղետ, բնական աղետ:

ОРГАНИЗАЦИЯ СБОРА ИНФОРМАЦИИ В КОНТЕКСТЕ БЕДСТВИЯ. ПОДХОДЫ ДО, ВО ВРЕМЯ И ПОСЛЕ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЙ

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Представлены результаты исследований проблем и стратегий сбора важной информации во время различных типов стихийных бедствий. Рассматривается использование технологий и специализированных инструментов для сбора данных о различных стихийных бедствиях, таких как стихийные бедствия, промышленные аварии и кризисы в области здравоохранения. Применяя

предложенные методы сбора данных, можно будет принимать обоснованные решения и улучшить управление стихийными бедствиями.

Ключевые слова: чрезвычайная ситуация, техногенная катастрофа, стихийное бедствие.

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SOURCES OF POLLUTION OF SURFACE WATERS, DEVELOPMENT OF RECOMMENDATIONS FOR THEIR DETECTION AND DEVELOPMENT OF PREVENTION METHODS

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Abstract

The problem of water pollution is becoming more and more urgent for the whole world. Unfortunately, Georgia is not an exception, where water sources, despite their number, are small and a significant part of them is polluted.

Unlike contamination of industrial wastewater treatment plants, which comes from multiple diffuse sources, biological contamination results from the movement of precipitation or snowmelt onto and into the soil. As runoff moves, it collects and transports natural and anthropogenic pollutants and deposits them in rivers, groundwater, or lakes.

Special attention should be paid to the biological pollution of water sources, which occurs as a result of washing or flushing of sources of anthropogenic biological pollution with rain and melt water. After entering the water environment, under favorable conditions, pathogenic organisms can multiply rapidly, which poses a threat to the environment.

Contamination of water sources is a major cause of water quality problems. The impact of source water contaminants on specific waters varies and cannot always be fully assessed. However, we know that these pollutants have harmful effects on drinking water supplies and wildlife.

That is why it is necessary to find the source of biological pollution of water in order to develop an effective method of its elimination.

Keywords: river, wastewater, Adjara region, water sources, pollution.

Introduction

Water pollution is one of the most important problems that people are trying to solve these days in a variety of ways. Despite the measures taken to improve wastewater treatment methods, the issue remains relevant. One of the most common is biological pollution, directly related to the entry of pathogenic microorganisms, bacteria, viruses and protozoa into water [1], [12].

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The main sources of contamination include wastewater [2]. Their bacterial contamination is characterized by the coli titer value, that is, the volume of water in milliliters that contains E. coli. This type of pollutant is most often found in domestic and wastewater from factories, wool washers and hospitals.

Conflict Setting

The purpose of the research is to study the sources of surface water pollution, develop recommendations for their identification and treatment methods.

Research Results

Organic compounds and microorganisms can enter both surface and groundwater, causing serious damage to ecosystems. The danger is primarily caused by pathogens of infections and diseases that negatively affect the health of people and animals. In the worst-case scenario, they can lead to total or irreversible consequences [3].

Organic pollutants include substances of plant, animal and chemical origin. The first category is the remains of vegetables, fruits, paper, the second is waste products of humans and animals, as well as various fatty and muscle tissues. Chemical pollutants are a particularly dangerous category, represented by petroleum products, pesticides and various industrial wastes [4].

Of the 341 studied water sources in Adjara, 144 were contaminated with E-Coli pollution (Tab. 1), 10 of them were marked by the presence of household waste, and in 2, turbidity was periodically observed (Tab. 2) [5].

Table 1.

Number of rivers contaminated with E-Coli

Municipality	Number of polluted sources	Number of unpolluted sources	Total
Kobuleti	40	34	74
Khelvachauri	17	52	69
Keda	17	45	62
Shuakhevi	19	43	62
Khulo	23	23	46
all	144	197	341

Petroleum oils cause the greatest harm to water in open sources, as they are extremely persistent pollutants and can spread over long distances [6]. The most dangerous are the light fractions, which actually completely stop gas exchange between water and the atmosphere, forming a film. Within one country, pollution with such substances can be local or regional [7].

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Everyone knows the fact that on the territory of the city of Batumi there were oil refineries and chemical plants, on the territory of which the depreciated old systems still pollute the Baartskhanistskali and Kubistskali rivers (Fig. 1) [8].

Table 2.

Number of rivers with high turbidity

Municipality	Number of polluted sources	Number of unpolluted sources	Total
Kobuleti	44	30	74
Khelvachauri	37	32	69
Keda	45	17	62
Shuakhevi	32	30	62
Khulo	31	15	46
all	217	124	341

Fig. 1. Source of oil pollution in the Baartskhanistskali and Kubistskali rivers.

Water contamination with bacteria and pathogenic microorganisms can lead to outbreaks of dangerous intestinal diseases. This is possible primarily if the quality of the treatment systems is insufficient or if they are absent. For this reason, third world countries are considered the main centers of such diseases. In this case, the danger may come not from the drinking water itself, but from the organisms living in it and the compounds formed as a result of various reactions.

Among them is hydrogen sulfide, a substance that can cause serious harm to the body if formed outside the human body. In this case, it is extremely toxic and can affect various organs, including the liver and stomach. Sometimes, to suffer from bacterial contamination, it is enough to wet your hands or food, but the substance produces an unpleasant odor [9], [11].

According to the studies of the London School of Hygiene and Tropical Medicine, one of the most common methods of cleaning water from microbiological contamination in the household environment is boiling. It kills 85 to 99% of bacteria [12], that die at high temperatures, but do not make the water suitable for drinking. Biological pollutants can also

be removed using electrocoagulation and electroflotation in electrolyzers. During purification, contaminants are absorbed by aluminum and iron hydroxides formed during the process and are then removed through sedimentation, flotation or filtration [5].

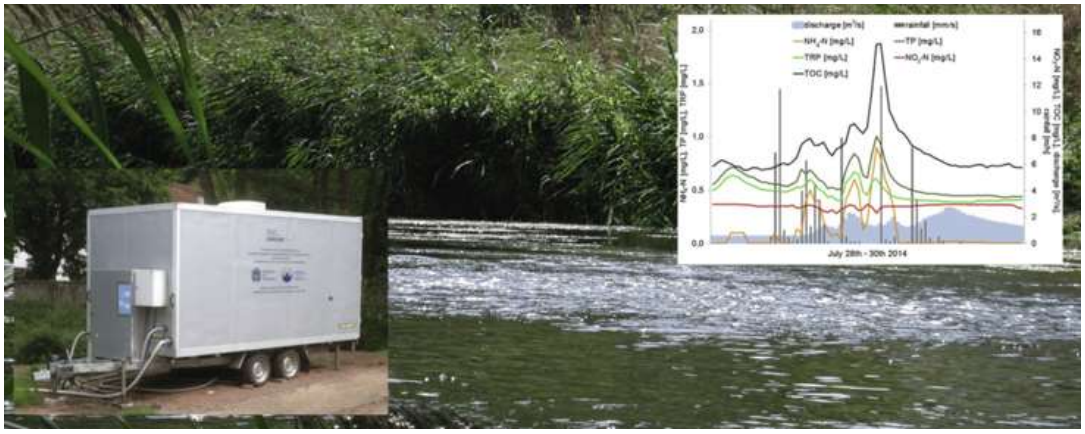

Fig. 2 Mobile station for water quality monitoring and a sample of typical output of this station.

To identify biological contaminants in the age of modern technological boom, we can use:

1. Traditional laboratory tests in accredited laboratories, which are time-consuming and require on-site processing of samples (see process description below);

2. 2. Technological innovation "portable TLF sensors" working on site 24/365, which shows the change in the level of E. coli pollution in the swimming areas of the sea (Fig. 2) [12];

3. DipTest method - in the sample taken from the water source, pre-prepared litmus-like impregnated paper (with dimensions 70mm*5mm) is placed and observed which area of the paper will be colored (Fig. 3). With this method, it is possible to determine the level of pollution in 60-65 minutes [13];

4. On the banks of the rivers, it is possible to place a sensor device, the sensors of which perceive e. coli content in water and records it, but it should be noted that this device is new and its accuracy is still a subject of research.

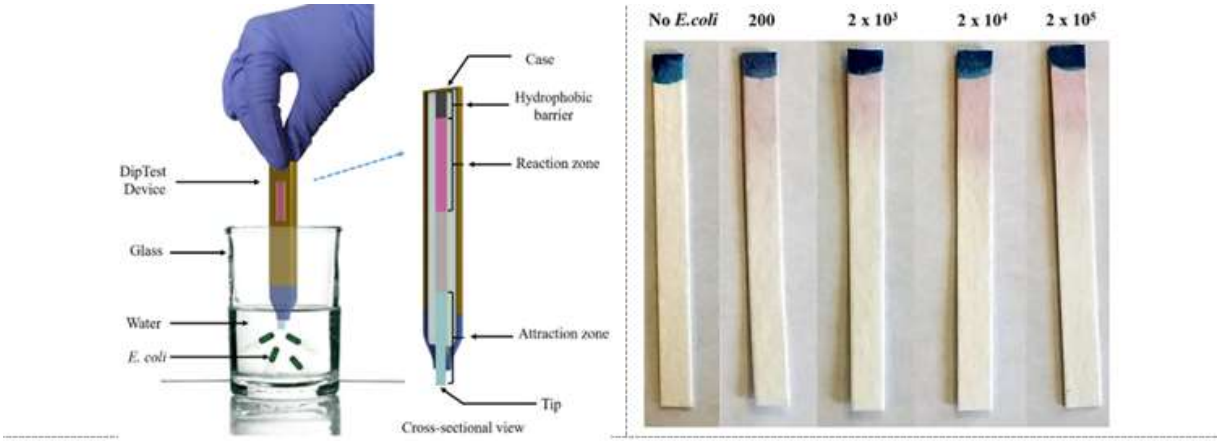

Fig. 3 Methodology of research and Concentration on E. coli increases

Among the listed methods, traditional laboratory studies stand out among the most common ones, but its main disadvantage is still time-consuming, when field laboratory studies range from 60 to 120 minutes. However, it should be noted that the laboratory analysis compared to other types of research gave us 100% accuracy, which is a very important factor.

Rehabilitation measures should be carried out immediately after river pollution. These measures vary depending on the type of pollutant.

- One of these measures is mechanical cleaning. For this purpose, disposal of solid waste discharged into rivers is carried out using containment and collection devices/devices.
- Another most common practice is phytoremediation. Several species of plants are used to effectively remove heavy metals from polluted rivers. For example, Eichhornia crassipes (water lily) is used to absorb cadmium and copper. Similarly, the symbiosis of blue-green algae Azolla-anabena and Azolaii is used for bioremediation of rivers polluted with arsenic and other metalloids[9].
- Some types of bacteria and derivatives of some fungi are used to break down pollutants in rivers (biodegradation). Acintobacter, Pseudomonas, Imycobacter species destroy alkanes, monoaromatic and polyaromatic substances, respectively[10].
- The study of the state of water sources and the development of recommendations for the treatment of waste water, taking into account the existing modern technologies, should continue the research.

Conclusion

Based on all of the above, it is recommended to arrange periodical or permanent mode research points on the rivers to monitor them to determine the level of pollution. The selection of the mentioned points and the selection of the research type require additional studies, which we will propose in future editions.

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ՄԵՐԿԵՐԵՎՈՒԹՅԱՆ ՋՐԵՐԻ ԱՂՏՈՏՄԱՆ ԱՂԲՅՈՒՐՆԵՐԸ. ԴՐԱՆՑ ՀԱՅՏՆԱԲԵՐՄԱՆ ԱՌԱՋԱՐԿՈՒԹՅՈՒՆՆԵՐԻ ԵՎ ԿԱՆԽԱՐԳԵԼՄԱՆ ՄԵԹՈԴՆԵՐԻ ՄՇԱԿՈՒՄ

Գուրամ Դարչիձե
Վրաստանի տեխնիկական համալսարան

Ջրի աղտոտվածության խնդիրն ավելի ու ավելի հրատապ է դառնում ողջ աշխարհի համար: Ցավոք, բացառություն չէ Վրաստանը, որտեղ ջրային աղբյուրների

G. Darchidze

SOURCES OF POLLUTION OF SURFACE WATERS, DEVELOPMENT OF RECOMMENDATIONS FOR THEIR DETECTION AND DEVELOPMENT OF PREVENTION METHODS

զգալի մասն աղտոտված է: Ջրի աղբյուրների աղտոտումը ջրի որակի խնդիրների հիմնական պատճառն է: Այդ պատճառով անհրաժեշտ է գտնել ջրի կենսաբանական աղտոտման աղբյուրը՝ դրա վերացման արդյունավետ մեթոդ մշակելու համար:

Առանձնահատուկ ուշադրություն պետք է դարձնել ջրային աղբյուրների կենսաբանական աղտոտմանը: Ջրային միջավայրում հայտնվելով բարենպաստ պայմաններում ախտածին օրգանիզմները կարող են արագորեն բազմանալ, ինչը լուրջ վտանգ է ներկայացնում շրջակա միջավայրի համար:

Բանալի բառեր. գետ, Աջարիայի շրջան, աղբյուրներ, աղտոտվածություն, կեղտաջրեր:

ИСТОЧНИКИ ЗАГРЯЗНЕНИЯ ПОВЕРХНОСТНЫХ ВОД: РАЗРАБОТКА РЕКОМЕНДАЦИЙ ПО ИХ ОБНАРУЖЕНИЮ И МЕТОДОВ ПРОФИЛАКТИКИ

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Проблема загрязнения воды становится все более актуальной для всего мира. К сожалению, Грузия не является исключением, где источники воды, несмотря на их количество, невелики и значительная их часть загрязнена.

В отличие от загрязнения промышленных очистных сооружений, которое происходит из нескольких диффузных источников, биологическое загрязнение возникает в результате перемещения осадков или талого снега на почву и в нее. По мере движения сток собирает и переносит природные и антропогенные загрязнители и откладывает их в реки, грунтовые воды или озера.

Особое внимание следует уделить биологическому загрязнению водных источников, которое происходит в результате промывки или промывки источников антропогенного биологического загрязнения дождевыми и талыми водами. Попадая в водную среду, при благоприятных условиях болезнетворные организмы могут быстро размножаться, что представляет угрозу для окружающей среды.

Загрязнение источников воды является основной причиной проблем с качеством воды. Воздействие загрязнителей исходной воды на конкретные воды варьируется и не всегда может быть полностью оценено. Однако, мы знаем, что эти загрязнители оказывают вредное воздействие на запасы питьевой воды и дикую природу.

Вот почему необходимо найти источник биологического загрязнения воды, чтобы разработать эффективный метод его устранения.

Ключевые слова: река, сточные воды, Аджарский регион, водные источники, загрязнение.
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APPROVAL OF THE NEED FOR THE RECONSTRUCTION OF ARENI PUMPING STATION

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Abstract

The Areni-Khachik pumping station raises the waters of the Arpa river from the 976 m mark to the pressure basin located at the 2012 m mark of the upper mountain pass of the Khachik village, from which the water was given to the Khachik community with a maximum output of 415 l/s and to the Amaghu village with a maximum of 41 l/s. with output.

The pumping station has three stages, the engine rooms of which are located: First stage, on the right bank of the Arpa river at the mark of 975 m, with a geodetic pumping height of 318 m, pumping output of 582 l/s. Second stage: at the 1295 m mark of the site near the Areni-Khachik highway, with a geodetic elevation of 370 m, pumping output of 456 l/s . And the third stage: at the site of 1651 m near the Areni-Khachik highway, with a geodetic elevation of 361 m, pumping output of 456 l /v .

All three stages of the pumping station belong to the class of high-pressure pumping stations, with a relatively small discharge output and high pressure, the specific power

consumption of which is significantly higher. Analyzing the technical condition of the pumping station, a program is proposed to implement its reconstruction and reduce operating costs.

Keywords: river, pump, cavitation, hydraulic shock, pipeline.

Introduction

The Areni pumping station was operated in 1974 to irrigate the lands of Areni, Khachik, Amaghu and Rind border settlements of the Yeghegnadzor region with water from the Arpa river.The building of the pumping station is located on the right bank of the Arpa river. Formerly, 9 high-pressure pumping units and 2 low-pressure pumping units were installed in the engine room to create excess pressure at the inlet of the propulsion pumps.

The Areni pumping station supplied irrigation water in opposite directions: the left-hand branch for Areni, Amaghu, Khachik settlements, and the right-hand branch for irrigating the lands of Areni and Rind settlements through two separate pipelines.The hydraulic system of the left-hand branch of the pumping station is a three-stage pumping station, and the right-hand one is a single-stage one.

After operation of the Hermon-Yelpin gravity two-line water pipeline (2007), the lands of Areni and Rind settlements fell under the service of this (Hermon-Yelpin) water pipeline, which eliminated the need to mechanically pump water through the right-hand branch of the Areni pumping station.

At the same time, an opportunity was created and, without serious professional justification, it was implemented from the end of the high-pressure line of the Hermon-Elpin water pipeline, bypassing the pumping station and using the pumping pipelines on both sides of the pumping station, to raise water by gravity to the 2nd stage pumping station of the left branch. Irrigation of the land areas of the right-hand branches of the Areni pumping station in full, and the left-hand branch, partially replaced by gravity mode, led to the following: The Areni coastal pumping station was completely shut down , its maintenance costs were saved (mainly by reducing the installed capacity of several thousand kilowatts of electricity). About 1,000 l/s of the output from the Arpa river previously taken by the pumping station is currently flowing outside the borders of the Republic of Armenia.

Currently, the irrigation water supply of Khachik settlement lands is carried out by the 2nd and 3rd level pumping stations of the left side branch of the Areni pumping station. Many years of operation of high-pressure branch water pipelines built in mountainous terrain show that they do not produce their design output. The elevated land areas of Vernashen, Gladzor, Aghavnadzor, Rind and Yelpin settlements are under the service of the Hermon-Yelpin high-pressure highway complex pipeline. The water supply of Vernashen and Gladzor settlements is carried out by throttling the remote control valves to closing in order to ensure the necessary pressure. As a result, in the case of feeding the 2nd level of Areni from the end of the water pipe, the problem of pressure increase occurs again, which is accompanied by a decrease in the output given to other consumers. Therefore, the already overloaded line of the water pipeline, by adding another high consumer, leads to a violation of the stability of the water supply to the settlements of Arpi Aghavnadzor, Rind, Yelpin. The modified scheme of

the Areni pumping station hydronode is shown in Fig.

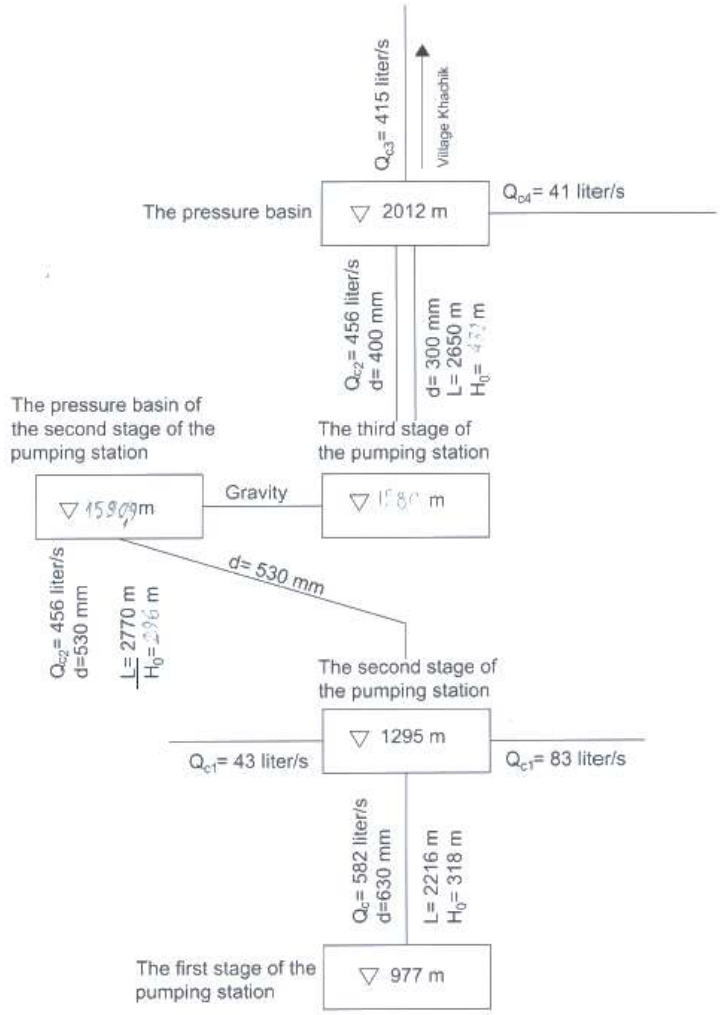

Fig. Scheme of Areni pumping station structures (geometric and hydraulic design parameters)

Since the system of the left side branch of the Areni pumping station is provided only for irrigation water supply of land areas of Khachik settlement, then the three-stage pumping station should be renamed three-stage pumping station of Khachik, or Khachik pumping station.

Conflict Setting

The task is to study technical condition of the Khachik three-stage pumping station and develop a plan for its reconstruction.

Research Results

1. Description of the condition of the 1st stage structures of the Khachik pumping station:

Approaching canal: The intake of the head of the approaching canal is located on the right bank of the embankment built on the Arpa river. The canal has a rectangular section, has a length of 460 m and a drop of 4 m, the average slope of the bottom is 0.0087. The channel at the lower end joins the receiving basin of the pumping station, from which the water is delivered by a buried pipe to the outside collector on the north wall of the engine room. The height of the wall of the approach channel is 1.1 m at the entrance section of the headland, the width of the floor is 1.4 m. The technical condition of the approach canal is satisfactory, it is necessary to carry out surface coating of the floor and walls in order to increase the degree of unevenness to n=0.014, and to plan the implementation of measures to establish a type a2 curve of the free surface of the water current along the length of the canal.

An automatic metal grid should be installed in the cut at the end of the approach canal for removing floating sediments. The technical condition of the receiving basin is very unsatisfactory. It should be completely reconstructed and adapted to the hydraulic regime above the approach canal and an appropriate damping measure should be implemented to maintain a constant water level in it.

Engine room: All the power equipment was dismantled: 11 hydro turbine units, suction and discharge pipes with their valves, reverse dampers and shaped parts, electrical equipment, control and protection cabinets, hoist. Briefly, the engine room is empty.

Lifting pipeline: The pipeline is single-line, the length of which is 2215 m, the diameter is 630 mm. Around 450 m of the pipeline's origin is buried. Previously, the maximum output through the pipeline was 682 l/s. Currently, the pipeline is fed from the edge of the Hermon-Elpin gravity aqueduct. According to the operator's information, a pipe burst recently occurred in the buried section of the pipeline. The above-ground section of the pipeline is equipped with compensators. A professional survey is required to determine the technical condition of the pipeline.

Anchor and free supports The anchor and free supports (concrete, partly metal) of the pipeline were destroyed and some free supports were deprived of their function of creating countermeasures. All supports are rebuildable.

Pressure basin. The pressure basin has the necessary height in relation to the pump shaft, which ensures the requirement to create an excess pressure at the inlet of the latter. The basin has two departments. receiver and accumulator. The receiving section of the basin is damaged in the bottom part, the accumulating section is filled with heavy rubbish. The pool does not have a car ramp or a slope pad. The pressure tank needs repair.

2. Description of the condition of the structures of the 2nd stage of the Khachik pumping station:

Receiving Basin: The 2nd stage intake basin is the 1st stage pressure basin. The intake basin of the 2nd stage has the necessary height relative to the pump shaft, which ensures the requirement of creating an excess pressure at the inlet of the latter. The technical condition of the basin is mentioned above in the description of structures of the 1st degree.

Engine room and auxiliary buildings. The engine room and service building need renovation. There are two parallel-connected pumping units with a capacity of 630 and 500 kW, each of which is in a single operating mode.

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Lifting pipeline: The pipeline is single-line, the length to the intermediate pressure basin is 2770 m, with diameter 530 mm. The entire length of the pipeline is above ground. Water from the intermediate basin is supplied by gravity to the duke site passing through the deep gorge, at the end of which the receiving basin of the 3rd level pumping station is built.

A professional survey is required to determine the technical condition of the pipeline and duker pipe. As a separate issue, it is necessary to study the expediency of the presence of a large slope canal on the thrust tract.

Anchors and free supports: The anchor and free supports (concrete, partly metal) of the pipeline were destroyed and some of the free supports were deprived of the function of creating countermeasures. All supports are rebuildable.

Intermediate and edge pressure basins

Intermediate pressure basin and edge basin need repair. The pressure head basin, which is the receiving basin of the stage 3 pumping station, does not have a perfect drainage system to the nearby gorge. Short-term free discharge of water from a basin with a sloping slope needs to be studied.

3 Description of the state of structures of the 3rd level of the Khachik pumping station:

Receiving basin : The 3rd stage receiving basin has the necessary height relative to the pump shaft, which provides the requirement to create an excess pressure at the inlet of the latter. he technical condition is described above in the description of Tier 2 structures.

Engine room and auxiliary buildings . The engine room and utility building need repair. Two 1000 kW parallel-connected pumping units are installed in the hall, each of which is in single operation mode. There is a mismatch of the installed pumping unit (ЦХС-300-600) with the pressure front of the pumping station.

Lifting pipeline. The pipeline is two-line, 420 mm and 320 mm in diameter and has an equal length of 2650 m. Except for a short length of origin, the pipelines are buried up to the final pressure basin. The technical condition of the 2 pipeline lines is not sufficient for reliable and safe operation.

Anchor and free supports. The anchor and free supports (concrete, partly metal) of the short length of the pipeline were destroyed and some of the free supports were deprived of the function of creating countermeasures. All supports are rebuildable.

Last pressure basin (bomb station): The pressure tank needs repair. In case of an accident of the gravity aqueduct supplying water to the Khachik settlement, there is a drainage pipeline in the basin.

For the reconstruction of the 3-level engine rooms and auxiliary buildings of the Khachik pumping station, to obtain a conclusion on their seismic resistance.

It is recommended:

1. To determine the amount of water supply necessary for irrigation of the lands of Khachik settlement, based on:

a. the possibilities of applying the latest irrigation technologies.

b. occupying the land with agricultural crops with high yield and relatively low water demand (provide justifications for the effectiveness of the proposed crops);

c. security reasons, to provide the border lands for the foundation of gardens instead of wheat;
d. construction of water basins requiring relatively small anti-filtration measures in the surrounding area of Khachik village, for the accumulation of water pumped by pumping stations at night.
3. for the 1st stage pumping station of Khachik, to develop and implement a self-priming method of pumps without the need for a charging pump system (two charging pumping units were planned in the previously operating pumping station).
4. to select the diameters and wall thickness of the pumping pipelines of all three stages of the Khachik pumping station according to the calculated output defined in point 1, taking into account the magnitude of the pressure increase that occurs in the event of an emergency power outage of the pumping station.
5. to maintain the current locations of pumping station engine halls and auxiliary buildings, pressure basins, suction tract pipes and the coordinates of the pumping pipelines.
6. make a topographic survey of the pipelines of pumping stations of the 1st and 2nd levels, 10 m wide on both sides, marking the number of the support and the distance from the starting point.
7. find out the geological, elemental, structural and operational reasons for the deterioration of anchor and intermediate supports and develop the use of protection measures and measures against them. To develop and implement structural arrangements for placing the pipe on the intermediate support to ensure easy longitudinal movement of the pipe due to thermal deformation. In areas with a large slope of the terrain, to reduce the distance between the anchor supports.
8. in order to avoid the occurrence of cavitation phenomena, establish the largest possible excess pressure in the suction tract of the pumps to obtain a cavitation reserve.
9. to provide comprehensive automatic protection measures against hydraulic shock and extreme air emissions for the pumping pipelines of a three-stage pumping station and to develop rules for their safe operation [1, 2, 3].
10.to increase the volume of the pressure basin of the 1st stage pumping station, so that in case of an emergency power outage caused by the local nature of the electric motors of the pumps, the possibility of short-term accumulation of water (provide the necessary justification) is created.
11. to develop a software alarm system and carry out installation, testing and verification of its devices in case of emergency power failure occurring due to local nature in any of the stages of the pumping station.
12. to provide all stages of the pumping station with a small power source to meet their own needs (especially at night). To find out the possibility of providing low voltage electric current from another substation as such source.

Conclusion

Analyzing the technical condition of Khachik three-stage pumping station, it is recommended to include in its reconstruction plan:

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1. To rebuild the former "Areni" 1st stage pumping station, renaming the "Areni" three-stage pumping station to "Khachik" pumping station.

2. The "Khachik" pumping station includes the first reconstructed stage and the second and third stages of the “Khachik” pumping station.

3. 180...200 l/s output should be set for the irrigation of land areas of Khachik settlement, instead of the previous output of 451 l/s.

4. All stages of the "Khachik" three-stage pumping station will receive water exclusively from the Arpa river through the existing approach canal.

5. To give 50 l/s output from the operating branch of the Hermon-Yelpi water pipeline in gravity mode for irrigation of the high lands of Areni settlement.

6. When determining the size of the water intake from the Arpa river, take into account the cooling water outputs necessary for the own needs of the 2nd and 3rd stages of the pumping station.

7. To provide the 1st level of the pumping station with the left compartment of the first level engine room of the former pumping station, in which to install 2 identical self-priming pumping units without a charging pump (as before) with parallel connection. One of these units is intended as a spare.

8. To carry out repair work in the 2nd and 3rd levels of the pumping station according to the new project.

9.To equip clearly defined siphon sites on the Hermon-Yelpin water pipelines with high-efficiency ventilation and automatic ventilation devices.

10. Development of pressure increase measures in the suction tract of the second stage of the pumping station, based on the results of its hydraulic modeling.

11. In the Khachik three-level system reconstruction project, to include the introduction of modern means of remote control in order to ensure safe management of the system in conditions of power outages of pumping stations.

12. In terms of improving the work of the Hermon-Elpin water pipeline, to include the issues of ensuring operational safety and increasing efficiency, including:

- ensuring the design capacity of the aqueduct;
- reduction of the maximum pressure of the aqueduct by 11 mtn;
- reconstruction of river crossings;
- development of measures for safe passage of water lines in Chiva village;
- furnishing of well-defined siphon sites of water lines with modern ventilation and ventilation devices [4];
- model studies of complex junctions (siphon, duker sites, river crossings).

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ԱՐԵՆԻԻ ՊՈՄՊԱԿԱՅԱՆԻ ՎԵՐԱԿԱՌՈՒՑՄԱՆ ԱՆՀՐԱԺԵՇՏՈՒԹՅԱՆ ՀԻՄՆԱՎՈՐՈՒՄԸ

Ա.Յա. Մարգարյան, **Վ.Հ.Թոքմաջյան**, **Դ.Վ. Մադոյան**
Ակադեմիկոս Ի.Վ. եղիազարովի անվան ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտ

Արենի-Խաչիկ պոմպային կայանը Արփա գետի ջրերը 976 մ նիշից բարձրացնում է Խաչիկ գյուղի վերնամասի լեռնանցքի 2012 մ նիշի վրա տեղակայված ճնշման ավազանը, որից ինքնահոս ճնշումային շարժումով ջուրը տրվել է Խաչիկ համայնքին՝ առավելագույն 415 լ/վ ելքով և Ամաղու գյուղին՝ առավելագույնը 41 լ/վ ելքով: Պոմպակայանն ունի երեք աստիճան, որոնց մեքենայական սրահները տեղադրված են՝ Առաջին աստիճան՝ Արփա գետի աջ ափին 975 մ նիշի վրա, 318 մ մղման գեոդե- զական բարձրությամբ, մղման 582 լ/վ ելք: Երկրորդ աստիճան՝ Արենի-Խաչիկ ավտոճանապարհի հարևանությամբ տեղանքի 1295 մ նիշի վրա, 370 մ մղման գեոդեզական բարձրությամբ, մղման 456 լ/վ ելք և Երրորդ աստիճան՝ Արենի-Խաչիկ ավտոճանապարհի հարևանությամբ տեղանքի 1651 մ նիշի վրա, 361 մ մղման գեոդեզական բարձրությամբ, մղման 456 լ/վ ելք: Պոմպակայանի երեք աստիճաններն էլ պատկանում են բարձր ճնշման պոմպակայանների դասին՝ համեմատաբար փոքր

թողարկման ելք և մեծ ճնշում, որոնց էլեկտրաէներգիայի տեսակարար ծախսը մղվող մեկ խորհանարդ մետր ջրի բարձրացման վրա ծախսվող էլեկտրաէներգիան զգալիորեն բարձր է: Վերլուծելով պոմպակայանի տեխնիկական տեխնիկական վիճակը, առաջարկվում է դրա վերակառուցումն իրականացնելու և շահագործման ծախսերը նվազեցնելու ծրագիր:

Բանալի բառեր. գետ, պոմպ, կավիտացիա, հիդրավլիկական հարված, խողովակաշար:

ОБОСНОВАНИЕ НЕОБХОДИМОСТИ РЕКОНСТРУКЦИИ НАСОСНОЙ СТАНЦИИ АРЕНИ

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Насосная станция Арени-Хачик поднимает воды реки Арпа с отметки 976 м над уровнем моря в напорный бассейн, расположенный на отметке 2012 м на перевале в верхней части села Хачик, из которого под действием силы тяжести вода подавалась в общину Хачик с максимальным расходом 415 л/с и в село Амагу с максимальным расходом 41 л/с. Насосная станция имеет три ступени, машинные цеха расположены: первая ступень на правом берегу реки Арпа на отметке 975 м, вторая ступень на отметке 1295 м, прилегающей к автодороге Арени-Хачик, с высотой подъема 370 м, выход тяги 456 л/с, и третья ступень на отметке 1651 м местности рядом с автодорогой Арени-Хачик, геодезическая высота тяги 361 м, выход тяги 456 л /с. Все три ступени насосной станции относятся к классу насосных станций высокого давления с относительно небольшой выходной мощностью и высоким давлением, при этом удельный расход электроэнергии, затрачиваемой на подъем одного кубометра перекачиваемой воды, значительно выше. Анализируя техническое состояние насосной станции, предлагается план ее реконструкции и снижения эксплуатационных расходов.

Ключевые слова: река, насос, кавитация, гидравлический удар, трубопровод.

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