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ИЗВЕСТИЯ
ВЫСОКИХ ТЕХНОЛОГИЙ

BULLETIN
OF HIGH TECHNOLOGY

3(27)/2023

ԵՐԵՎԱՆ – ЕРЕВАН – YEREVAN

2023

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UDC – 621.382.2/3

THE DESIGN OF HIGH EFFICIENCY AND LOW POWER SWITCHED OPAMP

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Abstract

The tendency of design of integrated circuits (ICs) goes to through the power and area reduction way. The surface area of very-large scale integrated circuits is shrinking along with the shrinking of technological dimensions. Power reduction requires usage of low-power design methodologies. The design of Switched-Opamp (SwOp) circuit based on typical Operational Transconductance Amplifier (OTA), with high efficiency is presented. Reduction of power consumption, using digitally controlled switches, is provided. The suggested SwOp was fabricated in a 14nm FinFET technology and achieved a DC gain of 38.4dB, a maximum operating frequency of 11.5GHz and a power consumption of 114.48uW for worst corner (SS) when the load capacitor is 5pF. The power consumption of proposed architecture is reduced about two times. Structure proposed in the paper can be integrated in modern analog-to-digital conversion application, high-speed receivers, memory systems.

Keywords: science, Switched Opamp, typical Operational Transconductance Amplifier (OTA), operating frequency, low power, high-performance, clock gating, FinFET.

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THE DESIGN OF HIGH EFFICIENCY AND LOW POWER SWITCHED OPAMP

Introduction

The main parameters of modern ICs are: low power consumption and small surface area on printed circuit board. Considering their low power operation, Operational Amplifiers (OpAmps) based on MOSFETs are becoming more usable in the majority of the current electronic systems [1].

As the reference were investigated different kind of architechtures of low power OpAmps [1-2]. The disadventage of those OpAmps is that they can't be integrated in high-speed ,10MHz and more, systems. Therefore there is a need to design a new scheme of OpAmp, which will allow to increase operating frequency, in case of an acceptable increase of the power.

A typical OTA scheme based on MOSFET technology has been researched (Fig. 1) [3], which shows that all nodes, apart from the input and output ones, include either a gate-drain-connected device or a source connected to them.
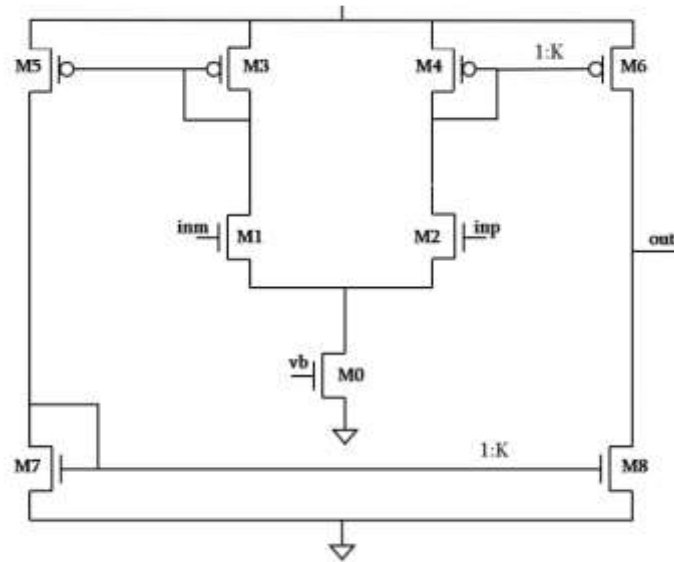
Fig 1 Typical OTA scheme

«$1:K$» is used to show that the width of $M6$ and $M8$ can be K (where $K > 1$) times wider than the other MOSFETs in the circuit. If it is assumed that $ß1 = ß2$, $ß3 = ß4$, so it can be observed that the current $id3$ or $id4$ is given by

$$- id3 = id4 = gm * (vp - vm)/2 = id \tag{1}$$

Moreover, if $ß6 = K * ß4 = K * ß3 = K * ß5$, $K * ß7 = ß8$,

then $id6 = -id8 = K * id4 = -K * id3$.

If the impedance of the capacitor is large compared to $ro6||ro8$, then the output voltage of the OTA is given by

$$vout = 2K * id(ro6||ro8) \tag{2}$$

and the voltage gain is given by

$$AV = vout/(vp - vm) = K * gm * (ro6||ro8) \tag{3}$$

Conflict Setting

The main problems of designing modern ICs are the reduction of the area and power consumption.

In fact, that the majority of ICs are continuously working, in order to conserve the significant amount of power, it is critical to decrease the power consumption of circuits in the IC. As a result, there is a need to do architectural changes in schemas which are widely used in very large-scale integration design and reducing power consumption in OpAmps is required nowadays. So, in OpAmps instead of reducing static power (leakage current) is preferred to reduce dynamic power by gating clock off [4-5]. And this method was used in this article while architecting SwOp design as being analog design SwOp need to use clock signal to be aligned and matched with digital circuits.

In this paper a low power SwOp using FinFET technology is designed. The design methodology of SwOp is described in next section.

Research Results

It can be seen from introduction that the maximum operating frequency of typical OTA is 155MHz, and power consumption is 217.51uW in the worst corner (Tab. 1).

Table 1

Typical OTA performance

Measurement	VDD=0.8V	VDD=0.88V	VDD=0.72V
Gain (dB)	41.6	44	22.1
Unity Gain Bandwidth (MHz)	296	529	155
Gain Bandwidth (MHz)	9.86	10.4	21.5
Phase Margin (degree)	53.8	120	11.3
Gain Margin (dB)	14.6	25.5	2.63

From the results of the research, it can be seen that in the worst case, 0.72V, a typical OTA can work at a maximum frequency of 155MHz, consuming 217.51mW of power.

Based on the designed architecture (Fig. 1) has been proposed a new circuit (Fig. 2) to improve op-amp performance and to save power consumption. [6-7]

Fig 2 SwOp circuit

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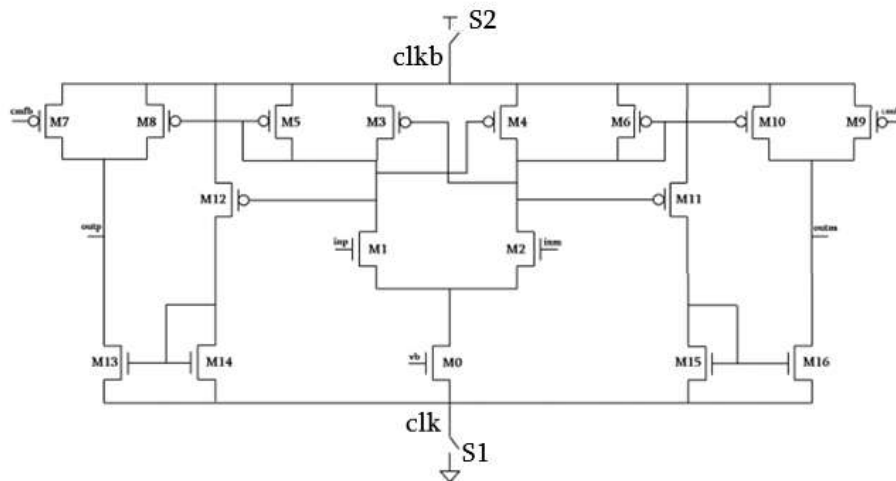
As it can be seen from the proposed SwOp scheme, it is based on typical OTA scheme in which was added $S1$ and $S2$ switch transistors, with help of which scheme is able to switch off the scheme from the power supply when needed and help to reduce dynamic power consumption.

Four cross-coupled transistors [7] ($M3$, $M4$, $M5$, and $M6$) are included in SwOp's load of the first stage, which brings a low impedance for common-mode signals. Thus, for different signals, that four transistors are not equal in size and the transconductance (gm) of $M3$, $M5$ ($M4$, $M6$) cannot be fully neutralized. Besides, the impedance of this node is not significantly high (about $1/(gm5 - gm3)$). Consequently, a non-dominant pole is generated by this node (Drain of $M3$ and $M5$). Also, as $1/(gm5 - gm3)$ which is much larger than $1/(ro3||ro5||ro1)$, no compensation is needed for OTA. Transistors sizes of Switched Op-amp are listed in Tab. 2.

Table 2

Transistor sizes of Switched Op-amp

Transistor	Length (um)	Number of fins	Number of fingers
M0	0.16	52	5
M1, M2	0.12	40	2
M3, M4	0.056	2	1
M5, M6	0.056	3	1
M7, M9	0.056	2	1
M8, M10	0.056	2	2
M11, M12	0.056	6	1
M13, M16	0.12	2	3
M14, M15	0.12	2	1

Common-mode feedback (CMFB) circuit allowed to keep op-amp outputs around common-mode voltage and use fully-differential topology.

The simulation results are shown in Fig. 3. Simulations are performed using HSPICE simulator [8] for 3 main PVT conditions (TT, SS and FF processes with respective voltage and temperature values). Transient analysis was run, to check the functionality of op-amp and in Fig.3 it is shown the simulation plots for TT typical corner.
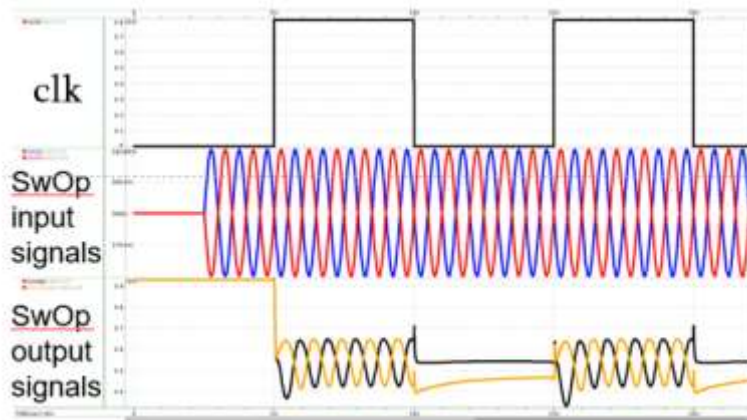
Fig. 3. Switched Op-amp transient waveforms

In the waveforms are presented clk, SwOp input and SwOp output signals. With help of positive edge of the clock signal (clk, clkb signals) SwOp is switching ON by using $S1$ and $S2$ switch transistors and amplifies input signals, and with clock signal's negative edge SwOp is switching off by saving power (Fig. 2).

SwOp simulation summary and comparison with typical OTA circuit is presented in Tab. 3.

Table 3

Comparison results of Switched Op-amp and typical OTA circuits

Process Voltage Temperature (PVT)	Measurement	Typical OTA (MOSFET)	Switched Opamp, SwOP (FinFET)
TT/0.8V/25C	Gain (dB)	41.6	49.5
	Unity Gain Bandwidth (GHz)	0.296	15.4
	Phase Margin (degree)	53.8	43.7
	Power consumption (uW)	220.52	119.2
SS/0.72V/125C	Gain (dB)	22.1	38.4
	Unity Gain Bandwidth (GHz)	0.155	11.5
	Phase Margin (degree)	11.3	34.5
	Power consumption (uW)	217.51	114.48
FF/0.88V/m40C	Gain (dB)	44	52.6
	Unity Gain Bandwidth (GHz)	0.529	19.6
	Phase Margin (degree)	120	46.9
	Power consumption (uW)	210.67	117.04

As it can be seen from the Table 3 most of the performance parameters SwOp's are better than Typical OTA's and particularly power consumption value of presented SwOp circuit to compare with typical OTA is twice lower.

Conclusion

The highly efficient high-performance SwOp architecture has been implemented in this paper. The switching operation implemented by digitally controlled switches improves the performance and reduces power consumption. The simulation results are compared with typical OTA. The disadvantage of the investigated OpAmps is that they can't be integrated with the systems with more than 1GHz operating frequency. The power consumption of proposed SwOp using digitally controlled switches, compared with typical OTA, reduced twice. In the worst corner (SS/0.72V/125C) the proposed architecture can be integrated in electronic systems with less than 10GHz operating frequency. The main disadvantage of SwOp compared with typical OTA is the large area.

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ԲԱՐՁՐ ԱՐԴՅՈՒՆԱՎԵՏՈՒԹՅԱՄԲ ԵՎ ՑԱԾՐ ԷՆԵՐԳԱՍՊԱՌՄԱՄԲ ՏԱԿՏԱՎՈՐՎՈՂ ՕՊԵՐԱՑԻՈՆ ՈՒԺԵՂԱՐԱՐԻ ՆԱԽԱԳԾՈՒՄԸ

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Ինտեգրալ սխեմաների (ԻՍ) նախագծման գործընթացը միտված է էներգասպառման նվազեցմանը և զբաղեցրած մակերեսի փոքրացմանը: Գերմեծ ինտեգրալ սխեմաների մակերեսը փոքրանում է տեխնոլոգիական չափերի փոքրացմանը զուգընթաց: Էներգասպառման փոքրացումը պահանջում է ցածր էներգասպառմամբ նախագծման մեթոդների կիրառում: Հոդվածում ներկայացված է բարձր արդյունավետությամբ տակտավորվող օպերացիոն ուժեղարարի (ՕՈւ) նախագծումը՝ հիմնված տիպային փոխհաղորդականային օպերացիոն ուժեղարարի (ՓՕՈւ) վրա, որը, երկուական կողով կառավարվող տրանզիստորների կիրառմամբ, ապահովվում է ցածր էներգասպառում: Առաջարկվող տակտավորվող ՕՈւ-ն նախագծվել է 14 նմ «FinFET» տեխնոլոգիայով և վատագույն դեպքի (SS) համար ստացվել է 38.4 դԲ ուժեղացում, 11.5 ԳՀց առավելագույն հաճախություն և 114.48 մկՎտ էներգասպառում, երբ ելքային բեռը 5 պֆ է: Առաջարկվող ճարտարապետության էներգասպառումը նվազել է շուրջ երկու անգամ: Այն կարող է օգտագործվել ժամանակակից անալոգաթվային փոխակերպիչներում, արագագործ ընդունիչներում, հիշողության համակարգերում:

Բանալի բառեր: տակտավորվող օպերացիոն ուժեղարար, տիպային փոխհաղորդականային օպերացիոն ուժեղարար, ցածր էներգասպառում, աշխատանքային հաճախականություն, բարձր արագագործություն, սինքրոազդանշանի շրջափակում, «FinFET» :

РАЗРАБОТКА СИНХРОННЫХ ОПЕРАЦИОННЫХ УСИЛИТЕЛЕЙ ВЫСОКОЙ ЭФФЕКТИВНОСТИ И НИЗКОГО ЭНЕРГОПОТРЕБЛЕНИЯ

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Процесс проектирования интегральных схем (ИС) направлен на снижение энергопотребления и уменьшение занимаемой площади. Площадь сверхбольших ИС сокращается по мере сокращение технологических размеров. Снижение энергопотребления требует применение методов проектирования с низким энергопотреблением. В статье представлена разработка высокоэффективных синхронных операционных усилителей (ОУ), основанных на типовом ОУ, который обеспечивает низкое энергопотребление с применением транзисторов, управляемых двоичным кодом. Предлагаемый синхронный ОУ проектерован по 14 нм «FinFET» технологии и в худшем случае было получено 38.4дБ усиление, 11.5 ГГц максимальной частоты и 114.48 мкВт энергопотребление, при выходной нагрузке 5 пФ. Энергопотребление предлагаемой архитектуры уменьшилось примерно в два раза. Его можно интегрировать в современные приложения аналого-цифрового преобразования, высокоскоростные приемники, системы памяти.

Ключевые слова: синхронный ОУ,типовой ОУ, низкое энергопотребление, рабочая частота, высокоскоростной, стробирования синхросигнала, «FinFET».

RESEARCH THE MODEL OF DETECTION POLYMORPHIC MALWARE BY THE CONVOLUTIONAL NEURAL NETWORK

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Abstract

The paper presents the results of research on the use of a convolutional neural network to detect polymorphic malware. The research was conducted on on basis of polymorphic software abc, cheeba, december_3, stasi, otario, dm, v-sign, tequila, flip.

The generated of datasets for training a convolutional neural network was carried out using «state matrices» of various dimensions. The Fadeev-Leverrier method was used as a mathematical apparatus. The simulation of the developed software at different iterations and visualization of the results was carried out.

Keywords: machine learning, polymorphic malware, intrusion detection system, «state matrices», Fadeev-Leverrier method.

Introduction

The heterogeneity of networks, equipment, software and other components increase the «attack surface» [1] on the network infrastructure (NI). The research [2] formulated the main conditions for creating a secure NI. In particular, it was noted that one of the most important components of the NI is an intrusion detection system (IDS) capable of adapting to possible and probable threats.

This requirement appeared after IDS «skipped» a lot of attacks that were carried out by attackers using *0-day vulnerabilities* and/or various exploits [3]. Machine learning has made it possible to transfer the means of both defense and attack to a qualitatively new level [4,5]. The increase in machine-to-machine interaction (Machine-to-Machine, M2M) has led to the fact that the very paradigm of the concept of a *secure automated system* has changed [6]. Among the many types of malware, polymorphic[1] malware is one of the most threatening. A distinctive feature of polymorphic malware from obfuscated malware is that polymorphic software changes its source code on its own, without human intervention [8]. The relevance of the work is determined by the ever-increasing role of using machine learning to attack critical Infrastructure objects using various types of malware.

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[1] *Polymorphic malware - is malicious software that is characterized by the following behavior: encryption, self-propagation, and modification of one or more components of the source code* [8].
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T.V.Jamgharyan

RESEARCH THE MODEL OF DETECTION POLYMORPHIC MALWARE BY THE CONVOLUTIONAL NEURAL NETWORK

An important task in the development of IDS with machine learning is the generation of data sets for training neural networks that are part of the IDS. Various researchers use various methods for the analysis of «state matrices» and the subsequent generation of data sets based on them, in particular: the method of Krylov-Danilevsky, Samuelson, Hessenberg, Lanczos. These methods allow solving particular problems within the given constraints. But these methods are not suitable for constructing «state matrices» of polymorphic malware, due to the small dimension of both the matrix itself and its single element. As indicated in [9], these methods do not provide reliable deployment of determinants in systems with a high-order state vector, which is critical when building «state matrices» based on the source code of polymorphic software.   Scientific novelty lies in the application of the Fadeev-Leverrier[2] method for generating «weight» coefficients and forming data sets when initializing a neural network based on a «state matrix» obtained from polymorphic malware. The application of the method allows, with an increase in the bit depth of the matrix, to reduce the amount of necessary polymorphic malware to activate the layers of the neural network. A convolutional neural network (CNN) with a different number of layers and elements was used as a neural network.

Discussion

1. Let there be data sets of network traffic $\{g_1, g_2, g_3 ... g_n\} \in G$ with embedded malicious polymorphic software $\{a_1, a_2, a_3 ... a_n\} \in A$.

   It is necessary to determine the ratio *A(G)* under which it is possible to unambiguously detect and identify *a*.

2. There is a state matrix $M = \begin{pmatrix} a_{11} & a_{12} & g & a_{1n} \\ a_{21} & a_{22} & g & a_{2n} \\ g & g & g & g \\ a_{n1} & a_{n2} & a_{n3} & a_{nn} \end{pmatrix}$, where - *a* is a set of malware bytes that form

   a data set for training, *g* - datasets of network traffic fragmented according to the rules set on the network interface. $k^{`} = \{k_1, k_2, g, k_n\}$ matrix eigenvector *M,* eigenvalue $Mk^{`} = \lambda k^{`}$ , where $\lambda$ eigenvalue $k^{`}$.

3. Characteristic matrix $C = M - \lambda E \begin{pmatrix} a_{11 - \lambda} & a_{12} & g & a_{1n} \\ a_{21} & a_{21 - \lambda} & g & a_{2n} \\ g & g & g & g \\ a_{n1} & a_{n2} & a_{n2} & a_{nn - \lambda} \end{pmatrix}$,

where E- identity matrix (In this case, a dataset consisting entirely of malware).
   With the coordinate notation of the vector *k*

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[2] *The Faddeev-Leverrier method is a modified Leverrier method that allows, when calculating the coefficients of the characteristic polynomial, to calculate the eigenvectors of matrices, the inverse matrix and the matrix trace. The method requires a larger number of operations, but unlike other methods, it allows you to work with matrices of large dimensions (including elemental ones).*

$$(a_{11} - \lambda)k_1 + a_{12}k_2 + g + a_{1n}k_n = 0,$$

$$a_{21}k_1 + \left(a_{22} - \lambda\right)k_2 + g + a_{2n}k_n = 0,$$

$$g$$

$$a_{n1}k_1 + a_{n2}k_2 + g + \left(a_{nn} - \lambda\right)k_n = 0$$

The determinant C is an nth degree polynomial with respect to λ $det\,\mathrm{C} = \left(-1\right)^n \left(\lambda^n - c_1\lambda^{n-1} - g - c_{n-1}\lambda - c_n\right)$ is called the characteristic polynomial.

The roots of this polynomial are the eigenvalues of the matrix *M*. To solve this problem and determine the activation function of a convolutional neural network in this study, the Fadeev-Leverrier method is used.

Conflict Setting

It is necessary to develop an algorithm that configures a convolutional neural network to perform a given function.

Boundary conditions

➢ the dimension of the «state matrix» is finite (≤4096 bit),

➢ the source code of polymorphic software (or at least 10-12% of its fragments) is known,

➢ at a given point in time, it is possible to search for only one type of polymorphic software.

The developed algorithm is shown Fig. 1.

Algorithm operation

The input of the software that searches for polymorphic software receives datasets generated both on the basis of the known code of polymorphic software and obtained by reverse engineering methods using *IDA Pro, Ghidra* tools [10].

step 1 preparation of datasets for the formation of the state matrix,

step 2 formation of the parameters of the «matrix of states» - dimension, numerical values of the elements of the matrix. The developed software is a dynamic array, which, in the presence of an appropriate computing resource, makes it possible to operate with matrices of dimension 16x16, 32x32, 64x64, 128x128, 256x256, 512x512, 1024x1024, 2048x2048, 4096x4096 elements and the size of each element $\leq 2^{12}$ bit,

step 3, 4 segmentation of the input data sets and activation of the «state matrix» of the required dimension,

step 5, 6 calculation of the value of the hash function from the data sets entered into the «matrix of states». The hash function is calculated by calling the hashlib library (step 6),

step 7 calculation of the coefficients of the «state matrix» by the Fadeev-Leverrier method,

step 8, 9 calculation of the hash value of the *sha-1* function from the datasets input to the CNN. The hash function is calculated by calling the hashlib library (step 9),

step 10 comparison of hash function values from datasets entered into the «state matrix» and hash functions from datasets entered into a CNN,

step 11 a decision-making cycle on the input of polymorphic software data into a CNN.

The main task of a CNN is: based on fragments of the source code of polymorphic software, to detect possible and probable subsequent modifications of this software. The choice of using a convolutional neural network is due to the fact that in a convolutional neural network the transfer

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function (activation function of neurons) can take on a wide range of values, which is fundamentally important in the study of polymorphic software, since the range of changes in polymorphic software is a priori unknown.
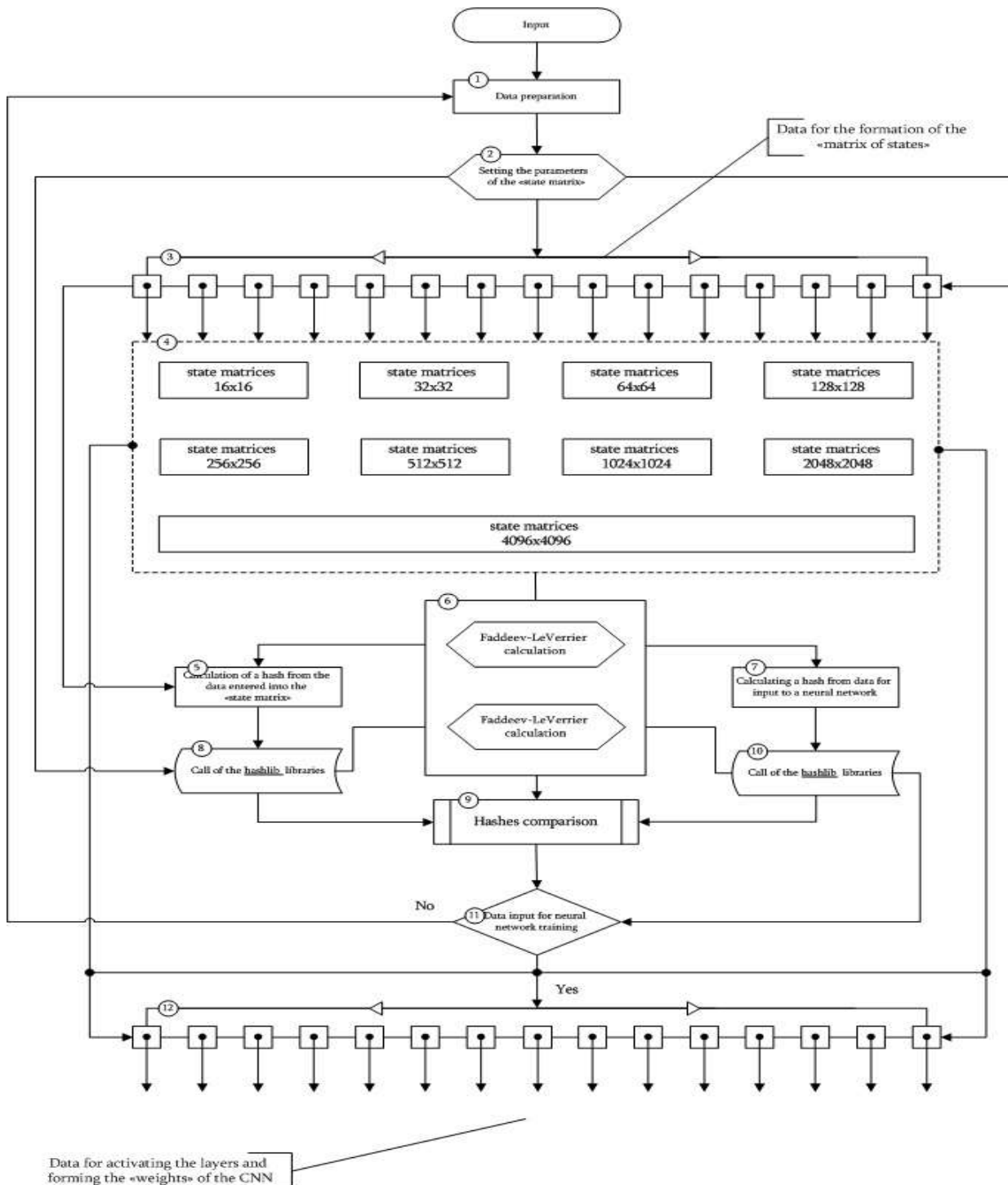
Fig. 1 The developed software algorithm

Visualization was carried out using the *TensorBoard* plugin [11].

Research Results

With an increase in the dimension of the «state matrix», the accuracy of detecting polymorphic software increases, but it also requires a large computing resource (Fig. 2,3). With an increase in the

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dimension of the «state matrix», the number of program execution errors increases, which is detected and blocked, but forces a repeated search for malware, which, with large volumes of processed traffic, will require significant computing resources. Program execution errors are detected and blocked.
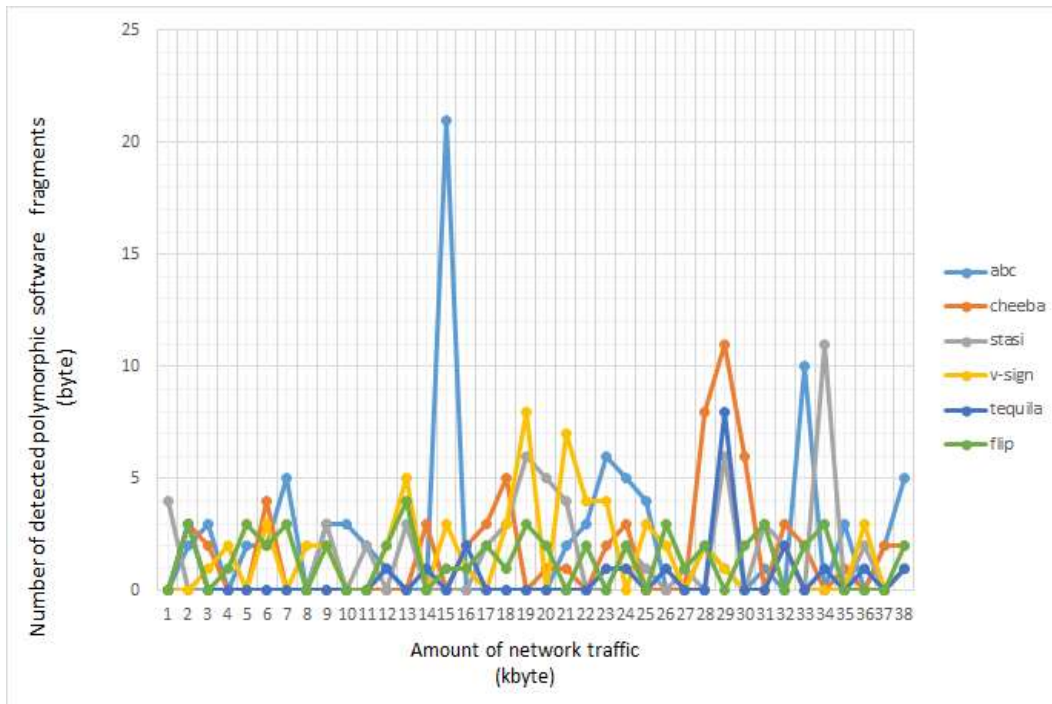
Fig. 2 Visualization of malware detection at size «state matrices» 32x32
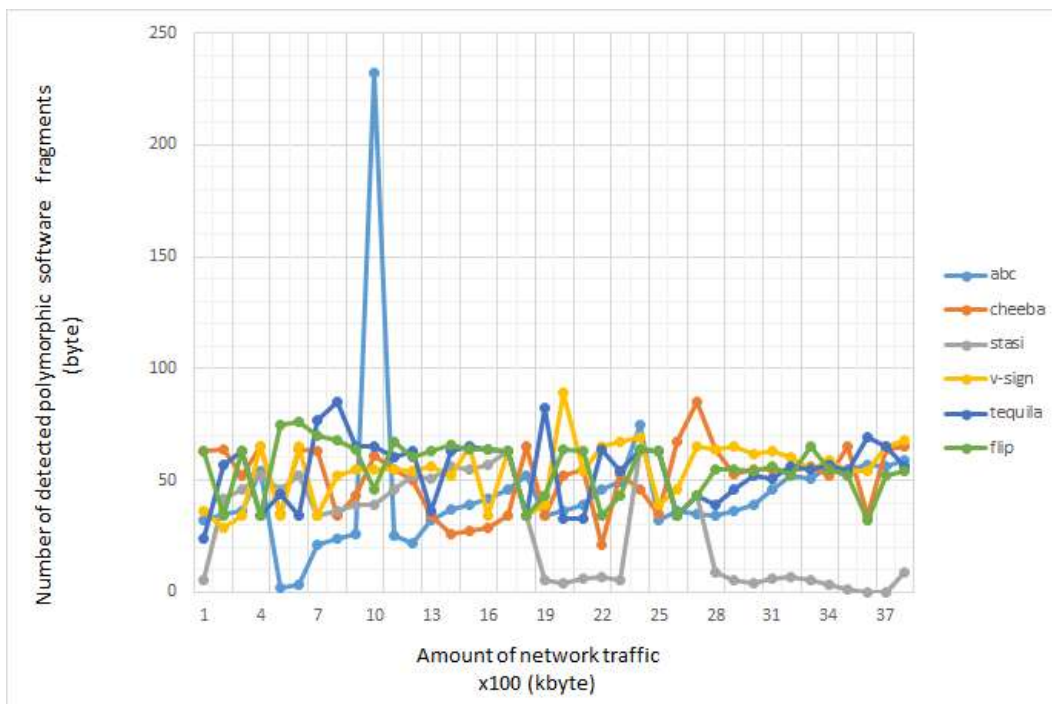
Fig. 3 Visualization of malware detection at size «state matrices» 512x512

The presence of at least 256 GB of RAM makes it possible to form a «state matrix» of 4096x4096 bits for training a convolutional neural network with a size of a single element of 4096 bits. In all cases, there is an increase in the degree of detection of polymorphic malware, but with an

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increase in the dimension of the «state matrix», the number of false positives increases. An increase in the number of iterations leads to an increase in the accuracy of malware detection with «state matrices» up to 128x128 in size by an average of 2-3.4% with large matrices by an average of 4-4.4%. In all cases of computing, having a large amount of RAM plays an important role.

Conclusion

The paper considers a software model for detecting malicious polymorphic software using a convolutional neural network. Datasets for training a convolutional neural network are formed on the basis of «state matrices» of various dimensions.

At each stage of inputting data sets into the «state matrix» and the convolutional neural network, the identity of the input data was controlled by the hashing method. The Fadeev-Leverrier method was used as a mathematical apparatus for calculating the coefficients of the «state matrices» to activate the «weights» of the convolutional neural network. The developed software allows preparing data for training a convolutional neural network and detecting polymorphic malware in the presence of at least 8-10% of the source code. The calculations were carried out on a Dell Power Edge T-330 server. The source code and the full results of the research are presented in [12].

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ՓԱԹՈՒՅԹԱՅԻՆ ՆԵՅՐՈՆԱՅԻՆ ՑԱՆՑՈՎ ՊՈԼԻՄՈՐՖ ՎՆԱՍԱԲԵՐ ԾՐԱԳՐԱՅԻՆ ԱՊԱՀՈՎՄԱՆ ՀԱՅՏՆԱԲԵՐՄԱՆ ՄՈԴԵԼԻ ՀԵՏԱԶՈՏՈՒՄ

Թ.Վ. Ջամղարյան
Հայաստանի ազգային պոլիտեխնիկական համալսարան

Հոդվածում ներկայացված է վնասաբեր պոլիմորֆ ծրագրային ապահովման հայտնաբերման համար փաթույթային նեյրոնային ցանցի կիրառման հետազոտության արդյունքները: Հետազոտությունն իրականացվել է abc, cheeba, december_3, stasi, otario, dm, v-sign, tequila, flip պոլիմորֆ վնասաբեր *ծրագրային ապահովման էլակերային կոդի հիման վրա կառուցած* տվյալների հավաքածուներով: Փաթույթային նեյրոնային ցանցի ուսուցումը իրականացվել է տարբեր չափերի մատրիցների միջոցով: Որպես մաթեմատիկական ապարատ օգտագործվել է Ֆադեև-Լևերիե մեթոդը: Իրականացվել է ծրագրային ապահովման իրագործման մոդելավորում տարբեր կրկնություններում և արդյունքների արտածոլում:

Բանալի բառեր: մեքենայական ուսուցում, տվյալների հավաքածու, պոլիմորֆ ծրագրային ապահովում, Ֆադեև-Լևերիե մեթոդ, *ներխուժումների հայտնաբերման համակարգ:*

ИССЛЕДОВАНИЕ МОДЕЛИ ОБНАРУЖЕНИЯ ПОЛИМОРФНОГО ВРЕДОНОСНОГО ПО СВЕРТОЧНОЙ НЕЙРОННОЙ СЕТЬЮ

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В статье представлены результаты исследования применения сверточной нейронной сети для обнаружения вредоносного полиморфного программного обеспечения. Исследование проводилось на наборах данных сформированных на основе полиморфного программного обеспечения *abc, cheeba, december_3, stasi, otario, dm, v-sign, tequila, flip.* Формирование наборов данных для обучения сверточной нейронной сети осуществлялось с помощью «матриц состояний» различной размерности. В качестве математического аппарата использовался метод Фадеева-Леверье. Проведено моделирование работы программного обеспечения при разных итерациях и визуализация результатов.

Ключевые слова: машинное обучение, полиморфное ПО, метод Фадеева-Леверье, система обнаружения вторжений, «матрица состояний».

UDC - 699.841

ON THE PROPERTIES OF CEMENT-SAND MORTARS PLASTIFIED WITH CARBONATE CLAYS

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Abstract

The use of cement-sand mortars plasticized with carbonate clays in earthquake-resistant construction has been demonstrated in experimental tests. The compositions and physical-and-mechanical characteristics of these mortars have been identified for the first time, allowing for a reduction in cement consumption of up to 40% as well as a complete

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elimination of the costly lime while enhancing the mortar's strength. The use of cement-sand mortars plasticized with carbonate clays has been suggested for performing earthquake-resistant construction from local sawn limestone. The experiments' findings were put to the test and put into practice in Nagorno-Karabakh's construction complex. The study's finding s are in line with research and regulatory documents for cement-clay mortars for masonry.

Keywords: masonry, sawn limestone, masonry mortar, cement, carbonate clay, strength characteristics, seismic resistant.

Introduction

The formation of the strength of the mortar and its adhesion to the stone depend mainly on the water-holding capacity of the mortar and the absorption properties of the stone.

The ability of the mortar to retain water and the stone's ability to absorb moisture are the two key factors that determine the strength of the mortar and its ability to adhere to the stone.

Stones with high absorption properties, which include the local saw limestone of Nagorno-Karabakh, suck out moisture from the solution, which leads to dehydration of the masonry mortar and a decrease in its strength, as well as the solidity of the masonry.

The local saw limestone of Nagorno-Karabakh are among the stones with strong absorption qualities that absorb moisture from the mortar, dehydrating the mortar and reducing its strength as well as the stability of the construction. Thus, one of the main ways to increase the seismic resistance of stone structures made of sawn limestone is the use of masonry mortars with high strength and water-holding capacity.

The use of cement-sand mortars plasticized with carbonate clays in earthquake-resistant construction, the reserves of the latter are widespread in Nagorno-Karabakh, was demonstrated through an analysis of studies, normative documents on masonry, and physical-and-mechanical properties of materials for masonry mortars [1–5]. In particular, the favorable effect of cement on the physical and mechanical properties of clays of the most diverse genesis and granulometric composition is indicated in the works of Babkov B.F. and Bezruk V.M. who revealed that calcium silicates moistened with water, which make up up to 75% of Portland cement, turn into new compounds that, interacting with clay particles, form a strong, water-resistant mass with high water-holding capacity. Additionally, it has been demonstrated that depending on the chemical and mineralogical makeup of the clays themselves, these processes can be sped up.

Therefore, the cement-clay mortar hardens more quickly, has a higher level of strength, and can hold more water when carbonate clays are used.

At the same time, carbonate clays have a pronounced heterogeneity, and the use of these clays in masonry mortars without laboratory tests can lead to a decrease in the strength characteristics of the masonry and, accordingly, to a decrease in the solidity of stone structures. However, because carbonate clays exhibit significant heterogeneity, using them in masonry mortars without first subjecting them to laboratory testing runs the risk of lowering the masonry's strength properties and, as a result, the stability of stone structures.

The idea of the expediency of using carbonate clays instead of lime in masonry mortars in the construction complex of Nagorno-Karabakh arose during the restoration work of facilities affected by hostilities, in connection with the suspension of lime production enterprises.

Conflict Setting

The idea of using cement-sand mortars plasticized with carbonate clays for creating masonry from saw limestone in antiseismic construction has been supported by experimental tests of the materials' physical and mechanical properties.

Utilizing cement-sand mortars plasticized with carbonate clays to construct buildings and other structures made of stone will increase seismic resistance and construction efficiency.

Research Results

For the first time, the compositions and physical and mechanical properties of cement-sand mortars plasticized with carbonate clays have been revealed, which make it possible to carry out earthquake-resistant construction from local building materials of Armenia and Nagorno-Karabakh.

Materials and methods:

1. Determination of the chemical, granulometric and macroscopic composition of local clay raw materials.
2. Experimental studies on choosing the composition and determination of the physical-and-mechanical characteristics of cement-sand mortars plasticized with carbonate clays for masonry from local sawn limestone in earthquake-resistant construction of buildings and structures.
3. Analysis of the reliability of research results
4. Approbation and practical application of research findings.

Experimental studies were carried out at the Armenian Research Institute of Earthquake Engineering and Protection of Constructions JSC with the participation of the author [6]

Armenian Scientific Research Institute of Seismic Construction and Protection of Structures

The following types of building materials were used in the studies: cement of the Ararat Production Association "AraratCement" M300 (Tab. 1).

Table 1

Physical-and-mechanical characteristics of Portland cement Ararat PO

Apparent density, kg/m³	Setting periods		Normal density of cement	Strength limit of cement, MPa, at			
	onset	end		Bending strength at ages		Compression strength at ages	
				3 days	28 days	3 days	28 days
1050	1h.10m.	4h.20m.	29,0	17,3	33,7	3,6	5,1

air hydrated lime - produced by the Stepanakert plant of building materials (Tab. 2).

Table 2

Chemical analysis of hydrated lime from Stepanakert building materials plant

Content of active oxides CaO+МдO in terms of dry matter, % by weight	Carbon dioxide content CO_2, % by weight	Lime grade
51,2	2,0	1

Clay from the Askeran deposit (Tables 3, 4, 5) [7].

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Table 3

Macroscopic description of clay raw materials

Deposit	Air dry color	Texture	Impurity with large inclusions	Impurity
Askeran	yellowish gray	dense	No	effervescence
Khramort	- // -	- // -	No	- // -

Table 4

Granulometric composition of clays of the Nagorno-Karabakh Republic

Deposit	Percentage of particle size, mm					Particle content (%), size		Classification according to the content of fine fractions (groups)
	1-0.06	0.06-0.01	0.01-0.005	0.005-0.001	<0,001	<10mkm	<1mkm	low dispersion
Askeran	3.71	21.81	18.09	25.92	30.47	69.53	30.47	- // -
Khramor	4.17	22.51	19.33	24.87	31.12	69.88	30.12	- // -

Table 5

**Chemical composition of clay raw materials of
Nagorno-Karabakh Republic deposits**

Deposit	Loss on ignition.	Content of oxides, %							Content of free quartz
		SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	R_2O	
Askeran	3,18	43,57	7,79	10,02	14,46	2,74	0,36	3,00	16,32
Khramor	3,40	47,65	10,21	9,14	10,42	3,12	0,28	3,10	17,85

Fine filler - river quartz sand of the Stepanakert deposit.

Table 6

**Grain composition of quartz sand fractions 0-5 mm
Stepanakert masonry mortar quarry**

Sieve size, mm / Residue	2,5	1,25	0,63	0,314	0,14	Passage through a sieve 0,14mm
Partial, %	6,5	13,0	34,3	35,5	8,5	2,2
Full, %	6,5	19,5	53,8	86,3	97,8	-

Size modulus M_s=2,67. The results of the sieve analysis of the sand showed that the content of particles larger than 5 mm in the sand is 5.5%.

According to the standard, the presence of grains larger than 5 mm should not exceed 10% by weight.

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Wall stone materials of the Armenia and Nagorno-Karabakh limestone deposit.

Table 7

Basic physical-and-mechanical properties of
Nagorno-Karabakh stone quarries

№	Name	Indicators		
		from	to	average value
1	Density, g/cm^3	1.87	2,15	2,01
2	True density, g/cm^3	2,0	2,32	2,16
3	Porosity, %	3,0	25,6	14,3
	Ultimate compression strength, MPa:			
	- dry:	7,9	19,8	13,9
	- in a water-saturated state:	5,6	16,3	10,9
	- after freezing	3,9	13,5	8,7
4	Softening coefficient	0,71	0,82	0,77
5	Frost resistance coefficient	0,65	0,74	0,70
6	Water absorption, %	0,9	9,3	5,1

Sample testing processes (Fig. 1, 2, 3, 4)

Fig. 1   **Fig. 2**

Fig. 3   **Fig. 4**

Experimental results

Strength characteristics of mortars for masonry

The graph of strength change for cement-clay masonry mortars is shown in Fig. 5, from which the effectiveness of the use of cement-clay mortars is seen in comparison with cement-lime mortars. Thus, with a quantitative ratio of 80% ÷ 20% and 60% ÷ 40%, the strength of the solution using a component of carbonate clays increases on average by 1.4 times.

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The effectiveness of cement-clay mortars in comparison to cement-lime mortars can be seen from the graph of strength change for cement-clay masonry mortars in Fig. 5. As a result, using the quantitative ratios of 80% ÷ 20% and 60% ÷ 40%, the strength of the solution containing a carbonate clay component increases by 1.4 times on average.
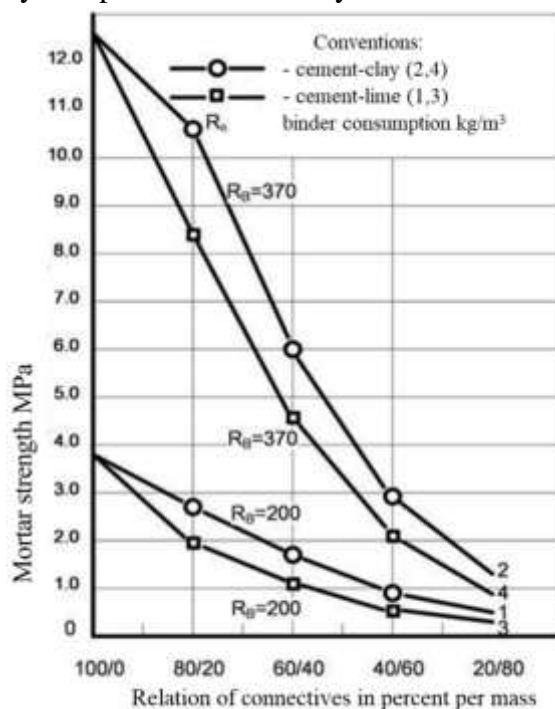
Fig. 5 Mortar strength change for masonry depending on the percentage

Adhesion strength of mortars with sawn limestone

The work of Polyakov S.V., Izmailov Ya.A., Orudzhev F.M. and Polyakov F.M. [8] is a thorough study of properties of masonry from saw limestone of various varieties and the adhesion strength of mortars. According to the research, the following elements have the biggest effects on how well mortar adheres to stone: the mortar's strength, composition, and consistency; the stone's absorption qualities; the condition of the stone's contact surfaces; the masonry's maturation conditions; and the bricklayer's qualifications. All of these elements function simultaneously and are interrelated in the "mortar-stone" system to generate adhesion, and different combinations of them might have different outcomes.

The adhesion strength the masonry was determined by laboratory testing of specimens in pull, R_t (normal bond) or shear, R_{sq} (tangential bond).

Comparison of the results of shear and tear tests showed that, in the general case, the ratio (hereinafter referred to as coefficient K) can vary over a wide range (K = 1, 2 - 4.0). For most limestones, the K value is in the range of 1.5 - 2.5. In many cases, K is practically equal to 2.0 (with minor deviations in one direction or another).

In accordance with the requirements of the current Building Code IV of the Republic of Armenia - 13.01-96 "Stone and reinforced masonry structures" in seismic areas, when constructing load-bearing and self-supporting walls made of natural and artificial stones is carried out to ensure adhesion strength, mortar with stone not lower than the following values:
- for stones of the correct form on mortars of grade 50 and higher (normal adhesion)

$$R_t = 0.17 \text{ MPa};$$

- for masonry of all types in an unbound section (tangential adhesion)

$$R_{sq} = 0.17 \text{ MPa.}$$

The values of normal adhesion at a coefficient K = 3 are shown in Table 7

Table 7

The values of normal adhesion at a coefficient K = 3

№ compositions according to the Table 5.20.	Plasticizer	Brand of mortar	Ultimate compression strength, MPa	Normal adhesion, MPa
				Sawn limestone
22	-	25	3,0	0,067
23	-	50	5,1	0,120
24	-	75	7,4	0,170
25	-	100	10,3	0,223
26	clay	25	3,6	0,063
27	clay	50	5,0	0,133
28	clay	75	7,6	0,160
29	clay	100	10,5	0,213
38	lime	25	3,2	0,060
39	lime	50	5,6	0,117
40	lime	75	7,5	0,133
41	lime	100	10,6	0,187

- Values of tangential adhesion at coefficient K = 3 are shown in Table 8

Table 8

The values of tangential adhesion at a coefficient K = 3

№ compositions according to the Table 5.20.	Plasticizer	Brand of mortar	Ultimate compression strength, MPa	Tangential adhesion, MPa
				Sawn limestone
22	-	25	3,0	0,20(0,11-038)
23	-	50	5,1	0,36(0,23-0,50)
24	-	75	7,4	0,51(0,40-0,57)
25	-	100	10,3	0,67(0,54-0,71)
26	Clay	25	3,6	0,19(0,13-0,26)
27	Clay	50	5,0	0,40(0,28-0,46)
28	Clay	75	7,6	0,48(0,34-0,52)
29	Clay	100	10,5	0,64(0,53-0,68)
38	Lime	25	3,2	0,18(0,15-0,25)
39	Lime	50	5,6	0,35(0,23-0,42)
40	Lime	75	7,5	0,40(0,32-0,46)
41	Lime	100	10,6	0,56(0,61-0,59)

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The measured tangential adhesion values and the manner in which the samples were destroyed attested to the feasibility of giving the investigated mortars made with sawn limestone a suitably high adhesion strength.

The transition from the obtained values of tangential adhesion (R_{sq}) to normal adhesion (R_t) was performed using the coefficient K = 3.

The coefficient K is assigned taking into account the following considerations:

- The samples were made in laboratory conditions, in compliance with all the rules of production work (cleaning, wetting the stone, careful dosage and preparation of the mortar, its consistency, etc.);

The samples were made by the same skilled workers under the supervision of technical staff, etc.

Thus, cement-clay mortars of grades 50 and 75 provide masonry of category II (Building CodeII-7-81 * Table 5), and cement-clay mortars of grade 100 provide masonry of category I, or to ensure seismic resistance of construction from sawn blades limestone, the use of cement-sand mortars, plasticized with carbonate clays, grades 50-75 and 100, which, according to the results of tests for frost resistance, meets the regulatory requirements of earthquake-resistant construction, is justified.

Reliability of results
1. Chemical and granulometric compositions, as well as macroscopic description of clay raw materials were carried out by the State Design and Survey Institute "Gruzgiprovodkhoz".
2. Experimental work was carried out at the Armenian Research Institute of Seismic Construction and Protection of Structures.
3. The obtained research results are consistent with the research regulations on earthquake-resistant construction.
4. The results of the research have been tested and implemented in the production of restoration work on objects affected by hostilities in the construction complex of Nagorno-Karabakh.

Conclusions
1. An important result of the conducted research is the experimental confirmation of the possibility of using cement-sand mortars plasticized with carbonate clays for laying stone structures made of sawn limestone. At the same time, these mortars' indicators of adhesion to stone not only compare favorably to cement-lime, but also offer stronger adhesion values.
2. The compositions of cement-sand mortars with their plasticization with carbonate clays were developed on the basis of experimental research that revealed the physical and mechanical qualities of the raw materials. It has been demonstrated that using these mortars effectively reduces cement consumption while 1.4 times increasing mortar strength when compared to cement-lime mortars.
3. Studies have shown that up to 40% of the cement in masonry mortars can be replaced with other materials without affecting the mortars' quality indicators (strength, water

resistance, and water absorption). This excludes the costly and in-demand usage of lime in mortars at the moment.

4. It has been established that the strength of tangential and normal adhesion of cement-sand mortars plasticized with carbonate clays exceeds the strength of their adhesion to sawn limestone, in comparison with cement-lime mortars, by almost 1.2 times. The use of cement-sand mortars, plasticized carbonate clays of the M50 and M75 grades, as well as the M100 grade, provides masonry of the first and second categories in terms of seismic resistance.

5. The norms for the consumption of materials for masonry mortars of grades M25, M50, M75, and M100 were developed and approved on the basis of a generalized analysis of the research results. Recommendations to reduce the consumption of cement and lime in masonry mortars for use in organizations of the Artsakhstroy trust (including in restoration work) were also made.

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ԿԱՐԲՈՆԱՏԱՅԻՆ ԿԱՎԵՐՈՎ ՊԼԱՍՏԻԿԱՑՎԱԾ ՑԵՄԵՆՏԱՎԱԶԱՅԻՆ ՇԱՂԱԽՆԵՐԻ ՀԱՏԿՈՒԹՅՈՒՆՆԵՐԻ ՄԱՍԻՆ

Ռ.Գ. Իսրայելյան, Ն.Ա. Միքայելյան, Ա.Յա. Մարգարյան, Մ.Ա. Իսրայելյան, Ա.Ա. Սողոմոնյան
Շուշիի տեխնոլոգիական համալսարան

Փորձարարական ուսումնասիրություններն ապացուցել են սեյսմակայուն շինարարության մեջ կարբոնատային կավերով պլաստիկացված ցեմենտավազային շաղախների օգտագործման հնարավորությունը։ Առաջին անգամ որոշվել են այս շաղախների բաղադրությունը և ֆիզիկամեխանիկական հատկությունները, ինչը հնարավորություն է տվել նվազեցնել ցեմենտի սպառումը մինչև 40%, ինչպես նաև 100%-ով բացառել թանկարժեք կրի օգտագործումը՝ դրա ամրության ցուցանիշները բարձրացնելու դեպքում։ Առաջարկություններ են մշակվել կարբոնատային կավով պլաստիկացված ցեմենտավազային շաղախների օգտագործման վերաբերյալ՝ տեղական սղոցված քարաքերից սեյսմակայուն շինարարություն իրականացնելու համար։ Փորձերի արդյունքները փորձարկվել և ներդրվել են Լեռնային Ղարաբաղի շինարարական համալիրում։ Հետազոտության արդյունքները համաձայնեցվում են քարակտրոցի համար նախատեսված ցեմենտ-կավե շաղախների վերաբերյալ գիտահետազոտական և նորմատիվ փաստաթղթերի հետ։

Բանալի բառեր. քարե շարվածք, սղոցված քրաքարեր, քարե շարվածքների շաղախներ, ցեմենտ, կարբոնատային կավեր, ամրության բնութագրեր, սեյսմակայունություն:

О СВОЙСТВАХ ЦЕМЕНТНО-ПЕСЧАНЫХ РАСТВОРОВ, ПЛАСТИФИЦИРОВАННЫХ КАРБОНАТНЫМИ ГЛИНАМИ

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Экспериментальными исследованиями доказана возможность использования в сейсмостойком строительстве цементно-песчаных растворов, пластифицированных карбонатными глинами. Впервые определены составы и физико-механические свойства этих растворов, позволяющие сократить до 40% расход цемента, а также исключить на 100% использование дорогостоящей извести, при повышении его показателей прочности. Разработаны рекомендации по использованию цементно-песчаных растворов, пластифицированных карбонатными глинами для выполнения сейсмостойкого строительства из местных пильных известняков. Результаты

R.G.Israyelyan, N.A.Mikayelyan, A.Ya.Margaryan, M.A.Israyelyan, A.A.Soghomonyan
ON THE PROPERTIES OF CEMENT-SAND MORTARS PLASTIFIED WITH CARBONATE CLAYS

экспериментов были апробированы и внедрены в строительном комплексе Нагорного Карабаха. Результаты исследований согласуются с научно-исследовательскими и нормативными документами по цементно-глиняным растворам для каменных кладок.

Ключевые слова: каменная кладка, пильные известняки, кладочные растворы, цемент, карбонатные глины, прочностные характеристики, сейсмостойкость.

CALCULATING THE WEAR INDICATORS OF MOUNTAIN ROADS' STRUCTURES AND THEIR EFFECTS ON THE ENVIRONMENT'S VULNERABILITY

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Abstract

The lack of clear boundaries of the vertical climatic zonality of mountainous countries in the norms for building climatology leads to errors in the timing of the interrepair work of highways. Given in GOSTs and other regulatory documents, these terms are of an average nature. For this reason, pavement structures and vehicles (road transport system) are subjected to premature wear and tear, and harmful emissions into the environment of mountainous areas increase.

In order to increase the durability of pavement structures of mountain roads and reduce harmful emissions into the environment, a method is proposed for determining the optimal time between repairs of mountain roads, taking into account the integrated indicators of their wear, under the influence of natural and climatic factors of mountain conditions.

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It has been determined how these elements affect how ecologically vulnerable mountainous places are, and the ideal time frame for lowering the need for mountain road maintenance has been provided.

The effectiveness of mathematical models and the reliability of the working hypothesis on the proportionality of the optimal periods for reducing overhaul life and the environmental vulnerability of mountainous areas have been proved.

Keywords: mountain roads, natural and climatic factors, harmful emissions, environmental vulnerability.

Introduction

The road transportation system experiences significant wear due to the influence of vertical climate elements that are dynamically growing in mountain environments. Due to these factors, the environment is becoming more polluted, including soil, air, and water bodies, as well as from road vibrations and noise, which causes environmental deterioration in hilly places.

The period between repairs of mountain roads along the vertical zonality of mountain regions, which is now poorly understood, can be reduced, according to an examination of the current regulatory documents and studies on the issue [1-11].

When calculating the reduction of the turnaround time, averaged indicators are used for the altitude ranges of 1000-1500 and 1500-2000 meters above sea level, where the reduction in these periods is 7% and 10%, respectively. In case of loss of stability of the subgrade, their reduction to 30% is allowed [12]. To determine the optimal time between repairs of roads, a mathematical model is proposed that reflects the environmental vulnerability of mountainous areas from the operation of the road transport system along vertical zonality.

Conflict Setting

1. In the creation of mathematical models that depict the dynamics of vertical changes in mountain environments caused by natural and climatic variables. For the altitude ranges of 800-2000 meters above sea level, the models are created with a height gradation of 200 meters, encompassing the regions with the highest population in mountainous nations.

2. In the creation of a mathematical model that depicts the environmental vulnerability of mountainous regions due to the operation of the road transportation system, under the effect of natural and climatic variables, as well as cars (external factors).

3. In accordance with vertical zoning, choose the best time to start inter-repair work on roadways.

Research methodology:

1. Statistical experiments and modeling of changes in natural and climatic factors of mountain conditions by vertical zonality.

2. Development of a mathematical model of the environmental vulnerability of mountainous areas from the operation of the road transport system.

3. Determination of the optimal time between repairs of mountain roads according to vertical zonality.

4. Verification of the reliability of the obtained factors.

Research Results

It has been established that the main volumes of construction and operation of automobile works in mountainous areas are carried out at altitudes of 800-2000 meters above sea level. For these conditions, mathematical models of vertical changes in natural and climatic factors have been developed. Tab. 1, [13-15].

Table 1

Mathematical models of the development of natural and climatic factors in mountainous areas within the heights of 800-2000 meters above sea level

Indicators	Height above sea level h, m						
	800	1000	1200	1400	1600	1800	2000
Relief complexity	$X_{1.1} = 04.604 + 1.411 \times 10^{-3}h$						
Value X1.1	1.60	1.90	2.20	2.40	2.70	3.00	3.28
Dynamics at altitude 800 m, Z1.1	1	1.18	1.36	1.53	1.73	1.89	2.05
Precipitation	$X_{2.1} = 33.56 + 472.56 \times 10^{-3}h - 80 \times 10^{-6}h^2$, мм						
Value X2.1	360.3	425.9	485.1	537.2	584.3	624.7	657.3
Dynamics at altitude 800 m, Z2.1	1	1.18	1.35	1.49	1.62	1.73	1.82
Air temperature	$X_{2.2} = 18.557 - 7.091 \times 10^{-3}h$, C°						
Value X2.2	12.9	11.5	10.1	8.6	7.2	5.8	4.4
Dynamics at altitude 800 m, Z2.2	1	0.89	0.78	0.67	0.56	0.45	0.34
Winds	$X_{2.3} = 0.8236 + 0.836 \times 10^{-3}h$, m/s						
Value X2.3	1.49	1.66	1.82	1.99	2.16	2.38	2.5
Dynamics at altitude 800 m, Z2.3	1	1.11	1.22	1.34	1.45	1.6	1.67
Barometric pressure	$X_{2.4} = 1000 - 0.11h + 0.41 \times 10^{-5}h^2$, Гпа						
Value X2.4	929	909	889	869	849	83	2811
Dynamics at altitude 800 m, Z2.4	1	0.98	0.96	0.94	0.91	0.89	0.87
Number of days with snow cover	$X_{2.5} = 81.689 - 118.631 \times 10^{-3}h + 75.128 \times 10^{-6}h^2$, days						
Value X2.5	34.9	38.2	47.6	62.9	84.2	11.6	144.9
Dynamics at altitude 800 m, Z2.5	1	1.09	1.36	1.8	2.41	3.19	4.15
Air humidity	$X_{2.6} = 60.68 + 4.45 \times 10^{-3}h$, %						
Value X2.6	64	65	66	67	68	68	70
Dynamics at altitude 800 m, Z2.6	1	1.02	1.03	1.05	1.06	1.06	1.09

It should be noted that during the study, less significant factors were excluded, which include:

1. **Squally winds.** According to reference data and the results of our research, the wind speed at an altitude of 2000 meters above sea level is only 2.5 m/s. (which is not comparable with the speed of 8-11 m/s) for squally winds;

2. **Snow avalanches**. Forecasting the development of these processes is carried out on the basis of engineering and geological surveys. Within the altitudes of 2000-2500 meters there are forests that prevent avalanches from descending to lower altitudes;

3. **Landslide processes**. Forecasting the development of these processes is carried out on the basis of engineering and geological surveys. The highest frequency of these processes for the conditions of Nagorno-Karabakh is observed at altitudes of 800-1000 meters above sea level (34%). This figure at altitudes of 1000-1600 meters is, respectively, 9% -13%. The

development of landslide processes is of a discrete nature and is specified for each case when allocating sites for construction;

4. **Mudflows.** Forecasting the development of mudflows in mountainous areas is carried out by means of maps of mudflow-bearing regions, which are taken into account when allocating land for construction;

5. **Collapses and screes.** The area of the greatest distribution of these processes covers absolute heights from 1000 to 3000 meters. Mountainous areas, as a rule, have permanent centers of occurrence and possible directions of movement, which are also taken into account when allocating land for construction;

6. **Seismicity**. With an increase in altitude above sea level, there is a certain trend towards an increase in horizontal ground accelerations. However, there is no pronounced character of their development along the vertical; this indicator depends on the geological conditions of construction, which in mountainous conditions are not very diverse;

7. **Depth of soil freezing**. Within the limits of heights from 800 to 2000 meters, the depth of soil freezing is 60-70 cm;

8. **Number of days with fog.** The formation of fog in mountainous areas depends on the season, height above sea level, atmospheric circulation, physical and geographical conditions, etc. Under these conditions, the formation of fogs is of a complex nature without their regular development. In some cases, in high mountain areas, the number of days with fog can be 35% per year or more. This is facilitated by a decrease in altitude of barometric pressure and air temperature, as well as an increase in wind speed and relative humidity.

To predict the influence of external factors on the state of mountain roads, methods of mathematical forecasting (the "Delphi" method) and process control modeling [16-18] are adopted.

Table 2

Weight coefficients of the impact of external factors on the wear and tear of the road transport system in mountainous areas

Factors	A	B	C	D
Relief complexity	54	6	36	0.1607
Precipitation	60	12	144	0.1786
Air temperature	58	10	100	0.1726
Wind speed	21	27	729	0.0625
barometric pressure	52	4	16	0.1548
Number of days with snow cover	71	23	529	0.2113
Relative humidity	20	28	784	0.0595
Total	336	-	3496	1.00
Convergence calculation $W = \frac{12 \times 3496}{12^2(7^3-7)} = 0.87$				
Note: A is the sum of ranks; B - deviation from the arithmetic mean; C - square deviation; D - weight coefficients of factors.				

Calculations according to the Delphi method were carried out using a computer program developed by us, in which the degree of reliability of forecasts was determined by the convergence of the results obtained by the formula:

$W = \frac{12S}{m^2(n^3-n)}$, where m is the number of experts; n is the number of factors; S is the sum of the squared deviations of the estimates of the ranks of each factor. In this case, the convergence values of the results should be within $0.5 \leq W \leq 1$.

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In Tab. 2 gives an example of determining the weight coefficients of the impact of external factors on the wear and tear of the mountain road transport system in mountainous areas.

The generalization of the forecasting results was carried out in several stages, until the coefficient of convergence of the results of values from 0.5 to 1.0 was reached. In our case, W=0.87, which confirms the high degree of reliability of the forecasts. Integrated indicators of the impact of external factors on the vulnerability of road areas from the operation of the road transport system are given in Tab. 3.

Table 3

Coefficients characterizing the ecological vulnerability of mountain districts from the operation of the road transport system

Factors	Height above sea level h, m						
	800	1000	1200	1400	1600	1800	2000
Relief complexity	0.161	0.192	0.221	0.242	0.272	0.301	0.332
Precipitation	0.179	0.211	0.242	0.267	0.267	0.310	0.328
Air temperature	0.173	0.194	0.222	0.258	0.258	0.384	0.509
Wind speed	0.063	0.071	0.076	0.084	0.084	0.096	0.105
barometric pressure	0.155	0.160	0.163	0.167	0.167	0.176	0.182
Days with snow	0.211	0.232	0.287	0.380	0.380	0.656	0.878
Air humidity	0.060	0.061	0.061	0.062	0.062	0.064	0.065
Total	1.000	1.121	1.263	1.987	1.398	1.987	2.399

The mathematical model of changes in the environmental vulnerability of mountainous areas from the operation of road transport has the form:

$$P_1 = 0.161Z_{1.1} + 0.179Z_{2.1} + 0.173Z_{2.2} + 0.063Z_{2.3} + 0.155Z_{2.4} + 0.211Z_{2.5} + 0.060Z_{2.6} \quad (1)$$

where $Z_{1.1}$, $Z_{2.1}$, $Z_{2.3}$, $Z_{2.4}$, $Z_{2.5}$, $Z_{2.6}$ – dynamics of changes in natural and climatic factors of mountain conditions by vertical zonality (Tab. 1).

Table 4

Analysis of the convergence of calculations based on a mathematical model with current building codes

Indicators	800	1000	1200	1400	1500	1600	1800	2000
Model calculation results	1.0	1.210	1.263	1.398	1.554	1.711	1.987	2.399
Average value for heights 1000-1500 m	(1.210+1.263+1.398+1.554):4 =1.356					-		
Also, for altitudes of 1500-2000 m	-				(1.554+1.711+1.987+2.399):4=1.913			
Decrease - according to VSN 41-88, for heights of 1000-1500 m, %	7				-			
Also, for heights of 1500-2000 m, %	-			10				
Proportionality according to the model	1.913:1.356=1.411							
The same, according to VSN - 41-88	10:7=1.429							
Deviation, %	1.26							

On the basis of the mathematical model, the optimal terms for performing the overhaul works of mountain roads are calculated. A working hypothesis is proposed that the coefficients for reducing the terms of these works should be commensurate (inversely

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proportional) to the coefficients of changes in the environmental vulnerability of mountainous areas by vertical zonality

The reliability of the hypothesis is confirmed by the convergence of calculations according to the model with the current building codes, Tab. 4.

Based on the calculations (Table 4), the coefficients for reducing the time between repairs of mountain roads by vertical zonality were determined - P_2 (Tab. 5). The results obtained confirmed the validity of our hypothesis.

Table 5

Coefficients for reducing the time between repairs of mountain roads

Indicators	Height above sea level h, m							
	800	1000	1200	1400	1500	1600	1800	2000
Calculation results for the -P1 model	1.00	1.210	1.263	1.398	1.554	1.711	1 987	2.399
Coefficients reducing the time between overhauls	1.00	0.826	0.792	0.715	0.643	0.584	0.503	0.417
Medium to 1000-1500 m altitude	(0.826+0.792+0.715+0.643):4=0.744				-			
The average value of the coefficient. to an altitude of 1500-2000 m	-				(0.643+0.0584+0.503+0.417):4=0,537			
Proportionality according to the model	$(0.537:0.744)^{-1} = 1.385$							
The same, according to VSN - 41-88	10:7=1.429							
Deviation, %	3.1							

The results of the study were introduced into the curriculum in universities, according to the textbooks recommended by the RA Ministry of Education and Science for universities [19].

The basis of the position of the work was reported and published in the materials of international scientific conferences [20-21].

Conclusion

1. The systematization of natural and climatic factors in mountain conditions has been carried out and a quantitative assessment of their development by vertical zonality in the altitude ranges of 800-2000 meters above sea level has been given.
2. A mathematical model has been developed for changing the environmental vulnerability of mountainous areas from the operation of road transport systems, taking into account their vertical zonality.
3. The effectiveness of the mathematical model and the reliability of the working hypothesis about the proportionality of the timing of the completion of overhaul works and the vulnerability of the environmental ecology of mountainous areas have been proven.
4. The reliability of the results of mathematical modeling and the timing of the reduction in the overhaul of highways according to the vertical zonality of mountainous areas has been proved.

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ԼԵՌՆԱՅԻՆ ԱՎՏՈՄՈԲԻԼԱՅԻՆ ՃԱՆԱՊԱՐՀՆԵՐԻ ԿՈՆՍՏՐՈՒԿՑԻԱՆԵՐԻ ՄԱՇՎԱԾՔԻ ՑՈՒՑԱՆԻՇՆԵՐԻ ՀԱՇՎԱՐԿԸ ԵՎ ՆՐԱՆՑ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ԱՐՏԱՔԻՆ ՄԻՋԱՎԱՅՐԻ ԽԱՓԱՆՄԱՆԸ

Ռ.Գ. Իսրայելյան, Ն.Ա. Միքայելյան, Մ.Ա. Իսրայելյան, Ա.Ա. Ասլանյան
Շուշիի տեխնոլոգիական համալսարան

Շինարարական կլիմատոլոգիայի նորմաներում բացակայում են լեռնային շրջանների ուղղաձիգ գոտիավորման հստակ սահմանները, որոնք բերում են ավտոմոբիլային ճանապարհների, վերանորոգման աշխատանքների կատարման ժամկետների խախտմանը:

Նորմատիվային փաստաթղթերում նշված կատարման ժամկետներն ունեն միջինացված բնույթ: Այդ առումով ավտոճանապարհները և ավտոտրանսպորտային միջոցները (ճանապարհա-տրանսպորտային համակարգ) ենթարկվում են ինտենսիվ մաշվածքի՝ ավելանում է վնասատու արտանետումը լեռնային գոտիների շրջակա միջավայր:

Ավտոճանապարհների կոնստրուկցիաների երկարակեցության բարձրացման նպատակով և վնասատու արտանետումը արտաքին միջավայրում նվազեցնելու համար առաջարկվում է ավտոմոբիլային ճանապարհների վերանորոգման օպտիմալ ժամկետների որոշման մեթոդը, հաշվի առնելով նրանց մաշվածքը լեռնային բնակլիմայական գործոնների ազդեցության տակ:

Ապացուցված են մաթեմատիկական մոդելների էֆեկտիվությունը, աշխատանքային հիպոթեզի հավաստիությունը և համաչափությունը, որոշված

ավտոճանապարհների վերանորոգման օպտիմալ ժամկետների, նաև՝ լեռնային շրջանների էկոլոգիական խոցելիությունը:

Բանալի բառեր. լեռնային ավտոմոբիլային ճանապարհներ, բնակլիմայական գործոններ, վնասատու արտանետումներ, էկոլոգիական խոցելիություն:

РАСЧЁТ ПОКАЗАТЕЛЕЙ ИЗНОСА КОНСТРУКЦИЙ ГОРНЫХ АВТОМОБИЛЬНЫХ ДОРОГ И ИХ ВЛИЯНИЕ НА ЭКОЛОГИЧЕСКУЮ УЯЗВИМОСТЬ ОКРУЖАЮЩЕЙ СРЕДЫ

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Отсутствие в нормах по строительной климатологии чётких границ вертикальной климатической зональности горных стран, приводит к погрешностям в сроках выполнения межремонтных работ автомобильных дорог. Приведённые в ГОСТах и других нормативных документах эти сроки носят усредненный характер. По этой причине конструкции дорожных одежд и автотранспортные средства (дорожно-транспортная система) подвергается преждевременному, износу увеличиваются вредные выбросы в окружающую среду горных районов.

С целью увеличения долговечности конструкций дорожных одежд горных автомобильных дорог и снижения вредных выбросов в окружающую среду, предложен метод определения оптимальных сроков межремонтных работ горных автомобильных дорог, с учётом интегрированных показателей их износа, под воздействием природно-климатических факторов горных условий.

Установлено влияние этих факторов на экологическую уязвимость горных районов, даны оптимального сроки снижения межремонтных работ горных автомобильных дорог.

Доказана эффективность математических моделей и достоверность рабочей гипотезы о соразмерности оптимальных сроков снижения межремонтных работ и экологической уязвимости горных районов.

Ключевые слова: горные автомобильные дороги, природно-климатические факторы, вредные выбросы, экологическая уязвимость.

UDC - 631.356.43

JUSTIFICATION OF AUGER CLOD-CRUSHER
OF THE POTATO HARVESTER

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Abstract

The reasons for the low degree of mechanization of potato harvesting are analyzed and it is proposed to equip the potato harvester machine with a passive auger clod-crusher. It will make possible to loosen the surface layer of the field with ridges, to grind plant residues and tubers, moving them with the loosened soil to the inter-field space, excluding their access to the potato harvester. The application of a clod-crusher will contribute to the full separation of the tuberous soil mass. A number of structural and technological parameters of auger clod-crusher were determined.

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Keywords: potato harvester, clod-crusher, drum, knife, tuber, conical auger.

Introduction

With the constantly increasing volumes of potato cultivation, the degree of mechanization of potato harvesting is becoming increasingly important [1]. In the soil and climatic conditions of Armenia and Artsakh, the short agrotechnical terms of potato harvesting make this problem even more urgent.

The research has shown that the low level of mechanization of potato harvesting is due to the high roughness of the soil, due to which the process of separation of the the potato-soil mixture is incomplete [2], which does not allow to switch to the combine harvesting method. It turns out that the solution of the problem of mechanization in our conditions leads to the improvement of the separation process at the initial stage of harvesting/during the transition of the potato-soil mixture from the tuber-bearing bed to the potato harvester.

Many studies have been carried out in the world in order to improve the separation of tuberous soil mass and various solutions have been proposed, namely:
- before entering the potato harvester, loosen the rough surface of the field with ridge, grind plant residues and tubers, limit the entry of excess soil into the potato harvester, harvest in optimal humidity conditions [2],
- to model the technological processes [3],
- apply additional labor organs for crushing hard soil [4],
- organize double separation [5],
- to improve the design of the separating organs, to adjust the design and technological parameters of the potato harvesters [5,6,7],
- apply combined labor organs [6],
- at the basis of the separation process, use the difference in the contact properties of the soil and tubers with the working organs of the separators [8].

Conflict Setting

The task is to ensure the crushing of potato tubers, the grinding of the surface layer of the field with ridges and the transfer of crushed tubers to the interplant space.

Research Results

To solve the problem, it was proposed to equip the potato harvester with an auger crusher, which is installed in the front of the machine and operates due to the rotational movement resulting from sticking to the ground (Fig. 1).

The axis of the crusher is connected by levers with a potato harvester, which is driven by a tractor. During the movement of the aggregate, the moving rollers, which are located in the interplant space, with the help of the ground grippers attached to them, get a rotary motion, which is transmitted to the contour of the field with ridges / inclined platforms / rotating conical augers are rigidly connected to the roller, and from it to the knife drum. The drum sits on the field with ridges and, with the help of knives attached to it, loosens the coarse soil of the central, relatively flat area of the potato tuber bed, simultaneously cutting and shredding the potato tubers in the direction of the process.

Conical augers, which are located in the sloping areas of the field with ridges, loosen the surface soil of that area and move it to the the interplant area. Due to the external pointed

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part of the augers, the potato tubers on the sloping sections of the field with ridges are also cut off and moved to the interplant space with the surface soil layer. As a result, the amount of coarse soil and tubers entering the potato harvester is reduced, as a result of which the potato separation process is improved.
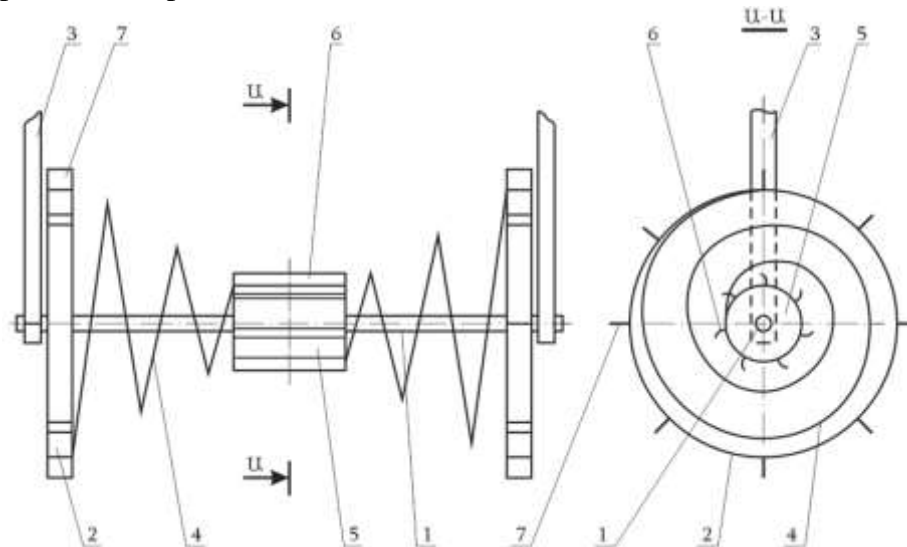

Fig. 1 The scheme of the conical augers of potato harvester.
1 - axle, 2 - driving roller, 3 - lever, 4 - conical auger,
5 - knife drum, 6 - knife, 7 – soil sticking part

To determine the design and technological parameters of the proposed crusher, consider the crusher as a rigid unity of three aggregates that perform different functions: drive rollers with soil sticking parts, two conical augers and a knife drum.

The crusher is such that it copies, or in other words "hugs" the field with ridges. Therefore, some parameters of the crusher were selected based on the geometric shape of the field with ridges, the location of potato tubers in the filed with ridges, the interplant space, and the structure of the aggregate. Thus, they were specifically clarified.

➤ The width of the knife drum, /equivalent to the width of the upper part of the field with ridges /, which is approximately: B_d=20 cm:

➤ The diameters of the knife drum and roller, respectively have made D_d= 13cm and D_r=30mc. These dimensions were obtained based on the outline of the field with ridges, taking into account the limitations of its overall dimensions, depending on the operating conditions of the clod- crusher.

➤ The drum`s knife`s height h_k=2cm. It was chosen based on the condition of not damaging with knives the tuber bed at the top of the field with ridges.

➤ The length of the conical augers is D_d=13cm. It is equivalent to the width of the sloping spaces of the field with ridges.

➤ The degree of sticking of the rollers of conical augers into the soil in the sloping parts of the field with ridges is h_a=3cm. It has been determined based on the condition of the tubers not being damaged in these parts of the field with ridges.

➤ The degree of sticking of the conical augers` rollers into the soil in the sloping parts of the field with ridges is h_a=3cm. It has been determined based on the condition of the tubers in order not to damage the tubes in these parts of the field with ridges.

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We haven`t referred to the size, shape and number of the soil-sticking parts of the movable rollers of the clod-crusher, bearing in mind that similar studies regarding the movement of mechanisms as a result of sticking to the soil have been carried out and applied in practice in the past.

In particular, in [9], which also refers to the movement of a crusher with the soil-sticking parts were determined the parameters , which we took as a basis.

Let's determine the parameters of the conical auger. The edge coils of the auger are rigidly connected to the knife drum on one side and to the drive roller on the other. Therefore, when calculating their diameters, it is necessary to take into account the fact that they are attached to the machine, as well as the degree of their depth into the soil on the sloping side of the field is h_a.

Therefore, the diameter of the big coil of the auger will be

$$D_{big\ coil} = D_c + 2h_a = 36 cm. \tag{1}$$

The diameter of the small coil of the auger will be

$$D_{small\ coil} = D_d + 2h_k = 17 cm. \tag{2}$$

The number of rotation of the cylinder depends on the parallel speed of the aggregate and can be determined from the following expression (we assumed that the cylinder slip is zero):

$$V_m t = \pi D_c\ n_c, \tag{3}$$

where V_m is the working speed of the potato harvester which is widely used in Armenia and Artsakh, which is given about 3km/h or 0.83m/s for the KTN-2B potato harvester t is the calculation time we accept.

Therefore, the number of rotation of the roller will be:

$$n_r = V_m t / \pi D_r = 53\ r/m: \tag{4}$$

The knife drum is rigidly connected to the auger, which is rigidly connected to the drive roller. Therefore, the rotations of the auger n_a, knife drum n_d and movable roller n_r are the same.

$$n_a = n_d = n_r = 53\ r/m$$

The motion of the conical auger was determined using the usual constant diameter auger`s parametrization theory.

The peculiarity in this case is that the diameters of the neighboring coils are gradually increasing alongside with the direction of the soil transportation.

When determining the parameters of the conical auger, the diameter of the smallest coil is taken as the basis, based on the fact that all the coils of the conical auger are fed with the soil layer of the same width, so the coil with the smallest diameter will be the most loaded.

It is known that the following connection exists between the motion of the auger S and the diameter D_a.

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S=kD$_a$,where k is coefficient determined experimentally. K=0,8- 1,0, in that case the auger turns out with perfect constructive parameters [10].

Let's take k=0.8.

In our case D$_a$ = D $_{small\ coil}$ = 17 cm.

Therefore, the motion of the auger will be S = 13,6 cm. Resulting from the combination of motion and length of the auger /L$_a$ = 26cm/ it is clear that between big and small coils of the conical auger we may have only one coil which diameter will be

$$D_{medium\ coil} = (D_{big\ coil} + D_{small\ coil})/2=26,5 \tag{5}$$

According to the basis theory of the parameters of the auger, the number of the auger motion must satisfy the following condition [10]. n$_a$ ≤ n$_{max}$, where n$_{max}$ is the maximum motion number of the auger, for which calculation is applied the following formula:

$$n_{max} = A/\sqrt{D_a} \tag{6}$$

Where A is coefficient depending on transported material, which in the case of being a soil is in the range values 22÷45. Therefore, we will get:

$$n_{max} = 53÷108_{m/min}$$

Therefore, n$_a$ ≤ n$_{max}$ condition satisfies

The conical auger should satisfy another condition too $\beta \leq \varphi$, where β is the angle of the auger conicity, φ is the relation angle between the auger and the soil surface of the filed with ridges. $\varphi = 22 - 45^0$ [10]:

Let`s determine the angle of conicity of the auger using pic.1

$$tg\ \beta = (D_{coil\ big}-D_{coil\ small})/2/L_a= 0,365, \tag{7}$$

and $\beta = 17^0$c. Therefore, satisfies $\beta \leq \varphi$ condition too.

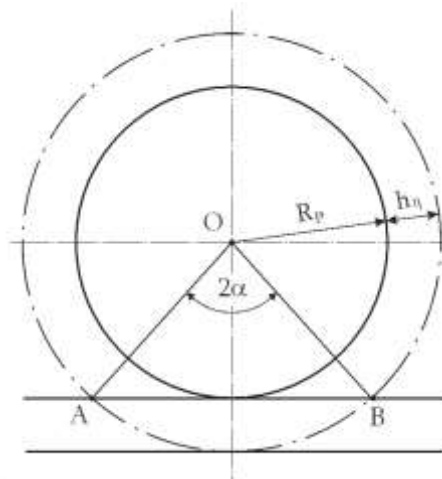**Fig. 2 The scheme for determining the number of drum knives**

Now let's refer to the knife drum of the clod-crusher. From a technological point of view it has been already justified that the width of the drum is 20 cm, the diameter is 13 cm, the height of the knives are 2 cm. The number of the motion of the drum was also determined – 53m/min. It remains to calculate the necessary number of knives.

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The number of the knives has been determined on the condition that there is not uncultivated area alongside with the motion direction of the drum.This condition will be satisfied in that case when one knife at the time of coming out from the soil (point B), the following knife will enter the soil(point A). From pic.2 we have

$$\cos \alpha = \frac{R_d}{(R_d + h_k)} = 0{,}87, \tag{8}$$

Therefore, $\alpha = 29^0$

The angle formed by two consecutive knives will be $2\alpha = 58^0$.

Therefore, the minimum number of the knives will be $Z = 360/58 = 6{,}2$.

Let`s accept the necessary number of knives $Z = 7$

During the work the drum of the clod-crusher does a complicated rotative movement around the axis ω R$_d$ with circumferential speed (ω is angular velocity of the drum) and is moving in tandem with speed V$_m$.

This process is characterized by a kinematic indicator (λ).

$$\lambda = \frac{\omega(Rd + \text{hd})}{vm} \tag{9}$$

The angular velocity of the drum was determined by the following formula [10].

$$\omega = \pi nd/30 = 5{,}54. \tag{10}$$

Therefore, the kinematic indicator will be $\lambda = 0{,}56$:

This value of the kinematic index is typical for machines with passive action.The proposed clod- crusher is also ranked among them.

In general, for a more efficient operation of the knife drum, it is necessary to ensure the condition ω R$_d$> V$_m$, or λ>1, in which case the trajectory of the absolute motion of the knife will be cycloid. This can be achieved by making the clod-crusher active. In the case of a passive clod- crusher, it will be necessary to increase the number of knives on the drum to improve the crushing quality. Adjustment of this and other parameters of the proposed clod-crusher will be done in the near future, after analyzing the results of laboratory and field experiments.

Conclusion

The researches have shown that in the soil and climate conditions of Armenia and Artsakh, the separating organs of the potato harvesters used during potato harvesting do not perform sufficient separation of the tuber soil mass, as a result of which the degree of mechanization of potato harvesting is low.

To increase the separation efficiency of potato harvesters, one more separating unit should be added to the design of potato harvester. In other words, the tuberous soil mass is separated in two stages: the first before entering the potato harvester, the second - into the potato harvester.

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For the first stage, it was suggested a passive action cone crusher moving with the help of sticking , which will be located between the tractor and the potato harvester, and will be connected to the potato harvester with articulated levers. Due to this, before the potato harvester machine`s ploughs are drawn into the upper part of the field with ridges, the latter`s surface with a soil layer 2-3 cm thick including hard soil, is crushed and taken out into the inter-field space. At the same time, a significant part of the potato tuber is crushed and partially transferred to the inter-plant space. As a result, the amount of soil, hard soil and tuber in the tuber-soil mass entering the potato harvester will decrease, and the load will also be significantly reduced on the separation unit of the potato harvester.

This will contribute to the complete separation of the tuber-soil mass in the potato harvester and will create an opportunity to significantly reduce manual work during harvesting and even reach the combine harvesting option.

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[3]*Ստեփանակերտի Գրիգոր Նարեկացի համալսարան*
[4]*Երևանի պետական համալսարան*

Վերլուծվել է կարտոֆիլի բերքահավաքի մեքենայացման ցածր աստիճանի պատճառները և առաջարկվել է կարտոֆիլահան մեքենան համալրել պասիվ գործողության շնեկավոր կոշտաջարդիչով: Այն հնարավորություն կտա մարգաթմբի մակերեսային շերտը փխրեցնել, բուսածածկույթը և կարտոֆիլի վրները մանրացնել և փխրեցված հողի հետ տեղափոխել միջմարգային տարածք, բացատելով դրանց մուտքը կարտոֆիլահան մեքենա: Կոշտաջարդիրչի կիրառումը կնպաստի պալարահողային զանգվածի լիարժեք զատմանը: Որոշվել են շնեկավոր կոշտաջարդիչի մի շարք կառուցվածքային և տեխնոլոգիական պարամետրեր:

Բանալի բառեր. կարտոֆիլահան, կոշտաջարդիչ, թմբուկ, դանակ, պալար, կոնական շնեկ:

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ОБОСНАВАНИЕ ПАРАМЕТРОВ ВИНТОВОЙ КОМКОДРОБИЛКИ КАРТОФЕЛЕКОПАТЕЛЯ

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Проанализированы причины низкой степени механизации уборки картофеля и предложено комплектировать картофелекопатель винтовой комкодробилкой пассивного действия. Это позволит разрыхлять поверхностный слой грядки, измельчать растительность и картофельную ботву, переместить их с разрыхленной почвой в межрядовое пространство, исключив их доступ к картофелекопателю. Внедрение комкодробилки будет способствовать полному отделению клубневой массы от почвы. Определен ряд конструктивных и технологических параметров винтовой комкодробилки.

Ключевые слова: картофелекопатель, комкодробилка, барабан, нож, клубень, конический шнек.

FUNDAMENTAL PROBLEMS OF POPULATION INCOME DISTRIBUTION AND STATE REGULATION INSTRUMENTS

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Abstract

In the modern world, attempts are continuously being made to comprehensively assess and measure indicators related to the progress of the standard of living and well-being both globally and for individual groups of the population. Assessing and measuring the social condition is a complex process, because the concepts of "living standard of the population" and "quality of life" are multi-vector and difficult to calculate and evaluate.

The assessment and measurement of the social progress of each state, individual social groups and territories (states, regions, etc.) with sufficient accuracy is an important factor in determining the indicators of population inequality. It should be the basis for implementing effective social policy through the principles and approaches of the state's social policy, individual groups of the population (especially socially vulnerable), effective management of the population's incomes and expenses. The basis for the formation of such a policy is the identification of social problems and the identification of ways to solve them. Socially oriented programs can be implemented both in the short term and in the long term. The formation of problems of population income distribution and state regulation and the search for tools to achieve it should become one of the key components of the policy implemented by the state. Taking into account the difficulties of social policy implementation and the use of appropriate tools during the development of that policy, the identification and characterization of the general trends in the formation and distribution of incomes of the population becomes a topical issue. As a first step, it is necessary to study the experience of countries with advanced free market relations and analyze the possibilities of their localization in Armenia for the selection and expansion of social policy tools. It is also necessary to evaluate the effectiveness of the tools used to fight against poverty and the implemented policies, comparing the relevant indicators of Armenia and neighboring countries.

Keywords: Income distribution inequality, income concentration coefficient (Gini index), social progress, social index, social groups.

Introduction

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AND STATE REGULATION INSTRUMENTS

Issues of social equality and justice, according to some researchers, threaten people's quality of life. One of the bearers of this view is Thomas Malthus, who considers poverty to be the inevitable result of a mismatch between population growth and the supply of resources necessary for people's existence, and above all, the ever-decreasing food supply. According to him, the population grows exponentially, and the means of existence with arithmetical progression, which gives birth to poverty, inequality and social disasters [1]. With the development of economics, Malthus's view was refuted. At the same time, he raised an important problem of regulating population growth, which requires control over population growth, which India, China, and a number of other countries are currently trying to overcome.

Karl Marx also had his views on the elimination of inequality and poverty. He criticized Malthus, who extended the biological laws of the struggle for existence directly to social relations and failed to justify the social nature of inequality and poverty. Karl Marx considers inequality and poverty to be inevitable satellites of capitalist society, which are oriented not to increase the welfare of workers, but to achieve maximum profit. He predicted that inequality and poverty would increase over time, the poor would get poorer and the rich would get richer [2]. However, that hypothesis was also not fully justified. Businessmen, based on the differences between the conflicting classes, were able to draw some conclusions and direct part of their super profits to improve the condition of workers, including pensions, health care and other social needs. This was mostly done purely out of economic expediency. Widespread trade union movements, strikes and demand clashes forced employers to make concessions in setting wages and indexing them to inflation.

In economics, inequality is a function of the level of consumption expenditure. It is customary to set a minimum material security index (it is often called the minimum subsistence level). It is different in different countries. Population groups whose standard of living is below that line are considered poor. To calculate the minimum standard of living, the concept of consumer basket is considered, which includes the most necessary and essential set of goods and services for the population. The value of the consumer basket is a time-varying quantity. For this reason, it is important to monitor how the composition and prices of the products included in the consumer basket change over time.

Over the years, the concept and structure of inequality is gradually changing. In some countries, the feminization of poverty is taking place, that is, the number of families headed by a woman is increasing, which is due to the increase in the dominance of the volume of services in the GDP (it is enough to note that more than 60 percent of the world GDP is formed by services) , with the mechanization and automation of production processes (especially requiring heavy physical work), increasing the volume of remote work (which does not require the physical presence of the employee at the workplace). It should be noted that a few days ago, the National Assembly of Armenia discussed the possibility of teleworking in the labor code and the fact of the dominance of women's work in the management system.

Inequality is not evenly distributed between different age groups of the population either. Families consisting of elderly spouses and single elderly people are usually classified as poor. However, it should be noted that in recent years, the number of poor young families has also increased in the United States, who, unlike most retirees, do not have their own

houses and apartments, and have to spend a significant part of their salary to rent an apartment.

Conflict Setting

The purpose of the research is to identify the reasons for the uneven formation, distribution and use of the population's income, to develop and propose an economic policy toolkit that will enable a fairer distribution of the population's monetary income, ensuring solidarity and social harmony between different social groups of the population, which is one of the key conditions for the formation of a stable society. . In order to achieve the set goal, the identification of social equality standards and indicators within the society, the analysis of income distribution and use indicators for a long period of time, the evaluation of the implemented social policy and the nomination of effective state management structures based on them is a priority task.

Research methodology

In the study, the approaches and principles of scientific abstraction, statistical groupings, statistical analyzes according to individual countries, international comparisons, as well as combinations of individual groups of countries and indices and their rating were applied.

Over the past decades, the increase in economic inequalities has been largely driven by increases in income and wealth, which have largely accumulated at the top of the distribution. However, household surveys, the data sources traditionally used to observe the dynamics of inequality, do not adequately reflect these changes. Surveys cannot adequately measure the income and wealth levels of the richest people.

The World Inequality Database (WID.world) overcomes this limitation by combining different data sources (national accounts, survey data, fiscal data and wealth rankings) [3]. This makes it possible to follow more precisely the evolution of all levels of income or wealth, from the bottom up. The main innovation here is the systematic use of data that allows comparisons between countries over a long period of time. To achieve this goal, the database is based on research on long-term inequality trends developed by an international group of scientists over the past 15 years [4].

The assessment and effectiveness of the economic policy of a unique state is determined not only by the rates of economic growth and their acceleration, but also by the progress of social indicators. The meaning and purpose of the state's socio-economic policy is to solve social problems and raise the standard of living of the population and its individual (especially vulnerable) groups. In this context, the improvement of the living standards of the poor strata of the population is emphasized, which is proposed as a key to the success of the implemented social policy for any state. As evidenced by both the international and Armenian experience of more than 3 decades, when there is a large number of poor people and people with a standard of living not much higher than the poor in society, the society degrades, a dangerous gap appears between the rich and the poor, as a result of which the state is divided into two parts: "state of the poor" and "state of the rich", which becomes the cause of social instability. Therefore, it is important to neutralize poverty as a social evil and the causes of inequality in society, and to alleviate inequality between different social groups.

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One of the most important issues of the social policy of the state is the regulation of the employment of the population, the provision of social protection of the population and the implementation of measures and programs aimed at justice.

It is the poor who bear the heaviest burden of epidemics in the world. It is the poorest who face the main difficulties of the setbacks in health care and education.

The crises of recent years have pushed the world further away from the global goal of ending extreme poverty by at least 2030, according to some projections.

Given current trends in global economic change, 574 million people (almost 7% of the world's population) will still live on less than 2.15 US$ a day. It should be noted that extreme poverty is concentrated in conflict-affected regions of the world [5].

Research Results
The role of the state in the redistribution of the population's income.

The market mechanism of distribution, apart from the solvency of consumers, does not take into account the capabilities of consumers and the necessity and characteristics of their demand for products.

The market gives a simple answer to the three economic questions: what to produce, how to produce, and for whom to produce, to produce for those who can afford the product. It is obvious that based on the principles of humanism, such an approach to income distribution in the market system needs adjustment and changes. As a result, there is a problem of redistribution of income, which each state solves in different ways and sizes. Different approaches to state intervention in income redistribution can be observed, from radical (Sweden) to conservative (USA).

The income inequality created in the market economy, which intensifies especially in the period of production decline and high inflation, should be weakened and to a certain extent compensated for the less well-off groups of the population through a system of measures, programs and laws aimed at social protection. All developed countries that have transitioned to a market economy currently have such programs aimed at easing social tensions.

Through appropriate policies, the state levies taxes on profits and personal incomes and enables less protected groups of the population (pensioners, unemployed, low-income families with many children, etc.) to pay transfers.

Attitudes toward remittance payments differ between the rich and the poor. The rich find the high-tax culture reminiscent of Robin Hood, who robbed the rich and gave their wealth to the poor. The poor believe that the high incomes of the owners of capital, land and real estate are obtained through dubious means, therefore, they are obliged to take a share of the income from the poor.

The state can directly influence the market mechanism by setting maximum prices for essential goods, as well as minimum wages. In addition, the state can give compensations to important vital branches of the economy (for example, agriculture). Despite some resistance from the more secure class, the use of transverts makes it possible to maintain the minimum standard of living of the population.

From the point of view of economics, the standard of living, first of all, is determined by the degree of satisfaction of material requirements (food, clothing, housing, basic

necessities, as well as a number of public services: health care, education, work and leisure conditions).

The development of the educational system, the continuous improvement of the qualifications of workers, the growth of the cultural level and the satisfaction of spiritual requirements are mostly related to consciousness. However, their provision is conditioned by material possibilities (social and personal income level). Economic policy at the macro and micro levels seeks to find methods of comparison and evaluation of the measurement of living standards.

The standard of living of the population can be characterized based on the analysis of statistical averages. However, it is not possible to determine the level of quality of life in such a way, because it depends on many indicators of material and spiritual nature. This quantity cannot give an idea about the incomes of individual citizens, but is an average indicator characterizing the well-being of the country's economy and population. However, this indicator is essential for analyzing and comparing the level of economic development of different countries.

The level of per capita income of the population depends on the volume and structure of the gross domestic product, GDP, the number of the population and demographic changes. GDP growth in developed countries depends to a significant extent on labor productivity (for example, 70% in the USA). Demographic growth in developing countries is less dependent on the level of the economy. Per capita income in these countries is significantly lower than in developed countries, while at the same time, the population in these countries is growing faster than labor productivity.

In developed countries, there are also some problems due to declining birthrates and aging populations. Due to this, the share of the working population is decreasing and the number of pensioners and people in need of social protection is increasing. In the post-Soviet countries, the transition to market relations of the economy is combined with high inflation, and the problems of income regulation and social protection are gaining special importance. In a number of post-Soviet countries, this led to a sharp increase in income inequality. The number of people living below the poverty line continues to rise, despite the fact that wage increases and indexation measures have been implemented in recent years.

Number of people living in extreme poverty living on less than 2.15 US$ per day worldwide by 2020 was decreasing (Fig. 1).

But that trend was disrupted in 2020. As a result of the crisis caused by the COVID-19 pandemic. The number of people in extreme poverty increased by 70 million, crossing the 700 million mark. The level of global extreme poverty reached 9.3%, compared to 8.4% in 2019 [7].

The international experience of social protection of the population, ensuring employment and stabilization of the economy can be applied in Armenia with certain adjustments.

The system of social protection measures, programs and laws is based on the principles of the Declaration of Human Rights, where human life is considered the highest value for society [8].

After the Second World War and the recovery of economies, all European and Eurasian countries saw a trend of increasing spending on social protection of the population.

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In the post-Soviet countries, these expenses were carried out mainly at the expense of the budget. Currently, the legislation of a number of post-Soviet countries envisages receipt of social protection expenses from business activities, but they remain quite small, and the majority of allocations for this purpose are made by the state budget and pension fund.
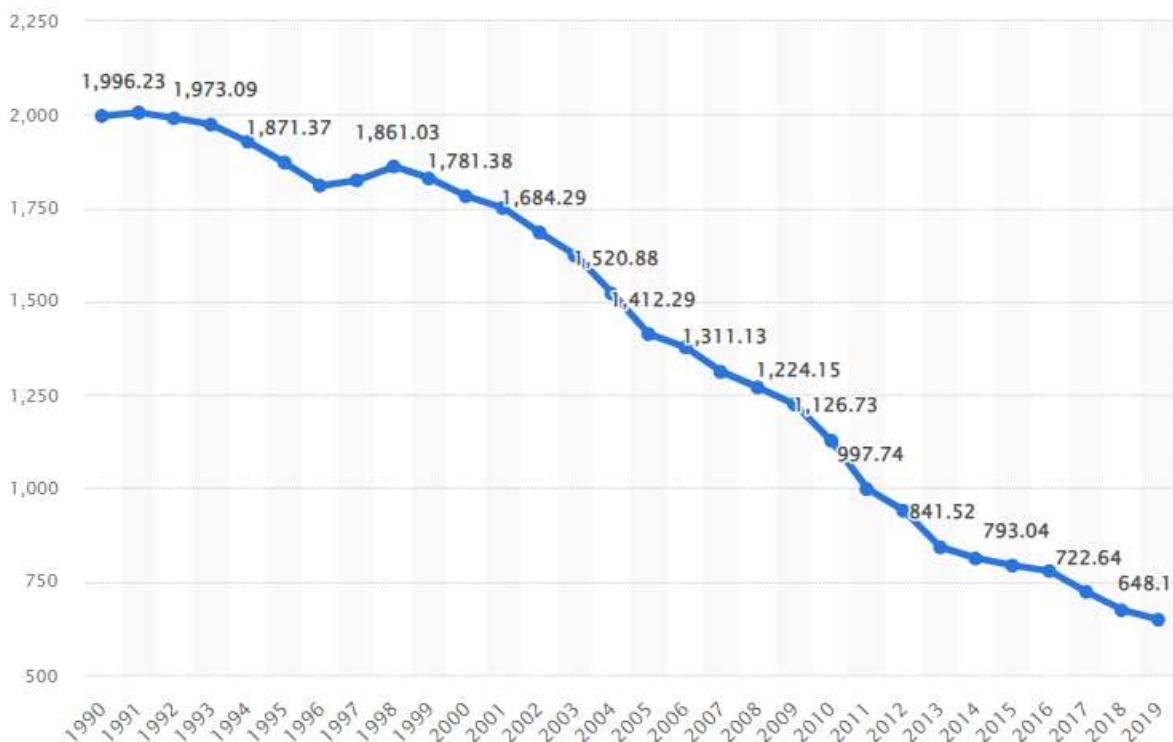

Fig. 1 The number of people with an income of less than 2.15 US$ per day in the world in 1990-2019, (million people) calculated by the purchasing power equivalent of 2017 [6]

In Western countries, the participation shares of the state, entrepreneurs and welfare recipients are also not equal. In France, Sweden, and to some extent in the USA, more than half of social protection funds are placed on entrepreneurs, in Great Britain, recipients of state assistance provide 1/5 of social spending for these purposes, the exception is Switzerland, where this figure is only 1%.

When solving the problems of social protection in the transitional conditions of the market economy, it is necessary to take into account the features of the market formation in the post-Soviet countries, which should ultimately be based on the analysis of international experience.

Let's discuss the American social protection and Swedish full employment models.

The American social protection model relies on two sources of funding: public and private.

By encouraging private entrepreneurship, the American government through tax levies affects the redistribution of national income, reducing inequality between the rich and the poor (Fig. 2).

"Causes and Consequences of Income Inequality: A Global Perspective" published by experts of the International Monetary Fund emphasizes the idea that widening income inequality is the defining challenge of our time.

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**Fig. 2 The number of families living below the poverty line in the USA
in 1990-2021, (1000 families) [9]**

The gap between the rich and the poor in developed economies has reached its highest level in recent decades. Inequality trends have been more erratic in emerging markets and developing countries, where some countries have seen a decline in inequality, but widespread inequalities in access to education, health and finance persist.
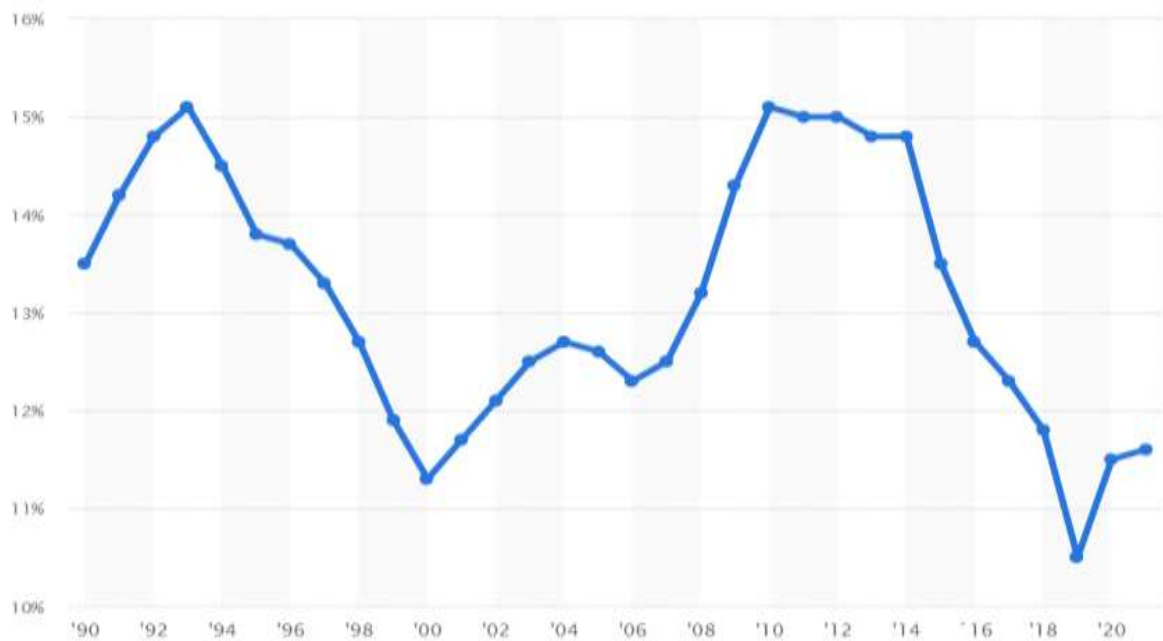

**Fig. 3 Poverty rate in the United States 1990-2021, as a percentage
of the total population [11]**

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Therefore, it is not surprising that the extent of inequality, its motivations and the question of "what to do" about it remains very relevant in the development and implementation of socio-economic development programs of the governments of both developed and developing countries. The issues of development and solution of this problem are also urgent by both policy makers and researchers [10].

Although the poverty rate in the US in 1993-2000 had a decreasing trend, from 15.1% to 11.3%, but in 2000-2010 it increased again, from 11.3% to 15.1%. In 2010-2019, it decreased from 15.1% to 10.5%, then an increase was observed in 2021. reaching 11.6%.

In the United States, the state bears the brunt of the costs of social protection. It includes not only monetary benefits but also material assistance in the form of grocery cards, school breakfasts and lunches, special meals for pregnant women and infants, etc. In this sense, the USA is recognized by many as a "caring state", especially for children and the elderly.

The state aid fund for the unemployed is also financed by the state in one-third part.

Private social assistance is provided in various forms, such as the provision of individual sponsorship, private social insurance, and benefits paid by businesses to their employees in the event of retirement, injury and illness at work. However, this aid is not mandatory, especially in the conditions of a general decline in production.

Switzerland's experience deserves special attention in the process of programs and measures to ensure the employment of the population and reduce unemployment. Thanks to the training of the workforce, the improvement of the qualifications of specialists, the use of advanced methods of securing employment, Switzerland was able to reconstruct the industry as quickly as possible. Although structural unemployment occurs under such conditions, it was significantly reduced thanks to certain measures implemented by the Swiss government. The training of specialists in Switzerland is carried out through special organizations for 18 weeks. As a rule, people who have completed training courses later get a job. The implementation of policies aimed at ensuring full employment and reducing unemployment is accompanied by a coordinated combination of measures of the government and local self-government bodies (Fig. 4).
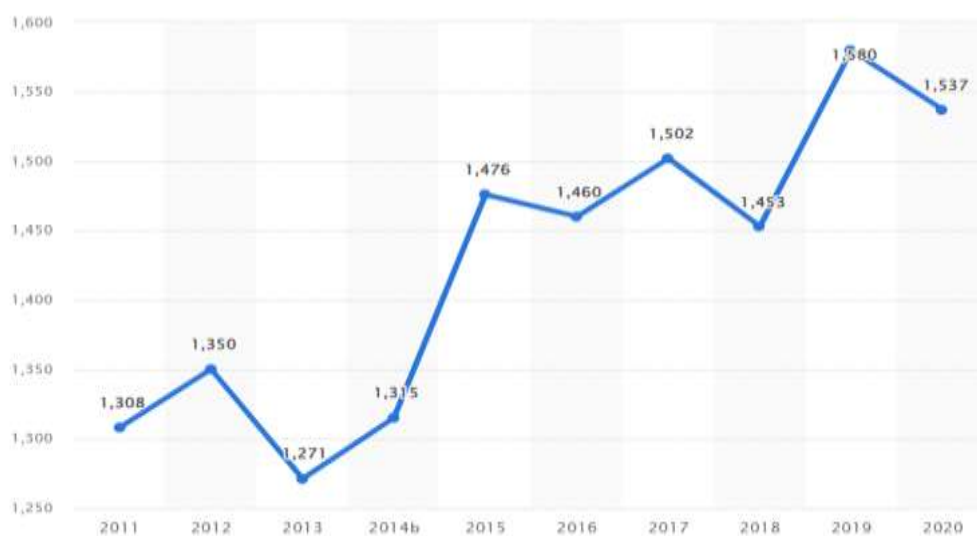

Fig. 4 Number of people at risk of poverty or social exclusion in Switzerland, 2011-2020. (thousand people) [12]

About 3/4 of the funds aimed at ensuring employment in Switzerland are spent on creating jobs, training employees and specialists, and implementing other measures that contribute to the professional growth of personnel. It is noteworthy that the growth of labor productivity, and therefore the economic growth of the country, depends on it.

In Switzerland people with certain physical disabilities are not forgotten. Special so-called protected jobs are created for them.

Conclusion

In the modern world, meeting the living standards and social needs of the population continues to be one of the important issues of the policies conducted by the states. In the current difficult geopolitical situation, a significant increase in food and energy prices is observed in some regions, which hinders the improvement of the population's standard of living. Especially the study of the experience of the formation and distribution of the income of the population of the advanced countries of the present world, such as the USA and Switzerland, and especially the tools used in this field can be very useful for developing countries, including Armenia, taking into account the features of the republic and the nuances of the tool's application and localization and apply them in socio-economic programs and in raising the standard of living of individual groups of the population, in solving both short-term and long-term problems.

The states are trying to solve this problem by applying various tools that can be useful for implementing an effective social policy in Armenia.

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Մ. Ա. Մարկոսյան
«Քաղաքագիտական, իրավագիտական և տնտեսագիտական հետազոտությունների և կանխատեսումների» ՀԿ

Աշխարհում շարունակաբար փորձեր են ձեռնարկվում բազմակողմանիորեն գնահատելու և չափելու ինչպես գլոբալ առումով, այնպես էլ բնակչության առանձին խմբերի կենսամակարդակի և բարեկեցության առաջընթացին վերաբերող ցուցանիշները: Սոցիալական վիճակի գնահատումը և չափումը բարդ գործընթաց է, քանի որ «բնակչության կենսամակարդակ» և «կյանքի որակ» հասկացությունները բազմավեկտոր են և դժվար հաշվարկելի ու գնահատվող:

Յուրաքանչյուր պետության, դրա բնակչության առանձին սոցիալական խմբերի և տարածքների (նահանգներ, շրջաններ, մարզեր, այլն) սոցիալական առաջընթացի բավարար ճշգրտությամբ գնահատումը և չափումը, կարևոր գործոն է հանդիսանում բնակչության անհավասարության ցուցանիշների որոշման համար: Այն պետք է հիմք հանդիսանա պետության սոցիալական քաղաքականության սկզբունքների և մոտեցումների, բնակչության առանձին խմբերի (հատկապես՝ սոցիալապես խոցելի), բնակչության եկամուտների և ծախսերի արդյունավետ կառավարման միջոցով սոցիալական արդյունավետ քաղաքականություն իրականացնելու համար: Այդպիսի քաղաքականության ձևավորման հիմք է հանդիսանում սոցիալական հիմնախնդիրների բացահայտումը և դրանց լուծման ուղիների բացահայտումը: Սոցիալական ուղղվածության ծրագրերը կարող են իրականացվել ինչպես կարճաժամկետ, այնպես էլ երկարաժամկետ կտրվածքներով: Բնակչության եկամուտների բաշխման և պետական

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կարգավորման խնդիրների ձևավորումը և դրան հասնելու գործիքակազմի փնտրտուքը պետք է դառնա պետության կողմից իրականացվող քաղաքականության առանցքային բաղադրիչներից մեկը: Նկատի ունենալով սոցիալական քաղաքականության իրականացման դժվարությունները և այդ քաղաքականության մշակման ընթացքում համապատասխան գործիքակազմի կիրառումը արդիական խնդիր է դառնում բնակչության եկամուտների ձևավորման և բաշխման ընդհանուր միտումների բացահայտումը և բնութագրումը: Որպես առաջին քայլ անհրաժեշտ է կատարել առաջավոր ազատ շուկայական հարաբերություններ ունեցող երկրների փորձի ուսումնասիրություն և վերլուծել Հայաստանում դրանց տեղայնացման հնարավորությունները՝ սոցիալական քաղաքականության գործիքակազմի ընտրության և ընդլայնման համար: Անհրաժեշտ է գնահատել նաև աղքատության դեմ պայքարի կիրառվող գործիքակազմի և իրականացված քաղաքականության արդյունքայնությունը՝ համեմատելով Հայաստանի և հարևան պետությունների համապատասխան ցուցանիշները:

Բանալի բառեր. եկամուտների բաշխման անհավասարություն, եկամուտների համակենտրոնացման գործակից (Ջինիի ինդեքս), սոցիալական առաջընթաց, սոցիալական ինդեքս, սոցիալական խմբեր

ФУНДАМЕНТАЛЬНЫЕ ПРОБЛЕМЫ РАСПРЕДЕЛЕНИЯ ДОХОДОВ НАСЕЛЕНИЯ И ИНСТРУМЕНТЫ ГОСУДАРСТВЕННОГО РЕГУЛИРОВАНИЯ

М. А. Маркосян
ОО по политологическим, правовым, экономическим исследованиям и прогнозированию

В мире постоянно предпринимаются попытки комплексной оценки и измерения показателей, связанных с прогрессом уровня жизни и благосостояния как в глобальном масштабе, так и для отдельных групп населения. Оценка и измерение социального состояния – сложный процесс, поскольку понятия «уровень жизни населения» и «качество жизни» многовекторны и сложны для подсчета и оценки.

Оценка и измерение социального прогресса каждого государства, отдельных социальных групп и территорий (штатов, областей и т.п.) с достаточной точностью является важным фактором определения показателей неравенства населения. Оно должно стать основой реализации эффективной социальной политики через принципы и подходы социальной политики государства, отдельных групп населения (особенно социально уязвимых), эффективного управления доходами и расходами населения. Основой формирования такой политики является выявление социальных проблем и определение путей их решения. Социально ориентированные программы могут реализовываться как в краткосрочной, так и в долгосрочной перспективе. Формирование проблем распределения доходов населения и государственного регулирования, поиск инструментов для их достижения должны стать одной из ключевых составляющих политики, реализуемой государством. Учитывая трудности

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реализации социальной политики и использования соответствующих инструментов при разработке этой политики, выявление и характеристика общих тенденций формирования и распределения доходов населения становится актуальным вопросом. В качестве первого шага необходимо изучить опыт стран с развитыми свободными рыночными отношениями и проанализировать возможности их локализации в Армении для выбора и расширения инструментов социальной политики. Также необходимо оценить эффективность используемых инструментов борьбы с бедностью и реализуемой политики, сравнивая соответствующие показатели Армении и соседних стран.

Ключевые слова. неравенство распределения доходов, Коэффициент концентрации доходов (индекс Джини), социальный прогресс, социальный индекс, социальные группы.

UDC – 338.241.42

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Abstract

The relations of distribution and redistribution of monetary income of the population have a direct impact on the socio-economic development rates. The coefficient of income concentration (Gini index) characterizes the proportions of income distribution between different groups of the population (decile, quintile and others). According to which there should be a certain principle of division between them, however, it should be at the basis of social justice, as shown by the sociological surveys conducted in Armenia and Artsakh,

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justice is mentioned in the first place among other value systems in the perceptions of the population, which is evidenced by the many values of the Armenian society and the place of that category in the strata and its importance in raising the standard of living of the population. In order to ensure high economic growth and to ensure social solidarity and cooperation within the society, it is especially important to reduce poverty and to identify the existing problems in this regard.

Keywords: Incomes of the population, coefficient of concentration of incomes (Gini index), inequality of income distribution, average class.

Introduction
When discussing the distribution and redistribution of monetary incomes of the population, it is necessary to pay more attention to the incomes of the poor and middle classes, as they make up the majority of the population in any society. This circumstance conditions both the majority of the provision of economic growth, as well as the provision of social solidarity within the society and, therefore, the foundations of a stable society. Especially in most developing countries, as well as in Armenia, poverty is not only a social but also a serious socio-political problem, the overcoming of which is a serious guarantee for the progress of any state. Therefore, the identification of the problems of poverty and the implementation of effective policies in that area and the formation of the middle class will ensure the upward development of the society.

In addition, how does it explain the different trends in inequality developments in advanced economies, with a particular focus on the poor and the middle class. Although most of the existing studies emphasize the Gini index of developed countries and the factors of income growth of the rich, it has become more relevant to study the issues of income formation and distribution of the population of developing countries, as well as their level of concentration.

Conflict Setting
The purpose of the research is to study the problems of concentration of monetary income of the population, to identify the causes of poverty in Armenia and to propose priority measures to reduce them. In order to achieve the set goal, the features of the policy implemented in the distribution and redistribution of the monetary income of the population, the tools used, and recommendations were developed in order to solve these problems.

Research methodology
In the study, the approaches and principles of scientific abstraction, statistical groupings, statistical analyzes according to individual countries, international comparisons, as well as combinations of individual groups of countries and indices and their rating were applied.

Research Results
Distribution of monetary income of the population is also an important factor for economic growth. Thus, if the income share of the richest 20 percent (quintile) of the

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population's monetary income distribution increases, GDP growth actually decreases in the medium term. Across the income distribution scale, an increase in the income share of the bottom 20 percent (the poor) is associated with higher rates of economic growth. The poor and the middle class are critical to economic growth through a series of interrelated economic, social and political instruments.

Economic policies that focus on the poor and the middle class can alleviate inequality. Regardless of the level of economic development, better access to education and health care and well-designed social policies can simultaneously ensure that labor market institutions do not overtax the poor, thereby increasing the income share of the poor and the middle class.

As the study of international experience shows, there is no unified policy in the distribution of incomes of the population and especially in reducing inequality. Appropriate socio-economic policies must be based on specific and clear policies and institutional arrangements of the country. In both developed and developing countries, the policy of distribution of monetary income of the population should be aimed at reforms aimed at increasing human capital and its skills, which should be ensured primarily by making tax systems more advanced. Overall, the complementarities between the goals of economic growth and income equality suggest that policies aimed at raising average living standards can also affect income distribution and provide more inclusive well-being [1].

The perception and understanding of justice within any society is primarily related to the proportions of income distribution between individual groups of the population. If these incomes are unevenly distributed, then a feeling of injustice arises between individual groups of society, which can have very negative socio-economic consequences. Sociological surveys among the population and the analysis of their results are an important tool in determining the opinion and attitude of individual groups of society regarding the distribution of incomes of the population, which should be the basis for the adjustment and implementation of social policy.

The fact that there has been a lack of justice in our society for years is substantiated in 2019. according to the results of a sociological survey. The survey was conducted among students and professors of universities of Armenia and Azerbaijan.

The respondents were specifically asked the following question: which of the mentioned values do you consider the most important?

1. justice

2. freedom

3. solidarity

4. cohesion

5. self-restraint and sacrifice

6. patriotism

7. goodness to people

8. family traditions

Options were ranked by respondents in order of importance. The options of the question were ranked in the first important position in the following proportion. (Fig. 1).

According to the results of the survey, 36% considered justice first, and for 75% the option of justice was in the 1-3 most important places.

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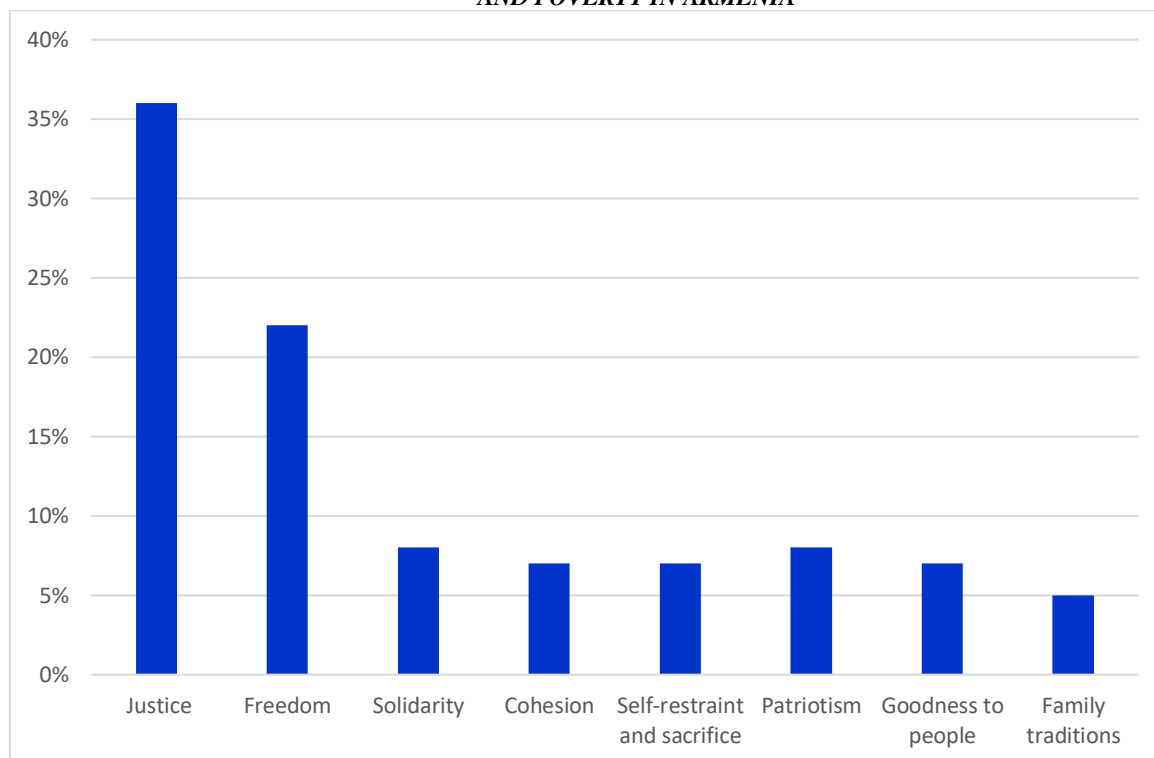***AND POVERTY IN ARMENIA***

Fig. 1 The specific weights of the options given primary importance to the question
"Which of the mentioned values do you consider the most important?"

It is noteworthy that the percentage of those who consider justice a priority was the highest by all criteria. Among respondents in Armenia, the share of the "justice" option was 39%, in the USA - 45%, 36% of male and 43% of female representatives considered justice first. Among undergraduate students, the share of those who consider justice a primary value was 43%, among master's students - 31%, and among professors - 52%, 44% of students majoring in economics considered justice, history - 48%, international economic relations - 37%.

According to the results of the survey, the researchers who conducted it conclude that in the past period of the Third Republic of Armenia, and especially in 1998-2018, during this period, the society had a big "deficit" of freedom and justice, which is why justice and freedom, one of the main components of the society's value system, had the status of the highest public values. Perhaps this was one of the main reasons for "activating" the society and the revolution of 2018.

The created situation demands that the values of both freedom and justice in the society be protected and ensured by the state's active and especially macroeconomic state policy [2].

The level of well-being of different population groups can be judged based on their consumer budget. Usually, the concept of a reasonable budget is used, which is considered sufficient for the normal functioning of the family. Another concept used is the average consumer budget, which is slightly larger than half of the rational budget. The pensioners' budget is smaller than that. The smallest budget is the budget that supports the physical existence of a person.

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According to Academician Abel Aghanbekyan, the enormous inequality between the rich and the poor is the main drawback of the Russian socio-economic system. In Russia, the ratio of those with low and high monetary incomes is officially equal to 13 (although it is difficult to agree with such a fact, because such calculations do not take into account the existence of the "shadow" economy and its influence in the process of uneven distribution of monetary incomes).

In Germany, that indicator is 6.9, in Scandinavian countries - 6, in Japan - 4.5. In the USSR in 1980 that indicator was 3, and in 1990 it was 4. Russia has set a problem until 2026. to increase that figure to 10, and to 6 in the early 2030s (this indicator is considered normal if it is in the range of 5-6). In order to reach that indicator, according to many experts, in the near future it is necessary to establish a minimum income that is not subject to income taxation. And in case of monthly salary of more than 100 thousand rubles, apply a smooth progressive tax [3].

In international combinations, inequality is assessed and measured by the inequality coefficient, the Gini index and the Gini year (by individual years).

The coefficient of income concentration (Gini index) is the deviation of the actual volume of income distribution of the population from the line of equal distribution. In the case of equal distribution, it is equal to zero, in conditions of absolute inequality, it is equal to one [4].

The global Gini index was 0.60 in 1820, 0.72 in 1910, and 0.67 in 2020 (Fig. 5). There has been a large decline in global inequality since the 2008 financial crisis [5].

Fig. 5 shows Global Income Inequality (Gini Index) for 1820-2020. Tab. 1 shows the Gini index in 41 European countries (arranged in ascending order of this coefficient) as of March 28, 2023.
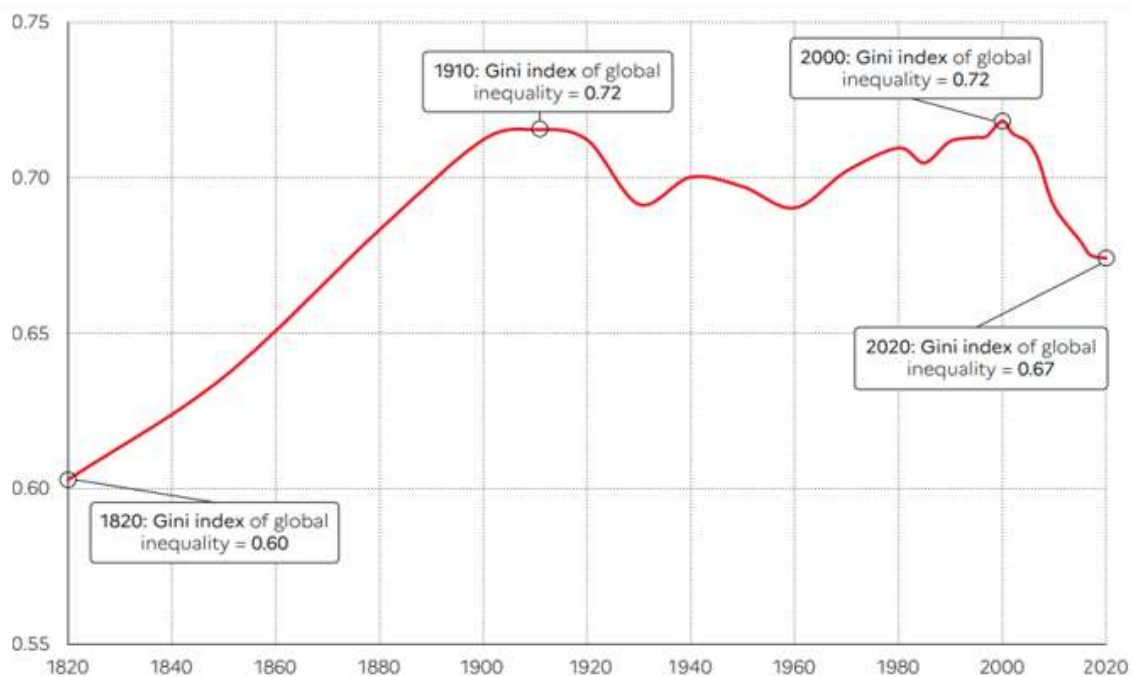

Fig. 2 Global income inequality (Gini index) 1820-2020 [6]

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Table 1

Gini index in 41 European countries
(arranged in ascending order of that index), as of March 28, 2023 [7]

No.	Country	Gini index
1.	Republic of Slovakia	23.2
2.	Czech Republic	25.5
3.	Denmark	26.5
4.	Hungary	26.8
5.	Belgium	27.2
6.	Norway	27.6
7.	Finland	27.8
8.	Serbia	28.1
9.	Croatia	28.9
10.	Belarus	29.0
11.	Iceland	29.2
12.	Sweden	29.3
13.	Netherlands	29.5
14.	Ukraine	29.8
15.	Armenia	29.9
16.	Slovenia	29.9
17.	Austria	30.4
18.	Estonia	30.8
19.	Ireland	30.9
20.	Malta	31.1
21.	Cyprus	31.2
22.	North Macedonia	31.8
23.	Poland	31.8
24.	Switzerland	31.9
25.	Greece	32.6
26.	Portugal	32.8
27.	France	33.2
28.	Bosnia and Herzegovina	34.3
29.	Spain	34.4
30.	Latvia	34.7
31.	The United Kingdom	34.8
32.	Germany	34.8
33.	Luxembourg	34.8
34.	Albania	34.9
35.	Romania	35.0
36.	Russia	35.0
37.	Moldova	35.1
38.	Italy	36.5

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No.	Country	Gini index
39.	Lithuania	39.2
40.	Bulgaria	40.3
41.	Georgia	44.6
Average on the continent		*31.83*

Table 2 shows the Gini index of 31 countries of the Asia and Pacific basin (arranged in order of increasing this coefficient), as of March 28, 2023.

Table 2

Gini index in 32 countries of the Asia and Pacific basin
(arranged in ascending order of that index), 28.03.2023. [7]

No.	Country	Gini index
1.	Kyrgyzstan	29.7
2.	Australia	32.6
3.	Singapore	33.7
4.	Taiwan	34.0
5.	Korea, Rep.	34.4
6.	New Zealand	34.6
7.	Brunei	36.6
8.	Pakistan	37.2
9.	Indonesia	37.3
10.	Azerbaijan	38.2
11.	Malaysia	40.3
12.	Afghanistan	41.0
13.	Kazakhstan	41.2
14.	Nepal	41.5
15.	Thailand	41.8
16.	Bhutan	42.1
17.	Tajikistan	42.2
18.	Bangladesh	42.4
19.	Mongolia	42.9
20.	Myanmar	42.9
21.	China	42.9
22.	Laos	43.3
23.	Vietnam	43.8
24.	Japan	44.2
25.	Cambodia	45.4
26.	Philippines	45.4
27.	Uzbekistan	45.5
28.	Papua New Guinea	46.3
29.	Hong Kong	48.2

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No.	Country	Gini index
30.	Turkmenistan	48.9
31.	Sri Lanka	49.0
32.	India	57.1
Average on the continent		*41.46*

Table 3

Average Gini index of the world, continents and the Middle
and Near East region, as of 28.03.2023 [7]

No.	Continents and region	Gini index
1	Europe	31.83
2	Asia and the Pacific	41.46
3	North and South America	50.07
4	Middle and Near East	50.12
5	Africa	50.13
World average (among 156 countries in the world)		*38.35*

It can be seen from Table 3 that the indicator of distribution of monetary income of the population between high and low income groups is the lowest in the European continent, and the highest in Africa.

Fig. 3 shows the Gini income inequality indicators in Transcaucasian republics.
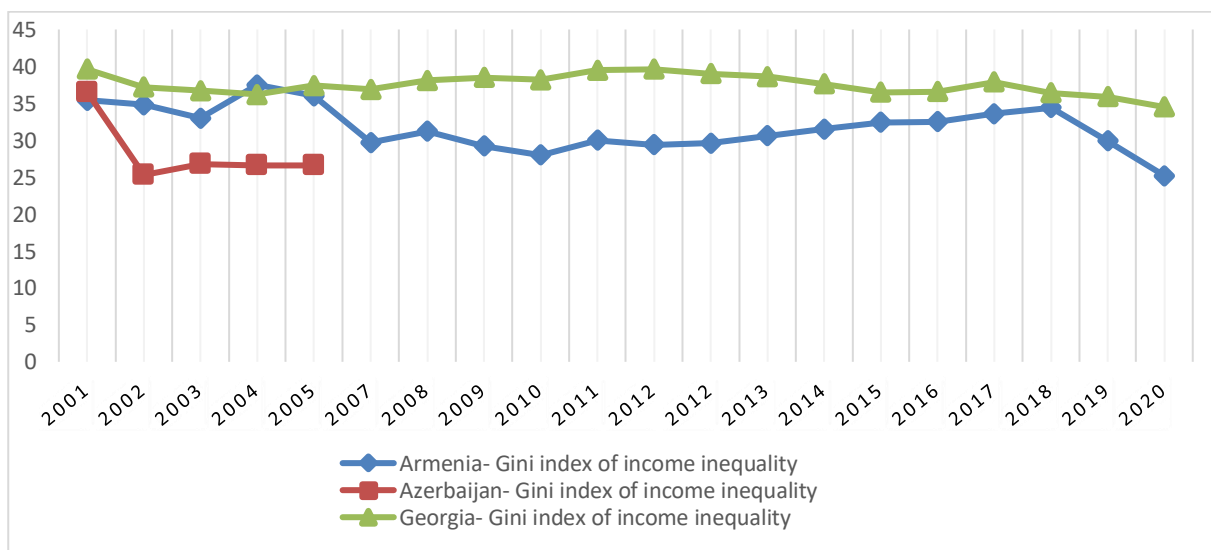
Fig. 3 Gini index values of Armenia, Azerbaijan and Georgia in 2001-2020. [8]

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2001-2020 The Gini index was the highest in Georgia. Starting from 2018, both Georgia and Armenia have seen a decrease in the magnitude of the Gini index.
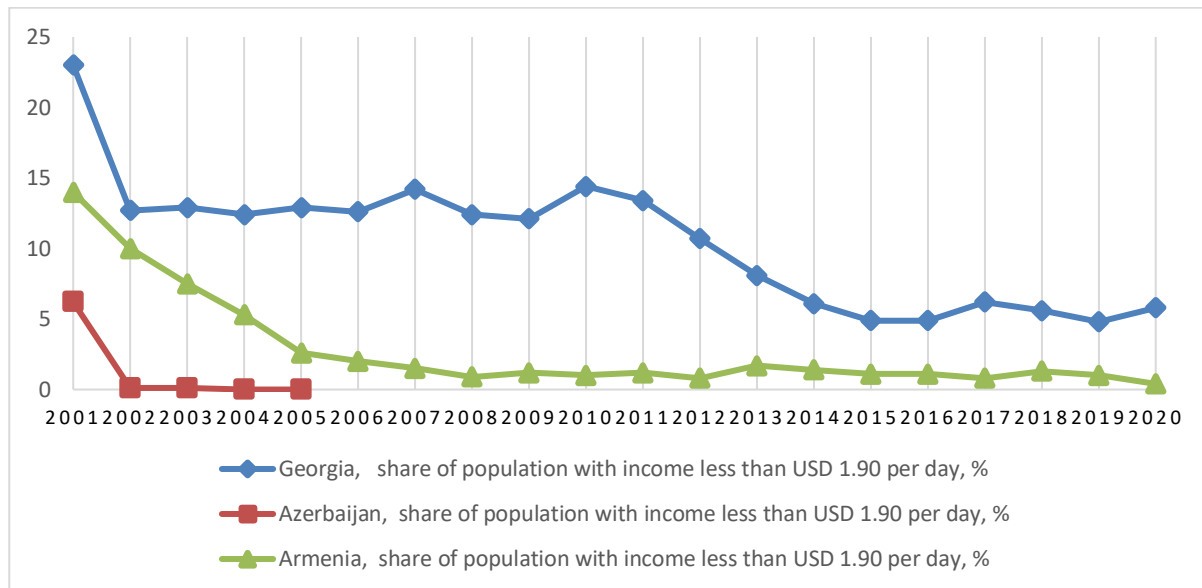

Fig. 4 The share of the population with an income of less than 1.90 USD per day
in the republics of the South Caucasus, 2001-2020 (%) [9]

Fig. 4 shows the share of the population with an income of less than 1.90 USD per day in the republics of the South Caucasus, from 2001 to 2020 in %. The share of the population with the lowest income in 2001 was in Georgia (23%), followed by Armenia (14%) and Azerbaijan (6.2%).

Table 4

The main indicators of inequality and poverty of the population of Armenia in 2001-2020. [10]

Year	Gini index	Poverty, percentage of population	Proportion of population earning less than US$ 1.90 per day	Proportion of population earning less than US$ 5.50 per day	Percentage income earned by the top 10 percent of earners
2001	35.4		14	83.8	29.1
2002	34.8		10	82.9	29
2003	33		7.5	82.6	28.2
2004	37.5		5.3	73.5	31.7
2005	36		2.6	67.5	30.8
2006	29.7		2	62.8	24.5
2007	31.2		1.5	56	25.1
2008	29.2		0.9	52.1	23.7
2009	28		1.2	60.7	22.9
2010	30		1	62.1	25
2011	29.4		1.2	59.3	24
2012	29.6		0.8	55.2	24.5
2013	30.6		1.7	53.1	24.7

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2014	31.5		1.4	51.1	25.7
2015	32.4		1.1	46.7	26.7
2016	32.5		1.1	42.4	25.3
2017	33.6		0.8	48.7	28.4
2018	34.4		1.3	48.9	29.2
2019	29.9	26.4	1	52.3	25.1
2020	25.2	27	0.4	53.5	21.5

Table 4 shows the main indicators of inequality and poverty of the population of Armenia in 2001-2020. In 2001, the Gini index was 35.4, in 2010 it was 30, and in 2020 it was 25.2. The share of the population with an income of less than 5.50 US $ per day in those years was 83.8%, 62.1%, 53.5%, respectively, and the percentage of income earned by the 10 percent of the highest earners was respectively: 29.1%, 25% and 21.5%.

The reduction of some values from the indicators of 2020 in Armenia is caused by 2 force majeure reasons: Covid-19 and the 44-day war. However, poverty in Armenia remains at a high level (table 5). The indicator of the extremely poor is particularly disturbing, which increased by 0.1% in 2021 compared to 2019. The same was observed in terms of the index of the poor population, it increased from 26.4% in 2019 to 26.5% in 2021. At the same time, the depth of poverty decreased significantly in 2019 from 10.1% to 4.8%. The same applies to the severity of poverty in 2019 from 3.4% to 1.4% in 2021. It is noteworthy that the proportion of extremely poor people in urban areas in 2019 was 1.1%, in rural areas - 2.0%, and in 2021 - 1.0% and 2.1%, respectively.
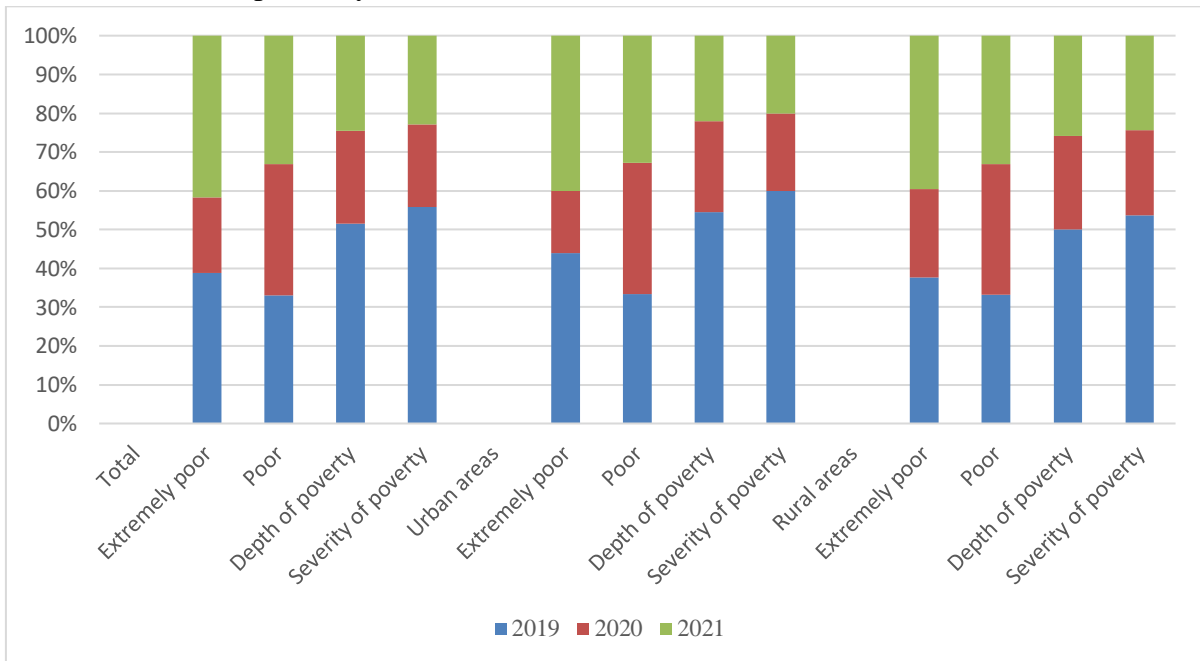
Note: The poverty indicators are not comparable with the data of previous years,
because they are calculated according to the average poverty line.
Fig. 5 Armenia's poverty indicators in 2019-2021, (%) [11]

Fig. 5 shows the magnitudes of poverty lines in Armenia in 2019-2021. The given comparison testifies to the positive trends in the fight against poverty and its effectiveness.

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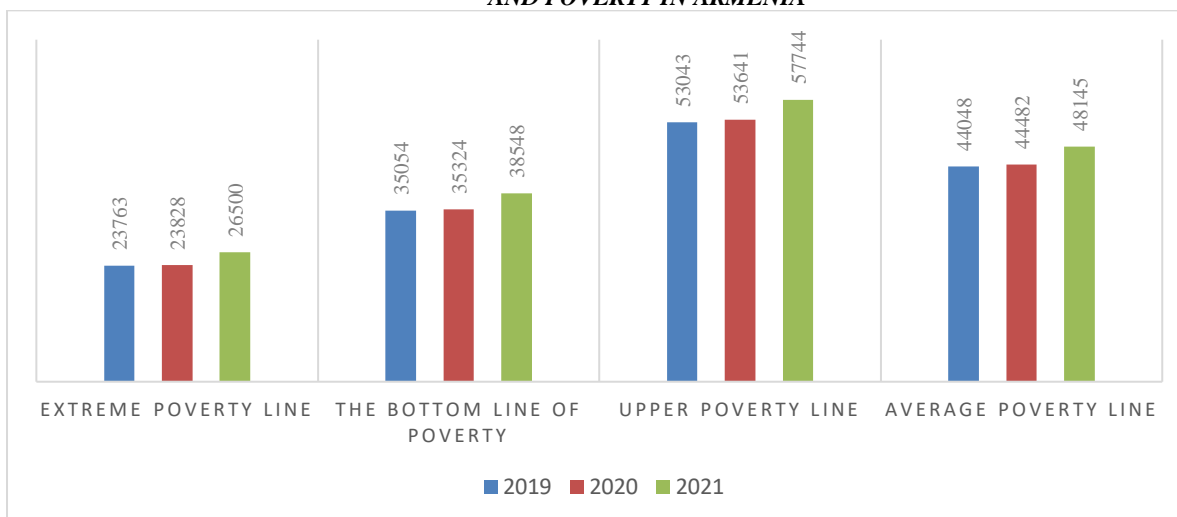*AND POVERTY IN ARMENIA*

Fig. 6 The poverty line in Armenia in 2019-2021, AMD [12]

The analysis of Armenia's poverty level by household size in 2019-2021, in percentages, is also of some interest. Households and the characteristics of their condition are the elements that form the basis of the economy, and provide an opportunity to make a "diagnosis" of the state of the economy. The analysis shows that as the number of household members increases, the poverty level of the household increases. The analysis shows that in order to reduce poverty, especially in households with members of a large family, it is necessary to use a radically different set of tools.

Table 5

Armenia's poverty level by household size in 2019-2021 (%) [13]

Number of household members	Extremely poor		Poor		Proportion of the poor population		Proportion in total population	
	2019-2021		2019-2021		2019-2021		2019-2021	
1	0.2	0.0	7.3	6.3	1.3	1.4	5	5.7
2	0.1	0.1	13.6	13.5	6.5	8.4	12.6	16.4
3	1.2	0.4	20.6	17.4	12	11.1	15	16.9
4	0.8	0.7	21.2	21.6	17.9	17.5	20.4	21.4
5	1	2.1	28.6	35.7	21.1	22.7	19.2	16.9
6	0.8	2.4	35.5	42.4	20.8	20.7	14.9	12.9
7 or more	5.1	5.9	41.1	49.1	20.3	18.2	12.9	9.8
Total	1.4	1.5	26.4	26.5	100	100	100	100

Conclusion

The results of the study prove that the implemented anti-poverty programs have given their results, reducing the share of the extremely poor and poor population in the total population in the republic. The increase in the effectiveness of social policy is noticeable, especially in households with members of large families, which should become the core of social programs for the improvement of that segment of the population. The problem of increasing the effectiveness of social policy is especially acute for countries located in regions with the possibility of risks of military operations. In the current conditions, among the measures to ensure and improve the internal and external security of the country, it becomes important to ensure social solidarity and stability, which is based on the fair distribution and redistribution of income.

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ԲՆԱԿՉՈՒԹՅԱՆ ԴՐԱՄԱԿԱՆ ԵԿԱՄՈՒՏՆԵՐԻ ԿԵՆՏՐՈՆԱՑՄԱՆ ԵՎ ԱՂՔԱՏՈՒԹՅԱՆ ՀԻՄՆԱԽՆԴԻՐՆԵՐԸ ՀԱՅԱՍՏԱՆՈՒՄ

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[3]*Ակադեմիկոս Ի.Վ. Եղիազարովի անվան ջրային հիմնարարգերի և հիդրոտեխնիկայի ինստիտուտ*

Բնակչության դրամական եկամուտների բաշխման և վերաբաշխման հարաբերությունները անմիջական ազդեցություն են թողնում զարգացման սոցիալ-տնտեսական տեմպերի միջն: Եկամուտների կենտրոնացման գործակիցը (Ջինիի ինդեքսը) բնութագրում է բնակչության տարբեր խմբերի միջն (դեցիլային, քվինտիլյաի և այլ) եկամուտների բաշխման համամասնությունները: Ըստ որում դրանց միջն պետք է լինի

բաժանման որոշակի սկզբունք, ինչն է պետք է ընկած լինի սոցիալական արդարության հիմքում, ինչպես ցույց են տալիս Հայաստանում և Արցախում իրականացրած սոցիոլոգիական հարցումները բնակչության պատկերացումների մեջ այլ արժեքային համակարգերի շարքում առաջին տեղում նշվում է արդարությունը, ինչը վկայում է հայ հասարակության բազմաթիվ շերտերում այդ կատեգորիայի տեղը և կարևորությունը բնակչության կենսամակարդակի բարձրացման գործում: Տնտեսական բարձր աճի ապահովման գործում և հասարակության ներսում սոցիալական համերաշխության և համագործակցության ապահովման համար հատկապես կարևոր է աղքատության նվազեցումը և այդ գործում գոյություն ունեցող հիմնախնդիրների բացահայտումը:

Բանալի բառեր. բնակչության եկամուտներ, եկամուտների համակենտրոնացման գործակից (Ջինիի ինդեքս), եկամուտների բաշխման անհավասարություն, միջին խավ

ПРОБЛЕМЫ ЦЕНТРАЛИЗАЦИИ ДЕНЕЖНЫХ ДОХОДОВ НАСЕЛЕНИЯ И БЕДНОСТИ В АРМЕНИИ

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Отношения распределения и перераспределения денежных доходов населения оказывают непосредственное влияние на темпы социально-экономического развития. Коэффициент концентрации доходов (индекс Джини) характеризует пропорции распределения доходов между различными группами населения (дециль, квинтиль и другие). Согласно которому между ними должен существовать определенный принцип разделения, однако он должен лежать в основе социальной справедливости, как показали социологические опросы, проведенные в Армении и Арцахе, справедливость упоминается на первом месте среди других систем ценностей в представления населения, о чем свидетельствуют многие ценности армянского общества, место этой категории в слоях и ее значение в повышении уровня жизни населения. Для обеспечения высоких темпов экономического роста и обеспечения социальной солидарности и сотрудничества внутри общества особенно важно сократить бедность и выявить существующие проблемы в этом отношении.

Ключевые слова. доходы населения, коэффициент концентрации доходов (индекс Джини), неравенство распределения доходов, средний класс.

WAYS TO IMPROVE THE AGRICULTURAL DIGITIZATION PROCESS

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Abstract

In today's world of global and regional military-political and economic events, the presentation of proposals for designing and implementing effective measures to assure food security and tackle the oncoming food crisis is becoming increasingly important for each nation. During the research, analytic, logical, comparative, and statistical methodologies were employed. According to studies, information and communication technologies have a key role in the growth of agricultural production in European and Central Asian countries, influencing society and the state in general on the social, economic, and political levels. The adoption of such technologies enables the improvement of the quality of goods and services, as well as the expansion of agricultural and food export. According to studies information and communication technologies play an important role in the development of agricultural production in European and Central Asian countries, influencing the social, economic and political field of society and the state in general. The adoption of such technologies enables the improvement of the quality of goods and services, to expand the export of agricultural and food products. Currently, developed and developing countries are migrating to their

digital agriculture system, which is tailored to each country's needs and operates in the interests of national policy.

Keywords: digitization, technolog, agriculture, integrated information environment.

Introduction

The objective of this research is to analyze and describe the role and importance of agriculture digitization, its features, importance, advantages, and features, as well as the requirement of its implementation in modern conditions, difficulties and solutions in transitional nations using RA as an example.

The management of the agri-food system is a key component of the strategic development of the economy, which includes innovative developments in digital technologies.

The implementation of modern management concepts in every branch of the economy, including in farming industry, requires the development and application of the new generation of digital technologies to create an opportunity to increase the efficiency of investments in the agri-food system, can become the main element of state support, and the digitization of the branch will enable a fast rate development of the farming industry.

Modern digital technologies can instantly solve problems, provide the most cost-effective models of production management, analyze and process large amounts of data, combine multiple information resources on a single platform, control and reduce production risks, and meet the information needs of a diverse set of stakeholders [1].

Agricultural professionals view digitization as a data collection tool with the potential to improve data collection, grouping, and analysis, as well as expand forecasting tools and forms, particularly for addressing harvesting organization, animal behavior management, and production efficiency issues. Digital agriculture is becoming increasingly crucial for agritech companies as the industry moves toward automation and the use of digital technologies.

Farming industry digitization helps to achieve the main goals of agriculture, such as increasing the efficiency of not only agriculture, but also the entire value chain of agricultural product production, making agricultural work more appealing to young people, solving the problems of the aging population in rural areas, increasing crop and livestock productivity, and having more operational information about the agricultural sector full and trustworthy data. Many nations are paying special attention to the quality of the resource potential, because the success of digitization of agricultural output is impossible without digital literacy training for agricultural workers. To better comprehend the nature, importance, and usefulness of digital agriculture, it is necessary to study the works of various renowned scholars and practitioners in this sector.

Thus, the Food and Agriculture Organization (FAO) specialists remark that digital agriculture gives increased prospects for more sustainable agriculture, both economically, environmentally, and socially [2].

And OECD experts believe that digital technologies, the Internet, mobile technologies and gadgets, digital analytics, artificial intelligence, digital services, and apps - are fundamentally altering agriculture and the food chain [3].

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Experts in the European Union (EU) believe that digital technologies have the potential to revolutionize the farming industry by enabling farmers to work more precisely, efficiently, and sustainably.

Recommendations based on digitization can help to make decisions more effective, gain new experience, enhance the environment, and make agricultural employment more appealing to young people. Consumers are becoming more aware about how their food is produced thanks to advances in digital technology [4].

Digital agriculture can be defined as the seamless integration of digital technologies to improve management efficiency in agricultural and livestock breeding, among other operations.

It enables sector businessmen to increase their own production, cut long-term costs, and manage risks.

As the accumulated experience in this sphere has shown, the availability of any national digitized agricultural system determines its effectiveness:

1) modern infrastructure that assures information security, cyber security, and personal data protection;

2) electronic platforms for providing electronic services;

3) digital information is stored in the state agencies;

4) complete coverage of the area with 3G, 4G, and LTE broadband connections;

5) information platforms for service engagement with agricultural workers;

6) informational and financial support for agricultural workers.

General global trends in the development of digital agriculture include:

1) Transition to an integrated management and control system based on modules with specific data sets, such as the farm register, livestock registration and identification system, management and payment processing system, land identification system, statistical data; registers, and market price system;

2) The introduction of artificial intelligence, which boosts agricultural output; the capabilities of artificial intelligence allow for rapid responses to changes in the state of soils and crops based on data analysis received through remote monitoring;

3) creation of electronic marketing platforms for the sale of locally produced agricultural products;

4) the establishment of scientific centers and general education courses, the programs of which are directed at the study of modern agricultural production methods.

According to the major positions, the study of the problems of management and formation of digital agriculture in the nations of Europe and Central Asia can infer that their main tendency is the construction of a unified information resource in the web-portals of branch services.

The Republic of Armenia has created and implemented an integrated information ecosystem that connects all electronic databases on a single online platform. A web-portal of this type allows for the provision of a variety of public services in real time, as well as access to registries.

Agriculture's proportion of the GDP structure in RA has declined dramatically over the last seven years (17.2% in 2015, and 11.1% in 2021), but it remains one of the most important and strategically vital sectors of the RA economy [5].

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It should be emphasized that, according to government projections, this indicator will continue to rise in the following years, reaching 9.8% by 2025 [6].

According to statistics, the economy grew by 11.8 percent in the first half of 2022 compared to the first six months of the previous year, but this gain does not apply to agriculture. According to Vahan Kerobyan, Minister of Economy of the Republic of Armenia, the flaw is in the data collection process, because agricultural data collection is not computerized, and we rely on operational data, which does not always inspire confidence with the human eye.

In December, 2019, the Government of the Republic of Armenia adopted the "2020-2030 Plan of the Key Orientations Ensuring the Economic Development of the RA Agriculture Sector" and it defines four digital and innovative components of the agricultural strategy:

▪ implementation of investments in national digital agriculture platforms and digitization initiatives, promotion and implementation of larger-scale (non-digital) agricultural innovations;

▪ digitization of the government's agricultural systems, and development of the Ministry's digital and innovative capabilities;

▪ capacity building of villagers and education system in the field of digital agriculture and innovations.

The main target areas for launching digital agriculture in Armenia are:

(a) digital provision of advisory and information services for farmers, which will include agricultural advisory services, market information and warning systems for weather, crop pest/disease threats,

(b) creating digital market linkages, i.e. creating platforms and services through which quality agricultural inputs, land and equipment are available to farmers, or which

(c) farmers will be given the opportunity to contact local and international buyers,

(d) digital financial services, such as agricultural insurance, lending and payments,

(e) digitization of supply chain management, including logistics, food safety and control/certification systems;

(f) macro-agricultural literacy tools for overall control of the agricultural system, policy and resource allocation planning and results monitoring,

(g) digital capacity building and agricultural skills training for youth and women engagement and empowerment,

(f) Innovative systems facilitating the digital exchange of data and ideas between agricultural researchers, academia, rural advisory services, extension training organizations, agribusinesses and farmers.

Finally, the use of digital and other technology will strengthen the stability of farmers' high revenues, as well as provide more advantageous economic conditions for businessmen and investors in the agrarian sector. At a higher level, digitization and innovation will result in faster rates of growth of the RA agricultural GDP indicator, faster response of public institutions involved in agriculture, increased awareness and cost-effectiveness, increased participation of women and youth in agriculture and environmental sustainability (e.g., water use) and climate protection, food improving safety, and, most importantly, creating and promoting new jobs in agricultural production and other related economic sectors, such as agro-production, food wholesale and retail, transport, logistics, finance and tourism.

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The creation and digitization of a single portal for the entire water economy (both irrigation and drinking water) is a priority for the economy of Armenia, especially for agriculture. Which will give an opportunity to know at any time how much water is stored in the republic's reservoirs, what land areas can be irrigated with them, and what land surfaces can be irrigated under the climatic and temperature conditions typical of the given stage, and the soil conditions typical of the given region.

On the other hand, the installation of high-tech water meters on irrigation water lines entering all of the country's villages will allow for the specification of the water consumption of the given community in terms of all days of the irrigation season, and thanks to digitization, it will be possible to specify the change in the volume of water use from year to year and, as a result, crop rotation options in the given region. Digitization of all statistics related to climatic conditions, which will create an opportunity for farmers to compare and understand which days in the spring there were the most drastic temperature fluctuations, recorded frosts, or which days of the year there were hailstorms and take measures accordingly.

Almost the same in terms of the spread and development of diseases and pests. This will give an opportunity to both the specialists of the agricultural consulting companies to be established and the farmers to orient themselves in terms of the timing of the spread of diseases and pests and to take timely measures to fight against them.

The final clarification and digitization of processing companies' production capacities (priority procurement opportunities), which will create opportunities for the government to finally verify the agricultural sector policy; for the establishment of new vineyards, which varieties to prioritize, which surfaces to provide subsidies for, and thus the winemaking and brandymaking strategy to be implemented will also be specified. In the end, digitization will make it possible to specify the promising fields of the republic's agriculture, both in plant breeding and animal husbandry. Accordingly, each farmer in his region will decide on the prospect of organizing his production.

First and foremost, Armenia has a tangible advantage in high-quality mobile communications, which is characterized by strong mobile geographic coverage (100% 3G coverage, >50% 4G LTE coverage, mostly in urban areas), almost universal mobile phone usage (97%), and mobile internet connectivity with a very high level of access (88%), with more than half of even low-income households in the country using an Internet connection on a daily or weekly basis.

Second, Armenia has a modest but experienced ICT and technology sector that operates at the level of both local startups and large international technology organizations such as Microsoft. A growing base of Armenian IT developers, sophisticated data analytics companies, and precision equipment manufacturers (including several innovative agriculture-oriented companies operating in Armenia specializing in remote control, drones, field sensors, automation, and software) are driving the digital and digital transformation of Armenia's agriculture sector. has an exceptional ability to develop, adapt and promote innovative technological solutions.

Third, as part of the country's broader growth strategy, Armenia has prioritized the ICT industry and digitization. This attitude has also been reiterated by the newly founded Ministry of High-Tech Industry of the Republic of Armenia, implying that any investment in digital agriculture will be supported by other sectors of the economy (for example, telecom

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operators and financial institutions are creating digital payment infrastructures and increasing investments in them).

Finally, Armenia may be proud of significant e-government accomplishments in other sectors of the economy, such as effective e-business registration and the national e-health platform, which serve as excellent models for agriculture.

On February 17, 2021, the Government of the Republic of Armenia issued the resolution "On Approving Armenia's Digitization Strategy, the Plan of Strategy Measures, and the Success Indicators." Digitization policy of Armenia aims at ensuring government, economy, and society digital interchange. The digital transformation plan aims to achieve the target goals of digitization by using a consistent approach to tackling the requirements and difficulties that the digitization process presents. The approach envisions enhancing, modernizing, and integrating the operational capabilities of existing digital systems via unified digital platforms.

The strategy envisions the enhancement, modernization, and integration of the operational capabilities of the presently operational digital systems via unified digital platforms [7].

Since 2019, Armenia has been operating an interest rate subsidy program for loans to the agricultural sector, which entails expanding economic opportunities for economic entities, introducing modern technologies, and increasing agricultural efficiency by improving credit conditions and partially subsidizing interest rates. On loans made by individuals and legal entities to Armenians involved in the agri-food sector.

TShe program's major purpose is to enhance capital investments, expand production capacity, introduce contemporary technologies, and increase agricultural productivity by raising the partial subsidy of interest rates on loans to individuals and legal entities operating in agriculture.

In May, 2022, the Board of the Eurasian Economic Commission approved "The international experience of digitization development in VAT. State support, regulation, practice" to the overview. The document contains a description of digital services and state support measures for the development of digitization in the agro-industrial complex of the Eurasian Economic Union states and a number of third countries.

The review of international practice and EAEU experience allows identifying the main paths of state regulation and support for the development of agricultural digital services.
The state's promotion of physical and economic access to the Internet and information and computer technologies in rural areas, the provision of grants for the development of digital solutions for VAT within the implementation of special acceleration programs, and the use of an interdisciplinary approach to the implementation of state scientific and technological programs are all mentioned as important factors in the document. The need to improve "digital literacy" through academic and short-term training programs of the villagers is important so that they can effectively apply digital technology, including accurate agricultural technologies in accordance with the adopted in March of this year instruction of the EEC Board. According to the commission's experts, digitizing state support for agriculture will reduce the administrative load on EEU governments. By ensuring the automation of governmental information systems, agricultural producers will have greater access to subsidies.It is believed that the review's application of expertise in the development of VAT

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digitization within the scope of the Union will help its members increase thir agro-industry competitiveness in local and export markets [8].

According to specific criteria, 134 countries within EAEU are placed in the 2021 Network Readiness Index. The Network Readiness Index is divided into four categories:

1) technology (access, content, and future technologies such as AI and the Internet of Things);

2) individuals (citizens, business, state bodies);

3) Governance (trust, regulation, and inclusivity);

4) impact (economics, quality of life, and the digital economy's support to accomplishing sustainable development goals).

Conflict Setting

However, launching digital or other agricultural advances is fraught with difficulties. Agriculture digitization is still highly underutilized, with very low adoption. A number of digital agriculture solutions launched in the country in the past, mostly funded by donors, have failed due to poor implementation by farmers and entrepreneurs or lack of ongoing funding and poor commercial sustainability. The digital transformation strategy aims to realize the target goals of digitization through a common approach to tackling the requirements and difficulties brought to the digitization process.

Research Results

Armenia occupies a slightly higher than average level among the 134 studied countries (Fig.). Armenia is also a partner country in the EU's "Smart Agriculture in the Black Sea Basin" program, the main goal of which is to design and implement a repeatable and transferable model to prepare agriculture and related industries for digital transformation, a procedure that is occurring all across the world.
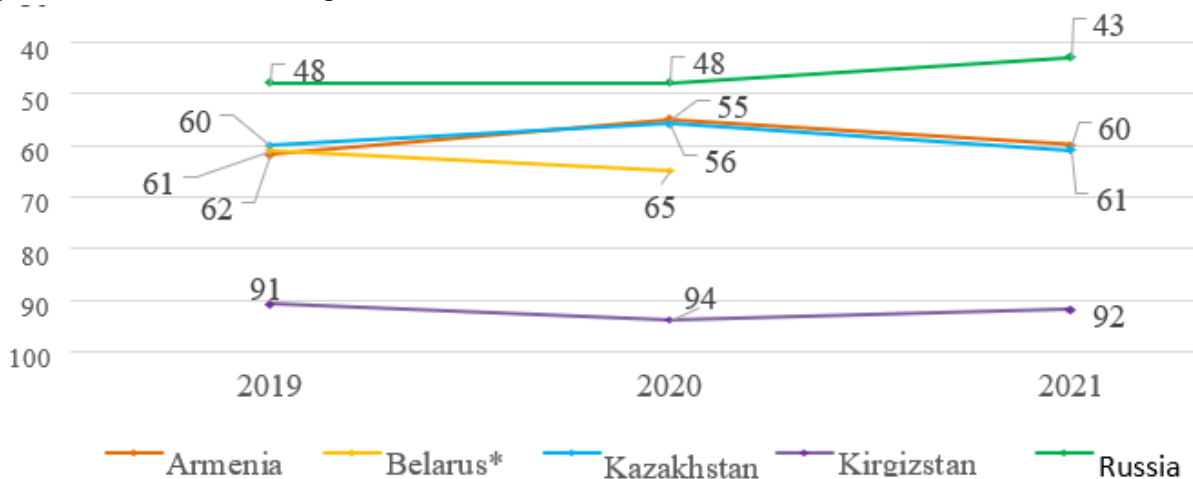
Fig. EAEU countries in Network Redeaness Index by all criteria in 2019-2021 [9]

The project's target group was established in the first two phases, and research and synthesis analysis were carried out, providing thorough information and suggestions on the level of readiness of digital agriculture, smart, and "IoT" technologies in the recipient countries. The "Smart Agriculture" platform is currently being created based on the research that has been completed. It will be a comprehensive online tool for planning a positive encounter - a process that is taking place all around the world. The platform will also help

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commercial opportunities by facilitating SF technologies and enhancing the demand and supply of IoT technologies in the sector to create a good learning environment for stakeholders to congregate and share information. The platform will also help commercial opportunities by facilitating SF technologies and enhancing the demand and supply of IoT technologies in the sector.

The project's next stages will be to arrange a debate to build a common road map on smart agriculture in the Black Sea Basin, as well as to jointly prepare a two-day international conference of the Black Sea Basin Network called "Smart Agriculture in the Black Sea Basin." Representatives from the project's six partner countries will attend the conference, which will include workshops utilizing the GOPP (goal-based project planning) methodology aimed at building a road map for agricultural digitization.

The project's eventual consequence will be the establishment of the Black Sea Basin Smart Agriculture platform and network, which will aid in the growth of interaction among transboundary players [10]. FAO is now assisting Armenia in implementing a digital transformation of the agricultural sector and developing a national digital agriculture strategy.

Through the «National Strategy of Digital Agriculture», Armenia can contribute to the revitalization of food production, create incentives and facilitate the process of developing digital technologies in the field of agricultural production.

They can be used for the purposes of activation of new markets, strengthening of social protection, decentralization of trade, and ultimately become a driving force for innovations in digital agriculture", says Raimund Yele, representative of FAO Armenia [11].

In order to promote the digitization process in agriculture in RA, it is advisable to develop and introduce in the shortest possible time a rating index evaluating the developed level of this process.

Specialists from agricultural and other authorized ministries are needed to participate in the development of the rating system, to address problematic and other issues that arise during the program's execution, and to certify its results, to create an expert council comprised of representatives from digitizing organizations, educational institutions, and the community.

It should be mentioned that such a technique has been in place in Russia since 2021 [12]. In 2018, the Moscow Higher School of Economics developed and implemented the digitization index, which describes the level of development of digitization technologies in sector organizations [13].

The development of innovations in the agro-industrial complex has significant potential in RA, but it requires state assistance and industry-wide B2G cooperation (business and government). On the one hand, digital technology will improve the quality of management decisions, provide targeted instruments for state assistance measures, automate the gathering of statistical information, improve agricultural insurance mechanisms, and make these technologies available to producers. On the other hand, agricultural producers' use of digital technology is becoming an important tool for boosting the economic efficiency of agricultural production and the competitiveness of firms. At the same time, it should be recognized that in order to transition to digital technologies, conventional agriculture must be developed to a suitable degree.

It should be emphasized that the use of digital technology in agriculture contributes to enhancing agricultural production efficiency, making logical judgments based on big data

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analysis, and increasing the efficiency of state control of agricultural support, including transparency.

These technologies also generate massive volumes of data, which may be merged with other data, saved, analyzed, and used to aid decision-making processes. Such "big data" might include a wide range of information assets that can be processed using new analytics techniques such as machine learning to estimate prospective outcomes based on a number of actions and conditions. All of this can help with future activity planning.

Conclusion

1) Create information systems to provide state support to agricultural producers, including the development of electronic algorithms to assess the applicant's compliance with the requirements for receiving subsidies, electronic data exchange between state databases for automatic verification of documents provided by the applicant, and reducing the administrative burden of the authorized bodies of the Member States.

- interactively receive up-to-date information about available state support measures for agriculture on the state information resource;

- send an electronic application for subsidy using an electronic digital signature.

2) Develop information systems to provide state support to agriculture to agricultural producers, including the development of electronic algorithms for assessing the applicant's compliance with the requirements for receiving subsidies, providing electronic data exchange between state databases for automatic verification of documents provided; the applicant, and reducing the administrative burden of the authorized bodies of the Member States, which will allow the applicant:

- interactively receive up-to-date information about available state support measures for agriculture on the state information resource;

- send an electronic application for subsidy using an electronic digital signature.

3) Create tools to aid in the development of digital solutions to increase the economic efficiency and competitiveness of agricultural production:

grant funding within the scope of special acceleration programs for digital companies with the prospect of investment in the agro-industrial complex;

application of an interdisciplinary approach to the implementation of state scientific and technical programs, with the involvement of programming specialists, to investigate the prospects of digitization of agricultural technologies (solutions), which will simplify future "duplication" of such projects.

4) Strengthen the capacities of advisory centers in terms of the transfer of SHTP's primarily digital technologies, including the establishment of regional test "digital fields" for the research and demonstration of digital technologies to agricultural producers from various agricultural sub-sectors.

5) Promote "digital literacy" among the rural population, increase internet connectivity in rural regions and strengthen the training system by facilitating learning and skill acquisition, provide financial assistance to eligible organizations involved in educational or consulting activities related to professional training and skill acquisition.

6) Support the acquisition of appropriate scientific research equipment; for example, the European Union has a Regional Development Assistance Fund (RDA), which was established to strengthen the EU's economic, social, and territorial cohesion by redressing

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regional imbalances. The Foundation employs a variety of supporting tools, such as investments in infrastructure and equipment required for applied research.

7) Encourage rural residents to enhance their "digital literacy." Improve the training system by promoting learning and skill acquisition and expanding internet availability in remote areas. Provide financial assistance to qualifying organizations involved in educational or advising activities related to vocational training and skill acquisition.

8) Fund the acquisition of necessary scientific research equipment; for example, the European Union has a Regional Development Assistance Fund (RDA), which was established to promote the EU's economic, social, and territorial cohesion by redressing regional imbalances. The Foundation employs a variety of supporting tools, such as investments in infrastructure and equipment required for applied research.

9) Promote scientific and applied research for the development of digitization in the agro-industrial complex by establishing institutional bodies in charge of promoting innovation in the agro-industrial complex.

10) Support the scientific and applied researches for the development of digitization in the agro-industrial complex by creating institutional organizations that will be responsible for the promotion of innovation in the agro-industrial complex; for example, in the United States the National Institute of Food and Agriculture (NIFA) exists to integrate all agricultural research funded by the federal budget. The European Union is building the EIP-AGRI platform, which will eventually become a universal center for agricultural innovations in Europe, where scientific ideas and applied research results can be exchanged.

11) Encourage the growth of new farmers who will use innovative agricultural practices in their operations by providing funding, training, and mentorship. In the United States, for example, the Startup Farmers and Ranchers Development Program (BFRDP) gives funding to organizations that assist beginning farmers in meeting their educational, technical, literacy, and informational problems.

12) It is necessary to develop and implement an index assessing the level of digitization in agriculture, which will greatly promote the process of using new digital technologies and solutions in the sector, will contribute to the formation of demand for leading digital technologies, popularization of domestic solutions in that direction, activation of the participation of executive bodies of state and local authorities, and that towards the implementation of state policies.

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ԳՅՈՒՂԱՏՆՏԵՍՈՒԹՅԱՆ ԹՎԱՅՆԱՑՄԱՆ ԳՈՐԾԸՆԹԱՑԻ ԿԱՏԱՐԵԼԱԳՈՐԾՄԱՆ ՈՒՂԻՆԵՐԸ

Կ.Ա. Ներսիսյան[1], **Ա.Խ. Մարկոսյան**[2], **Ժ.Մ. Միրզոյան**[1]

[1]Շուշիի տեխնոլոգիական համալսարան

[2]«Քաղաքագիտական, իրավագիտական և տնտեսագիտական հետազոտությունների և կանխատեսումների» ՀԿ

Գլոբալ և տարածաշրջանային ռազմաքաղաքական և տնտեսական զարգացումների արդի պայմաններում յուրաքանչյուր երկրի համար մեծ նշանակություն ունի պարենային անվտանգության ապահովման ու վերահաս պարենային ճգնաժամին դիմակայելու համար արդյունավետ միջոցառումների մշակումը:

Ագրոարդյունաբերական համալիրի զարգացման բավարար ներուժ ունի նաև Հայաստանը: Սակայն բավարար արդյունքների հասնելու համար պահանջվում է նոր տեխնոլոգիաների ներդրում և արտադրական գործընթացների թվայնացում:

Բանալի բառեր. թվայնացում, տեխնոլոգիաներ, գյուղատնտեսություն, ինտեգրված տեղեկատվական միջավայր

ПУТИ СОВЕРШЕНСТВОВАНИЯ ПРОЦЕССА ЦИФРОВИЗАЦИИ СЕЛЬСКОГО ХОЗЯЙСТВА

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В современных условиях глобальных и региональных военно-политических и экономических событий разработка эффективных мер по обеспечению продовольственной безопасности и противостоянию надвигающемуся продовольственному кризису имеет большое значение для каждой страны.

K.A.Nersisyan, A.Kh.Markosyan, Zh.M.Mirzoyan
WAYS TO IMPROVE THE AGRICULTURAL DIGITIZATION PROCESS

Армения также имеет достаточный потенциал для развития агропромышленного комплекса. Однако, для достижения удовлетворительных результатов требуется внедрение новых технологий и цифровизация производственных процессов.

ECONOMIC JUSTIFICATION FOR THE USE OF A DRONE TO ASSESS THE CHARACTERISTICS OF RADAR SYSTEMS

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Abstract

The immediate goal of obtaining an economic result (effect) from the implementation of scientific and technical programs is to increase production efficiency. The article substantiates that the costs of obtaining research results using a drone compared to a helicopter are significantly lower, which indicates a high economic effect from using the proposed method.

Keywords: helicopter, unmanned aerial vehicle, economic effect.

ECONOMICS
A.Kh.Markosyan, M.V.Markosyan, V.H.Avetisyan, H.G.Martirosyan
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Introduction

Scientific and technical measures are related to the following directions: introduction of advanced technologies, automation and mechanization of production processes and technologies, improvement of raw materials, introduction of technical characteristics and constructions of products, assimilation of new types of products.

The expediency of the implementation of scientific and technical measures should be determined by their economic justification and the prospective of the research should be confirmed by ensuring the utility of the use of new techniques in the economy.

The overall assessment of the long-term effectiveness of scientific and technical measures is evaluated by the size of the economic result (effect) that the public economy will receive in the event of the application and use of these innovations.

The magnitude of the annual economic result (effect) obtained from the application of scientific and technical measures is the sum of the savings received by the manufacturers and users of the new technology from all types of production resources (live labor, raw materials and materials, capital investment) that they receive in the economy, in the application and use of that product.

As a result of all that, in the end, the newly created value of the state is created by increasing the size of the national income.

The basis for evaluating the economic effectiveness of scientific and technical measures is the increased amount of profit obtained from these measures (decrease in cost), which is obtained from the application and use of new techniques and technologies.

According to the "Methodology for determining the economic efficiency of the use of new technologies, innovations and rationalization recommendations in the national economy (main provision)" the expected profit of the new technology to be released the increase is determined by the following formula [1]:

$$\Delta\Pi_t = (U_t - C_t)A_t - (U_1 - C_1)A_1, \tag{1}$$

where: $\Delta\Pi_t$- is the amount of planned (programmed) profit increase in year t, in drams, U_t and C_t are the wholesale price and cost per unit of new equipment per year of production: U_1 and C_1 are the wholesale price and cost of the product to be replaced in the year preceding the year of release of the new equipment, A_t is the external volume of new products released in year t (planned), A_1 is the size of the annual production volume prior to year t.

The amount of cost reduction from the use of new techniques in the resulting processes is determined by the following formula [1]:

$$\Delta C = (C_1 - C_t)A_t, \tag{2}$$

where C_t and C_1 —are the annual cost of the product (work) unit in year t and the amount of the cost of the year preceding the planned year, in drams, A_t— is the volume of output in year t in natural units.

The amount of savings is determined for all types of replaceable units of raw materials, materials, fuel, energy, wages and equivalent means and other production costs, which are related to the implemented scientific and technical measures.

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The summary economic effect of the release and use of new technology is calculated by the following formula:

$$Э_х^t = \sum_s \prod_t - E_h \sum_\Delta K_t, \tag{3}$$

where: $Э_х^t$ in the tth year of technology (scientific and technical event) is the summary effect of the economy as a result of implementation (investment), $\prod_t$ − is the increase in profit received from the investments of all scientific and technical activities in the t-th year. The results of the calculations are calculated using the coefficient $E_н$ ($E_н=0,15$) of the costs brought to the efficiency of the new technique. $\sum_s K_t$ are capital (simultaneous costs) related to the implementation of all measures for the introduction of new technology in year t.

In the case of the summary accounting calculation (effect) determination (temporary) of capital investments (simultaneous costs) of manufacturers and users of new equipment, both direct capital costs and other simultaneous costs that are necessary for the creation and use of new technologies, regardless of their funding sources. Such expenses include R&D (R&D) costs, including the costs of testing and processing prototypes (only for new equipment). In that case, the results of the GRPCA, which are related to the inventions of new technologies at the level of discoveries, make it possible to significantly expand the scale of their application in the future, because such measures of new technologies should be considered (attributed) only to those costs. The costs of acquisition, transportation, assembly, disassembly, technical preparation related to the acquisition of new equipment and new productions. The costs of replenishing working capital associated with the creation and use of new equipment. The costs of production areas, other elements of fixed assets, which are related to the production and use of new equipment and basic equipment. Costs related to technical measures and equipment that prevent the negative effects of the use and operation of the equipment on the environment (environmental pollution is prevented), as well as working conditions (external noise is reduced, costs to exclude damages, etc.)

The effectiveness of scientific and technical measures for each year is determined by the following criteria and indicators:

In terms of production:

The increase in the volume of production due to the introduction of new technology.

a) number of important types of products per measurement units,

b) the increase in the volume of net product output,

c) increase in the release of products with the highest quality category.

In line of work:

a) increasing the productivity of work thanks to the introduction of new technology. That calculation is made by the following formula [1]:

$$B_t = \left[\frac{Ц_t}{Ч_1 - \sum_\Delta Ч_t} : \frac{Ч_t}{Ч_1} - 1 \right] . 100, \tag{4}$$

where: B_t is the increase in labor productivity due to the introduction of new equipment in the t-th year in %, ,$Ц_t$ and $Ч_1$ are the volume of goods produced (without taxes), in AMD, and the average number of industrial production personnel in the year preceding the introduction of new equipment. $\sum_\Delta Ч_t$ - the decrease in the number of industrial production personnel (conditional dismissal of workers, which is achieved at the expense of the introduction of new equipment in year t).

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b) the relative dismissal of the number of industrial production personnel. The calculation is made by the following formula [1]:

$$\Delta Ч_t = \frac{(T_1 - T_t), A_t}{T_ф},$$ (5)

where $T_1 - п$ and T_t are the labor costs per unit product in kind or value terms before the new technique and after its introduction in the t-th year, respectively, $T_ф$ is the labor time fund of one worker, in days. A_t is the volume of production of new equipment in year t in natural indices,

c) the relative economy of the salary fund. The calculation is made by the following formula [1]:

$$\Delta 3 = (3_1 - 3_t).A_t,$$ (6)

where $\Delta 3$ is the comparative economy of wages, in drams, 3_1- and 3_t, respectively, in terms of in-kind or value externalities per unit of output, is the amount of wage costs before the introduction of new equipment and in the t-th year after that.

d) the amount of saving material costs. The amount of savings in material costs is determined by the following formula:

$$\Delta m_t = (m_1 - m_t).A_t,$$ (7)

where Δm_t is the reduction in material costs in the t-th year before the introduction of new equipment and in value terms, m_1 and m_t are the material costs per unit of output in the nth year, respectively, before the introduction of the new technology and after it in terms of kind or value.

Conflict Setting

The results of the implementation of scientific and technical measures in terms of the development and application of new techniques should be taken into account, the savings of material, technical and labor resources, norms and standards of material resources per unit of output. It appears through the evaluation of the norms and normative indicators of these types of resources, as well as the calculation of labor and capital. In addition to the above-mentioned indicators of economic efficiency, the calculations of the use of new technology are also carried out on the basis of the consumer effect of the product unit, that is, the units of productivity and other similar indicators. At the same time, it is necessary to carry out the calculations according to individual elements of costs, both in terms of value and in kind units, based on the considerations in order to increase the effect of new technology on increasing the technical and economic indicators of the released products (reducing the costs of material resources, reducing work time). by increasing the unit capacity).

Research Results

Complex calculation of equipment for testing the directivity properties of metric range radars using a drone in a hover mode: 2 options were the basis for the calculations. In case of the 1st option, the studies are done with the help of a helicopter, and in the case of the 2nd, with the help of a drone. It is estimated that the cost of 1 hour of helicopter service is 3000

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USD:, and the cost of purchasing a drone is 7000 USD. It is also assumed that the helicopter will make a 5-hour flight in one day, and in the case of the drone, flights of the same size will be made. Therefore, according to the above methodology, the expected increase in profit of the new technique, which is determined according to formula 1 of the methodological guideline, will be:

In the case of a helicopter,	In the case of a drone
At = 5 hours * 3 thousand USD:= 15 thousand	USD A1 = 7 thousand USD
Ct = 15000-1500=13500	C1 = 0.5 thousand USD: 7-
0.5 = 6.513.5 - 6.5 = 7.0 thousand USD:	

Aaccording to formula 2 of the methodological guideline:

$$Cl = 0.5 \text{ thousand USD:}$$

$$Ct = 1.5 \text{ thousand USD:}$$

Therefore, the cost savings will be within 1 day 1.5-0.5=1.0 thousand. USD:

Summary analysis of drone versus helicopter studies. the calculated effect according to formula 3 given above will be:

$$\Pi t = 7.0$$

$$\Delta Kt = 2.0 \text{ thousand USD:}$$

7.0 thousand USD: - 0.15 * 2 thousand USD = 6.7 thousand USD:

According to the (4th) formula, the labor saving will be:
 In the case of the helicopter, it is assumed that its crew consists of three people, and in the case of the drone, they are absent. therefore, the saving will be:
$$21.6/8-4*4/8-1=5.4*0.5-1=2.7-1=1.7 \text{ thousand USD:}$$
$$Цt=15*1.2*1.2=21.6 \text{ thousand USD:}$$
According to formula 5, saving 1 day's work will be:
$$8 – 4 = 4 \text{ people}$$
According to formula (6), the relative savings of the salary fund per day will be:
$$110 - 20 = 90 \text{ USD:}$$
According to the formula (7), the material costs will be (in the case of a helicopter, it is formed through fuel, wear and tear of the helicopter and overhead costs), it will be:
$$3000 \text{ USD} - 800 \text{ USD} = 2200 \text{ USD:}$$

Conclusion

The costs of research results using a drone compared to a helicopter are significantly lower, which indicates the high economic effect of using the proposed method.

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ՌԱԴԱՐԱՅԻՆ ՀԱՄԱԿԱՐԳԵՐԻ ԲՆՈՒԹԱԳԻՐԵՐԻ ԳՆԱՀԱՏՄԱՆ ՀԱՄԱՐ ԴՐՈՆԻ ՕԳՏԱԳՈՐԾՄԱՆ ՆՊԱՏԱԿԱՀԱՐՄԱՐՈՒԹՅԱՆ ՏՆՏԵՍԱԿԱՆ ՀԻՄՆԱՎՈՐՈՒՄԸ

Ա.Խ. Մարկոսյան, Մ.Վ. Մարկոսյան, Վ.Հ. Ավետիսյան, Հ.Գ. Մարտիրոսյան

Երևանի կապի միջոցների գիտահետազոտական ինստիտուտ

Գիտատեխնիկական միջոցառումների իրականացումից ստացված տնտեսական արդյունքի (էֆեկտի) անմիջական նպատակն է հանրային արտադրության արդյունավետության բարձրացումը։ Անօդաչու թռչող սարքի (դրոն) օգտագործմամբ հետազոտության արդյունքների ստացման արժեքն, ի համեմատություն ուղղաթիռի, զգալիորեն ցածր է, ինչը վկայում է առաջարկվող մեթոդի կիրառման բարձր տնտեսական արդյունավետության մասին։

Բանալի բառեր. ուղղաթիռ, անօդաչու թռչող սարք, տնտեսական արդյունատետություն

ЭКОНОМИЧЕСКОЕ ОБОСНОВАНИЕ ЦЕЛЕСООБРАЗНОСТИ ИСПОЛЬЗОВАНИЯ ДРОНА ДЛЯ ОЦЕНКИ ХАРАКТЕРИСТИК РАДИОЛОКАЦИОННЫХ СИСТЕМ

А.Х. Маркосян, М.В. Маркосян, В.Г. Аветисян, А.Г. Мартиросян

Ереванский НИИ средств связи

Непосредственной целью получения экономического результата (эффекта) от реализации научно-технических программ является повышение эффективности производства. Расхды на результаты исследований с использованием дрона по сравнению с вертолетом, значительно меньше, что свидетельствует о высоком экономическом эффекте применения предложенного метода.

Ключевые слова. вертолет, безпилотний летательный аппарат, экономический эффект.

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Submitted by the resolution of coordinating board
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