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ИЗВЕСТИЯ
ВЫСОКИХ ТЕХНОЛОГИЙ

BULLETIN
OF HIGH TECHNOLOGY

4(28)/2023

ԵՐԵՎԱՆ – ЕРЕВАН – YEREVAN

2023

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UDC – 551.579.3:556

DETERMINATION OF THE OPTIMAL OBSERVATION NETWORK FOR HYDROLOGICAL STUDIES OF RIVERS OF ARMENIA

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Abstract

Hydrological observation stations are the source of accurate information necessary for the study of spatiotemporal changes of the river flow and for organizing the effective management of water resources. The paper presents the optimal observation network for hydrological studies of river flow in Armenia.

The study is based on the optimization methodology of the regime hydrological observation network developed by I.F.Karasev. Statistical, interpolation, comparison, and analogy methods were used. It was inferred that the optimal observation network for hydrological studies of river flow in Armenia will consist of 86 hydrological observation stations.

Keywords: hydrological observation station, optimal hydrological network, river flow, water resources, climate change.

Introduction

In the South Caucasus, under the conditions of global climate change, a decrease in river flow is observed. The greater demand for fresh water predicted in the future, as well as its inefficient use, dictates the development and implementation of radical measures to increase the efficiency of water resources and systems management. Based on those programs, it is necessary to have the ability to predict the quantitative and qualitative characteristics of water resources and their changes.

The source of information about water resources (quantity, quality, spatiotemporal distribution) is related to the hydrological observation stations and the results of hydrological observations and measurements carried out at these stations [1]. Prevention of natural disasters caused by droughts and floods will be impossible without the development of effective forecasting methods, which should be based on the identification of precipitation-flow relationship and statistical analysis of hydrological data of previous years.

Assessment of water resources and spatial distribution of hydrological characteristics requires a dense monitoring network, which in turn implies significant costs for the

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installation and operation of respective instruments. Therefore, it is necessary to have an optimal observation network for hydrological studies, which can provide information on the features of spatiotemporal changes of river flow and reduce costs in the observation network [2].

Quantitative monitoring of surface water in Armenia is currently carried out at 91 hydrological observation stations. Since 1991, the hydrological observation network has been significantly reduced, which is extremely dangerous in conditions of global climate change.

Currently, there is an established hydrological monitoring network in Armenia. Hydrological observatin stations have on the average of more than 50, in some cases more than 70 years of observation data [3]. Hydrological observation stations were installed on different rivers in different periods in order to solve different problems. However, there is still no scientific justification regarding the optimal hydrological observation network for the territory of the republic.

Regarding the determination of the optimal hydrological monitoring network various approaches and methods are found in the literature [2, 4, 5, 6], but due to the difference in the goals of designing the hydrological monitoring network, there is no single generalized methodology, particularly for the regime study of the river flow.

Conflict Setting

For water resource state assessment, as well as for resource planning, and water-related disasters prediction and prevention under climate change conditions, it is important to have an optimal observation network in order to conduct hydrological studies ensuring reliable and continuous data, which can provide information on the features of spatiotemporal changes in water flow, on the one hand, and reduce material costs in the network, on the other hand.

Proceeding from this, a goal has been set to develop an optimal observation network for hydrological studies of rivers in Armenia, based on the optimization methodology of the regime hydrological observation network developed by I.F.Karasev [7].

An optimal hydrological observation network should provide the necessary accurate data on the spatiotemporal features of the river flow and to organize effective management of water resources. The optimal observation network should be designed in a way, so that the interpolation between the data of different observation stations makes it possible to obtain reliable information for any point of the country.

Research Results

For the implementation of the work, monthly, annual, maximum discharges of 80 hydrological stations of Armenia for the 1940-2022 period, and average annual air temperature, atmospheric precipitation, relative air humidity data from 45 meteorological stations for the 1940-2022 period [3] were used. To achieve the research goal, the optimization method of regular hydrological observation network developed by Karasev was used. Besides, statistical, interpolation, comparison, and analogy methods were applied.

I.F.Karasev's method for determining and placement of the optimal monitoring network for hydrological studies of rivers enables to determine such density of the

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hydrological monitoring network, which will be sufficient to obtain reliable and characteristic information on spatiotemporal changes of river flow and avoid baseless material costs.

The structure of the hydrological observation network can be presented as follows: [7, 8]

Special hydrological stations study the features of the hydrological regime of a specific water object,

Regime observation hydrological stations provide regular studies of the hydrological regime of water objects,

Operational hydrological observation stations are intended for obtaining information on the current, in-situ hydrological regime of water objects.

The baseline data for the methodology for optimization methodology of the regime hydrological observation network developed by I.F.Karasev are: . Y - the river flow, $gradY$ - the gradient of the river flow, C_v - the coefficient of variation of the annual flow, $r(l)$ - the normalized correlation function of the annual flow, where l- is the distance between the catchment centers of observation stations, σ - the relative error of determining the annual flow.

It is necessary to determine the following criteria of the catchment area of the hydrological observation station: representative criterion, gradient criterion and correlation criterion [7].

Representative criterion of the catchment area:

The representative criterion of the catchment area is the first and main condition for the placement of the hydrological observation network. The catchment area per observation station should not be too small, otherwise the information about river flow received therefrom will not address the general zonal patterns of flow, but it will express local features only, i.e. it cannot be representative. In other words, it is necessary to determine that boundary of the catchment area which separates the azonal catchment from the zonal catchment. Azonal catchments are mostly small rivers. And the rivers with a flow identified by zonal features are mainly characterized by clear flow patterns.

Gradient criterion of the catchment area:

The gradient criterion of the catchment area indicates the minimum size of the catchment area, in which the observation stations identify the changes in the flow norm which are conditioned by geographic zonality or altitudinal zonation of climatic factors.
The gradient criterion of the catchment area is determined:

$$F_{grad} \geq \frac{8\sigma_0^2}{(gradY)^2} Y_{min}^2, \tag{1}$$

where Y_{min} is the average of the flow module, $gradY$- is the gradient of the flow module, σ_0- is the relative error of determining the annual flow.
The relative error:

$$\sigma_0 = \frac{C_v}{\sqrt{N}}, \tag{2}$$

where N is the number of observation years.

Correlation criterion of the catchment area:

The upper limit of the hydrological observation stations' optimal catchment area ~~of~~ is the correlation criterion. When the regime of a river for which there is no observation data on

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water flow is studied the method of hydrological analogy is widely used. This method is also applicable in cases where the river basin with data and the river basin without data are located at a small distance from each other and have similar climatic and physical-geographical conditions. Increase of the correlation criterion results in low correlation or absence of correlation at all between the observed water discharges at two hydrological stations. In the methodology developed by I.F.Karasev, the correlation criterion of the catchment area is determined by the following formula:

$$F_{cor} \leq \frac{\sigma_0^4}{a^2 C_v^4}, \tag{3}$$

where:

$$a = \frac{1}{L_0}, \tag{4}$$

where L_0- is the correlation radius.

According to I.F.Karasev's method, the optimal catchment area F_{opt} for one regime hydrological observation station should be in the following range:

$$F_{rep} < F_{grad} \leq F_{opt} \leq F_{cor}, \tag{5}$$

The optimal number of hydrological observation stations in a river basin with any F surface area is determined by:

$$N_{opt} = \frac{F}{F_{opt}}, \tag{6}$$

where N_{opt}- is the optimal number of hydrological observation stations in the given area, F- is the total area of the given area.

In order to determine the representative criterion of the catchment area, a relationship was established between the flow modules of the observation stations and the areas of their catchments (Fig. 1). Then, based on the statistical methods of Fisher and Student [9], the representative criterion of the catchment area was determined, which was 346 km^2.
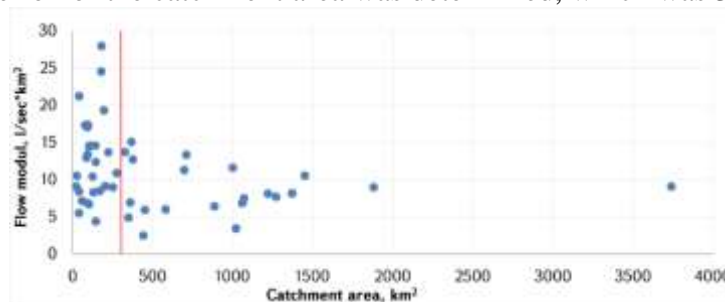
Fig. 1. Graph of the relationship between flow modules and catchment area

The gradient criterion of the catchment area is determined based on formula (1) and indicates the minimum size of the catchment area, in which the observation stations are identified/ highlighted the changes in the flow norm which are conditioned by geographic zonality or altitudinal zonation of climatic factors. For determination of the gradient criterion, the average value of the flow module of the territory of Armenia is determined by the GIS program [10], which is 10,8 $l/sec * km^2$. Coefficient of variation $C_v = 0,30$ and relative error $\sigma_0 = 0,032$ of average annual discharges is calculated for 59 hydrological observation stations.

The relative error was determined by formula (2). The flow gradient of the territory of Armenia was determined by the GIS program [10] and it is equal to 0,057 $l/sec * km^2$.

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Plugging the results into equation (1), the value of gradient criterion of the catchment area is 294 km^2.

The correlation criterion determined by formula (3) is responsible for the upper limit of the optimal catchment area of hydrological observation stations. In order to determine the correlation criterion of the catchment area, a correlation matrix [11] was built between the correlation coefficients of the annual discharges of the observation stations and the distance between the catchment centers of the observation stations (Fig. 2). To this end, for 59 hydrological observation stations the geometric centers of the catchments and their geographical coordinates were determined using the GIS program. According to I.F.Karasev's method, it is proposed to determine the linear distance between the centers of the catchment area of observation stations, while we proposed to apply a new approach, the relief distance between the centers of the observation stations catchment area, determined by GIS program [10].
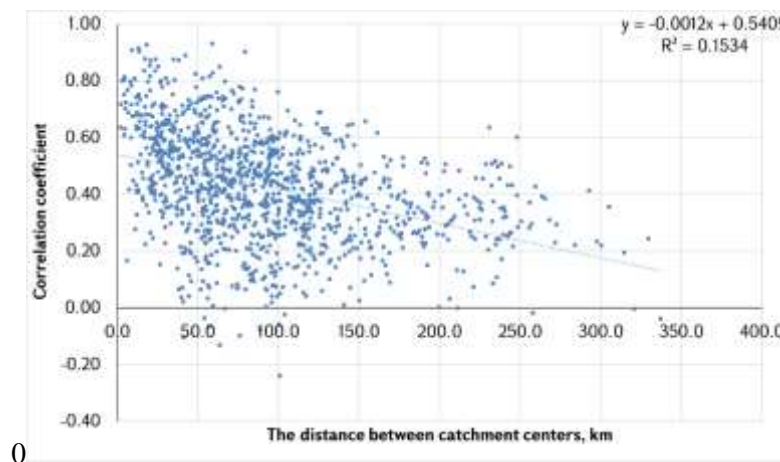
Fig. 2 Graph of the relationship between the distances of the catchment centers of the observation stations and the correlation coefficient of the annual discharges

The resulted field of points can be approximated by a linear function if the catchment basins are located in the neighborhood. In our conditions, the catchment basins are located in the neighborhood, and the approximation can be made with a linear function. As a result, the value of the flow correlation radius (L_0) is 451 km (Fig. 2).

Let's make a grouping of points with an interval of 20 km and calculate the mean square deviation of those points with respect to the mean (Fig. 3).
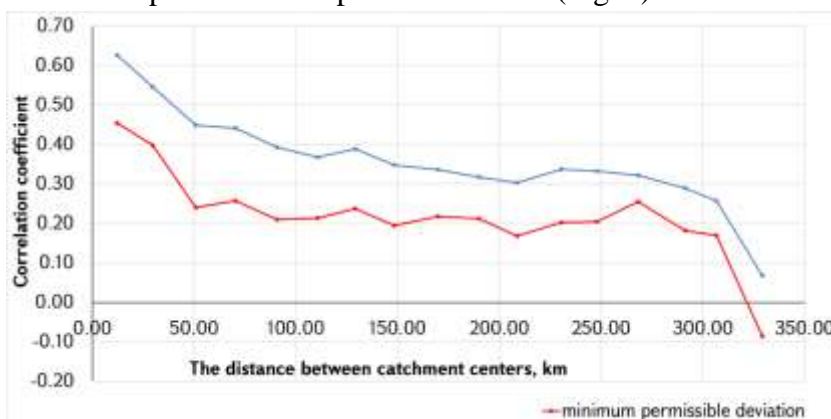
Fig. 3 Determination of the flow correlation radius (L$_0$) with an averaged range of ΔL=20 km

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Taking into account the obtained results, the value of the flow correlation radius (L_0) was taken as 323 km. Based on the obtained data by using formula (3) the correlation criterion of the catchment basin area (F_{cor}) was calculated, which is equal to 15 km^2. The result indicates that in the case of Armenia, the correlation criterion is almost insignificant for determining the optimal catchment area.

Having the data of the three criteria for determining the optimal catchment area and in setting them in formula (5) the optimal catchment area corresponding to one regime hydrological observation station is determined:

$$F_{rep}` 346\text{km}^2 < F_{grad}` 294\text{km}^2 \leq F_{opt}` 346\text{km}^2 \leq F_{cor}`15\text{km}^2$$

It has been accepted by us, that the optimal catchment F_{opt} for one regime hydrological observation station is equal to the representative area F_{rep} of the catchment, which is 346 km^2.

Based on the obtained results and using equation (6), the optimal number of observation stations for the hydrological studies of the flow of rivers in Armenia was calculated, which equals to 86.

Conclusion

In order to study the zonal features of spatiotemporal changes in the flow of rivers of Armenia, one regime observation station should cover a catchment area of at least 346 km^2, and the optimal observation network for hydrological studies of rivers should consist of 86 hydrological observation stations. The existing hydrological observation network in Armenia is sufficient to provide reliable and continuous data for water resources state assessment and their planning, under climate change conditions, and forecasting and early warning of water-related disasters.

Thus, to tackle specific problems new hydrological observation stations can be established.

References
1. Guide to Hydrological Practices, Volume I. Hydrology – From Measurement to Hydrological Information, WMO-No. 168, 2011, 314 pages.
2. Optimal selection of number and location of meteo-hydrological monitoring networks on Vu Gia, International journal on advanced science engineering information technology, 2016, №3, page 324-328.
3. Annual data on surface water resources of the Republic of Armenia, 1937-2022, "Armhydromet" SNCO, Ministry of Environment, Republic of Armenia.
4. Sumargo, E. (2020) The Hydrometeorological Observation Network in California's Russian River Watershed: Development, Characteristics, and Key Findings from 1997 to 2019 // New York, 2020. E1781-E1800 https://doi.org/10.1175/BAMS-D-19-0253.1 .
5. Tatijana Stosic, Borko Stosic, Vijay P. Singh. Optimizing streamflow monitoring networks using joint permutation entropy, Journal of Hydrology, Volume 552, 2017, Pages 306-312 https://doi.org/10.1016/j.jhydrol.2017.07.003.
6. Mishra, A.K., Coulibaly, P. Hydrometric network evaluation for Canadian watersheds, Journal of Hydrology, Volume 380, Issues 3–4, 2010, Pages 420-437, https://doi.org/10.1016/j.jhydrol.2009.11.015.

7. Karasev, I.F. On the principles of placement and prospects for the development of the hydrological network // Proceedings of the State Hydrological Institute. - 1968. - Issue. 164. - p. 3 - 36.

8. Karasev, I.F., 1980. River hydrometry and accounting of water resources. Leningrad: Gidrometeoizdat, 310 pages.

9. Methodological recommendations on assessing homogeneity of hydrological characteristics and determining their calculated values from heterogeneous data (Nestor-Istoriya, St. Petersburg, 2010, 162 pages.

10. Jalalvand, A., Gaidukova, E.V., Sakovich, V.M. Construction of hydrological characteristics distribution maps with insufficient data using GIS technologies. Natural and technical sciences. 2018. No. 12 (126), p. 177-180.

11. Gaidukova, E.V. Sensitivity of criteria for the optimal density of a regime hydrological network to climate change (using the example of the minimum flow of the Ob River basin). Dissertation for the degree of Candidate of Technical Sciences. Russian State Hydrometeorological University. St. Petersburg, 2004.

References

1. Руководство по гидрологической практике, Том I. Гидрология: от измерений до гидрологической информации. ВМО-№ 168, 2011, 314 с.

2. Optimal selection of number and location of meteo-hydrological monitoring networks on Vu Gia, International journal on advanced science engineering information technology, 2016, №3, page 324-328.

3. Ամենամյա տվյալներ ՀՀ մակերևութային ջրային ռեսուրսների վերաբերյալ, ՀՀ «Հայհիդրոմետ» ՊՈԱԿ, 1937-2022թթ.:

4.   Sumargo E. (2020) The Hydrometeorological Observation Network in California's Russian River Watershed: Development, Characteristics, and Key Findings from 1997 to 2019 // New York, 2020. E1781-E1800 https://doi.org/10.1175/BAMS-D-19-0253.1

5.   Tatijana Stosic, Borko Stosic, Vijay P. Singh, Optimizing streamflow monitoring networks using joint permutation entropy, Journal of Hydrology, Volume 552, 2017, Pages 306-312 https://doi.org/10.1016/j.jhydrol.2017.07.003.

6. Mishra A., Coulibaly P., Hydrometric network evaluation for Canadian watersheds, Journal of Hydrology, Volume 380, Issues 3–4, 2010, Pages 420-437, https://doi.org/10.1016/j.jhydrol.2009.11.015.

7. Карасев И. О принципах размещения и перспективах развития гидрологической сети // Труды ГГИ. - 1968. - Вып. 164. - С. 3 - 36.

8. Карасев И.Ф. Речная гидрометрия и учет водных ресурсов. Л., Гидрометеоиздат, 1980, 310 с.

9. Методические рекомендации по оценке однородности гидротехнических характеристик и определение их расчётных значений по неоднородным данным. С-Пб, Нестор-История, 2010г.-162с.

10. Джалалванд А., Гайдукова Е.В., Сакович В.М. Построение карт распределения гидрологических характеристик при недостаточности данных с использованием гис-технологий. Естественные и технические науки. 2018. № 12 (126), с. 177-180.

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11. Гайдукова Е. Чувствительность критериев оптимальной плотности режимной гидрологической сети к климатическим изменениям (на примере минимального стока бассейна р. Оби). Диссертация на соискание ученой степени кандидата технических наук / Российский государственный гидрометеорологический университет. Санкт-Петербург, 2004.

ՀԱՅԱՍՏԱՆԻ ԳԵՏԵՐԻ ՀԻԴՐՈԼՈԳԻԱԿԱՆ ՈՒՍՈՒՄՆԱՍԻՐՈՒԹՅՈՒՆՆԵՐԻ ՕՊՏԻՄԱԼ ԴԻՏԱՑԱՆՑԻ ՈՐՈՇՈՒՄ

Միսակյան Է.Է.
Ակադեմիկոս Ի.Վ. Եղիազարովի անվան Ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտ

Գետային հոսքի տարածաժամանակային փոփոխությունների ուսումնասիրության և ջրային ռեսուրսների արդյունավետ կառավարում կազմակերպելու համար անհրաժեշտ ճշտության տեղեկատվության աղբյուր են հանդիսանում հիդրոլոգիական դիտակետերը: Աշխատանքում ներկայացվում է Հայաստանի գետերի հոսքի հիդրոլոգիական ուսումնասիրությունների օպտիմալ դիտացանցը: Ուսումնասիրության հիմքում դրվել է Ի. Կարասևի մշակած ռեժիմային հիդրոլոգիական դիտացանցի օպտիմալացման մեթոդաբանությունը: Օգտագործվել են վիճակագրական, միջարկման, համադրման, նմանակման մեթոդներ: Հայաստանի գետերի հոսքի հիդրոլոգիական ուսումնասիրությունների օպտիմալ դիտացանցը բաղկացած կլինի 86 հիդրոլոգիական դիտակետերից:

Բանալի բառեր. հիդրոլոգիական դիտակետ, օպտիմալ հիդրոլոգիական դիտացանց, գետային հոսք, ջրային ռեսուրսներ, կլիմայի փոփոխություն:

ОПРЕДЕЛЕНИЕ ОПТИМАЛЬНОЙ НАБЛЮДАТЕЛЬНОЙ СЕТИ ДЛЯ ГИДРОЛОГИЧЕСКИХ ИССЛЕДОВАНИЙ РЕК АРМЕНИИ

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Гидрологические наблюдательные пункты являются источником точной информации, необходимой для изучения пространственно-временных изменений речного стока и организации эффективного управления водными ресурсами. В статье представлена оптимальная сеть наблюдений для гидрологических исследований речного стока Армении. Исследование было основано на методологии оптимизации режимной сети гидрологических наблюдений, разработанной И. Карасевым. Использовались методы статистики, интерполяции, сравнения и аналогии. Оптимальная наблюдательная сеть для гидрологических исследований речного стока в Армении будет состоять из 86 гидрологических наблюдательных пунктов.

Ключевые слова: гидрологический наблюдательный пункт, оптимальная гидрологическая сеть, речной сток, водные ресурсы, изменение климата.

WATER SYSTEMS

TO THE CALCULATION OF BANK PROTECTION MEASURES FOR CHANNELS SLOPES EXPOSED TO ALONGSHORE WAVES

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https://doi.org/10.56243/18294898-2023.4-11

Abstract
Calculation methods for strengthening and covering slopes with paving stones or tiles have been developed, and precise formulas for calculating the diameters of paving stones have been adopted. The three most characteristic locations of the triangular base of the measuring pyramid on the slope are: a) When the stones forming the nest on the slope are positioned in such a way that the measuring stone placed on the tip of the pyramid is most easily overturned in the direction of the tidal current; b) When the measuring stone can be tilted in the direction of the shoreline, towards large widths; c) When the possible direction of

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overturning makes a large angle of 30° with the shoreline, that is when one of the sides of the equilateral triangle of the base of the pyramid is parallel to the shoreline.

Keywords: channel, alongshore wave, coastal slope, shoreline.

Introduction

Of all the coastal protection measures, the protection of coastal slopes by stone sketch has the longest history. Currently, based on theoretical development or experimental and field observations, methods for determining diameter or weights of stones, stable waves [3, 5, 6] are created and created, but these formulas relate only to the frontal impact Waves on the shore and, therefore, their use for assessing the stability of the stone sketch of the coastal slopes of channels requires the corresponding correction. Here, first of all, we are referring to the Shaitan calculation scheme, which deals only with the frontal impact of the waves on the stone fill and in which the calculated stones are erroneously cylindrical rather than spherical (Fig. 3, a) and b)).

Conflict Setting

Below, we restrict ourselves to the consideration of the three, the most characteristic locations of the triangular base of the pyramid of stones on the slope (Fig. 3.c))

Research Results

Let us consider the stability of soil particles forming the coastal slope of the channel when alongshore periodic waves are superimposed on the surface of the water flow. Suppose that the water depth on the slope above the calculated soil particle is equal H, and the soil particle size is negligible in comparison with the length (λ) and with the amplitude (a) of the alongshore wave. Let us also assume that a crystalline soil particle has a shape close to a cube with a side d.
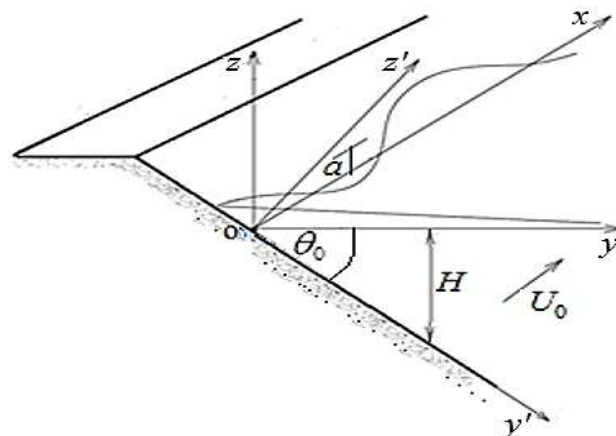
Fig. 1 Design scheme of alongshore waves in the channel

Since three-dimensional waves act on a soil particle on a slope, the particle can move in the following three directions: along the axis y', which is aligned with the coastline; along

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the axis , located in the plane of the slope and directed downward, towards the great depths of the water, and in the direction of the axis z', i.e., orthogonal to the plane of the coastal slope (Fig. 1.). In this case, we assume that, due to the smallness of the particle, the forces acting on it are attached at the center of gravity of the particle.

When lining the slopes of the channel with paving stones or tiles, first of all, it is necessary to determine the thickness of the lining element. Usually, each paving stone or slab is hewn in its own nest formed by neighboring stones, and therefore their movement along the slope is practically impossible. An element (stone or slab) can only be thrown out of its nest in the direction of the axis Oz' by the force of filtration backpressure (Fig.1), which manifested itself only when the wave bottom passes over the element (Fig.2) .
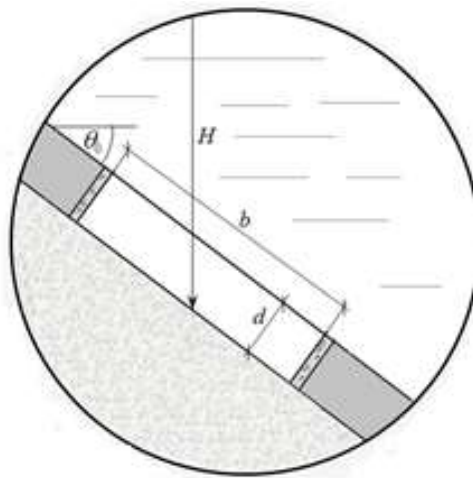
Fig.2 Scheme for calculating the thickness of the channel facing plate

In this case, we must apply the equilibrium equation,

$$\gamma'_s \cos\theta_0 d + c - \gamma A = 0. \tag{1}$$

based on which the thickness of the coating element is determined by the formula [1]

$$d_{z'} = \frac{\gamma A - c}{\gamma'_s \cos\theta_0}, \tag{2}$$

Here, the coefficient of adhesion c reflects the tensile or shear stresses resulting from the anchoring of the plates or the grouting of the gaps between the plates. In their absence $c = 0.$

In the case of short waves propagating along the channel, when calculating the parameter A, thr depth H should be substituted the difference $H - d\cos\theta_0$ (Fig. 2.), which, in the case of Stokes waves propagating over the slab gives

$$d = \frac{\gamma}{\gamma'_s \cos\theta_0} a\exp\left(-k\frac{H - d\cos\theta_0}{\sin\theta_0}\right) - \frac{c}{\gamma'_s \cos\theta_0}. \tag{3}$$

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The inverse task can be made, which is to determine the depth of water in the channel, deeper which, the concrete slab by thick d will be resistant on the coastal slope of the canal. The water depth is calculated by the formula [1, 2]

$$H = d\cos\theta_0 + \frac{\sin\theta_0}{k}\ln\left(\frac{\gamma}{\gamma'_s} \cdot \frac{a}{d\cos\theta_0}\right). \tag{4}$$

We can also use the relation (4) to estimate the stability of the coastal slope. In particular, if we compare the depth calculated by (4) with the wave amplitude of a given on the shoreline, and it turns out that $H < a,$ then we can consider that slabs with thickness d, or blocks with the same height d, are stable when streamlined by alongshore waves. Otherwise, we should either increase the thickness of the cladding element or decrease the angle of the coastal slope to the horizon.
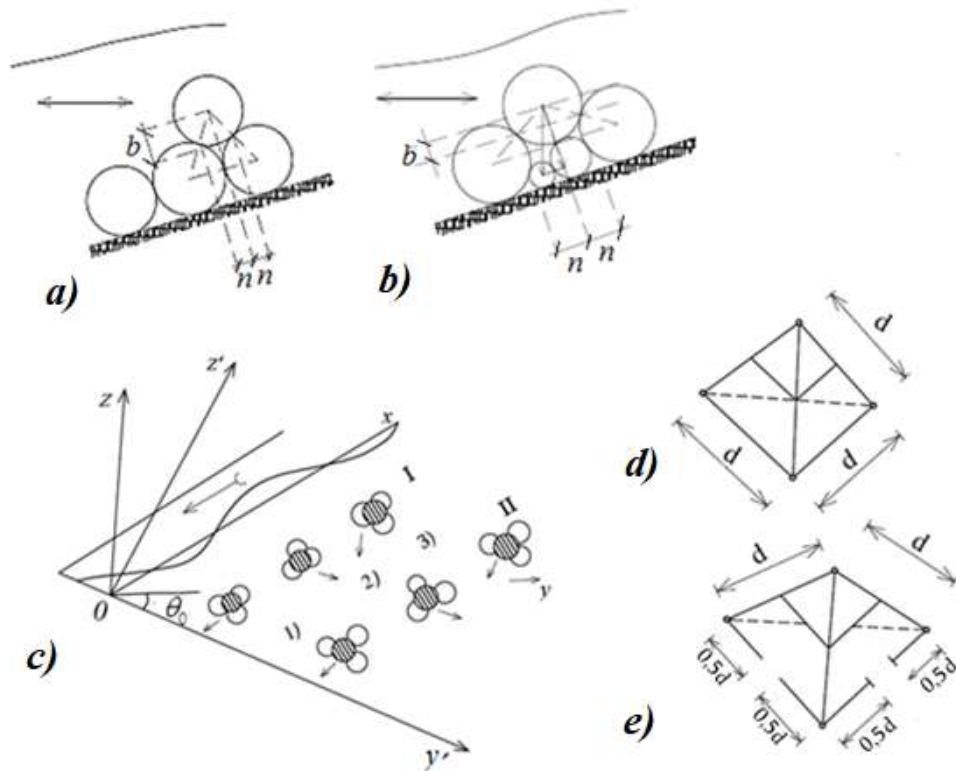
Fig. 3 Calculation schemes for assessing the stability of the protective stones sketch from the effects of waves $a)$ and b) - with frontal Impact of waves [6]; $c), d)$ and e) - when the Impact of an alongshore wave ([1])

On our proposed schemes (Fig. 3 $c), d)$ and e)), the surface stone having a size small compared to the wave parameters is placed in the nest formed from three identical surfaces in the form and size of stones. Such pyramidal schemes of the location of the stones are suitable for estimating the stability of the stone sketch, both when exposed to front and three-dimensional alongshore waves.

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Below, we restrict ourselves to the consideration of the three, the most characteristic locations of the triangular base of the pyramid of stones on the slope (Fig. 3.*c*))

These cases:

1. When the base stones on the slope are located, so that the stone on the top of the pyramid is most easily turned over in the direction of the waves, that is, in the direction of the coastline (Fig. 3 *c*), position 1);

2. When the settlement stone can roll down the slope, perpendicular to the coastline (Fig. 3 *c*), position 2);

3. When the stone at the top of the pyramid is turned over by waves at an angle of 30° relatives to the shoreline, that is when a single edge of the base of the pyramid of stones is parallel to the shoreline, and the top of this base triangle is directed toward greater depths (Fig. 3. *c*), position 3).

In the first case, the equation of moments of forces applied in the center of gravity of the stone with diameter , relative to the instantaneous axis of rotation (it is shown in Fig. 3.*d*) with a bold line) will be written in the following form:

$$G' \cos\theta_0 \cdot n - 0{,}5\tilde{c}\rho\omega \,|\vec{V}|^2 \cdot b = 0 , \qquad (5)$$

where G' denotes the weight of a spherical stone under water

$$G' = 0{,}523\gamma'_S d^3; \qquad (6)$$

ω - the midship area of the of the stone perpendicular to the axis Ox

$$\omega = 0{,}648 d^2; \qquad (7)$$

n and b - shoulders of forces of weight and the component along the axis Ox of the force of the frontal flow around the stone, respectively

$$n = 0{,}145d , \quad b = 0{,}41d . \qquad (8)$$

If we assume that the center of gravity of the reference stone is submerged in water to a depth of H , we can calculate the velocity modulus $|\vec{V}|$. Then the solution of equation (5) with respect to diameter d gives us that limiting value of stone diameter that ensures the stability of homogeneous stone sketch in the direction of wave propagation. This diameter is calculated by formula

$$d_1 = 1{,}75 \frac{\tilde{c}\gamma}{g\gamma'_s \cos\theta_0}(U_0 + AG)^2 . \qquad (9)$$

In the relation (9) it is taken into account that maximum wave impact in the axis Ox direction is observed when the wave crest passes over the calculated stone, i.e. when $\sin(\sigma t - kx) = 1$.

In the second limiting case, when the calculated stone may fall out of the socket and roll down the slope of the canal, the equation of limiting equilibrium (moments) takes the form:

$$G' \cos\theta_0 \cdot n - G' \sin\theta_0 b - 0{,}5\tilde{c}\rho\omega \,|\vec{V}|\vec{V}_{Oy}b = 0 . \qquad (10)$$

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If we put the values of forces and arms into equation (5) and take into account that the velocity component along the axis Oy' is

$$\vec{V}_{Oy'} = AG\cos(\sigma t - kx) \tag{11}$$

from equation (11) we obtain the diameter of the stone at the limit equilibrium in the direction of the axis Oy':

$$d_2 = 0{,}133 \frac{\tilde{c}\gamma}{g\gamma_s'} \cdot \frac{AC\cos\beta\left[U_0^2 + 2U_0 AG\sin\beta + A^2 G^2\right]^{1/2}}{0{,}076\cos\theta_0 - 0{,}214\sin\theta_0}. \tag{12}$$

When calculating by formula (12), instead of $\beta = (\sigma t - kx)$, the extreme value of the phase $\beta = \beta'$ should be substituted for $\beta = (\sigma t - kx)$. In the case $U_0 = 0$, i.e. on the surface of standing water $\beta' = 0$, which corresponds to passing over the stone of the nodal line of the wave back, and when $U_0 \neq 0$ the extreme value of the wave phase is calculated by the dependence

$$\beta' \approx \arcsin\left\{-\frac{U_0^2 + A^2 G^2}{6U_0 AG} \pm \left[\left(\frac{U_0^2 + A^2 G^2}{6U_0 AG}\right)^2 + 1\right]^{1/2}\right\}. \tag{13}$$

In the third case, when the possible tipping direction of the stone is at an angle of 30° with the shoreline, the equation of moments takes the form

$$G'\cos\theta_0 \cdot n - G'\sin\theta_0\cos 60° - 0{,}5\tilde{c}\rho\omega\,|\vec{V}|\,\vec{V}_{30°} \cdot b = 0, \tag{14}$$

Where the projection of velocity vector in the direction of rock shift is defined by formula

$$\vec{V}_{30°} = \frac{\sqrt{3}}{2}\left[U_0 + AG\sin\beta\right] + 0{,}5AG\cos\beta. \tag{15}$$

If we determine the limit value of rock diameter from equation (14), we get

$$d_3 = 0{,}115\frac{\tilde{c}\gamma}{g\gamma_s'} \cdot \frac{\left[U_0 + AG(\sin\beta + 0{,}585\cos\beta)\right]}{0{,}076\cos\theta_0 - 0{,}107\sin\theta_0} \times \left[U_0^2 + 2U_0 AG\sin\beta + A^2 G^2\right]^{1/2} \tag{16}$$

Based on (16), the analytical determination of the extreme value of the wave phase involves long calculations. In this case, without much loss of accuracy, we may limit ourselves to determining the limiting value of the wave phase β, which corresponds to zero velocity of the main water flow in the channel ($U_0 = 0$), and is equal to $\dfrac{\pi}{3}$. Then dependence (16) will take a simpler form:

$$d_3 = 0{,}115\frac{\tilde{c}\gamma}{g\gamma_s'} \cdot \frac{\left(U_0 + 1{,}16AG\right)\left(U_0^2 + 1{,}73U_0 AG + A^2 G^2\right)^{1/2}}{0{,}076\cos\theta_0 - 0{,}107\sin\theta_0}. \tag{17}$$

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In the case of a device of a homogeneous stone sketch, the above formulas give excessive stone diameters, as they correspond to the most marginal state of the stones on the coastal slope. Most often the outcrops consist of stones of various shapes and merits, which can be arranged on the coastal slope arbitrarily. One of such probable forms, suitable for real quantitative estimation of stability of a rock outline is a case when the surface stones (having a spherical form) only half of their diameter protrudes from the sockets formed by the underlying three stones of the same diameter (Fig. 3.*e*). In this case the shoulders of tilting of the stone n and b the cross-sectional area ω of the midsection take the following values:

$$n = 0{,}217d \; ; \quad b = 0{,}25d \; ; \quad \omega = 0{,}785d^2 \, . \tag{18}$$

Only the values of coefficients $\tilde{c}$ of frontal streamline forces on the stone can be considered unchanged.

Taking into account the values of these parameters, the minimum diameter d^* of the design stone of heterogeneous embankment in the direction of waves and water flow in the channel, i.e. in the direction of the axis Ox, is calculated by the formula

$$d_1^* = 0{,}86 \frac{\tilde{c}}{g} \cdot \frac{\gamma (U_0 + AG)^2}{\gamma_s' \cos\theta_0} \, . \tag{19}$$

In the axis Oy' direction, i.e. down the slope, perpendicular to the shoreline

$$d_2^* = 0{,}057 \frac{\tilde{c}\gamma}{g\gamma_s'} \cdot \frac{m_0 - 2{,}82}{m_0 - 1{,}15} \cdot \frac{AG\cos\beta' \cdot \left[U_0^2 + 2U_0 AG \sin\beta' + A^2 G^2\right]^{1/2}}{0{,}076\cos\theta_0 - 0{,}214\sin\theta_0} \, , \tag{20}$$

and, down the slope, at an angle of 30° to the shoreline

$$d_3^* = 0{,}05 \frac{\tilde{c}y}{g\gamma_s'} \cdot \frac{m_0 - 1{,}41}{m_0 - 0{,}58} \cdot \frac{(U_0 + 1{,}16AG)\left(U_0^2 + 1{,}73U_0 AG + A^2 G^2\right)^{1/2}}{0{,}076\cos\theta_0 - 0{,}107\sin\theta_0} \, . \tag{21}$$

In dependencies (19) ÷ (21) m_0 means the slope coefficient of the bank slope of the canal, $m_0 = \cot\theta_0$; In the absence of stationary flow of water in the channel, in these dependencies must be substituted $U_0 = 0$; The coefficient $\tilde{c}$ of the frontal streamline flow in accordance with Mescheli's recommendations [4], according to which $\tilde{c} \approx 1{,}05$; Wave phases β' are determined by dependence (13) or approximately it is possible to assume that $\beta' = \pi / 3$.

After determining the limiting diameters of the stones using dependencies (19) ÷ (21), the maximum of them should be chosen as the calculation one.

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Conclusion

As the water depth on the slope increases, the values of diameters calculated by the above dependencies decrease. Therefore, initially the calculations should correspond to the shoreline, where the water depth is $H = 0$.

In addition, note that the opposite direction of alongshore waves in the channel relative to the uniform flow does not affect the size of the stones, because, in this case, in the above formulas simultaneously change both signs of the front U_0 and signs of extreme values of the wave phase β', and therefore the formulas for calculating the diameter of the stone remain unchanged.

References

1. Gagoshidze Sh. Analytival Methods for Calculation of peridical water waves (2018)// Technical University. - 232 p.
2. Gagoshidze Sh. Kodua M, Saghinadze I. Kadaria I. River hydro-construction and geomorphological processes of the Georgian Black Sea coast (2017)// Technical University. 192 p.
3. Junkovsky N.M. Effect of wind waves on hydraulic structures (1964) // M.: Nauka, 1964, 228 p.
4. Meskheli K.P. Experimental study of the resistance of bodies during their oscillatory motion in a liquid. (1984) // Tr. GruzNIIEGS, Energy, M., 1, p. 48-53.
5. Mikhlin, S.G. Method of boundary integral equations (1978) // Series: Mechanics / New in foreign science. M.: Mir, 1978. Issue. 15.209 s.
6. Shaitan V.S. Study of the stability of stones in a heterogeneous ripple under the action of waves. //(1965) Tr. hydr. laboratories of VNII VODGEO, Sat. XII, M.: G SI.

Reference

1. გაგოშიძე შ. წყლის პერიოდულ ტალღურ მოძრაობათა გაანგარიშების ანალიზური მეთოდები (2018). //ტექნიკური უნივერსიტეტი -232 გვ.
2. გაგოშიძე შ. კოდუა მ. სადინაძე ი. ქადარია ი. სამდინარო ჰიდრომშენებლობა და საქართველოს შავიზღვისპირეთის გეომორფოლოგიური პროცესები (2017) //ტექნიკური უნივერსიტეტი -192 გვ.
3. Джунковский Н. М., Джунковский Н. М   Действие ветровых волн на гидротехническое сооружения (1964) // М.: Наука, 1964, 228 с.
4. Михлин, С.Г. Метод граничных интегральных уравнений (1978) // Серия: Механика / Новое в зарубежной науке. М.: Мир, 1978. Вып. 15. 209 с
5. Месхели К.П. Экспериментальное исследование сопротивления тел при их колебательном движении в жидкости. (1984)// Тр. ГрузНИИЭГС, Энергия, М., 1, с. 48-53.
6. Шайтан В.С. Исследование устойчивости камния в неоднородной наброске при действии волн. //(1965) Тр. гидр. лаборатории ВНИИ ВОДГЕО, сб. XII, М.: ГСИ

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ԱՓԱՄԵՐՁ ԱԼԻՔՆԵՐԻ ԱԶԴԵՑՈՒԹՅԱՆԸ ԵՆԹԱՐԿՎՈՂ ՋՐԱՆՑՔՆԵՐԻ ԱՓԱՊԱՇՏՊԱՆ ՄԻՋՈՑԱՌՈՒՄՆԵՐԻ ՀԱՇՎԱՐԿԻ ՎԵՐԱԲԵՐՅԱԼ

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Մշակվել են ափամերձ ալիքների ազդեցության ենթարկվող եռանկյունաձև և սեղանաձև ջրանցքների լանջերի ամրացման հաշվարկային մեթոդներ:

Լանջերը բետոնե սալերով ամրացնելու դեպքում տրվում են հաշվարկային գործակիցներ՝ կախված դրա խորությունից՝ դրա հաստությունը որոշելու համար: Դիտարկվել է ջրանցքի ափամերձ լանջին բուրգի եռանկյունաձև հիմքի տեղակայման երեք առավել բնորոշ դեպքերը:

Բանալի բառեր. *ջրանցք, ափամերձ ալիք, ափամերձ լանջ, առափնյա գիծ*

К РАСЧЕТУ БЕРЕГОЗАЩИТНЫХ МЕРОПРИЯТИЙ КАНАЛОВ, ПОДВЕРЖЕННЫХ ВОЗДЕЙСТВИЮ ВДОЛЬБЕРЕГОВЫХ ВОЛН

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Разработаны методы расчета укрепления откосов каналов треугольного и трапецеидального сечений бетонными плитами и каменной набросной подверженных воздействию вдольбереговых волн.

В случае укрепление откосов бетонными плитами приведены расчетные соотношения для определения толщины плиты в зависимости от её заглубления.

При укреплении откосов каменной наброской, рассматриваются три наиболее характерных случаев расположения треугольного основания пирамиды созданной наброской на береговом склоне канала, в частности:

а) Когда камни, образующие гнездо на склоне, расположены таким образом, что расчётный камень, помещенный на вершину пирамиды, опрокидывается по направлению течения волнового потока; б) Когда расчётный камень может быть опрокинут перпендикулярно береговой линии, в сторону больших глубин; в) Когда возможное направление опрокидывания камня составляет угол 30° с береговой линией, то есть когда одна из сторон равностороннего треугольника основания пирамиды параллельна береговой линии.

Ключевые слова: канал, вдольбереговая волна, береговой откос, береговая линия, размеры элементов покрытия.

UDC – 691.316

RESULTS OF EXPERIMENTAL RESEARCH ON OBTAINING LOW-CEMENT WALL MATERIALS FROM WASTE OF SAMING OF LOCAL LIME STONES

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Abstract

The results of experimental studies are presented on the production of single low-cement modified dry-pressed bricks from limestone stone sawing waste from Martakert stone quarries. The technological parameters for the manufacture of these bricks and their physical and mechanical properties have been established. A high convergence of the properties of the resulting wall material was determined in comparison with ceramic and silicate bricks used in construction. Using the method of analogy, the compliance of the quality indicators of experimentally obtained bricks with the requirements of regulatory documents was proven.

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RESULTS OF EXPERIMENTAL RESEARCH ON OBTAINING LOW- CEMENT WALL MATERIALS FROM WASTE OF SAMING OF LOCAL LIME STONES

The fundamental possibility of producing low- cement bricks from stone sawing waste from local quarries, as well as their use in construction, has been established. The production of low-cement bricks makes it possible to increase construction efficiency and reduce the cost of operating completed facilities. This also leads to a reduction in environmental risks from the accumulation of stone sawing waste in large areas and pollution of the air and water basins of the region.

Keywords: waste limestone, dry pressing, technological parameters, brick, modifier, convergence.

Introduction

In the construction complex of Nagorno-Karabakh, the most common are structural solutions for the walls of buildings made of sawn limestone, dimensions 390x190x188 mm, weighing 30-32 kg. Masonry made from these materials is characterized by high labor intensity, technological imperfections and as a consequence a shortage of specialists.

The problem is also complicated by the variability of the physical and mechanical properties of local limestones, such as: bulk density(1960–2080kgf/m3), water absorption (11.5-14.5%), strength (8.4-13.6MPa), etc. [1,2,3]. The variability of the physical and mechanical properties of limestones lead to a decrease in the quality of masonry, which limits their use for the construction of load-bearing wall structures of multi-story buildings in earthquake-resistant construction. In general, sawn limestone masonry does not correspond to the nature of modern construction, and the transition to light weight concrete small-piece wall materials, taking into account changes in the structural layouts of buildings, leads to an increase in the estimated cost by almost 40%.

An analysis of the costs of using artificial wall materials in construction (ceramic, lightweight concrete, cellular, silicate, etc.) showed that the most economical are stones made from cellular and silicate concrete [4]. However, given the limited energy capabilities, the production of these materials has not received further development. Making masonry from hyper-pressed bricks also does not solve the problem, due to the increase in the estimated cost of construction and the increase in operating costs of the buildings and structures being constructed [5, 6].

The research of the problem [7-11] led to a working hypothesis about the possibility of producing low-cement pressed wall materials from waste stone sawing limestone from local stone quarries. This solution to the problem also has an environmental focus - reducing the risk of waste accumulation over large areas and pollution of the air and water basins of the region.

Conflict Setting

Improving the technical and technological parameters of erected stone structures in earthquake- resistant construction, using wall materials from local limestone sawing waste. The possibility of implementing this idea was confirmed by experimental studies\ of the scientific and production association "SAT" in Yeravan

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RESULTS OF EXPERIMENTAL RESEARCH ON OBTAINING LOW- CEMENT WALL MATERIALS FROM WASTE OF SAMING OF LOCAL LIME STONES

Research Results

1. Determination of the chemical and mineralogical composition of the starting materials.
2. Identification of the ratios of the components of the feed stock. Determination of technological parameters for the production of molding sand.
3. Establishing the physical and mechanical properties of the new material, their compliance with the requirements of current regulatory documents for construction.

The following materials were used as starting materials for the experiments:

- Limestone waste from stone sawing of the Martakert stone quarry;
- Portland cement grade 400 from Ararat Production Association "Ararat Cement";
- Natural pigment from the Hrazdan deposit;
- plasticizer, water-soluble methyl cellulose MC-100(TC6-05-1857-78).

Experimental studies have determined the technological parameters for the production of single bricks (250x120x65mm), dry pressing from a modified molding mixture and their physical and mechanical properties (tab. 1).

Table 1

Compositions and technological parameters for the production of cement-limestone mixtures and their physical and mechanical properties

Ingredients №	Technological properties							Physical and mechanical properties		
	Waste, g.	Portlan cement, g.	Pigment, g.	Modifier, %	Water, g.	Stirring time, min	Molding time, min	Pressing force, MPa	Water absorption %	Density, g/cm³
1	2	3	4	5				6	7	8
1	4000	160			520	9	10		13,5	2,018
2	4000	200			520	4,9	2		13	1,944
3	4000	240			240	4,8	1	3,5	14,7	2,013
4	4000	320			400	5,3	1.3		14,9	1,995
5	4000	320			520	4,8	2.8	6,3	12,1	2,06
6	4000	400			600	4,0	1.4	8,1	10,8	2,13
7	4000	500			400	3,2	1.2	8,9	10,4	1,985
8	4000	240	120		240	4,7	1.9	5,4	14	2,02
9	4000	240	200		320	3,2	1.3	6,0	13,6	2,00
10	4000	240	200		400	2,8	1.1	6,4	12,5	2,05
11	3599	240		3,3	240	-	0,75	14,0	6,1	1,992

The molding of the mixture was carried out under a pressure of 80 MPa , because The pressing force on a single brick, according to various sources, should not exceed 300 kg/cm^2. Experimental studies of the possibility of manufacturing wall materials were carried out using dry (samples 3, 8, 9, 11) and semi-dry pressing methods (samples 1, 2, 4, 5, 6, 7, 10). Sample 11 was made with the introduction of modifier MC-100 (TC6-05-1857-78) Into the composition of the molded mixture in an amount of 3.3% (tab. 1).

Frost resistance tests of samples 7 and 11 were carried out at the scientific and production association "SAT" (tab. 2), control testing of their strength was carried out in the

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central testing laboratory, Natural porous aggregates of volcanogenic rocks of the Republic of Armenia for concrete. (tab. 3).

Analysis of the convergence of physical and mechanical properties of low-cement single dry- pressed bricks, in comparison with ceramic and sand-limebricks (tab. 4).

Table 2

Results of testing samples for frost resistance

Mixture ingrediets	Control strength of samples, MPa	Strength of samples after testing them for Frost resistance, MPa	Strength loss, % after frost resistance Testing at 25 cycles
N7	3,5	3,05	12.85
№11	14,0	13,5	3.50

Table 3

Results of control tests for pressing strength of samples

№	Sample number	Weight, g	Product volume	Compression strength, kg/cm²	
				Sample strength	Average value
1	7	3900	12x12	34*	67
2		4215	12.1x12	66	
3		4450	12x12	69	
4	11	3385	12.2x12.1	142	142
5		3895	12.1x12.1	143	
6		3645	12.3x12.1	144	

Note34*- random size.

Table 4

№	Brick types	Basic physicomechanical properties					Notes
		Density g/cm³	Compressive strength mark, MPa	Water absorption %	Thermal conductivity, watt/m²ºC	Frost resistance cycles	
1	2	3	4	5	6	7	8
1	Low-cement Dry pressing	1.992	15	6.1	0.5	25	Experimental results
2	Ceramic	1.960	No less 15	No less 6	More0.5	No less 25	GOST530-2012
3	Silicate	before 2100	No less 15	6	Noless0.56	No less 25	GOST379-95
4	Average values	1.985	15	6.03	0.52	25	-
5	Convergence	0.07	0	0.17	0.12	0	-

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The high convergence of the physical and mechanical properties of the experimentally obtained bricks in comparison with the ceramic and silicate bricks used in construction, as well as the analysis of the results by the method of analogy, led to the conclusion that the composition and quality indicators of low-cement modified bricks correspond to the current building standards for construction, inincluding SNRA1V-13.01-96"Stone and reinforced stone structures".

Conclusion

Based on the results of experimental studies, the fundamental possibility of producing a rational material for laying walls from stone sawing waste from the Martakert limestone quarry was proven, which confirmed the reliability of the working hypothesis.

It has been established that the method of dry pressing of a molding mixture with a cement content of up to 7% and a modifier in an amount of 3.3% makes it possible to obtain wall material with a compressive strength of 142 kg/cm2and a density of 1.992 g/cm3. At the same time, compared those drypressing, cement consumptions reduced by more than two times.

A promising direction of research is the experimental substantiation of the possibility of producing a wider range of building materials from limestone waste (tiles, lined slabs, ventilation blocks, etc.) based on waste-free technology in a closed cycle.

References

1. Report on geological exploration work on a limestone deposit, carried out to assess the quality of raw materials and calculate reserves for cement production in the Martakert region of the NKR. Stepanakert: "Artsakh in the project" LLC, 1988, 32 pg.
2. Test results of delivered cubes measuring 5x5x5 cm from the Stepanakert building materials plant. Baku, Research Institute named after. Dadasheva S.A., 1985
3. Polyakov S.V. Izmailov Y.V. etc. Masonry from saw limestones. Chisinau, "Map of Moldovenaske", 1973, 344 pg.
4. Ter-Petrosyan P.A., Israelyan R.G. Choosing a rational option for creating and using construction resources. Collection of scientific works of National University of Architecture and Construction, Yerevan, Volume III (42). 2011, pg. 109-114.
5. Zhdanova N.V. Shcherbachenko T.V. Comparative studies of the properties of hyper-pressed brick. Altai State Technical University, Polzunovsky Almnakh, N 1, 2021, pg. 53-55.
6. TC5741-021-00284753-99 Construction and hyper-pressed materials.
7. Korovyakov V.F. Expanding the production of local building materials is an effective way to reduce the cost of building low-rise buildings. Collection of scientific papers. M., MSUCE, 2009, pg. 50-53.
8. Sergeev A.M., Dibrov G.D., Shmitko E.I., Kovalev S.K. Use of local materials in construction. K., "Budivelnik", 1975.- 184 pg.

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9. Oleinik P.P. , Brodsky V.I., Formation of a waste management and processing system. Collection of scientific papers of the international conference "Stroyinvest - 2011", M.: MSAPUC, 2011, pg. 445-457.
10. ShchitkovaI. Yu. Samoshina E.N., Kislitsina S.N. Boltyshov K.A. Modern composite building materials. Textbook, Penza, PTUAIS, 2015, 136 pg.
11. Kuzbasnaya T.G. Use of technogenic waste in the production of building materials.

References

1. Отчёт о геолого-разведочных работах по месторождению известняка, выполненных с целью оценки качества сырья и подсчёта запасов для производства цемента в Мартакертком районе НКР. Степанакерт: ООО "Арцахинжпроект", 1988, 32 с.
2. Результаты испытания доставленных кубиков размерами 5х5х5 см. из степанакертского комбината строительных материалов. Баку, НИИ им. Дадашева С.А., 1985 г.
3. Поляков С.В. Измайлов Ю.В. и др. Каменная кладка из пильных известняков. Кишинев, "Карта Молдовеняске", 1973, 344 с.
4. Тер-Петросян П.П., Исраелян Р.Г. Выбор рационального варианта создания и использования ресурсов строительства. Сборник научных трудов Ереванского государственного университета Архитектуры и Строительства, Ереван, Том III (42). 2011, С. 109-114.
5. Жданова Н.В. Щербаченко Т.В. Сравнительние исследования свойств гиперпресованного кирпича. Алтайский государственный технический университет, Ползуновский альмнах, N 1, 2021, С 53-55.
6. ТУ 5741-021-00284753-99 Материалы строительные и гиперпрессованние.
7. Коровяков В.Ф. Расширение производства местных строительных материалов- эффективный путь снижения стоимости строительства малоэтажных домов. Сборник научных трудов. М., МГСУ, 2009, С. 50-53.
8. Сергеев А.М., Дибров Г.Д., Шмитко Е.И., Ковалев С.К. Применение местных материалов в строительстве. К., "Будивельник", 1975.- 184 с.
9. Олейник П.П. , Бродский В.И., Формирование системы управления и переработки отходов. Сборник научных трудов международной конференции «Стройинвест – 2011», М.: ГАКХиС, 2011, С. 445-457.
10. Щиткова И.Ю. Самошина Е.Н., Кислицина С.Н. Болтышов К.А. Современные композиционные строительные материалы. Учебное пособие, Пемза, ПТУАиС, 2015,136 с.
11. Кузбасная Т.Г. Использование техногенных отходов при прироизводстве строительных материалов. Строительные материалы, 2002, N 2, С 10-11.

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ՏԵՂԱԿԱՆ ԿՐԱՔԱՐԻ ՔԱՐԱՀԱՆՔԵՐԻ ԹԱՓՈՆՆԵՐԻՑ ՍԱԿԱՎԱՑԵՄԵՆՏԱՅԻՆ ՊԱՏԻ ՆՅՈՒԹԵՐ ՍՏԱՆԱԼՈՒ ՓՈՐՁԱՐԱՐԱԿԱՆ ՀԵՏԱԶՈՏՈՒԹՅԱՆ ԱՐԴՅՈՒՆՔՆԵՐԸ

Իսրայելյան Ռ.Գ., Մարգարյան Ա.Յա., Իսրաելյան Մ.Ա., Գրիգորյան Ա.Մ.
Շուշիի տեխնոլոգիական համալսարան

Ներկայացված է տեղական կրաքարի քարահանքերի թափոններից միատարր սակացեմենտային չոր մամլումով արտադրության փորձարարական ուսումնասիրությունների արդյունքները: Սահմանվել են նշված ալյուսների արտադրության տեխնոլոգիական պարամետրերը և ֆիզիկո-մեխանիկական հատկությունները: Որոշվել է ստացված ալյուսների հատկությունների բարձր համընկնումը շինարարությունում օգտագործվող կերամիկական և սիլիկատային ալյուսների հետ: Նմանակությունների մեթոդով ապացուցվել է փորձնականորեն պատրաստված ալյուսների որակի ցուցանիշների համապատասխանությունը նորմատիվային փաստաթղթերի պահանջներին: Սահմանվել է տեղական կրաքարերի թափոններից պատրաստված սակացեմենտային ալյուսների օգտագործմանը շինարարությունում: Սակացեմենտային ալյուսների արտադրությունը թույլ է տալիս բարձրացնել շինարարության արդյունավետությունը և նվազեցնել շահագործվող օբյեկտների գործնական ծախսերը: Սա նաև հանգեցնում է շրջակա միջավայրի ռիսկերի նվազմանը, որոնք կապված են մեծ տարածքներում թափոնների կուտակման հետ, ինչը հանգեցնում է տարածաշրջանի օդի և ջրի աղտոտմանը:

Բանալի բառեր. կրաքարի թափոններ, չոր մամլում, տեխնոլոգիական, պարամետրեր, ալյուս, վերափոխիչ:

РЕЗУЛЬТАТЫ ЭКСПЕРИМЕНТАЛЬНЫХ ИССЛЕДОВАНИЙ ПО ПОЛУЧЕНИЮ МАЛОЦЕМЕНТНЫХ СТЕНОВЫХ МАТЕРИАЛОВ ИЗ ОТХОДОВ КАМНЕПЕЛЕНИЯ МЕСТНЫХ ИЗВЕСТНЯКОВ

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Приводятся результаты экспериментальных исследований по изготовлению одинарных малоцементных модифицированных кирпичей сухого прессования из известняковых отходов камнепиления Мартакертских каменных карьеров. Установлены технологические параметры изготовления этих кирпичей и их физико-механические свойства. Определена высокая сходимость свойств полученного стенового материала, в сравнении с используемыми в строительстве керамическими и силикатными кирпичами. Методом аналогии доказано соответствие показателей качества экспериментально полученных кирпичей требованиям нормативных документов. Установлена принципиальная возможность изготовления малоцементных

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кирпичей из отходов камнепиления местных карьеров, а также их применения в строительстве. Производство малоцементных кирпичей позволяет повысить эффективность строительства и снизить затраты на эксплуатацию завершенных объектов. Это приводит так же к снижению экологических рисков от накопления отходов камнепиления на больших территориях, и загрязнянения воздушных и водных бассейнов региона.

Ключевые слова: отходы извястнякового камня, сухое прессование, технологические параметры, кирпич, модификатор.

DATA PREPARATION MODEL FOR TRAINING NEURAL NETWORKS

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Abstract

The paper presents the results a research of changes in the state of the operating environment when it is damaged by malware. The Windows operating system of various versions and builds was selected as a test environment. The research was carried out using polymorphic malware *abc, cheeba, december_3, stasi, otario, dm, v-sign, tequila, flip*. The research was conducted to obtain the value of operating system signatures for subsequent training of neural networks. Context triggered piecewise hashing and performance testing methods were used for research the assessment of changes in the state of the operating environment when it is damaged by malware. Simulation of the developed method was carried out in the Hyper-V virtual environment.

Keywords: polymorphic malware, software testing method, data reliability, context triggered piecewise hashing, Parrot OS, svchost.

Introduction

The active development of machine learning (ML) technology has provided attackers with new tools for developing malware. In particular, if an attack on the network infrastructure (NI) will sooner or later be detected, then an attack against the operating system (OS) threatens the *reliability of the processed and stored data[1]*. The danger lies in the fact that the use of proprietary operating systems with closed source code makes it impossible to accurately assess the integrity of the operating system during operation, since it becomes

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[1] Data reliability is the property of the processed data not to have hidden errors [1].

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unclear whether the operating system is affected by malware or whether an undeclared feature introduced by the manufacturer itself is activated. It is possible to evaluate only the image of the official distribution. In proprietary operating systems, analyzing the use of functions/libraries and other components is quite difficult due to the lack of source code. Based on the above, an urgent task is to study the behavior of the OS before and after being damaged by malware. Among the many types of malware, polymorphic[2] malware plays a special role. This research examines the behavior of the Windows OS of various versions and builds when it is infected with polymorphic malware. Since malware is also built on the basis of a specific code base, various software testing methods are also applicable to it (*configuration testing method, regression testing method, gray, white, black box method, functional testing method, performance evaluation method* [2,3]). It becomes possible to infect a system with previously known malware and evaluate its behavioral model using specified parameters and calculate a signature. The solution to this problem allows us to solve the inverse problem: to assess the degree of infection of the OS by its «signature cast». Various researchers are trying to solve the problem of detecting malware activity in an OS using different methods, but each of them considers a specific OS [4,5,6,7]. The novelty of the research lies in the use of software *performance testing* methods and *context triggered piecewise hashing*[3] to assess changes in the state of the operating environment when it is infected with malware.

Conflict Setting

It is necessary to obtain an OS signature value when exposed to malware with specified parameters.

Discussion

Various polymorphic malware, the source code and the modification algorithm of which are known, are gradually being introduced into the Windows operating system of various versions and builds (with a known, verified hash value of the unaffected version).

The workload of the *svchost* process is calculated and the context triggered piecewise hashing OS hash value is calculated. The choice of the svchost process to evaluate the OS state is due to the fact that *svchos*[4]*t* is the main process when activating service processes and loading dynamic libraries. All other processes are children of *svchost*. Thus, it is possible to have a system not affected by malware, record the value of svchost and compare it with the value of the affected system at different points in time. Creating a signature base of the state of the operating environment allows you to evaluate its current state and assess the degree of infection by malware. The Windows operating systems (versions, build numbers) analyzed are presented in tab 1.

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[2] Polymorphic malware is software that is characterized by the following behavior: encryption, self-propagation and modification of one and/or several components of the source code.
[3] Context triggered piecewise hashing (CTPH) is a method for computing piecewise hashes from input data [8].
[4] svchost.exe in the Microsoft Windows family of operating systems is the main process for services loaded from dynamic libraries [9].

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Table 1

Windows operating systems (versions, build numbers) analyzed

Windows 7	Windows 10		Windows 10 IoT	Windows Server 2016 (version 1607/1709/1803)
version	version	build	build	build
7077	1809	17763	16299-1	10.0.09841
7100	1903	18362	16299-2	10.0.10074
7227	1909	18363	18362	10.0.10537
7228	2004	19041	19041	10.0.10586
7270	20H2	19042	19043	10.0.14300
7271	21H1	19043	18363	10.0.14393

Experimental procedures

On the Dell Power Edge T-330 server, the Hyper-V role is installed in the Windows Server 2016 Standart operating system environment. A SDN (Software Defined Networking) has been deployed in which Parrot OS with the Metasploit framework installed and various versions (builds) of Windows OS downloaded from the official website are installed [10].

Table 2

Windows operating systems (versions, build numbers) analyzed

Build number/ OS version	Unaffected OS image hash value	Hash value of the image of the affected OS malware abc, cheeba, december_3 (CTPH value 64 bytes)	Hash value of the image of the affected OS malware abc, cheeba, december_3 (CTPH value 128 bytes)	Hash value of the image of the affected OS malware abc, cheeba, december_3 (CTPH value 256 bytes)
Windows 10				
1909/ 18363	6fba99620cf84e69 33b140027ce9fbbe ed51bf23	31e5aafa83e17c999 142b7aa270d6a55f7 77afcd	cf63fe5a9ce046eb7b b068e95d5ee79e9eb d696b	72a096e3d803d7585 b2e9be0ce5debfe5a5 c1552
20H2/ 19042	b70a55869178c69 27ec29171b6afd56 3686e8efe	3851c4417b41a488 77f8644d60a8d7d52 8dd5c92	358879ccd1e04b5b3 149386dd80d588abd 7e1b6d	4a99c6be6113f3318f 1040c7fb1bd2d39b3 7b55d
Windows 10 IoT				
18362 19043	632667547e7cd3e 0466547863e120 7a8c0c0c549	11fbf8b0fae93c46ae 6fa191bc67daf114a 8b573	909eb9d63b44be52c 318b10f6d538c552a 7133a3	d21c11f950477838d 9b5544d55a4192b9e 97371d
Windows Server 2016				
10.0.10537	f7f2c3285303b9a b412da2d7e3e453 488b40f6ab	50996e82617dcef60 73cf328e3dfef7ccd3 ba20d	fd8f08f0541cf41438 d6e400f0682ccb457f e663	f1d670bc47ef19755b 6c57bd0f618079348 3a2bb
10.0.14300	346b8b56fc47599 ae393a5de4afb37 3a05216c55	ad04ced83163588f0 831304c632084b65 85f8ddd	f209bcf375dfecce93 c545a2208273d5765 9bf90	325cdc77897bcf7ce0 c10276650b56ac777 a50d3

Within virtual machines, various combinations of the number of processors and RAM are configured. The primary assessment was the CPU load without damaging the OS by

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malware. Load estimation was done by measuring the value of the svchost process. After each measurement, the OS CTPH value was calculated. The second stage was to gradually introduce malware *abc, cheeba, december_3, stasi, otario, dm, v-sign, tequila, flip* into the OS and measure the state of the *svchost* process and the OS CTPH value. The CTPH values for Windows operating systems affected by malware are presented in tab. 2.

The malware was introduced using the Metasploit framework. The assessment of changes in the state of polymorphic software was carried out by comparison with the source code based on the method proposed in [11]. The svchost process load was measured using process explorer software from the Sysinternals (Winternals) software package [12]. The assessment of changes in the state of the operating system was carried out using the piecewise context hashing method with a variable hashing step size using *ssdeep* software [13]. In all cases, testing was carried out with anti-malware software disabled and the OS updated to the latest state. No additional application software that could affect the results of the study was installed.

Research Results

Fig. 1-4 shows the results of visualization of the recycling of the CPU of a virtual machine with Windows 7, Windows 10, Windows 10 IoT, Windows Server 2016 installed when it is damaged by malware *abc, cheeba, december_3, stasi, otario, dm, v-sign , tequila, flip*.
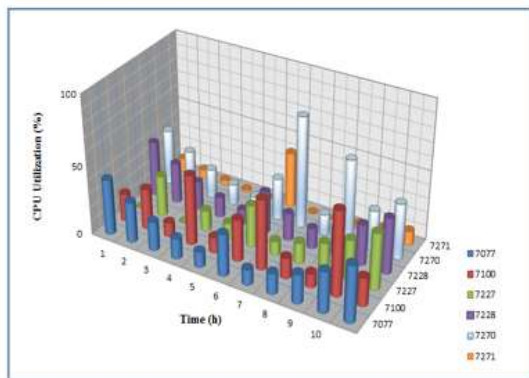
Fig. 1 Visualization of CPU utilization running the Windows 7 operating system, if it is infected with malware
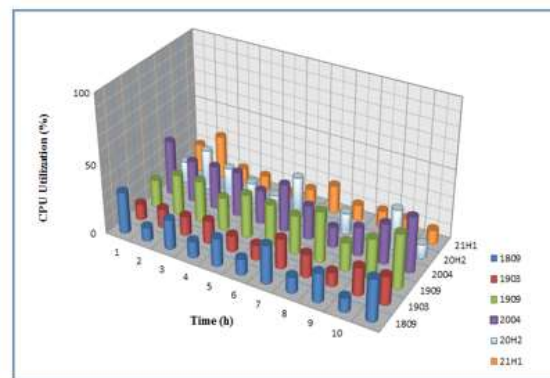
Fig. 2 Visualization of CPU utilization running the Windows 10 operating system, if it is infected with malware
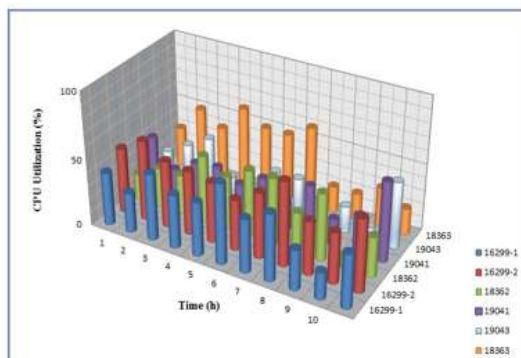
Fig. 3 Visualization of CPU utilization running the Windows 10 IoT operating system, if it is infected with malware
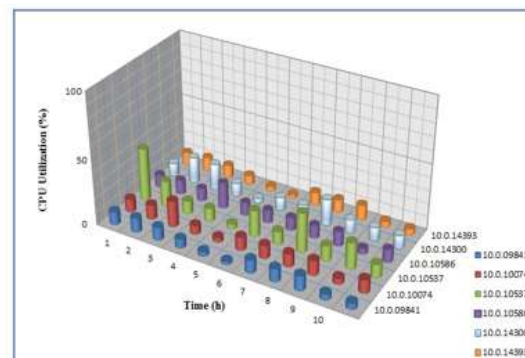
Fig. 4 Visualization of CPU utilization running the Windows Server 2016 operating system, if it is infected with malware

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The virtual machine is configured in the following configuration: 4 cores with a processor frequency of 3100 Mhz and a RAM capacity of 32Gb.

When the operating system is infected with malware, additional activation of svchost child processes occurs. Increasing the amount of malware embedded in the OS increases the number of child svchost processes, correspondingly increasing processor utilization, which as a result can lead to a hidden attack on availability. In all types used, polymorphic software affected the *hal.dll*[5] and *datachannel.dll*[6] libraries. In Windows 7, both libraries are affected, increasing the level of processor utilization; in Windows 10, of the system libraries, only the *datachannel.dll* library is affected, which ultimately reduces processor utilization, but makes the system more affected since malicious code is transferred between different processes (programs)) by modifying your code within a single OS. It is also possible for malware to be transferred undetected between different hosts. Knowing the value of the hash function under various OS states allows you to build a dataset for training neural networks integrated with the SIEM (Security information and event management) system that monitors hosts with Windows OS installed.

Conclusion

The paper discusses a model for determining whether an OS is affected by polymorphic malware, built on the methods of CTPH and software performance testing. The analysis of CPU utilization after the defeat of the operating system was determined by the number of svchost processes and the degree of computing resource they consumed. It was determined that in all cases the polymorphic malware used primarily affected processes associated with the use of the dynamic libraries *hal.dll* and *datachannel.dll*. The most vulnerable operating systems were Windows 7 (builds 7100, 7227, 7228), Windows 10 IoT (builds 18362, 19041, 19043. The least vulnerable OS is Windows Server 2016. In Windows Server 2016 build 10.0.14393, the *datachannel.dll* library was blocked if the Hyper-V role was activated and a Windows OS was running in a virtual environment. Based on the research, the values of CTPH of unaffected OS and affected OS were cataloged at CTPH step values of 64, 128, 256, 512 bytes. The research all results are presented in [14].

References

1. National standard of the Russian Federation, «Quality of service information», GOST R-51170-98, (2020) // 12, Moscow, Standardinform.
2. Myers G., Badgett T., Sandler K., The Art of Software Testing, 3rd Edition. - M.: Dialectics, 2012. - 272 p.
3. Sinitsyn S., Nalyutin N., Software verification. - M.: BINOM, 2008. - 368 p.
4. Abusnaina A., et al, «Burning the Adversarial Bridges: Robust Windows Malware Detection Against Binary-level Mutation». https://doi.org/10.48550/arXiv.2310.03285

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[5] hal.dll (hardware abstraction layer) is a library responsible for the interaction of the software and hardware parts of the computer.

[6] datachannel.dll - a library responsible for ensuring data transfer between various programs and components.

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5. Anand S., et al, «MALITE:Lighweight Malware detection and Classification for Constrained Devices», https://doi.org/10.48550/arXiv.2309.03294

6. Islam N., Shin S., «Review of Deep Learning – based Malware Detection for Android and Windows System», https://doi.org/10.48550/arXiv.2307.01494

7. Yousuf M.I, et al, «Multi-feature dataset for Windows PE Malware Classification». https://arxiv.org/abs/2210.16285

8. Kornblum J., (2006), «Identifying Almost Identical Files using Context Triggered Piecewise Hashing. Digital Investigation» 3, 91-97. Digital Investigation. 3. 91-97. 10.1016/j.diin.2006.06.015.

9. Download page and description of the svchost process., https://learn.microsoft.com/en-us/windows/application-management/svchost-service-refactoring «Changes to Service Host grouping in Windows 10», Microsoft. 2021-08-27. Retrieved 2021-01-10.
   the resource is available on 20.12.2023.

10. Official download page for various versions of the Windows operating system, https://www.microsoft.com/ru-ru/software-download , the resource is available on 20.12.2023.

11. Jamgharyan T., (2022). «Research of Obfuscated Malware with a Capsule Neural Network». *Mathematical Problems of Computer Science*, *58*, 67–83. https://doi.org/10.51408/1963-0094

12. Official operating system testing tools download page Windows, Sysinternals, https://learn.microsoft.com/en-us/sysinternals/ , the resource is available on 20.12.2023.

13. Ssdeep software download page. https://ssdeep-project.github.io/ssdeep/index.html , the resource is available on 20.12.2023.

14. All research results.https://github.com/T-JN , the resource is available on 20.12.2023.

References

1. Национальный стандарт Российской Федерации, «Качество служебной информации», ГОСТ Р-51170-98, (2020)// 12, Москва,Стандартинформ.

2. Майерс Г., Баджетт Т., Сандлер К.. Искусство тестирования программ, 3-е издание, The Art of Software Testing, 3rd Edition. — М.: «Диалектика», 2012. - 272 с.

3. Синицын С., Налютин Н., Верификация программного обеспечения. - М.: БИНОМ, 2008. — 368 с.

4. Abusnaina A. et al, «Burning the Adversarial Bridges: Robust Windows Malware Detection Against Binary-level Mutation». https://doi.org/10.48550/arXiv.2310.03285

5. Anand S., et al, «MALITE: Lighweight Malware detection and Classification for Constrained Devices», https://doi.org/10.48550/arXiv.2309.03294

6. Islam N., Shin S., «Review of Deep Learning –based Malware Detection for Android and Windows System». https://doi.org/10.48550/arXiv.2307.01494

7. .Yousuf M.I, et al, «Multi-feature dataset for Windows PE Malware Classification».
    https://arxiv.org/abs/2210.16285

8. Kornblum J., (2006), Identifying Almost Identical Files using Context Triggered
    Piecewise Hashing. Digital Investigation 3, 91-97. Digital Investigation. 3. 91-97.
    10.1016/j.diin.2006.06.015.

9. Страница загрузки и описания процесса svchost. https://learn.microsoft.com/en-
    us/windows/application-management/svchost-service-refactoring «Changes to Service
    Host grouping in Windows 10», Microsoft. 2021-08-27. Retrieved 2021-01-10, the
    resource is available on 20.12.2023.

10. Официальная страница загрузки различных версий операционной системы
    Windows,
     https://www.microsoft.com/ru-ru/software-download   the resource is available on
    20.12.2023.

11. Jamgharyan T., (2022). «Research of Obfuscated Malware with a Capsule Neural
    Network». *Mathematical Problems of Computer Science*, *58*, 67–83.
     https://doi.org/10.51408/1963-0094

12. Официальная страница загрузки инструментов тестирования операционной
    системы Windows, Sysinternals. https://learn.microsoft.com/en-us/sysinternals/,the
    resource is available on 20.12.2023.

13. Официальная страница загрузки ПО ssdeep. https://ssdeep-
    project.github.io/ssdeep/index.html , the resource is available on 20.12.2023.

14. Полные результаты исследования. https://github.com/T-JN , the resource is
    available on 20.12.2023.

ՆԵՅՐՈՆԱՅԻՆ ՑԱՆՑԵՐԻ ՈՒՍՈՒՑՄԱՆ ՀԱՄԱՐ ՏՎՅԱԼՆԵՐԻ ՆԱԽԱՊԱՏՐԱՍՏՄԱՆ ՄՈԴԵԼ

Խեմչյան Ա.Ա., **Ջամղարյան Թ.Վ**.
Հայաստանի ազգային պոլիտեխնիկական համալսարան

Ներկայացված են օպերացիոն միջավայրի վիճակի փոփոխությունների ուսումնասիրության արդյունքները, վնասաբեր ծրագրային ապահովումով գրոհի դեպքում։ Որպես թեստային օպերացիոն միջավայր ընտրվել է տարբեր տարբերակների և կառուցվածքների Windows օպերացիոն համակարգը։ Հետազոտությունն իրականացվել է վնասակար պոլիմորֆ ծրագրային ապահովման միջոցով՝ *abc, cheeba, december_3, stasi, otario, dm, v-sign, tequila, flip*։ Հետազոտությունում ստացված օպերացիոն համակարգի սիգնատուրաների ցուցանիշները հետագայում կիրառվել են նեյրոնային ցանցերի ուսումնատրության համար։ Համատեքստի մասնակի հեշավորման և արտադրողականության փորձարկման մեթոդները կիրառվել են որպես գործող օպերացիոն միջավայրի վիճակի փոփոխությունների գնահատման մեթոդներ, երբ այն

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վնասված է վնասաբեր ծրագրային ապահովումով: Մշակված մեթոդի մոդելավորումն իրականացվել է Hyper-V վիրտուալ միջավայրում:

Բանալի բառեր. *պոլիմորֆ ծրագրային ապահովում, ծրագրային ապահովման ֆորձարկման մեթոդ, տվյալների հուսալիություն, համապեքստի հատվածային հեշինգ, Parrot OS, svchost:*

МОДЕЛЬ ПОДГОТОВКИ ДАННЫХ ДЛЯ ОБУЧЕНИЯ НЕЙРОННЫХ СЕТЕЙ

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Представлены результаты исследования изменения состояния операционной среды при поражении ее вредоносным программным обеспечением. В качестве тестовой среды, выбрана операционная система Windows различных версий и сборок. Исследование проводилось с применением вредоносного полиморфного программного обеспечения *abc, cheeba, december_3, stasi, otario, dm, v-sign, tequila, flip*. Исследование проводилось с целью получения значения сигнатур операционной системы для последующего обучения нейронных сетей. В качестве методов исследования оценки изменения состояния операционной среды при поражении ее вредоносным ПО применялись *методы кусочно-контексного хэширования и тестирования производительности*. Моделирование разработанного метода проведено в виртуальной среде Hyper-V.

Ключевые слова: полиморфное ПО, метод тестирования ПО, достоверность данных, кусочно-контекстное хэширование, Parrot OS, svchost.

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Abstract

Complex objects, characterized by intricate operations, interconnected components, and dynamic behaviors, pose unique challenges for digital control systems. This article highlights the importance of automated digital control systems in managing these complexities, emphasizing their crucial role in ensuring safety, reliability, and efficiency.

Addressing these challenges involves dealing with system complexity, non-linear dynamics, uncertainties, real-time requirements, data quality, and the need for optimization. Furthermore, ensuring regulatory compliance, safety, scalability, energy efficiency, and cybersecurity adds additional layers of complexity.

This article explores the challenges faced by digital control systems when dealing with complex objects-systems with intricate operations and interconnected components. It emphasizes the vital role of automated digital control in ensuring safety, reliability, and efficiency in such scenarios.

Keywords: complex objects, digital control, automation, reliability, efficiency, system complexity, scalability, industrial processes.

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Introduction

Complex objects refer to systems or structures that have multiple interconnected components, intricate operations, and dynamic behaviors. Examples of complex objects include industrial processes, power grids, transportation systems, and buildings. These objects present unique challenges for digital control due to their complexity, non-linear dynamics, uncertainties, and the need for real-time monitoring and decision-making.

Automated digital control systems play a crucial role in ensuring the safe and reliable operation of complex objects. They provide real-time monitoring, analysis, and control capabilities that enable efficient and optimized operation, improved performance, and reduced energy consumption. These systems help maintain stability, enhance safety, and ensure compliance with regulatory standards. Additionally, automated digital control systems enable predictive maintenance, fault detection, and rapid response to mitigate potential risks and prevent system failures.

Key Challenges in Designing and Implementing Automated Digital Control Systems: [11]

1. Complex objects often entail intricate interconnections and dependencies among components, presenting a challenge in accurately modeling and controlling their behavior. Control algorithms and strategies need to be designed with consideration for these complexities, ensuring robust and adaptive control.

2. Uncertainties and variations in operating conditions, environmental factors, and system parameters are inherent in complex objects. Effective control systems must adeptly handle these uncertainties, adapting to dynamic changes to maintain optimal performance.

3. Real-time monitoring of various sensors and actuators, coupled with swift and accurate decision-making capabilities, is imperative for complex objects. Control systems must rapidly process substantial amounts of data, execute computations, and generate control signals within tight time constraints.

4. Complex objects often encompass multiple subsystems and devices from different manufacturers, each adhering to its communication protocols and interfaces. Designing control systems capable of integrating and communicating with these diverse components is a challenge that necessitates standardization and interoperability.

5. With the increasing connectivity of automated digital control systems to networks, vulnerability to cyber threats rises. Ensuring the security and privacy of data and safeguarding the control system from unauthorized access or malicious attacks becomes paramount.

6. Control systems must exhibit scalability to accommodate the complexity and size of the object being controlled. Additionally, they should demonstrate flexibility to handle modifications, expansions, or changes in the system's requirements without causing significant disruptions or necessitating extensive re-engineering.

Addressing these challenges requires interdisciplinary approaches that combine expertise in control theory, system modeling, data analytics, communication protocols, cybersecurity, and human-machine interaction. Advanced technologies such as artificial intelligence, machine learning, and cloud computing can also play a significant role in designing effective automated digital control systems for complex objects.

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Importance of Automated Digital Control Systems: Automated digital control systems are of utmost importance for ensuring the safe and reliable operation of complex objects. Here are some key reasons: [11]

1. Digital control systems enable precise and optimized control of complex objects, leading to improved operational efficiency, reduced energy consumption, and increased productivity.

2. Accurate control ensures that complex objects operate within safe limits, mitigating risks of accidents, equipment damage, or environmental hazards. Control systems can implement safety protocols, alarming, and emergency response mechanisms.

3. Digital control systems can adapt to changing conditions, allowing them to maintain control performance despite variations or disturbances, ensuring stable and reliable operation.

4. Automated systems provide real-time monitoring and diagnostics capabilities, enabling early detection of anomalies, faults, or deviations from desired operating conditions. This facilitates proactive maintenance and prevents potential failures.

Designing and implementing effective automated digital control systems for complex objects involve several challenges: [11]

1. Complex objects often have intricate structures and numerous interacting components, making it challenging to model the system accurately and design appropriate control strategies.

2. Integrating different control components, such as sensors, actuators, controllers, and communication networks, into a cohesive system can be complex. Compatibility, data exchange, and synchronization issues need to be addressed.

3. Determining optimal control parameters for complex objects is challenging due to non-linearity, multi-variable interactions, and uncertainties. Controller tuning methods and optimization algorithms need to be developed and applied effectively.

4. Complex objects generate vast amounts of data, requiring efficient data acquisition, processing, and decision-making algorithms for real-time control. Ensuring timely and accurate data acquisition and processing is crucial.

5. Control systems need to be robust against uncertainties, variations, and faults. Designing fault detection, isolation, and recovery mechanisms, as well as implementing redundancy strategies, are essential for reliable operation.

6. With increased connectivity, complex objects are susceptible to cyber threats. Designing secure control systems with authentication, encryption, intrusion detection, and prevention mechanisms is critical for protecting against cyber attacks.

Conflict Setting

In the dynamic landscape of automated control systems (ACS), the path to achieving optimal efficiency, reliability, and user interaction is fraught with challenges.

ACSs hold the promise of making operations more efficient and reliable. But, in the real world, it's not always going smoothly. We delve into a common struggle faced in various

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industries as ACS innovation meets the complexities of different sectors. This conflict lies at the heart of our exploration.

Materials and methods

Automated Control Systems: ACS implements an automated process of collecting, storing and processing information necessary to make comprehensive decisions about the object. The operation of the ACS must be justified, that is, it must lead to useful techno-economic, social or other results. In particular, the use of ACS makes it possible to increase efficiency or reduce errors caused by the human factor, improve the quality of the control object and control itself, etc. The most important task of the ACS is to increase the efficiency of facility management based on the increase in labor productivity and the improvement of management process planning methods. ACS consists of various elements and devices that are interconnected to carry out a certain process.

Let's highlight a number of general requirements for ACS, according to which they should have or provide:

- Means of ensuring compatibility with each other.

The components of the ACS must be compatible with each other, as this helps ensure effective communication and coordination between the component parts. ACSs are often designed to perform specific tasks within a larger system or process, such as those associated with a residential home, such as water, gas, smoke venting, vehicle speed control, or traffic flow control. In many cases, multiple control systems may be needed to work together to achieve a desired result, such as controlling building deformation. Compatibility of control systems can facilitate the integration of new systems or the upgrading of existing ones. For example, if a company wants to add a new management system to its manufacturing process, it will be much easier to do so if the new system can be easily integrated with existing systems. In general, compatibility between ACSs is important to achieve the efficient operation of complex systems, as well as to facilitate the integration and modernization of these systems.

- A sufficient degree of reliability to achieve the stated objectives.

ACSs must have a sufficient degree of reliability to achieve their stated objectives. ACS reliability refers to its ability to perform its intended functions consistently and accurately over time. If the ACS is not reliable, it can lead to real-time system failures and other negative outcomes.

Achieving a satisfactory degree of reliability for an ACS requires careful design, testing and maintenance. Some of the main factors that can affect the reliability of the ACS include:

1. Selection of components: choosing high-quality, reliable components is essential to ensure the reliability of the ACS. Components that are prone to failure or have short lifetimes can significantly reduce overall system reliability.

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2. Additional components include: Incorporating additional components or subsystems into the design of the ACS can ensure that the system continues to function even in the event of a failure or malfunction.
3. Testing: the ACS testing according to the test methodology is necessary to ensure that it functions properly under different conditions.
4. Service: regular maintenance and inspection of the ACS can help identify potential problems and prevent breakdowns before they happen.
    Generally, achieving a sufficient degree of reliability for an ACS is important to ensure that it can achieve its stated objectives and perform intended functions consistently and accurately over time. This requires great attention to design, testing and maintenance, as well as the use of high-quality, reliable and, where necessary, additional components.

  ▪ Sufficient adaptability to changes in the conditions of its use.
ACS must have sufficient adaptability to changes in the conditions of its use. The ability of an ACS to adapt to changing conditions is known as its "flexibility" or "adaptability". This is important because the operating conditions of the system may change over time, and the system must be able to adapt to each change in order to continue to function effectively.
  There are several factors that can affect the adaptation of ACS, including:
1. Scalability: The ACS should be designed with scalability in mind, meaning that it can be easily expanded or modified to meet changing conditions or requirements.
2. Integration of sensors. ACS must be able to integrate with a wide range of sensors and other input devices to be able to collect and analyze data from various sources to adapt to changing conditions.
3. Flexibility of the management algorithm. The control algorithms used by the ACS must be flexible enough to adapt to changes in the controlled process or system. This may involve adjusting set points, changing control strategies, or introducing new control algorithms altogether.
4. User interface. The ACS should have a user-friendly interface that allows operators to change settings easily, adjust parameters, and monitor system performance.
    In general, the adaptability of the ACS is important to ensure that it can continue to function effectively and achieve its objectives under changing conditions. By embracing scalability, sensor integration, flexible control algorithms, and a user-friendly interface, engineers can help ensure that ACS remains adaptable and efficient over time.

  ▪ Monitoring and diagnosis of the correct execution of automated functions, indicating the location, type and cause of violations of the system's correct operation.
The ACS must have monitoring and diagnostic capabilities to ensure the correct performance of automated functions. This is necessary to detect any deviations or malfunctions in the system's operation, that may have significant consequences on the operation, security and efficiency of the system. Monitoring and diagnostic capabilities should provide information about the location, type, and cause of any system malfunction. This information can help to the system operators quickly identify and correct any problems that may occur, thereby minimizing any negative impact on system performance and ensuring that it operates safely

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and reliably. Furthermore, the ability to monitor and diagnose system performance can help identify any patterns or trends that may indicate underlying problems or areas for improvement in system design or performance. This can help optimize system performance and prevent future occurring problems. In summary, monitoring and diagnosing automated control system performance is essential to ensure safe, reliable, and efficient operation.

▪ Measures to protect personnel from wrong actions that lead to an emergency state of the facility or control system, as well as from unauthorized interference and leakage of information.

The ACS should provide means to protect personnel from wrong actions that could lead to emergency situations in the control system, as well as from unauthorized interference and leakage of information. These measures are essential to ensure the safety of personnel.

Some of the activities that ACS can provide include:

1. User access control. A system can implement a strict user access control policy, where users are granted only the privileges necessary to perform their job functions. This can prevent unauthorized access to the system and help protect against accidental or intentional actions that could lead to an emergency.
2. Authentication and authorization. The system may require strong authentication and authorization procedures for users to access the system. This can prevent unauthorized access to the system and ensure that only authorized personnel can make changes to system configuration and operation.
3. Additional safe mechanisms. The system can be designed with additional components to prevent emergencies in case of component failure or malfunction.
4. Training and knowledges. Personnel can be trained and informed of the potential risks and consequences of wrongdoing or unauthorized intervention. This can help prevent accidental or intentional actions that could lead to an emergency.

In summary, the ACS must provide means to protect personnel from wrongdoing and unauthorized interference to ensure the security of the system and its personnel.

Components of automated control systems

Automated control systems usually consist of several components that work together to achieve their goals. Here are some of the key ingredients.

▪ Sensors

Devices that measure physical variables such as temperature, pressure or flow rate. They provide input to the control system.

▪ Actuators

Devices that can be controlled by the system to control physical processes or devices. Examples are motors, valves and relays.

▪ Management algorithms

Sets of instructions that control system behavior based on inputs from sensors. They define how the system should respond to changes in measured physical variables.

▪ Programmable logic controllers (PLC)

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Specialized computers that control actuators based on inputs from sensors and control algorithms.

- Human Machine Interface (HMI)

It is an interface through which a operator can interact with the system. It usually includes a display screen, buttons, and other controls.

- Communication networks

Communication networks play a pivotal role in the functioning of automated control systems. They are the arteries through which data flows, connecting different components and enabling real-time control and monitoring. These networks can be broadly categorized into two main types: wired and wireless. In the system we designed (In our developed system), data is sent over a wired network.Wired networks are characterized by the use of physical cables to transmit data. They are known for their reliability and stability, making them well-suited for applications where data integrity is primary important. In industrial settings, Ethernet-based wired networks are often the backbone of ACS infrastructure, ensuring that critical data reaches its destination without interference.

- Power sources

They provide the power needed to operate various system components such as sensors, motors and PLCs.

System health check

- Checking sensor parameters and making a decision.

The information received from the sensors is processed according to table 1, where the limit values of the sensors are included:

Table 1

Table of limit values of sensors available in automated control system

Sensor name	Minimum value	Maximum value
Temperature sensor 1	-50	500
Humidity sensor 1	0	95
Pressure sensor 1	0	160
…	…	…

Based on table 1, the system makes decisions, and the graphic interface displays information about the given device, whether the device is in a state or not, errors and warnings about the given device are also displayed.

- Sequential execution of actions. The various activities of the ACS process occur in a specific order. A management system involves the sequential execution of clearly defined actions.
- Displaying the states of devices in the system and preparing for actions.
  Data rendering is carried out through a computer with a graphical interface, which represents the current data of the ACS. Based on the data of the devices represented by the graphical interface, certain actions are performed. In other words, the purpose of WHO is not only to collect data, but also to perform actions based on the collected data.

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Based on the above, a program has been developed and offered for the ACS, which allows not only to collect and display the data of all the devices in the system in a graphical interface, but also to manage the system. As a result, two programs were developed, one for the server and the other for the client. The server receives the data from the system's devices through the CAN highway, analyzes them and sends to the user (client) using the UDP protocol. And for the user, in the graphical interface, the data is displayed.

Considering the complexity of such systems, we have presented in our article a method of data collection and monitoring software, the description of the server part that is given below.

Server side

The server program is a console application (Console Application) designed to collect data from the devices of the automatic control system using the Canopen protocol and the Can bus. It then sends this data to the user via the UDP protocol and displays it in the program interface.

The program is developed in the Qt environment, which provides a number of advantages for developers. For example, Qt offers a wide variety of prebuilt widgets and tools that can be used to build cross-platform applications. Qt also provides an integrated development environment (IDE) that simplifies the development process and makes it easy to write, debug, and test code.

The software uses the Canopen protocol, that is a communication protocol used in industrial automation systems to exchange data between devices. CanOpen supports a variety of data types and allows for real-time data exchange, making it ideal for use in ACSs. Additionally, the program uses the UDP protocol to send data to the user. UDP is a lightweight protocol suitable for applications requiring fast and efficient data transfer. It is often used in applications that require real-time communication. Overall, the combination of Qt, Canopen, and UDP provides a powerful set of tools for building applications that require real-time data exchange and efficient communication. Using these technologies, the server software is able to collect data from the devices and send it to the user in a fast, efficient and reliable way.

Note: UDP (User Datagram Protocol) and TCP (Transmission Control Protocol) are two of the most common transport layer protocols in computer networks. TCP is a connection-based protocol, which means that it establishes a connection between two devices before transferring data. This connection is maintained throughout the data transfer, and the two devices exchange data in a sequential and reliable manner. In contrast, UDP is a connectionless protocol, meaning that data is sent without first establishing a connection. This makes UDP faster and simpler than TCP, but also less reliable because packets can be lost or dropped. The main difference between TCP and UDP is speed, as TCP is comparatively slower than UDP. In general, UDP is a much faster, simpler and more efficient protocol, however, retransmission of lost data packets is possible using TCP. It should be taken into account that if data reliability is important in any case, then you should not use the UDP protocol, it is unreliable, but provides a fast connection between the server and the user.

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The CAN (Controller Area Network) bus is a popular industrial network standard that focuses on connecting different devices and sensors in the same network[6]. The CAN interface is actively used in industrial automation, where the CAN standard CiA (CAN in Automation) is used very often [7].

The main features of the CAN protocol are:
- Very high reliability and security,
- Each message has its own priority,
- There is an error detection mechanism,
- Re-sending messages sent in error,
- Data transmission is broadcast,
- There can be several master devices in the same network,
- Wide range of data rates [7].

CANopen is designed as a high-level network protocol that runs on top of the physical CAN protocol. The CANopen protocol contains 8 protocols, but as a rule, different applications use some of them. In particular, only two of them were used in the AKS software: SDO (Service Data Object) and PDO (Process Data Object). SDO and PDO are the 2 main ways of transferring data using the CANopen protocol, which are different from each other. SDO is a slow data transfer method compared to the second major data exchange method PDO.

Qt is a cross-platform environment, where the system was programmed in C++ language [1]. Qt CAN Bus is a simple API for connecting to the CAN bus, sending and receiving CAN frames[8].

In order to receive and send CAN frames, several actions are first performed in the program:

1. A CAN highway device has been created.
2. Checked whether our desired software module is provided by QCanBus or not. QCanBus is one of the Qt classes that provides registration and creation of software modules.
3. It was checked which interface of the selected software module is free.
4. A connection has been established with that interface.
5. After these steps, the device is opened to write and read CAN frames.

We receive the data on the server in the form of SDO or PDO. PDO consists of COB-ID and data. Using COB-ID, we determine from which device the data came and with what protocol. The length of the PDO data packet is limited to 8 bytes.

Data is transferred from the server to the user using the UDP protocol[2]. The data is stored in the server in structures, and depending on the change of one of them, the data is sent to the user (client). The minimum size of the transferred data is 16 bytes, and the maximum size cannot exceed 2400 bytes.

In order to send the data using the UDP protocol, several operations were performed in the program.

1. We need to know the IP address to which we need to send the data, in this case it is the IP address of the user's (client) computer.
2. We need to know the address with which we should send
3. We have integrated the IP address and the protocol in the program for sending data[9]

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Client side

Fig 1. Display of some data received by UDP in the client program

This program is a graphical interface that displays the data of all the devices in the ACS. The program's function is to receive data and display it.

In order to receive the data using the UDP protocol, several operations were performed in the program:

1. Determining which server the server sends the data to.
2. Establishing a connection with the server

After that, the user program displays the data of all the devices in the system.

The graphical user interface is written in QML, a programming language for developing graphical interfaces[3][10]. In figure 1 shows the display of device data in the user program in the ACS.

Research results

In the field of automated control systems (ACS), where data collection and display are instrumental for optimizing efficiency and system performance, research results offer valuable insights into how these systems can be enhanced.

1. Research results indicate that the integration of the CANopen protocol and the UDP protocol within ACSs leads to significant improvements in data collection and transfer, ultimately enhancing the overall system efficiency. Researches have shown that this combination ensures the seamless flow of data from server to user, resulting in a more responsive and streamlined ACS.

2. Research has provided insights into the reliability and precision of data collected using the CANopen protocol in ACSs. It has been demonstrated that the CANopen protocol offers a high degree of accuracy and dependability, outperforming alternative data collection methods and contributing to the overall reliability of the system.

3. Results indicate that advanced graphical interfaces developed in the Qt environment play a pivotal role in user interaction and experience within ACSs. Researches show that such interfaces significantly improve user engagement and make data collection and system operation more intuitive and user-friendly.

4. Research in the realm of complex object control systems highlights the specific challenges faced in implementing digital control systems. These results underscore the significance of addressing system complexity, non-linear dynamics, uncertainties, and other factors unique to complex objects to ensure optimal system performance.

5. Research underscores the critical importance of interdisciplinary collaboration in the development and improvement of digital control systems, particularly when managing complex objects. Studies indicate that interdisciplinary teams can effectively address the multifaceted challenges of these systems.

6. Recent investigations have explored the cybersecurity measures necessary to safeguard data collection and transfer processes within ACSs, especially when advanced protocols like CANopen and UDP are utilized. These researches emphasize the need for robust cybersecurity solutions.

7. Research highlights the significance of designing digital control systems that comply with industry-specific regulations and standards. These results provide insights into how compliance can be achieved without compromising system performance or operation.

8. Research results point to the critical role of real-time data collection and analysis in complex objects. Recent researches have delved into the technologies and strategies required to achieve effective real-time data processing within ACSs.

Conclusion

In the ever-evolving landscape of automated control systems (ACS), our exploration of the integration of advanced protocols, versatile programming environments, and interdisciplinary collaboration has revealed a promising path towards ACS optimization. Through research results, it becomes evident that the integration of the CANopen and UDP protocols can significantly enhance data collection, while the use of user-friendly interfaces in the Qt environment fosters improved user interaction. These advancements are important in ACS efficiency and reliability. Additionally, our investigation into complex object control systems emphasizes the importance of tackling unique challenges within such environments, thus making ACSs more adaptable and capable.

Furthermore, exploration has highlighted the critical relevance of interdisciplinary collaboration in navigating the intricacies of ACSs. Effective cybersecurity measures have proven to be indispensable, as they safeguard data integrity and system stability. Simultaneously, achieving regulatory compliance, ensuring real-time data processing, and promoting energy efficiency all contribute to the holistic improvement of ACSs.

The case studies further affirmed their impact in real-world scenarios. Collectively, these research results underscore the potential for ACSs to not only meet but also exceed expectations in terms of efficiency, reliability, and user experience.

References

1. National standard of the Russian Federation, «Quality of service information», GOST JBlanchette, J., & Summerfield, M. (2008). C++ GUI Programming with Qt 4, Second

Bulletin Of High Technology N4(28) 2023.-pp. 36-49.

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Edition (752 pages). //https://tfetimes.com/wp-content/uploads/2015/09/c-gui-programming-with-qt-4-2ndedition.pdf

2. Thelin, J. (2007). Foundations of Qt Development (534 pages). //http://www.cosmic-rays.ru/books62/2007Johan_Thelin_Foundations_of_Qt_Development.pdf

3. Bocklage-Ryannel, J., Lorquet, C., & Thelin, J. Qt 6 QML (728 pages). //https://www.qt.io/hubfs/_website/QML%20Book/qt6book-with-frontpage.pdf

4. Pfeiffer, O., Ayre, A., & Keydel, C. (2003). Embedded Networking with CAN and CANopen (553 pages).
https://komaragiri.weebly.com/uploads/2/2/5/5/22557070/embedded_networking_with_can_and_canopen_9780976511625.pdf

5. Research and Application of Automatic Control System in Modern Mechanical Engineering //Published by Atlantis Press, 2018.

6. CANopen – The standardized embedded network // https://www.can-cia.org/canopen/

7. CAN protocol. Description, frame format, error control.
https://microtechnics.ru/protokol-can/

8. *Qt Documentation - Qt Serial Bus //*https://doc.qt.io/qt-6/qtserialbus-peakcan-overview.html

9. *Qt Documentation - QUdpSocket //*https://doc.qt.io/qt-6/qudpsocket.html

10. *Qt Documentation - QML Tutorial //*https://doc.qt.io/qt-6/qml-tutorial.html

11. Szewczyk, R., Zieliński, C., & Kaliczyńska, M. (2016). Challenges in Automation, Robotics and Measurement Techniques (886 pages).
https://www.scribd.com/document/452936888/Advances-in-Intelligent-Systems-and-Computing-577-Wojciech-Mitkowski-Janusz-Kacprzyk-Krzysztof-Oprz%C4%99dkiewicz-Pawe%C5%82-Skruch-Eds-Trends-in-Adva

References

1. National standard of the Russian Federation, «Quality of service information», GOST JBlanchette, J., & Summerfield, M. (2008). C++ GUI Programming with Qt 4, Second Edition (752 pages). //https://tfetimes.com/wp-content/uploads/2015/09/c-gui-programming-with-qt-4-2ndedition.pdf

2. Thelin, J. (2007). Foundations of Qt Development (534 pages). //http://www.cosmic-rays.ru/books62/2007Johan_Thelin_Foundations_of_Qt_Development.pdf

3. Bocklage-Ryannel, J., Lorquet, C., & Thelin, J. Qt 6 QML (728 pages). //https://www.qt.io/hubfs/_website/QML%20Book/qt6book-with-frontpage.pdf

4. Pfeiffer, O., Ayre, A., & Keydel, C. (2003). Embedded Networking with CAN and CANopen (553 pages).
https://komaragiri.weebly.com/uploads/2/2/5/5/22557070/embedded_networking_with_can_and_canopen_9780976511625.pdf

5. Research and Application of Automatic Control System in Modern Mechanical Engineering //Published by Atlantis Press, 2018.

6. CANopen – The standardized embedded network // https://www.can-cia.org/canopen/

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7. Протокол CAN. Описание, формат кадра, контроль ошибок.
https://microtechnics.ru/protokol-can/

8. *Qt Documentation - Qt Serial Bus //*https://doc.qt.io/qt-6/qtserialbus-peakcan-overview.html

9. *Qt Documentation - QUdpSocket //*https://doc.qt.io/qt-6/qudpsocket.html

10. *Qt Documentation - QML Tutorial //*https://doc.qt.io/qt-6/qml-tutorial.html

11. Szewczyk, R., Zieliński, C., & Kaliczyńska, M. (2016). Challenges in Automation, Robotics and Measurement Techniques (886 pages).
https://www.scribd.com/document/452936888/Advances-in-Intelligent-Systems-and-Computing-577-Wojciech-Mitkowski-Janusz-Kacprzyk-Krzysztof-Oprz%C4%99dkiewicz-Pawe%C5%82-Skruch-Eds-Trends-in-Adva

ԲԱՐԴ ՕԲՅԵԿՏՆԵՐԻ ԱՎՏՈՄԱՏ ԿԱՌԱՎԱՐՄԱՆ ՀԱՆԳՈՒՑՆԵՐԻՑ ՏՎՅԱԼՆԵՐԻ ՀԱՎԱՔԱԳՐՄԱՆ ԵՎ ԴՐԱՆՔ ԳՐԱՖԻԿԱԿԱՆ ԻՆՏԵՐՖԵՅՍՈՒՄ ԱՐՏԱՊԱՏԿԵՐՄԱՆ ՄԵԹՈԴ

Շահվերդյան Ա.Ա[1,2], **Սմբատյան Ա.L.**[1,2]
¹ Երևանի Կապի Միջոցների Գիտահետազոտական Ինստիտուտ ՓԲԸ
² Ճարտարապետության և Շինարարության Հայաստանի Ազգային Համալսարան

Բարդ օբյեկտները, որոնք բնութագրվում են բարդ գործառնություններով, փոխկապակցված բաղադրիչներով և դինամիկ վարքագծով, յուրահատուկ մարտահրավերներ են ներկայացնում թվային կառավարման համակարգերի համար: Այս հոդվածը ընդգծում է ավտոմատացված թվային կառավարման համակարգերի կարևորությունը այս բարդությունները կառավարելու համար՝ ընդգծելով դրանց կարևոր դերը անվտանգության, հուսալիության և արդյունավետության ապահովման գործում:

Այս մարտահրավերների լուծումը ներառում է համակարգի բարդության, ոչ գծային դինամիկայի, անորոշությունների, իրական ժամանակի պահանջների, տվյալների որակի և օպտիմալացման անհրաժեշտության հետ գործ ունենալը: Ավելին, կանոնակարգային համապատասխանության, անվտանգության, մասշտաբայնության, էներգաարդյունավետության և կիբերանվտանգության ապահովումն ավելացնում է բարդության լրացուցիչ շերտեր:

Այս հոդվածը ուսումնասիրում է թվային կառավարման համակարգերի առջև ծառացած մարտահրավերները, երբ գործ ունենք բարդ օբյեկտների՝ բարդ գործառնություններով և փոխկապակցված բաղադրիչներով համակարգերի հետ: Այն ընդգծում է ավտոմատացված թվային կառավարման կենսական դերը նման սցենարներում՝ անվտանգության, հուսալիության և արդյունավետության ապահովման գործում:

Բանալի բառեր. բարդ օբյեկտներ, թվային կառավարում, ավտոմատացում, հուսալիություն, արդյունավետություն, համակարգի բարդություն, մասշտաբայնություն, արդյունաբերական գործընթացներ:

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МЕТОД СБОРА ДАННЫХ ИЗ УЗЛОВ АВТОМАТИЧЕСКОГО УПРАВЛЕНИЯ СЛОЖНЫХ ОБЪЕКТОВ И ИХ ОТОБРАЖЕНИЯ В ГРАФИЧЕСКОМ ИНТЕРФЕЙСЕ

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Сложные объекты, характеризующиеся сложными операциями, взаимосвязанными компонентами и динамическим поведением, создают уникальные проблемы для цифровых систем управления. В этой статье подчеркивается важность автоматизированных цифровых систем управления в управлении этими сложностями, подчеркивая их решающую роль в обеспечении безопасности, надежности и эффективности.

Решение этих проблем включает в себя решение проблем сложности системы, нелинейной динамики, неопределенностей, требований реального времени, качества данных и необходимости оптимизации. Кроме того, обеспечение соответствия нормативным требованиям, безопасности, масштабируемости, энергоэффективности и кибербезопасности усложняет ситуацию.

В этой статье исследуются проблемы, с которыми сталкиваются цифровые системы управления при работе со сложными объектами — системами со сложными операциями и взаимосвязанными компонентами. В нем подчеркивается жизненно важная роль автоматизированного цифрового управления в обеспечении безопасности, надежности и эффективности в таких сценариях.

Ключевые слова: сложные объекты, цифровое управление, автоматизация, надежность, эффективность, сложность системы, масштабируемость, производственные процессы.

UDC – 621.396

DESIGN OF A SPECIAL SYSTEM (TRANSMITTER-ANTENNA) FOR ANTENNA MEASUREMENTS USING A UAV

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Abstract

In civilian and military radars and communication systems, antennas of various purposes are used, in particular, in the meter range of waves. Meter-band antennas are large pieces of equipment, often covering areas of 30 meters or more.

In the article, there are reasons for the need to measure antennas, their features and requirements for the equipment. The structure of the developed transmitter, circuit solutions, obtained parameters and their comparative analysis are presented. Conclusions are drawn regarding the use of the created facilities.

Keywords: transmitter, antenna measurements, frequency synthesizer, filter.

Introduction

Today, measurements of radio-technical equipment are of great importance, which make it possible to assess their condition and/or quality of preparation. During measurements, the frequency range is important, depending on which the size of the measurement object

changes, which in turn affects the principles and methods of measurement. The only economically effective way for measure such systems is to carry them out using aircraft.. helicopters and UAV [1].

As a rule, specially ordered planes or helicopters are used, on which measuring and transmitting equipment are installed. Flights ordered by the latter are quite expensive and not all countries have such funds. Since the size and weight requirements on the equipment in use until now were quite mild, due to the use of high-powered aircraft, there was no problem with their renewal and downsizing. Today, the development of unmanned aerial vehicles has created an opportunity to look at the above questions in a different way, because it allows to reduce the cost of measurements in an orderly manner [2,4,9]. The above imposes its requirements on the equipment to be used. The equipment is divided into two groups: ground and airborne. Ground equipment is a measuring device-spectrum analyzer controlled by computers. The equipment installed on the flaying object (FO) is a transmitter whose radiation frequency depends on the operating range of the antenna to be measured and must be able to be changed by the control system. The fact that the equipment is installed on FO already imposes certain restrictions and requirements on the latter. Of course, the restrictions are bilateral [1,8]. Limitation on FO, resulting from the necessary flight time, weight of the lifting equipment, as well as limitation on dimensions, mass, power circuit, radiation range of the lifting equipment. The stated requirements cause serious problems in their resolution[1].

Conflict Setting

Present the proposed equipment to be installed on the flying device, which by its size and weight meets the requirements for the use of small UAVs and enables changing the radiation frequency. Present the research results.

Research results

A transmitter device based on a synthesizer that converts the metric wavelength range $\lambda = (8,57...1.5)$ m and the corresponding frequency range into the $f = (35...200)$ MHz range has been developed and investigated. Fig. 1 shows a block diagram of the transmitter.
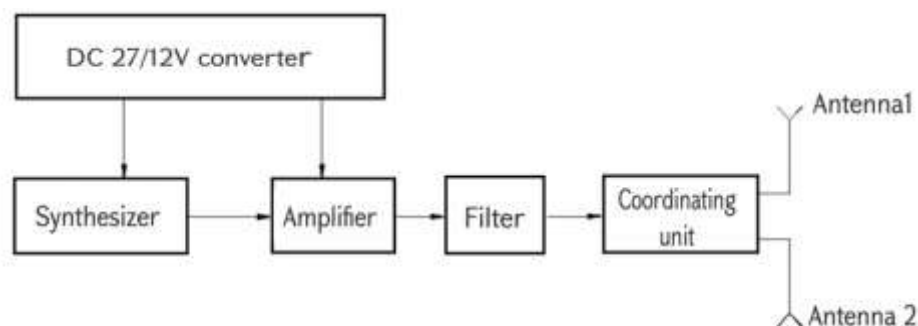
Fig.1 Bloc diagram of transmitter

The ADF4351 microcircuit was chosen as the base of the synthesizer. It is a unit with wide-band phase automatic tuning. The circuit diagram of the synthesizer is given in Fig. 2.

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Fig.2 The circuit diagram of the synthesizer

A GK-163 quartz generator with a frequency of 200MHz and low phase noises was chosen to generate the reference signal of the synthesizer. The electrical schematic diagram of the control and amplification is given in Fig. 3.

Fig.3 The electrical principle diagram of the control and amplification loop

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The signal from the output of the generator is fed to the frequency synthesizer through the DA1 amplifier. The ADL5536 microcircuit was selected as an amplifier. Its necessity is determined by the fact that the level of the output signal of the quartz G1 generator is not sufficient for the input of the synthesizer. The output signal of the synthesizer is fed to the DA2 preamplifier. ADL5536 microcircuit was selected as a pre-amplifier. The amplified signal is then fed to the output amplifier U4. The PHA-202+ microcircuit was chosen as the output amplifier, which provides 1 W output power. The synthesizer is controlled by the U1 microcontroller, which receives commands from the computer through the COM interface. The U3 microcircuit acts as a COM converter. The electrical principle diagram of the control and amplification loop is given in Fig. 3.

A low-frequency filter is designed to suppress high harmonics at the output of the amplifier, the cut-off frequency of which is 250 MHz. The need for such a filter lies in the fact that drones have controlling, communication, and GPS systems on them, and an additional transmitter on drones can interfere with their normal operation. The electrical scheme of the filter ensuring electromagnetic compatibility is given in Fig. 4.
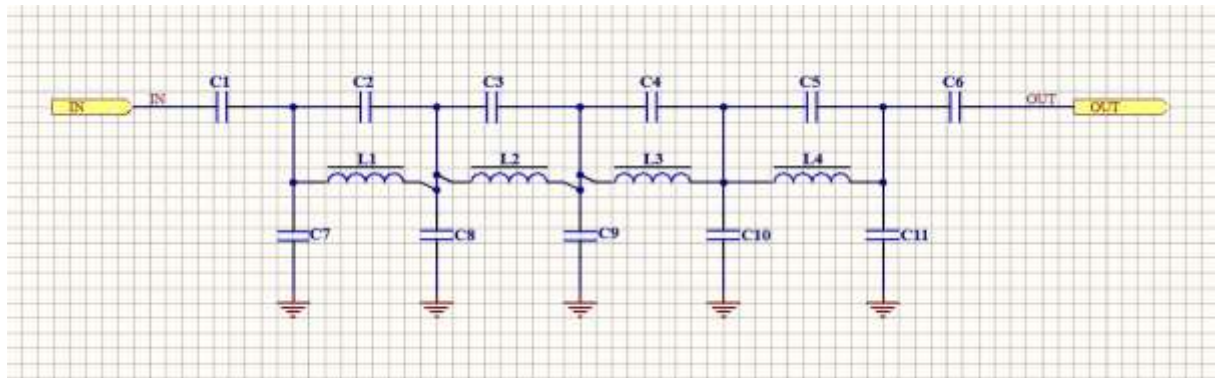
Fig. 4 The electrical scheme of the filter ensuring electromagnetic compatibility

A half-wave dipole antenna was selected as the radiating antenna in the developed system, which, due to its dimensions and weight, is a suitable option for placement on unmanned aerial vehicles. The corresponding matching circuit is used to match the output signal of the filter with the generator. The electrical scheme of the matching node is shown in Fig. 5.
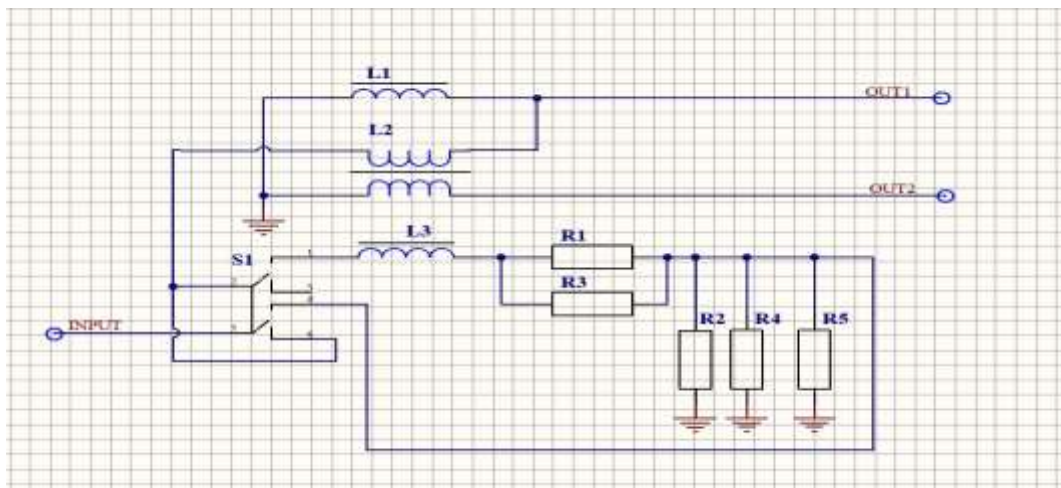
Fig.5 The electrical scheme of the matching node

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A DC converter built on the basis of the LM2576 microcircuit was chosen to feed the transmitter. It converts the 27V voltage of the drone's battery to the 12V required by the transmitter.

The basic electrical circuit of the converter is shown in Fig. 6.
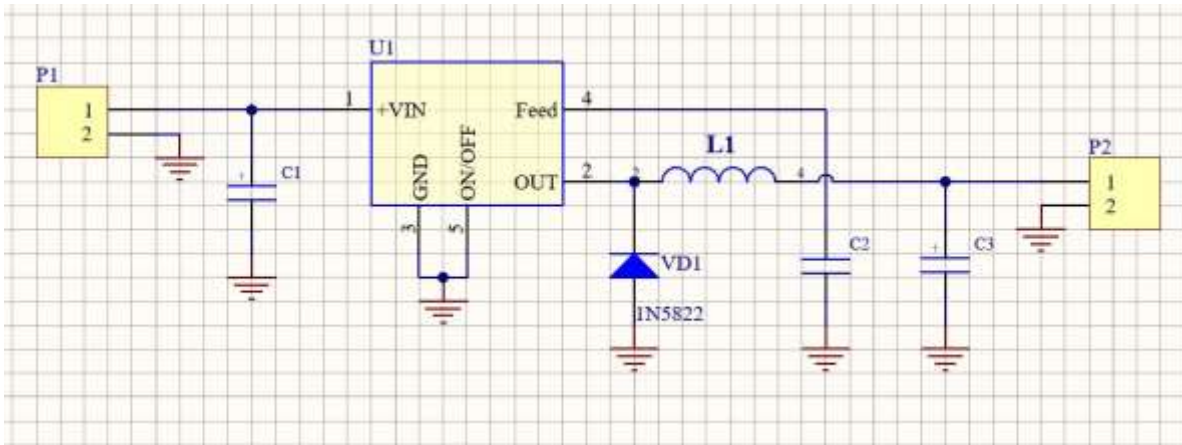
Fig. 6 The basic electrical circuit of the converter

On Fig. 7 shows a view of the conductor assembled in a caprolon case.

Fig.7 A transmitter assembled in a Karoline case

The wings of a half-wave generator are attached to the frame, and a DC converter is assembled on the frame, the image of which is shown in Fig. 8.

The spatial dimensions of the transmitter housing are $(90 \times 65 \times 40)$ mm2, and the weight of the transmitter and half-wave vibrator assembly does not exceed 0.5 kg.

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Fig. 8. A DC converter is assembled on the cover and a half-wave coil attached to it

On Fig. Figure 9 shows the transmitter and half-wave vibrator assembly attached to the drone, which is mounted on a measuring tripod.
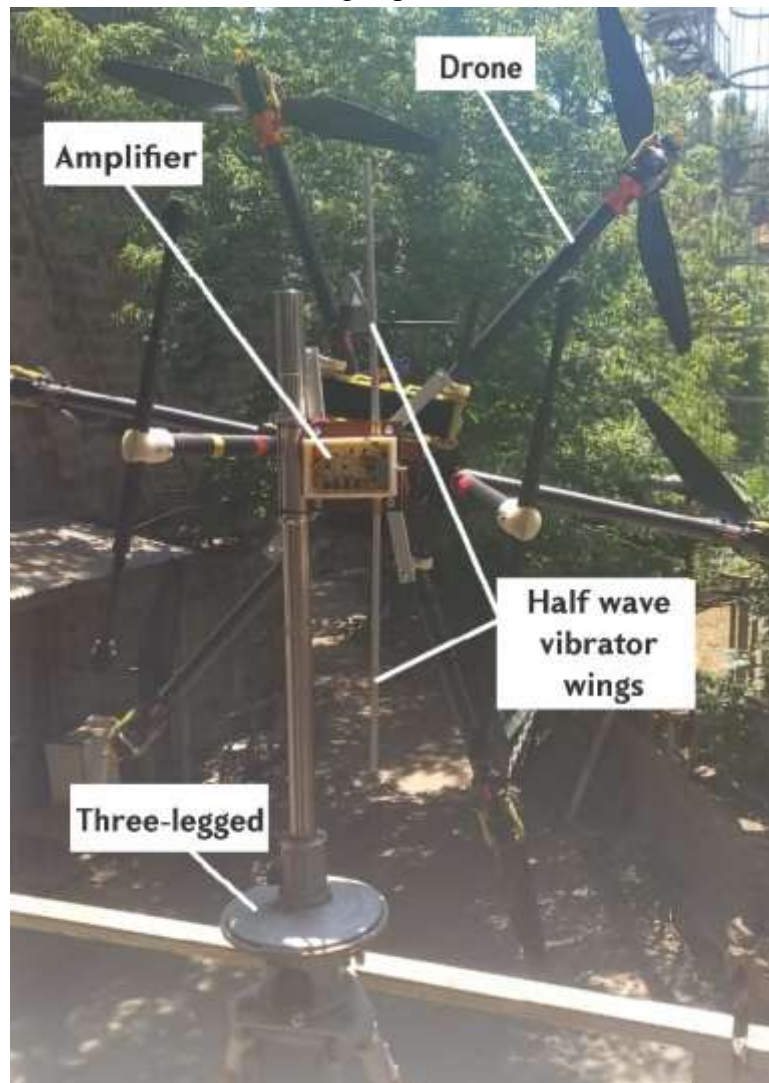
Fig. 9. The drone placed on the measuring tripod with the assembly attached to it

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The results of measuring the Direction Diagram (DD) of the mentioned system in two dimensions are presented in Fig. 10 and 11.
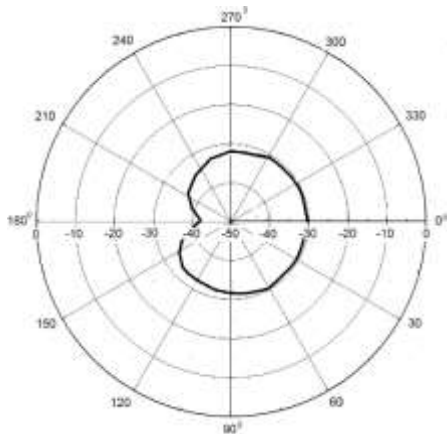
Fig. 10 DD of the System "Drone + transmitter + auxiliary half-wave vibrator + navigator" in the H-plane of the half-wave vibrator at a frequency of 200 MHz
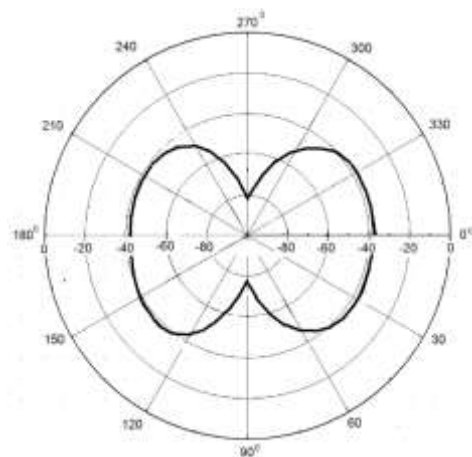
Fig. 11 DD of the System "Drone + transmitter + auxiliary half-wave vibrator + navigator" in the E-plane of the half-wave vibrator at a frequency of 200 MHz

From Fig. 10 it follows that the DD of the "drone + transmitter + auxiliary half-wave vibrator + navigator" system has an insufficient change compared to the DD of the half-wave vibrator at the corner site. It should be noted that when measuring the antenna system under test, it receives the radiation power of the transmitter located on the drone in those angles in which, according to Fig. 10, the radiating system "drone + transmitter + auxiliary half-wave vibrator + navigator" has a fairly even pattern.

Conclusion

Thus, a small-sized, fairly light-weight, frequency-regulated, reliable and necessary power transmitter was developed and built on a modern element basis, which, when installed on a drone, creates an opportunity to perform the parameters of large-sized antenna systems of ultra-short wave radars, in particular, the directivity diagram (DD), with the help of a round flying near object.

The necessary measuring stand was assembled, with the help of which, based on the developed method for measuring weakly directional antennas, the deviation of the DD of the

assembled system "drone + transmitter + auxiliary half-wave vibrator + navigator" from the DD of a single half-wave vibrator in free space was studied.

The results obtained confirm, as expected, that the placement of the half-wave emitter on the drone does not lead to a significant change in the emitter pattern in the indicated angles. This fact is important from the electrodynamic point of view, therefore, if the change in the pattern is significant, it is necessary to take into account the distortion of the pattern when measuring the antenna system under test, when it is necessary to determine the parameters of the test object with high accuracy.

References

1. Patent No. 2814A, Republic of Armenia, MAG G01R 29/00. A method of measuring the directivity diagram of a ground antenna using a helicopter. V.H. Avetisyan, M.V. Markosyan, A.A. Nikoghosyan, A.A. Sargsyan: Championship number: 23.05.2013. Publication number 25.02.2014.6

2. Klassen V.I., Prosvirkin I.A., Levitan B.A., Topchiev S.A. Measurement of radiation characteristics of large antenna using UAVs. Communication Technologies & Equipment,2014, vol. 1, pp.60-65.

3. Klassen V.I., Levitan B.A., Prosvirkin I.A., Topchiev S.A. Method of Antenna directivity Measurement with UAV by test flight Method. Patent RU № 2626561 C1, 2017, bull. no. 22, 9 p.

4. Prosvirkin I.A. Fly-by method for measuring the directivity patterns of large-aperture antennas using an unmanned aerial vehicle and the GLONASS system. Dissertation for the degree of Candidate of Technical Sciences, Kazan', 2018, 157 p.

5. US Patent № 10067172, 04.09.2018 «Far-field antenna pattern characterization via Drone/UAS platform».

6. Gogoberidze Yu.T., Klassen V.I., Levitan B.A., Litnovskij V.Ya., Prosvirkin I.A., Topchiev S.A. Method for automated orientation of an onboard Antenna of an Unmanned Complex for measuring Antennae directivity parameters. Patent RU 2704393 C1, 2019, bull. no. 31, 9 p.

7. Luchin D.V., Minaeva O.A., Spodobaev M.Yu., Trofimov A.P. Yudin V.V. Drone based Software-Hardware Complex for Antenna Array radiation pattern Measurement Telecommunications and Radio Engineering, 2018, no. 10, pp.57-65.

8. Zubkov M.P., Mukhametova A.A., Malkov O.B. Automated measurement process control System Antenna characteristics. Proc. of the X-th All-Russian Scientific and Practical Conference of Students, Postgraduates, Educators and Industry Workers. Information technology and control automation. Omsk, Omsk State Technical University (OmSTU), 2019, pp.114-122.

9. Staravoitov E.I., Russanov V.I., Perspektivnie tekhnologii obletnikh metodov radiotekhnicheskikh izmerenii. Radiostroenie.2022, No 01.C.1-30.

10. A.Kh.Markosyan, M.V.Markosyan, V.H.Avetisyan, H.G.Martirosyan Economic justification for the use of a Drone to Assess the characteristics of Radar Systems. Bulletin of High Technology, Yerevan, N3(27) 2023.-pp.89-94.

ԴՐՈՆՆԵՐԻ ԿԻՐԱՌՄԱՄԲ ԱՆՏԵՆԱՆԵՐԻ ՉԱՓՈՒՄՆԵՐԻ ՀԱՄԱՐ ՆԱԽԱԳԾՎԱԾ ՅՈՒՐԱՀԱՏՈՒԿ ՀԱՄԱԿԱՐԳ (ՀԱՂՈՐԴԱԿ-ԱՆՏԵՆԱ)

Մարկոսյան Մ.Վ., Ավետիսյան Վ.Հ., Մարտիրոսյան Հ.Գ.
Երևանի Կապի Միջոցների Գիտահետազոտական Ինսփիփուփ ՓԲԸ

Տարբեր նշանակության անտենաները, մասնավորապես մետրային ալիքների տիրույթում օգտագործվողները, կիրառվում են քաղաքացիական և ռազմական նշանակության ռադարներում, ինչպես նաև կապի համակարգերում: Հոդվածում բերվում են անտենաների չափումների անհրաժեշտության հիմնավորումները, դրանց յուրահատկությունները և սարքավորման նկատմամբ դրվող պահանջները:

Նկարագրվում է մշակված հաղորդիչի կառուցվածքը, սխեմատիկ լուծումները, ստացված պարամետրերը և դրանց համեմատական վերլուծությունը: Բերված արդյունքները հաստատում են, որ կեսալիքային տատանակի տեղակայումը դրոնի վրա չի բերում տատանակի (ուղղորդվածության դիագրամի) զգալի փոփոխության $0^0...90^0$ անկյունների հատվածում:

Բանալի բառեր. հաղորդակ, անտենային չափումներ, հաճախականությունների սինտեզատոր, զտիչ:

РАЗРАБОТКА СПЕЦИАЛЬНОЙ СИСТЕМЫ (ПЕРЕДАТЧИК-АНТЕННА), ПРЕДНАЗНАЧЕННОЙ ДЛЯ АНТЕННЫХ ИЗМЕРЕНИЙ С ПОМОЩЬЮ БПЛА

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В гражданских и военных РЛС и системах связи применяются антенны различного назначения, в частности, в метровом диапазоне волн.

В статье приведены обоснования необходимости измерения антенн, их особенности и требования, предъявляемые к оборудованию.

Представлены структура разработанного передатчика, схемные решения, полученные параметры и их сравнительный анализ. Сделаны выводы относительно использования созданных средств.

Ключевые слова: Передатчик, антенные измерения, синтезатор частот, фильтр.

THE EFFECT AND POST EFFECT OF ORGANO-MINERAL FERTILIZERS AND GROWTH PROMOTERS ON QUANTITY AND QUALITY OF POTATO YIELD CULTIVATED IN POST-FOREST BROWN SOILS

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Abstract

The article presents the results of the studies on the changes in the quantity and quality indicators of the potato crop under the effect and post-effect of the application of organo-mineral fertilizers and growth promoters in post-forest brown soils, in potato fields grown in drought conditions.

The results of field experiments and laboratory studies showed that equivalent doses of organomix and mineral fertilizers in potato fields had an equal effect on increasing potato yields. In the variants receiving organomix, each ton provided an additional yield of 18-20 c/ha per year of exposure and 3-3.5 c/ha per year of subsequent exposure, while equivalent doses of mineral fertilizers had no reverse effect compared to the tester.

Despite the one-time and fractional application of equivalent doses of organic mixes and mineral fertilizers, as well as in the exposure and post-exposure versions of biofluid, the nitrate content increased compared to the tester (31-114 mg/kg on average during exposure years, 3-15 mg/kg on average during research years). however, their quantities in the potato harvest are within the limits of the MAD (the marginal allowable density).

Keywords: organo-mineral fertilizers, growth promoter, potato, quantity and quality of harvest, effect, post effect.

Introduction

Currently, the intensification of agriculture is of particular importance in solving key issues of the strategy, which can be achieved by the introduction and rooting of scientific achievements, new techniques and technologies, advanced experience. It is necessary to make the processes of product creation manageable in the agroecosystem, having a clear understanding of the natural animal biotic and non-living abiotic components that create the system, to correctly assess the features of their development and influence.

Both in Artsakh and in the Republic of Armenia, small and large collective farms and individual farms are developing at a high speed.

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After the collapse of the Soviet system and the privatization of lands in Artsakh and RA, the process of importing mineral fertilizers was severely reduced in those regions, as a result of which the yield level of agricultural crops also decreased.

In order to maintain the level of yield of agricultural crops, to increase it further, as well as to maintain the fertility of the soil, the use of alternative methods for growing agricultural crops, to develop and apply such a system of fertilization, which will result from the economic possibilities of these regions, becomes of primary importance.

Since 2011, the joint Armenian-Norwegian organization "Orwako" has been producing biohumus, organomix, supercompost and growth-stimulating bio-liquid to farms using the latest biotechnological methods, based on household and agricultural waste, using Californian red worms. That organization also had bases for the supply of organic fertilizers and growth promoters in Artsakh (Stepanakert and Askeran). Biohumus and organomix contain almost all easily assimilated macro and micronutrients for plant nutrition. They contain 40-60% dry organic mass, 10-12, even 18% humus, 20-30% total nitrogen, 2.1-3.2% phosphorus, 2.7-3.1% potassium. In addition to macroelements, the biofluid, which is the aqueous extract of vermicompost, also contains enzymes, hormones, auxins, heteroauxins, etc. [5,9]. A ton of vermicompost is equivalent in its nutritional value to 7-8 tons of manure for plants [5,9], a ton of organomix is equivalent to 5-6. 5 tons of manure [4, 10,12].

Organomix is a biologically active, environmentally friendly organic fertilizer, rich in macro and microelements, a mixture of biohumus, peat and compost. It does not contain pathogenic microorganisms and weed seeds and is safe to use. Bio-liquid, which is obtained from biohumus and is its aqueous extract, is prepared by special fermentation, contains nutrients, humic acids, fulvic acids necessary for plants. Available nitrogen is 10.8 g/l, available phosphorus is 8.8, potassium is 1.7, magnesium is 9.0 [5, 11].

Potatoes are very demanding, especially to organic fertilizers, which, along with providing plants with nutrients, simultaneously improve the agrophysical properties of the soil, creating favorable conditions for plant growth and development not only in the year of application, but also the following year with a subsequent effect [6]. Therefore, a systematic and unified solution to these problems is extremely important and relevant and derives from the requirements of the strategy for the development of agriculture, and is considered one of the priorities of ensuring food security.

Conflict Setting

The aim of the work is to study and find out for the first time the effect and post-effect of the equivalent amounts and application dates of the organomix organic fertilizer, growth-promoting bio-liquid and organo-mineral fertilizers obtained by the Armenian-Norwegian joint enterprise (Orwako) from household and agricultural waste and peat with the latest biotechnological methods in the arid conditions of the foothill zone. on the growth, development, transition of phenological stages and yield of potatoes and compare them with the results of the influence of the ratio of mineral fertilizers used in the region and make recommendations for agricultural production to maintain the level of soil fertility in the region and obtain ecologically safe food through the gradual development of organic agriculture.

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THE EFFECT AND POST EFFECT OF ORGANO-MINERAL FERTILIZERS AND GROWTH PROMOTERS ON QUANTITY AND QUALITY OF POTATO YIELD CULTIVATED IN POST-FOREST BROWN SOILS

The studies on the effects of the mentioned fertilizers and growth promoters were carried out in 2021-2023, and concerning the post-effect - in 2022-2023. The field experiments were carried out in post-forest brown soils, which are characteristic for the region also in the sense that the predominant part of the potato fields (86.2%) is cultivated in this soil type.

The environmental reaction of the soils of the experimental field: the humus content is 3.3-3.4%, the pH ranged from 6.9 to 7.1, available nitrogen (N) is weakly (3.4-3.6 mg) provided, with mobile phosphorus- medium (P_2O_5 is 5.1-5.3 mg), exchangeable potassium is good (K_2O in 100 g of soil: 34.0-36 mg).

Field experiments were set up with 3 replications, with the following options:

1. Checker (without fertilization)
2. Organomix 8t/ha one time, in sowing
3. Organomix 10t/ha one time, in sowing
4. Organomix 5t/ha one time, (in sowing)+$N_{30}P_{40}K_{40}$ (in sowing)+ N_{30} with nutrition
5. Organomix 5t/ha in sowing+ Organomix 3t/ha (with nutrition)+ bio-liquid 14l/ha (nutrition)
6. Bio-liquid 14l/ha soaking the planting material + organomix 5t/ha (in sowing)+organomix 3t/ha (nutrition)
7. $N_{80}P_{80}K_{80}$ (in sowing)+ N_{40} (nutrition)

Studies were carried out both in the impact and post-impact years on the Impala variety of potatoes, the planting rate of which was 32.8 c/ha, further processing and harvesting were carried out according to the agro-rules adopted in the region.

The amounts of organo-mix and NPK were given in such a way that the content of nutrients in them provides the equivalent amount of application of these fertilizers. Agrochemical and quality indicators of soils, plants and tubers were determined by universal methods [9], nitrates with the help of "Soex" nitrate meter. The yield data were subjected to mathematical analysis, dispersion analysis method, determination of Sx,% and AET 0.95 c, experimental error and the most significant difference [7,8].

Research Results

According to the average data of the three-year repetitions of the field experiments, the equivalent doses and application periods of organo-mineral fertilizers, as well as different methods of applying the growth-promoting bio-liquid had a significant effect on the yield of potatoes grown in drought conditions. It is noteworthy that the effect and after-effect patterns of the application of the mentioned fertilizers and growth promoters have been preserved everywhere, but the harvest level of 2022 and 2023 is higher than that of 2021. Thus, if in 2022 and 2023 the yield of potatoes without fertilization was 150.0 and 156.0, respectively, then in 2021 it was 142.4 c/ha or about 8-14 centners less (Table 1). This circumstance is explained by the fact that both in 2022 and 2023, the amount of atmospheric precipitation (562 mm and 584 mm, respectively) and the number of sunny days during tuber accumulation (38 and 39) were more favorable for potato growth and development than in 2021 with relatively little precipitation (476mm) and sunny days (25 days). From the data in Table 1, it can be seen that, on an average of 3 years, the equivalent doses of organo-mineral fertilizers

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(Organomix 8t/ha (one-time) and $N_{80}P_{80}K_{80}+ N_{40}$) had an almost equal effect on the increase in potato yield compared to the version without fertilization (the yield increase was 150.8 t/ha, respectively) ha (100.9%) 147.2 c/ha (98.5%), but when the potato planting material was moistened with a bioliquid solution in the version of fractional application of organic mix, the average of 3 years compared to the version without fertilization was the highest: 215.2 c /ha or 144.0%, even compared to the version where the same rate of bio-liquid was given as foliar nutrition (at the stage of cocooning), the yield increase was 169.2 c/ha (113.2%), or by changing the method of applying bioliquid to tubers up to the difference in crop yield was 46.0 c/ha or 30.8% compared to planting by wetting, foliar feeding method.

The advantage of using bioliquid, the method of soaking the planting material before planting, compared with foliar nutrition is due to the fact that the bioliquid promoted the germination of dormant buds at the base of the potato planting material, which resulted in the formation of more above-ground (stems) and underground (stolons) organs, which led to an increase in potato yields.

Table 1

The effect of organomineral fertilizers and growth promoter on the amount of potato harvest according to post- effect years (2021-2023)

N/N	Variants	The average yield, c/ha (2021)	The extra crop c/ha	The extra crop %	The average yield, c/ha (2022)	The crop c/ha	extra %	The average yield, c/ha (2023)	The crop c/ha	extra %	The average yield of three years, c/ha (2021-2023)	The crop c/ha	extra %
1	Checker (without fertilization)	142,4	-	-	150,0	-	-	156,0	-	-	149,5	-	-
2	Organomix 8t/ha one-time, in sowing	290,0	147,6	103,7	301,0	151,0	100,7	310,0	154,0	98,7	300,3	150,8	100,9
3	Organomix 10t/ha one-time, in sowing	296,0	153,6	107,9	315,0	165,0	110,0	312,0	156,0	100,0	307,8	158,3	105,9
4	Organomix 5t/ha, in sowing $N_{30}P_{40} K_{40}$(in sowing)+) N_{30} with nutrition	300,0	157,6	110,7	307,0	157,0	104,7	316,0	160,0	102,6	307,7	158,2	105,8
5	Organomix 5t/ha, in sowing + Organomix 3t/ha, with nutrition +bio-liquid 14l/ha (nutrition)	307,0	164,6	115,6	322,0	172,0	114,7	327,0	171,0	109,6	318,7	169,2	113,2
6	Bio-liquid14l/ha by soaking the planting material +organomix 5t/ha (in sowing)+organomix 3t/ha (nutrition)	342,0	199,6	140,2	372,0	220,0	148,0	380,0	224,0	143,6	364,7	215,2	144,0
7	$N_{80}P_{80}K_{80}$ (in sowing)+ N_{40} (nutrition)	285,0	142,6	100,1	300,0	150,0	100,0	305,0	149,0	95,5	296,7	147,2	98,5
	Sx,%	1,5			1,3			1,9					
	MSD 0,95 c	5,4			4,8			6,8					

At the same time, it can be seen from the data in Table 1 that the fractional application of organomix and mineral fertilizers and their joint equivalent doses compared to one-time applications had a more beneficial effect on increasing the number of crops and compared to the option without fertilization, if in the case of one-time application of organo-mineral fertilizers (variants 2 and 7) crop addition was 100.9 and 98.5% then their equivalent joint doses were 105.8%.

According to the results of the studies, the amounts of mineral and organic fertilizers given during the previous year had some reverse effect on the increase of the potato harvest.

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As it can be seen from the data in Table 2, in the versions that received organomix, on average for 2022-2023, each ton given in the previous year provided an additional yield of about 3-3.5 c/ha in the following year, while mineral fertilizers provided a crop additive in very small quantities, compared to the tester, 2.5 c/ha (1.6%), which is within experimental error and is not significant.[Fig.1]
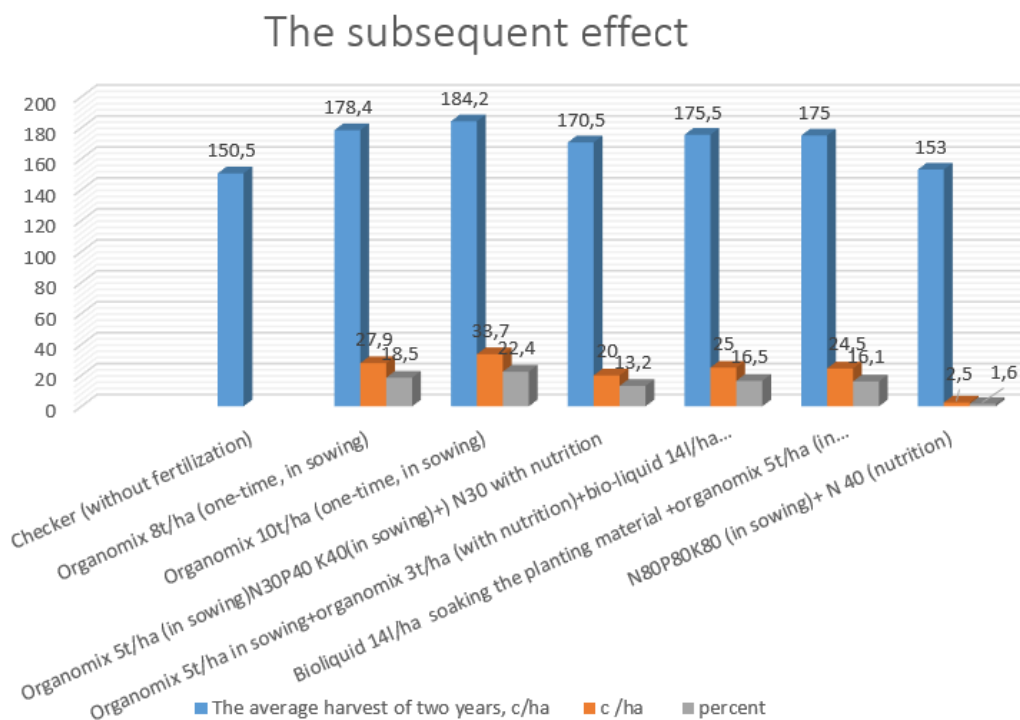
Fig.1 The subsequent sffect

This is probably explained by the fact that the organic matter in the organomix does not manage to fully decompose and turn into mineral nutrients in the first year of application and becomes more available to plants in the following year of application.
Along with an increase in potato yield, as well as the structure of the crop, it is very important what effect or subsequent effect this fertilizer or a combination of fertilizers has on the quality indicators of the most important food product, the potato.

Studies conducted by us in the period from 2021 to 2023 concerning the effects of fertilizers and growth stimulants, in the period from 2022 to 2023 concerning the subsequent effects, showed that if a single and fractional application of organomix and growth-stimulating bio-liquid positively affected the increase in starch and vitamin C (ascorbic acid) in potato tubers, mineral fertilizers, on the contrary, reduced or caused almost no change compared to the control variant (Tab. 3). According to the average data of three years, if the content of dry matter and starch in the test version was 20.8 and 15.2%, the output was 31.1 and 22.7 c/ha, then organomix 8t/ha and bioliquid 14l/ha by soaking the planting material+ the content of these indicators in the options of organomix 5t/ha (in sowing) + organomix 3t/ha (nutrition) was 24.0; 19.0%, output: 72.1; 57.1 c/ha and 24.0; 19.2%, output: 87.5; 70.0 c/ha, then in the variant that received only mineral fertilizers (variant 7), the content of dry matter and starch was 22.9, respectively; 15.9% and 67.9%; 47.2 c/ha.

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Table 2

The subsequent effect of organomineral fertilizers and growth promoter on the amount of potato harvest by year (2022-2023)

N/N	Variants	2022			2023			2022-2023		
		The average yield, c/ha	The extra crop		The average yield, c/ha	The crop	extra	The average yield of two years, c/ha	The crop	extra
			c/ha	%		c/ha	%		c/ha	%
1	Checker (without fertilization)	149,0	-	-	152,0	-	-	**150,5**	-	-
2	Organomix 8t/ha one-time, in sowing	176,6	27,6	18,5	180,2	28,2	18,6	178,4	27,9	18,5
3	Organomix 10t/ha one-time, in sowing	183,4	34,4	23,1	185,0	33,0	21,7	184,2	33,7	22,4
4	Organomix 5t/ha, in sowing $N_{30}P_{40} K_{40}$(in sowing)+) N_{30} with nutrition	170,0	21,0	14,1	171,0	19,0	12,5	170,5	20,0	13,2
5	Organomix 5t/ha, in sowing + Organomix 3t/ha, with nutrition +bio-liquid 14l/ha (nutrition)	174,0	25,0	16,8	176,9	24,9	16,4	175,5	25,0	16,5
6	Bio-liquid14l/ha by soaking the planting material +organomix 5t/ha (in sowing)+organomix 3t/ha (nutrition)	174,8	25,8	17,3	175,2	23,2	15,3	175,0	24,5	16,1
7	$N_{80}P_{80}K_{80}$ (in sowing)+ N_{40} (nutrition)	152,0	3,0	2,0	154,0	2,0	1,3	153,0	2,5	1,6
	Sx,%	1,8			1,6					
	MSD 0,95 c	6,4			5,4					

Table 3

Effects and post-effects of organomineral fertilizers and growth promoters on dry matter, starch content and output, vitamin C and nitrate content in potato tubers

N/N	Variants	Effect of fertilizers and growth promoters (2021-2023 average)						Aftereffect of fertilizers and growth promoter (2022-2023 average)					
		Dry matter,%	starch%	vitamin C, mg %	Output c/ha		content of nitrates mg/kg	Dry matter,%	starch, %	vitamin C, mg %	Output c/ha		Nitrate content mg/kg
					Dry matter	starch					Dry matter	starch	
1	Checker (without fertilization)	20,8	15,2	10,0	31,1	22,7	78,0	20,6	14,9	9,9	31,0	22,4	75,0
2	Organomix 8t/ha one-time, in sowing	24,0	19,0	10,8	72,1	57,1	109,0	21,2	15,6	10,0	37,6	27,8	78,0
3	Organomix 10t/ha one-time, in sowing	24,6	19,1	10,9	75,7	58,8	139,0	21,4	15,6	10,2	39,4	28,7	80,0
4	Organomix 5t (in sowing) N30P40 K40 (in sowing)+) with N30 nutrition	23,2	18,5	11,0	71,4	56,9	150,0	21,0	15,2	10,2	35,8	25,9	76,0
5	Organomix 5t/ha in sowing + organomix 3t/ha (with nutrition) + bio-liquid 14l/ha (nutrition)	23,9	19,2	11,2	76,2	61,2	135,0	21,6	15,8	10,4	37,9	27,7	76,0
6	Bio-liquid 14 l/ha by soaking the planting material + organomix 5 t/ha (in sowing) + organomix 3 t/ha (nutrition)	24,0	19,2	11,1	87,5	70,0	140,0	22,0	16,0	10,4	38,5	28,0	76,0
7	$N_{80}P_{80}K_{80}$ (in sowing)+ N_{40} (nutrition)	22,9	15,9	9,9	67,9	47,2	192,0	20,8	15,0	9,9	31,8	23,0	75,0

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A similar pattern was observed in ascorbic acid content. The content of vitamin C in the tubers was 9.9 mg% in the version of the full ratio of mineral fertilizers, and 10.8-11.2 mg% in the versions that received organomix and growth promoter or only organomix.

From the results of the analysis of the content and output of dry matter, starch and vitamin C in potato tubers obtained as a result of the effects of applied organomineral fertilizers and a growth stimulant, shown in Table 3, it is clear what effect organomineral fertilizers individually or in combination and their equivalent dosages had on potato yield.This pattern manifested itself in qualitative indicators, as well as in the amount due to the harvest.

According to the two-year post-impact data, under the influence of one-time and fractional application of organomix compared to the control version, the content of dry matter and starch increased by only 0.6-1.4% and 0.7-1.1%, the output was 6.6-7 .5 and 5.4-6.3 c, while no significant changes in vitamin C content were observed in post-exposure years. Therefore, it can be stated that the application of organomix, regardless of the form of application, had a more positive effect and post-effect on the quality indicators of potatoes (dry matter, starch, vitamin C, nitrates) than the equivalent doses of mineral fertilizers.

Conclusion

In post-forest brown soils, in potato fields grown in arid conditions, the one-time application of equivalent amounts of organic and mineral fertilizers almost equally affected the amount of potato harvest, while the fractional or joint application of these fertilizers had a more beneficial effect on the mentioned indicators than their one-time application.

Bio-liquid, as a growth stimulator, significantly contributes to the rapid germination of potato seedlings, the increase of above-ground and underground organs, and as a result, soaking the tubers with the same amount of bio-liquid before planting, increases the amount of potato harvest compared to the method of foliar nutrition (three-year average: 46.0 c/ha). or 30.8%), increases output of dry matter and starch content while providing environmentally safe high-quality potatoes.

Despite the one-time and fractional application of equivalent doses of organomix and mineral fertilizers in the impact and post-effect options, compared to the variant without fertilization, the nitrate content increased (in the case of exposure by 31-114 mg/kg, in the case of after-effect by 3-15 mg/kg), but their amounts in the potato crop is within the limits of the MAD (the MAD for nitrate content in the open field is 250 mg/kg).

Due to the limitations and high cost of mineral fertilizers, in case of their absence, crop fields must be fertilized with an organomix norm of 8 t/ha, 60% of which is in sowing, 40%, in the case of potatoes, the planting material must also be treated with a bio-liquid solution of 14 l/ha, as a result, in arid conditions 350-365 c/ha will be provided in the year of exposure, 175 c/ha (additional harvest of 25 c/ha) of potato crop - in the post-impact year, which was proposed to be invested in farms.

References
1. Avagyan V. A., Haykazyan V.Ts. Production and application of biohumus, «Hay-Edit» publishing house, 1998, -22

2. Avagyan V. A. "Agroecology" - Yerevan, 2004, 100 p.

3. Galstyan M.H. Fertilization efficiency of winter wheat and potatoes in the conditions of the Sevan basin. Yer: Limoush. 2007-156 p.

4. Galstyan M.H., Markosyan M.S.; Simonyan L. L.; Nalbandian L.S., Aleksanyan V.A; The effect of application dates of different doses of organic fertilizers and growth promoters on the dynamics of nutrient accumulation in potato plants and their removal with the crop. Biological journal of Armenia. LXXII 1-2, 2020, pp. 9-16.

5. Orwako - production and composition of bio-humus, organomix, bio-liquid. c. Abovyan, 2014, 19p.

6. Movsisyan Y.M. Basics of agrochemistry - Yerevan, "Armenia" publishing house, 1971, 465 p.

7. Dospehov B. A. Methodology of field experience, M Kolos, 1973, 336 p.

8. Mineev V.G. Agrochemistry, M., Kolos. , 2004, 719 p.

9. Yagodin B. A., Smirnov P. M., Peterburgsky A. V. Agrochemistry (methods of plant and soil analysis) Ed. B. A. Yagodina. 2nd ed. additional, M., Agropromizdat, 1989, 639 p.

10. Aleksanyan V.A., MirzoyanM. Sh., Galstyan S. B., Galstyan M. H. (2023) Determination of the economic-ecological effectiveness of using organic mineral fertilizers and growth promoters in potato crops cultivated in the foothills of the republic of Artsak, Bulletin of High Technology N1 (25) 2023.-pp. 48-58. hhttps://doi.org/10.56243/18294898-2023.1-48

11. Mirzoyan M.Sh. The influence of introducing organic nutrients and growth stimulant into the soil in different periods on the growth, development and formation of potato tubers in arid conditions of the foothill zone, Bulletin Of High Technology N4 (23) 2022.-pp. 40-49. https://doi.org/10.56243/18294898-2022.4-40

12. Organomineral fertilizer as an alternative for increasing potato yield and quality //http://dx.doi.org/10.1590/1807-1929/agriambi.v26n4p306-312

References

1. Ավագյան Վ. Ա., Հայկազյան Վ.Յ. Կենսահումուսի արտադրությունը և կիրառությունը, Հայ-Էդիտ հրատ.,1998, -22 էջ:

2. Ավագյան Վ. Ա., «Ագրոէկոլոգիա» – Երևան, 2004թ, էջ:

3. Գալստյան Մ.Հ. Աշնանացան ցորենի և կարտոֆիլի պարարտացման արդյունավետությունը Սևանի ավազանի պայմաններում: Եր. «Լիմուշ», 2007, 156էջ:

4. Գալստյան Մ.Հ., Մարկոսյան Մ.Ս., Սիմոնյան Լ.Լ., Նալբանդյան Լ.Ս., Ալեքսանյան Վ.Ա Օրգանական ծագման պարարտանյութերի և աճի խթանիչի տարբեր չափաբանակների կիրառման ժամկետների ազդեցությունը կարտոֆիլի բույսերում սննդատարրերի կուտակման դինամիկայի և բերքի հետ դրանց օտարման վրա //Հայաստանի կենսաբանական հանդես, Եր., 2020, LXXII, N1-2, էջ` 9-16:

5. Օրվակո (Orwako) -Կենսահումուսի, օրգանոմիքսի, կենսահեղուկի ստացումը և բաղադրությունը //Աբովյան, 2014թ, 19 էջ:

6. Մովսիսյան Ե.Մ. Ագրոքիմիայի հիմունքներ //Եր., «Հայաստան» հրատ., 1971, 465 էջ:

7. Доспехов Б. А. Методика полевого опыта //М: «Колос», 1973, 336 с.

8. Минеев В. Г. Агрохимия //М: «Колос», 2004, 719 с.

9. Ягодин Б. А., Смирнов П. М., Петербургский А. В. Агрохимия (методы растительных и почвенных анализов) / Под ред. Б. А. Ягодина. 2-е изд. с доп., //М: «Агропромиздат» 1989, 639с.

10. Aleksanyan V.A., MirzoyanM. Sh., Galstyan S. B., Galstyan M. H. (2023) Determination of the economic-ecological effectiveness of using organic mineral fertilizers and growth promoters in potato crops cultivated in the foothills of the republic of Artsak, Bulletin of High Technology N1 (25) 2023.-pp. 48-58. hhttps://doi.org/10.56243/18294898-2023.1-48

11. Mirzoyan M.Sh. The influence of introducing organic nutrients and growth stimulant into the soil in different periods on the growth, development and formation of potato tubers in arid conditions of the foothill zone, Bulletin Of High Technology N4 (23) 2022.-pp. 40-49. https://doi.org/10.56243/18294898-2022.4-40

12. Organomineral fertilizer as an alternative for increasing potato yield and quality //http://dx.doi.org/10.1590/1807-1929/agriambi.v26n4p306-312

ՕՐԳԱՆԱՀԱՆՔԱՅԻՆ ՊԱՐԱՐՏԱՆՅՈՒԹԵՐԻ և ԱՃԻ ԽԹԱՆԻՉԻ ԱԶԴԵՑՈՒԹՅՈՒՆՆ ՈՒ ՀԵՏԱԶԴԵՑՈՒԹՅՈՒՆԸ ՀԵՏԱՆՏԱՌԱՅԻՆ ՇԱԳԱՆԱԿԱԳՈՒՅՆ ՀՈՂԵՐՈՒՄ ՄՇԱԿՎՈՂ ԿԱՐՏՈՖԻԼԻ ԲԵՐՔԻ ՔԱՆԱԿԻ ԵՎ ՈՐԱԿԻ ՎՐԱ

Միրզոյան Մ.Շ.
Շուշիի տեխնոլոգիական համալսարան

Ներկայացված են հետանտառային շագանակագույն հողերում, բնական պայմաններում աճեցվող կարտոֆիլի դաշտերում օրգանահանքային պարարտանյութերի և աճի խթանիչի կիրառման ազդեցությամբ և հետազդեցությամբ կարտոֆիլի բերքի քանակի և որակական ցուցանիշների կրած փոփոխությունների վերաբերյալ կատարված ուսումնասիրությունների արդյունքները: Դաշտային փորձերի և լաբորատոր հետազոտությունների արդյունքներով բացահայտվել է, որ կարտոֆիլի դաշտերում օրգանոմիքսի և հանքային պարարտանյութերի համարժեք չափաքանակները հավասարապես են ազդել կարտոֆիլի բերքի քանակի ավելացման վրա: Օրգանոմիքս ստացած տարբերակներում, յուրաքանչյուր տոննան ազդեցության տարում ապահովել է 18-20g/հա, իսկ հետազդեցության տարում՝ 3-3,5g/հա հավելյալ բերք, մինչդեռ հանքային պարարտանյութերի համարժեք չափաքանակները ստույգիչ համեմատ հետազդեցություն չեն ունեցել: Չնայած օրգանոմիքսի և հանքային պարարտանյութերի համարժեք չափաքանակների միանվագ և կոտորակային կիրառման, ինչպես նաև կենսահեղուկի ազդեցության և հետազդեցության տարբերակներում, ստույգիչ

համեմատությամբ նիտրատների պարունակությունը ավելացել է (ազդեցության տարիների միջինով 31-114 մգ/կգ, հետազոտության տարիների միջինով՝ 3-15մգ/կգ-ով), սակայն դրանց քանակությունները կարտոֆիլի բերքում գտնվում է ՍԹԽ-ի շրջանակներում:

Բանալի բառեր: օրգանահանքային պարարտանյութեր, աճի խթանիչ, կարտոֆիլ, բերքի քանակ և որակ, ազդեցություն, հետազդեցություն

ВОЗДЕЙСТВИЕ И ПОСЛЕДСТВИЕ ОРГАНО-МИНЕРАЛЬНЫХ УДОБРЕНИЙ И СТИМУЛЯТОРОВ РОСТА НА КОЛИЧЕСТВО И КАЧЕСТВО УРОЖАЙНОСТИ КАРТОФЕЛЯ, КУЛЬТИВИРУЕМОГО НА ЗАЛЕСНЫХ БУРОЗЕМАХ

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Представлены результаты исследований по изменению количественных и качественных показателей урожая картофеля под влиянием применения органо-минеральных удобрений и стимуляторов роста на залесных буроземах, на полях картофеля, выращиваемого в условиях засухи. По результатам полевых опытов и лабораторных исследований выявлено, что эквивалентные дозы органических смесей и минеральных удобрений на картофельных полях одинаково повлияли на увеличение количества урожая картофеля. В вариантах полученного органомикса каждая тонна в год воздействия обеспечивала 18-20 ц/га, а в год последствия – 3-3,5 ц/га прибавочного урожая, тогда как эквивалентные дозы минеральных удобрений по сравнению с контролем не имели последствий. Несмотря на однократное и частичное применение эквивалентных доз органомикса и минеральных удобрений, также как в вариантах воздействия и последствия биологической жидкости по сравнению с контролем содержание нитратов увеличилось (в годы воздействия в среднем – 31-114мг/кг, в годы последствия в среднем 3-15 мг/кг), однако их количества в урожае картофеля находятся в рамках УДН (установленных дозволенных нарушений).

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Abstract

The most unstable and ungovernable class of society is the poor. The goal of socio-economic development in any country is to ensure stability, which is practically impossible to achieve if the country has a high level of poverty. Policy makers aiming to reduce it and improve the living standards of the poorest need to be able to get accurate information about who, where, and why is in that situation. Poverty looks and measures differently in different countries. Reducing poverty is one of the goals of the sustainable development program adopted by the United Nations. It should be noted that the above-mentioned UN program includes 16 more goals that address various socio-economic needs, from educational outcomes to environmental sustainability, that must be met for people and communities to live a life of dignity.

It is proposed to solve the problem of poverty reduction in the context of developing and implementing a flexible policy of income distribution and redistribution. The main tool in this process can be the provision of mass employment of the population.

Keywords: poverty, Gini coefficient, incomes and expenses of the population, social policy, state support for the vulnerable classes of the population.

Introduction

In the modern world, poverty has been and continues to be a socio-economic evil. The authorities of almost all countries of the world, as well as international organizations (UN, World Bank, etc.), implement many programs aimed at reducing the level of poverty. As evidenced by the indicators of the reduction of extreme poverty in the world, the countries with the largest population in the world have recorded the most notable successes in that process. In particular, extreme poverty has almost disappeared in China. However, poverty will continue to be a focus of attention for national governments. It should be noted that due to the Russian-Ukrainian and Middle East wars, an increase in food and energy prices is observed in the world market, which primarily affects the poor population.

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Poverty refers to the lack of sufficient income and productive resources to sustain a sustainable livelihood. Its manifestations include hunger and malnutrition, limited access to education, health, recreation, and other basic services, social discrimination and exclusion of inequality, in general, a decrease in citizen activity.

In the solution to that problem, indicators related to poverty, both globally and for a separate group of countries, become important in their dynamics.

In 2015, more than 736 million people lived below the international poverty line. About 10 percent of the world's population (pre-pandemic) lived in extreme poverty and struggled to meet the most basic needs, such as health, education, and access to water and sanitation. For every 100 men in the same age group, 122 women aged 25 to 34 live in poverty, and more than 160 million children are at risk of living in extreme poverty by 2030 [1].

Significant progress has been made in reducing poverty in recent decades. According to the most recent estimates, 10 percent of the world's population lived on less than $1.90 a day in 2015. That's down from 16 percent in 2010 and 36 percent in 1990. This means that eradicating extreme poverty is within humanity's reach. However, the decline has slowed down. In April 2013, the World Bank set a new goal of ending extreme poverty within a generation. The new goal is that by 2030, no more than 3 percent of the world's population will be able to live on just $1.90 a day. By measuring the level of poverty, an opportunity is created to specify and implement the strategy for overcoming poverty. Measuring poverty also helps developing countries assess program effectiveness and guide their development strategies in a rapidly changing economic environment. The problem of income inequality in the population has always been at the center of attention of both socio-economic policymakers and various authors. The analyses made in their research and specially elaborated recommendations are dedicated to the alleviation of that especially social defect that hinders economic development and thus to the promotion of progress in both global and national economies.

According to, Livingstone et al.'s (2020) article [2] scarcity and poverty lead to psychological distress that depletes basic cognitive resources. There is a strong correlation between low-wage workers and limited education, suggesting that less education is a cause of poverty. Therefore, to address the global challenge of poverty, it makes sense to embrace the idea of increasing school maintenance and training activities to increase the opportunities for low-income workers and families to find better jobs and earn better wages. A significant relationship exists between income inequality and capitalist production relations, and the capitalist system can increase poverty because it encourages and allows for freedom of choice, self-interest, market mechanisms, and limited government intervention. In a capitalist society, the owners of capital in the value chain, based on their economic dominant position in society (insofar as they are the owners of the means of production, capital) tend to exploit wage workers by paying them for only part of their labor, which leads to the exploitation of wage workers' labor by capitalists and continue to get rich at a faster rate, mainly at the expense of hired labor.

According to Schweiger (2019) [3], poverty can have a temporary or permanent dimension, as it can be short-term, long-term or it can be chronic. Creating situational vulnerability and exposing the various harms that poverty has on children's lives is contrary to

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ethical and moral obligations. Parents and society at large must adopt strategies and practices that promote the overall well-being of all children. As Schweiger attests, no child should be raised in poverty to be deprived of basic human needs, as this can affect them throughout their childhood and even after they grow up. Parents are believed to be influenced or blamed for raising their children in poverty. This is because parents may have made poor financial and family management decisions, or they may have supported their children when they had alternative means of helping them.

Wietzke argues that there is a significant relationship that exists between poverty, fertility, and inequality. During the last decades of the 20th century, faster economic progress was often associated with rapid shifts away from the grip of poverty in Third World countries. The author argues that few studies have offered sufficient evidence of fertility differences between the poor and the non-poor. An assessment of more than 600 household surveys from Third World countries shows that key predictors of high birth rates, such as extreme gaps in women's education and agricultural employment, tend to be highly concentrated among poor people. It is wise to note that a high birth rate is associated with extreme poverty, therefore the moral and ethical practice that should be followed to deal with the increasing incidence of poverty in third-world countries is to minimize the birth rate. According to Wietzke (2020) [4], the idea that the proximate effect of fertility rates on poverty operates primarily through a channel of unequal income distribution suggests that the best way to reconcile existing concerns about population dynamics is through rights- and equity-based strategies. The results suggest that the existing focus on reproductive and women's rights in the global development goals can be an essential mechanism for accelerating aspects of progress toward economic development and poverty reduction. The author equally suggests that countries and societies affected by extreme cases of poverty need to move to a more conceptual and multidimensional analysis of poverty to find an effective solution. It is important to harmonize people on the importance of managing birth rate and educational disparities as a means of combating poverty.

In this study, De Haan and Sturm (2017) [5] examine how economics contributes to social stratification differences in disposable income. After reviewing the relevant literature, the authors thoroughly summarize the current empirical findings. They then provide fresh data from their studies to support the claim that financial factors contribute significantly to income disparity. They found that the highest earners, those in the top 10% of the income distribution, benefited the most from more affordable access to financial resources. On the other hand, research shows that lower incomes and greater income inequality are associated with limited access to finance. The authors also conclude that although financial development contributes to economic expansion, the benefits of this expansion are not equally distributed. Instead, the wealthy benefit disproportionately, contributing to growing economic inequality. In their view, measures aimed at increasing access to credit for low-income people are necessary to reduce poverty and economic inequality. Possible measures include promoting financial literacy, expanding access to credit, and opening up new avenues for saving and investing. The results obtained by De Haan and Sturm are consistent with earlier studies that reveal a significant relationship between financial factors and income inequality. They conclude that addressing the link between money and inequality is critical to reducing poverty and promoting overall economic growth.

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Bourguignon's work [6] offers a comprehensive survey of global inequality as it stands today. The article first outlines the history, geographic distribution, and constituent diversity of inequality. The article examines the main causes of inequality, including the impact of globalization, technological progress, and government economic policies. The effects of inequality on poverty and health are also analyzed, as well as the effects of inequality on economic development and social conflict. Bourguignon's work contributes significantly to the debate about ending poverty and economic inequality. He emphasizes the need for policymakers to address inequality and offers several policy recommendations for "fair" progressive taxes, transfer payments, active schooling and labor market policies, population social protection programs, and social security systems. The article summarizes existing knowledge on the issue of inequality, drawing on a wealth of information from the academic literature and empirical research. It connects with previous work by proposing research-based policy and highlighting the link between inequality and economic development, poverty alleviation, and social stability.

An article by Dabla-Norris et al. (2015) [7] summarizes the statistics and causes of income inequality around the world. Using statistics and case studies, the authors examine the impact of tax and transfer systems and the impact of labor market institutions on income formation and inequality, as well as economic development. The article contributes to addressing poverty and economic inequality by providing a thorough understanding of the causes and consequences of income inequality and highlighting the potential role of policy in reducing income inequality. Although there is no "golden mean" for solving these problems, the authors conclude that tax and transfer systems, labor market regulations, and investments in education and training can help reduce income inequality. The article's detailed overview of poverty and economic inequality is supported by a wealth of data and research, making it a valuable study for those researching these issues. The author's inclusion of data from other nations and analysis of the interaction of multiple variables and income inequality enriches the current literature and sheds light on the origins and impact of this social ill.

Conflict Setting

The purpose of the study is to assess the trends of poverty development in the context of the world economy, as well as to identify changes in the level of poverty according to individual countries and their groups and their causes. To achieve that goal, the following problems are set to be solved:
➢ to identify the group (ten) of countries with a high level of poverty and its causes,
➢ to identify the group (ten) of countries with a low level of poverty and its causes,
➢ to present dozens of countries below various poverty lines,
➢ identify the ten countries with the highest interest income and its impact on the poverty level,
➢ identify and assess the impact of the country's development model and economic policy in reducing poverty.

Research Results

Extreme poverty reached pre-pandemic levels in 2022, but the UN Sustainable Development Goal of reducing extreme poverty by 2030 is still a long way off. In 1990, an

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estimated 2.0 billion people lived below the extreme poverty line, 38% of the world's population at the time. Poverty has been reduced during the Millennium Development Goals (MDG) period (especially from 2000-2015), demonstrating the power of a focused global effort; in fact, the goal (halving extreme poverty) was achieved in 2011, four years ahead of schedule. In 2019 (the most recent year for which World Bank global estimates are available), 660 million people lived in extreme poverty, 8.5% of the world's population. In 2020, that number grew to an estimated 733 million. In 2022, it was estimated that it decreased to 682 million. (Fig. 1). The number of people living in extreme poverty has more than halved since 1990, but 8.5% of the world's population still lives below the $2.15 poverty line.
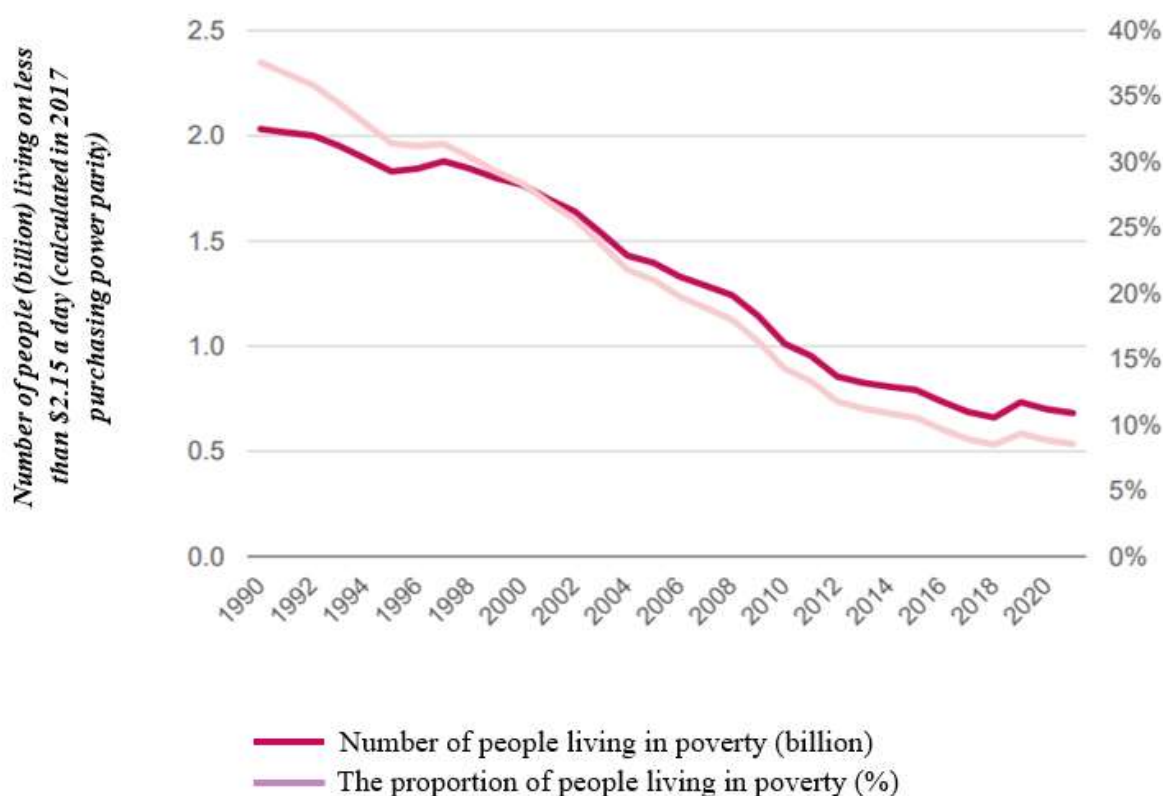
**Fig. 1 The number of people living in extreme poverty
in the world and their share in the total population [8]**

The share of workers worldwide living in extreme poverty has halved over the past decade, from 14.3 percent in 2010 to 7.1 percent in 2019.

Even before COVID-19, baseline projections suggested that 6 percent of the global population would still live in extreme poverty in 2030, missing the goal of eradicating poverty. The effects of the COVID-19 pandemic threaten to push more than 70 million people into extreme poverty.

One in five children lives in extreme poverty, and the negative effects of poverty and deprivation in the early years can last a lifetime.

In 2016, 55 percent of the world's population, about 4 billion people, did not benefit from any form of social protection [9]:

Tab. 1 shows the highest poverty as of 2020, as a percentage of the population and ranking (list of 10 countries of the world 2000-2020 (among 45 countries)).

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Table 1

Highest poverty as of 2020, by percentage of population and position (list of 10 countries in the world 2000-2020 (among 45 countries)) [10,11,12,13]

Country	2020	2019	2018	2017	2016	2015	2010	2005	2000
	Poverty, percentage of population - position								
Mexico	43.9-1	un.ₔ.	41.9-7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Colombia	42.5-2	35.7-7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Argentina	42-3	35.5-8	32-13	25.7-11	30.3-8	n.a.	n.a.	n.a.	n.a.
Mali	41.9-4	42.3-3	43.8-4	44.9-4	46.8-6	47.2-5	n.a.	n.a.	n.a.
Bolivia	39-5	37.2-6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ecuador	33-6	25-12	23.2-20	21.5-26	22.9-23	23.3-23	32.8-14	42.2-12	64.4-2
Peru	30.1-7	20.2-27	20.5-33	21.7-25	20.7-32	21.8-29	30.8-16	55.6-3	48.4-7
Costa Rica	30-8	23.9-14	22.9-23	22.1-21	22.9-22	23.6-20	n.a.	21.2-24	20.6-19
Mongolia	27.8-9	un.ₔ.	28.4-14	n.a.	29.6-10	n.a.	38.8-9	n.a.	n.a.
Armenia	27-10	26.4-9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

This and the following tables were compiled and calculated by the author.

From the data in Tab. 1, it follows that as of 2020, the highest poverty, by percentage of the population and the place occupied (in the list of 10 countries of the world 2000-2020 (among 45 countries)) is Mexico in the 1st place with 43.9%, Colombia is in 2nd place with 42.5%, and Argentina is in 3rd place with 42%.

Tab. 2 shows the highest poverty ratio as of 2019, the percentage with an income of less than US$5.50 per day, and rank (list of 10 countries in the world 2000-2019 (out of 60 countries)).

Table 2

As of 2019, the highest poverty ratio, percent with an income of less than US$5.50 per day and position (list of 10 countries in the world 2000-2019 (among 60 countries))

Country	2019	2018	2017	2016	2015	2010	2005	2000
	Poverty Ratio, Percent Earning Less Than $5.50 a Day – Position							
Malawi	97.3-1	n.a.	n.a.	96.8-1	n.a.	96.2-2	n.a.	n.a.
Uganda	91.1-2	n.a.	n.a.	89.9-3	n.a.	n.a.	94.3-3	n.a.
Zimbabwe	85-3	n.a.	84.1-3	n.a.	n.a.	n.a.	n.a.	n.a.
India	83.8-4	82.6-11	85.3-2	88.7-5	88.9-6	n.a.	n.a.	n.a.
Vanuatu	76.2-5	n.a.	n.a.	n.a.	n.a.	78.4-14	n.a.	n.a.
Kiribati	68.8-6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Kyrgyzstan	63.7-7	66.1-18	70.3-8	71.3-9	73.8-11	70.5-17	84.7-13	95.2-5
Indonesia	61.9-8	62.8-19	65.3-10	68.3-10	72.9-12	82.5-12	90.5-10	96.9-3
Georgia	54.2-9	53.9-20	53.9-11	56.3-11	56.2-19	70.6-16	71.7-18	81.6-11
Fiji	52.6-10	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

From the data in Table 2, it follows that as of 2019, the highest poverty ratio, the percentage with an income of less than 5.50 US dollars per day, and position (list of 10 countries of the world 2000-2019 (among 60 countries)) in 1st place is Malawi 97.3%, Uganda is in 2nd place with 91.1%, and Zimbabwe is in 3rd place with 85%.

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Table 3

Highest poverty ratio, percent with income less than US$1.90 per day and position as of 2020 (List of top 10 countries in the world 1990-2020 (among different countries))

	Country	2020	Country	2019	Country	2018
1	Colombia	10.8	Malawi	70.1	Niger	50.6
2	Ecuador	6.5	Uganda	42.2	Tanzania	44.9
3	Georgia	5.8	Zimbabwe	39.8	Angola	31.1
4	Peru	5.8	Honduras	12.7	Chad	30.9
5	Indonesia	3.8	India	10	Nigeria	30.9
6	Bolivia	3.1	Vanuatu	10	Burkina Faso	30.5
7	Mexico	3.1	Brazil	5.4	Togo	28.1
8	Costa Rica	2.2	Colombia	5.3	Sierra Leone	26.1
9	Brazil	1.9	Georgia	4.8	Guinea-Bissau	21.7
10	Kyrgyzstan	1.3	Indonesia	4.4	Benin	19.9
	20 countries		*59 countries*		*59 countries*	
	Country	2017	Country	2015	Country	2010
1	Somalia	70.7	Zambia	61.4	Madagascar	80.2
2	Zimbabwe	34.2	Togo	54.7	Zambia	68.5
3	Lesotho	32.4	Benin	50.7	Malawi	68.4
4	Djibouti	19.1	Ivory Coast	33.4	Guinea-Bissau	66.7
5	Sao Tome and Principe	15.6	Nigeria	32.3	Rwanda	59.2
6	Honduras	13.9	Kenya	29.4	Nigeria	34.9
7	India	13.4	Ethiopia	27	Ethiopia	31.3
8	Indonesia	6.6	India	18.7	Gambia	29.8
9	Georgia	6.2	Namibia	15.6	Sao Tome and Principe	22.6
10	Serbia	5.4	Botswana	15.4	Indonesia	18.3
	76 countries		*84 countries*		*83 countries*	
	Country	2005	Country	2000	Country	1990
1	Niger	80.5	Tanzania	84	China	72
2	Madagascar	74.2	Uzbekistan	82.3	Pakistan	65.1
3	Rwanda	66.1	Rwanda	75.2	Indonesia	62.8
4	Uganda	58	Swaziland	56.1	Honduras	42
5	Solomon Islands	50.6	Indonesia	43.6	Brazil	24
6	Republic of the Congo	49.6	Kyrgyzstan	38.2	Thailand	12.3
7	Ghana	42.5	South Africa	36.8	Sri Lanka	11.6
8	Senegal	41.1	Bangladesh	33.3	Chile	10.7
9	Kenya	36.7	Moldova	31.1	Costa Rica	10.4
10	South Africa	28.3	Ecuador	28.4	Tunisia	8.6
	74 countries		*49 countries*		*17 countries*	

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Tab. 3 shows the highest poverty ratio as of 2020, the percentage with an income of less than US$1.90 per day, and position (list of 10 countries in the world 1990-2020 (among different countries)).

From the data in Tab. 3, it follows that as of 2020, the highest poverty ratio, the percentage with an income of less than US$1.90 per day and position (list of 10 countries of the world 1990-2020 (among different countries)) in 1st place is Colombia with 10.8%, and then Ecuador with 6.5%, and in third place is Georgia with 5.8%.

Table 4

As of 2019, the proportion of the poor population to the total population, calculated by those below the line of less than 1.90 US dollars a day, in percentage (list of 10 countries of the world 2000-2019 (among different groups of countries))

	Country	*2019*	*Country*	*2018*	*Country*	*2015*
1	Belgium	0.1	Belgium	0.1	Albania	0.1
2	China	0.1	Finland	0.1	Belgium	0.1
3	Luxembourg	0.1	Greece	0.1	Finland	0.1
4	Netherlands	0.1	Malta	0.1	France	0.1
5	Portugal	0.1	Netherlands	0.1	Malta	0.1
6	Slovakia	0.1	Uruguay	0.1	Netherlands	0.1
7	Thailand	0.1	Denmark	0.2	Tunisia	0.1
8	Uruguay	0.1	Estonia	0.2	Ukraine	0.1
9	Cyprus	0.2	Hungary	0.2	United Kingdom	0.1
10	Latvia	0.2	Poland	0.2	Uruguay	0.1
	59 countries		*59 countries*		*84 countries*	
	Country	*2010*	*Country*	*2005*	*Country*	*2000*
1	Belgium	0.1	Finland	0.1	Austria	0.2
2	Denmark	0.1	Netherlands	0.1	Canada	0.2
3	Finland	0.1	Slovenia	0.1	Ireland	0.2
4	France	0.1	Austria	0.2	Norway	0.2
5	Hungary	0.1	Belgium	0.2	United Kingdom	0.2
6	Iceland	0.1	Norway	0.2	Belgium	0.3
7	Portugal	0.1	Palestine	0.2	Greece	0.5
8	Russia	0.1	Slovakia	0.2	Spain	0.5
9	Canada	0.2	Denmark	0.3	USA	0.7
10	Israel	0.2	Greece	0.3	Italy	1.2
	83 countries		*74 countries*		*49 countries*	

It follows from the data in Table 4 that as of 2019, the proportion of the poor population to the total population, calculated by those below the line of less than 1.90 USD per day, in percentages (list of 10 countries of the world 2000-2019, in 2019 Belgium (0.1), China (0.1), and Luxembourg (0.1) were the lowest in terms of this index. Especially, the high efficiency of the poverty reduction policy should be noted in China, which can be taken as an

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example from countries with a smaller population. Among the mentioned countries, the most successful in reducing poverty over time was Belgium, whose indicator was 0.3 percent in 2000 and it was 0.1 percent in 2021.

Table 5

Lowest poverty as of 2019, as a percentage of total population and position (list of 10 countries in the world 2000-2019 (among different countries))

	Country	*2019*	*Country*	*2018*	*Country*	*2015*
1	China	0.6	China	1.7	Belarus	5.1
2	Kazakhstan	4.3	Kazakhstan	4.3	China	5.7
3	Belarus	5	Belarus	5.6	Thailand	7.2
4	Maldives	5.4	Malaysia	5.6	Malaysia	7.6
5	Thailand	6.2	Vietnam	6.7	Iceland	8.8
6	Malaysia	8.4	Indonesia	9.8	Czech	9.7
7	Indonesia	9.4	Thailand	9.8	Indonesia	11.2
8	Czech	9.5	Czech	10.1	Finland	11.6
9	Slovakia	11.4	Finland	11.6	Chile	11.7
10	Denmark	12.1	Slovakia	11.9	Norway	12.2
	61 countries		*64 countries*		*60 countries*	
	Country	*2010*	*Country*	*2005*	*Country*	*2000*
1	Belarus	5.2	Iceland	9.6	Morocco	15.3
2	Montenegro	6.6	Czech	9.8	Poland	16
3	Azerbaijan	9.1	Montenegro	11.2	Tonga	16.2
4	Iceland	9.2	Slovakia	11.6	Jamaica	18.7
5	Serbia	9.2	Norway	12	Indonesia	19.1
6	Norway	10.5	Austria	12.6	Costa Rica	20.6
7	Russia	12.5	Finland	12.6	Tunisia	25.4
8	Slovakia	13	Belarus	12.7	Russia	29
9	Indonesia	13.3	Malta	14.2	Philippines	33
10	Finland	13.7	Jamaica	14.8	Tanzania	35.6
	54 countries		*46 countries*		*24 countries*	

From the data in Table 5, it follows that the lowest poverty, as a percentage of the total population and position (the list of 10 countries of the world 2000-2019 (among different countries) in 2019 was recorded in China: 0.6%, Kazakhstan 4.3% and 5% in Belarus. It is important to note that the countries with the least poverty among the former Soviet Union republics are only two. Also, it is important to note that if, in 2017, 2018, and 2019, the country with the lowest poverty by population was China, then in 2000, 2005, 2010, and 2015 there were the following countries: Morocco (15.3%), Iceland (9.6%), Belarus (5.2%), Belarus (5.1%).

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Tab. 6 shows the percentage income earned by the top 10 percent of earners as of 2019 and position (list of 10 countries in the world 2000-2019 (among different countries)), from which it follows that in 2000-2019, the highest percent was in Brazil (41.9%), Panama (38%), Paraguay (35.2%), and in 2000 respectively: Bolivia (47.8%), South Africa (44.9%), Panama (43.2%).

Table 6

As of 2019, percentage income earned by the top 10 percent of earners and position (list of top 10 countries in the world 2000-2019 (among different countries))

	Country	*2019*	*Country*	*2018*	*Country*	*2015*
1	Brazil	41.9	Brazil	42.5	Namibia	47.3
2	Panama	38	Angola	39.6	Zambia	44.4
3	Paraguay	35.2	Burkina Faso	37.5	Botswana	41.5
4	Uganda	34.5	Mexico	37.1	Brazil	40.9
5	Turkey	31.6	Panama	37.1	Panama	39
6	Bulgaria	31.4	Paraguay	35.8	Benin	37.6
7	Peru	31.1	Philippines	33.5	Paraguay	36.7
8	Argentina	31	Tanzania	33.1	Philippines	34.9
9	Malawi	31	Togo	32.9	Bolivia	34.8
10	Bolivia	30.8	Bulgaria	32.6	Turkey	33.5
	35 countries		*53 countries*		*48 countries*	
	Country	*2010*	*Country*	*2005*	*Country*	*2000*
1	South Africa	51.3	South Africa	54.2	Bolivia	47.8
2	Zambia	45.2	Bolivia	45.3	South Africa	44.9
3	Paraguay	40.5	Brazil	44.6	Panama	43.2
4	Rwanda	39.8	Rwanda	43.9	Mexico	42
5	Panama	39.7	Paraguay	40.4	Rwanda	40.8
6	Mexico	37.1	Panama	40.2	Angola	40.2
7	Malawi	36.9	Mexico	39.6	Argentina	37.7
8	Madagascar	34.3	Nicaragua	39.6	Philippines	37.7
9	Peru	34.2	Peru	38.5	Peru	36.8
10	Uruguay	33.6	Venezuela	36.4	Thailand	33.7
	49 countries		*44 countries*		*30 countries*	

Let's also note that the countries listed in Table 6 are not the richest in the world at all. The given figures show that the incomes in the countries listed in Table 6 are very unevenly distributed, which especially affects the poor, so there is no coincidence that the countries listed in Tables 5 and 6 are not repeated (except Thailand in 2000), which testifies to the ineffective policy of income distribution in those countries. In other words, the richest 10% of the population receives the main part of income redistribution in the mentioned countries, which means that the incomes of the poor population do not increase.

National poverty reduction programs and policies have played an important practical role in the development and implementation of poverty reduction policies.

Just as global trends in the proportion of people living in extreme poverty mask regional differences, regional trends in extreme poverty mask differences in progress at the

national level. Although the number of people living in extreme poverty has decreased in most countries around the world since 1990, the extreme poverty rate has remained stable or increased in 37 countries. In 2022, the proportion of people living in extreme poverty was lower in 122 countries than in 1990, but the proportion of people living in extreme poverty increased or remained the same in 37 countries.

China and India have had the largest reductions in people living in extreme poverty, lifting more than a billion citizens out of extreme poverty since 1990. Rapid economic growth in the economies with the largest populations is a key factor in reducing global poverty. In 1990, China and India were home to 1.2 billion people living in extreme poverty, more than 61% of the world's people living in extreme poverty at the time. By 2022, fewer than 117 million people in both countries were living in extreme poverty—a huge reduction. However, despite the success achieved in reducing poverty in the mentioned countries, these policies have recorded different results in the two mentioned countries. China essentially eliminated extreme poverty in 2017 (leaving it at 0.1 percent), while about 8.2 percent of India's population remains below the extreme poverty line in 2022 [14].

Conclusion

In the coming years, poverty reduction will continue to be one of the most important issues of both the world economy and national economies. Many programs will continue to be developed to solve this problem. They will be implemented with varying efficiency and success. It is necessary to solve the problem of poverty reduction in every society in the context of developing and implementing a flexible policy of income distribution and redistribution. As a result of the analysis presented in the research, it was revealed how the policy of income distribution and redistribution cannot be implemented. To reduce the level of poverty. Anti-poverty policies in China and India demonstrate how effective policies can reduce poverty by approximately one billion people. It is a result of the high efficiency of the socio-economic development models and developed programs of the mentioned countries, which serve not to enrich a group of people, but to increase the income of the majority of the population. The main tool in this process was the provision of mass employment of the population, which gives grounds for asserting that modern economics has an effective tool to overcome poverty as a social evil.

References

1. Peace, dignity and equality on a healthy planet, https://www.un.org/en/global-issues/ending-poverty, accessed on 2023-11-13

2. Livingston, V., Davis-Wagner, D., Chung, I., Nevels, B. J., & Gabriel, N. (2020). Trapped in poverty: a conceptual framework to evaluate the culture of poverty vs. the culture of inequality for black female-headed families. International Journal of Social Policy and Education, 2(5), 1–13.

3. Schweiger, G. (2019). Ethics, poverty, and children's vulnerability. Ethics and social welfare, 13(3), 288-301.

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THE GLOBAL EXPERIENCE AND TRENDS OF POVERTY OVERCOMING

4. Wietzke, F. B. (2020). Poverty, inequality, and fertility: the contribution of demographic change to global poverty reduction. Population and Development Review, 46 (1), 65-99.

5. De Haan, J., & Sturm, J. E. (2017). Finance and income inequality: A review and new evidence. European Journal of Political Economy, 50, 171-195.

6. Bourguignon, F. (2018). The world changes in inequality: An overview of facts, causes, consequences, and policies. CESifo Economic Studies, 64 (3), 345-370.

7. Dabla-Norris, M. E., Kochhar, M. K., Suphaphiphat, M. N., Ricka, M. F., & Tsounta, M. E. (2015). Causes and consequences of income inequality: A global perspective. International Monetary Fund.

8. Development Initiatives based on World Bank PIP, Mahler et al. 2022, UN World Population Prospects and IMF World Economic Outlook. Forecasts begin in 2020.

9. Poverty-data, datasets, Data on Poverty by the World Bank Poverty and Inequality Platform,https://github.com/owid/poverty-data/blob/main/datasets/pip_README.md, accessed on 2023-11-13

10. Poverty, percent of the population, https://www.theglobaleconomy.com/rankings/poverty_ratio/,

11. Poverty ratio, percent living on less than 1.90 USD a day, 2020, https://www.theglobaleconomy.com/rankings/poverty_ratio_low_range/, accessed on 2023-11-13

12. Poverty ratio, percent living on less than 5.50 USD a day, https://www.theglobaleconomy.com/rankings/poverty_ratio_high_range/, accessed on 2023-11-13

13. Percent income earned by the top 10 percent of earners, https://www.theglobaleconomy.com/rankings/income_top_10_percent_earners/, accessed on 2023-11-13

14. Economic poverty trends: Global, regional and national, https://devinit-prod-static.ams3.cdn.digitaloceanspaces.com/media/documents/Economic_poverty_factsheet_June_2023.pdf, accessed on 2023-11-13

ԱՂՔԱՏՈՒԹՅԱՆ ՀԱՂԹԱՀԱՐՄԱՆ ՀԱՄԱՇԽԱՐՀԱՅԻՆ ՓՈՐՁԸ ԵՎ ՄԻՏՈՒՄՆԵՐԸ

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

Հասարակության ամենաանկայուն և անկառավարելի խավն աղքատներն են: Ցանկացած երկրում սոցիալ-տնտեսական զարգացման նպատակը կայունության ապահովումն է, որի ձեռք բերումը գործնականում անհնար է, եթե երկրում բարձր է աղքատության մակարդակը: Այն նվազեցնելու և ամենաաղքատների կենսամակարդակը բարելավելուն միտված քաղաքականություն մշակողները պետք է կարողանան ճշգրիտ տեղեկատվություն ստանալ այն մասին, թե ո՞վ, որտե՞ղ և ինչո՞ւ է հայտնվել այդ վիճակում: Աղքատությունը տարբեր երկրներում ունի յուրօրինակ տեսք և չափելիություն:

Աղքատության նվազեցումը ՄԱԿ-ի կողմից ընդունված կայուն զարգացման ծրագրի նպատակներից մեկն է: Անհրաժեշտ է նշել, որ ՄԱԿ-ի վերոհիշյալ ծրագիրը ընդգրկում է ևս 16 նպատակ, որոնք լուծում են սոցիալ-տնտեսական տարբեր կարիքներ՝ կրթական արդյունքներից մինչև բնապահպանական կայունություն, որոնք պետք է բավարարվեն, որպեսզի մարդիկ և համայնքները ապրեն արժանապատիվ կյանքով:

Աղքատության նվազեցման հիմնախնդիրը առաջարկվում է լուծել եկամուտների բաշխման և վերաբաշխման ճկուն քաղաքականության մշակման և իրականացման համատեքստում: Այս գործընթացում հիմնական գործիք կարող է ծառայել բնակչության զանգվածային զբաղվածության ապահովումը:

Բանալի բառեր. աղքատություն, Ջինիի գործակից, բնակչության եկամուտներ և ծախսեր, սոցիալական քաղաքականություն, բնակչության խոցելի խավերի պետական աջակցություն

ГЛОБАЛЬНЫЙ ОПЫТ И ТЕНДЕНЦИИ В ПРЕОДОЛЕНИИ БЕДНОСТИ

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ОО по политологическим, правовым, экономическим исследованиям и прогнозированию

Самый нестабильный и неуправляемый класс общества – бедные. Целью социально-экономического развития любой страны является обеспечение стабильности, чего практически невозможно достичь, если в стране высокий уровень бедности. Политики, стремящиеся сократить его и улучшить уровень жизни беднейших слоев населения, должны иметь возможность получать точную информацию о том, кто, где и почему находится в такой ситуации. Бедность выглядит и измеряется по-разному в разных странах. Сокращение бедности является одной из целей программы устойчивого развития, принятой ООН. Следует отметить, что вышеупомянутая программа ООН включает еще 16 целей, направленных на решение различных социально-экономических потребностей, от результатов образования до экологической устойчивости, которые необходимо достичь, чтобы люди и сообщества могли жить достойной жизнью.

Проблему снижения бедности предлагается решать в контексте разработки и реализации гибкой политики распределения и перераспределения доходов. Главным инструментом в этом процессе может стать обеспечение массовой занятости населения.

Ключевые слова. бедность, коэффициент Джини, доходы и расходы населения, социальная политика, государственная поддержка уязвимых слоев населения

UDC - 316.334.5:504.03

ASSESSING THE IMPORTANCE OF ENVIRONMENTAL AND SOCIAL STANDARDS FOR THE ARTIK RESERVOIR RECONSTRUCTION PROJECT IN THE SHIRAK REGION OF ARMENIA

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Abstract

The Artik Reservoir, located in Shirak region within the Karangu River basin, is poised for reconstruction beginning in 2023. This initiative is spearheaded by a consortium consisting of the Institute of Water Problems and HydroEngineering after Academician I.V. Yeghiazarov CJSC and the Shushi Technological University Foundation, commissioned by the Water Committee of RA MAIE. The reservoir, essential for irrigating agricultural lands in

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five villages, namely Nor Kyank, Panik, Vardakar, Anushavan and Meghrashen, faces reconstruction due to a dam failure during floods in 1994. The affected communities, integral to the Artik expanded community, are primarily engaged in agriculture, facing income constraints & labor migration due to water scarcity. Despite this, the region boasts historical and cultural monuments, presenting an opportunity for diverse forms of tourism. The region is also diverse in flora & fauna representatives with a significant number red listed since 2010. The article emphasizes the importance of adhering to environmental and social standards within the framework of the project, as well as seeks to contribute valuable insights to the ongoing discourse surrounding the project, highlighting the critical role of sustained environmental and social studies throughout its development. The primary objective is to assess the expected benefits and risks associated with the Artik Reservoir Reconstruction Project, with a particular focus on its environmental and social aspects, ultimately striving for a balanced and sustainable outcome.

Keywords: reservoir, dam, environmental impact assessment, social conditions, impacted community, stakeholders.

Introduction

The Artik Reservoir is situated in the Artik Region of Shirak Marz, within the Karangu River basin and positioned northwest of Artik City, along the Artikjur River. Starting from 2023, the reservoir dam is set for reconstruction with the project's documents developed by the consortium of the Institute of Water Problems and HydroEngineering after Academician I.V. Yeghiazarov CJSC and the Shushi Technological University Foundation and commissioned by the Water Committee of RA MAIE.

The Artik Reservoir is designed to irrigate the agricultural lands of five villages within the region, situated approximately 6-8 km from the reservoir. These villages include Nor Kyank, Panik, Vardakar, Anushavan and Meghrashen, collectively covering a land area of 2612 hectares. The five impacted communities are part of Artik expanded community, which is also the regional center and the main economical hub of the Artik settlement.

The initial social survey revealed that the residents of both the expanded community and the impacted communities are predominantly involved in agricultural activities, including the cultivation of wheat, barley, potatoes, vegetables and animal husbandry. In the privately owned and leased agricultural lands of the community, the residents mainly sow grain crops such as wheat and barley. In addition, the land's favorable conditions make it suitable for cultivating grain crops, growing potatoes and raising livestock. However, as shown by assessment results, the lack of water in the area hinders the community's ability to generate significant income. There are limited large agricultural farms within the community, thus in general each household unit utilizes its own production locally. Community residents also cultivate vegetable crops and fruits, such as apples, plums, pears, and cherries in small plots or orchards near their houses. Although grain crop production and animal husbandry are essential for the economic development of the Artik community, their current progress is quite moderate.

Further assessment revealed that both the expanded Artik community and the impacted communities boast a wealth of historical and cultural monuments in their territory,

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as well as picturesque locations. These assets can contribute to the development of various forms of tourism (including but not limited to historical tourism, agritourism, ethnotourism) and facilitate recreational activities both for the local population and other visitors. The residents are also known for their handy & household crafts passed through generations. In addition, beekeeping traditions are another important occupation for the community residents. The affected communities feature churches, castles, cemeteries, and old settlements of local and national significance, spanning chronologically from the 3rd millennium BC to the second half of the 20th century, therefore it's crucial to ensure the protection of the mentioned assets during the reconstruction stage of the reservoir dam, as well as put an emphasis on the potential development of touristic routes in the region. It is noteworthy that the construction of the Artik Reservoir initially took place between 1988 and 1992, following the design plans created by the "Glkhhayjrshin" organization and the "Volgogradshin" design institute. Unfortunately, on May 31, 1994, during floods in the Karangu River basin, the dam of the Artik Reservoir experienced a failure, resulting in the loss of its water regulating capabilities leaving the irrigation potential of at least 420.0 hectares of agricultural land in Nor Kyank, Vardakar, Panik, Meghrashen and Anushavan villages under question to date.

Conflict Setting

The purpose of this article is to underscore the significance of adhering to environmental and social standards in the context of the Artik Reservoir Reconstruction Project in the Shirak Region of Armenia, as well as contribute insights to the discourse on the Artik Reservoir Reconstruction Project, emphasizing the crucial role of continuing the environmental and social studies throughout the project development in achieving a balanced and sustainable outcome, with the main task being to evaluate the anticipated benefits and risks associated with the Artik Reservoir Reconstruction Project in the light of environmental and social aspects.

Materials and Methods: The research method involves a multi-faceted approach, incorporating data collection methods such as site visits, document analysis, desktop assessment and a review of pertinent literature to ensure a comprehensive evaluation. Special attention is given to monitoring the potential impacts on biodiversity, water quality, cultural heritage, tourism potential and community well-being.

Research Results

The Artik Reservoir is located to the northwest of Artik city in Shirak region, along the left-bank Artikjur tributary of the Karkachun or so called Karangu river. The hydro-economic assessments to determine the reservoir volume were conducted based on factors such as the 50% and 75% monthly supply flows from the left bank culverts of the Artikjur River and the Karkachun River, monthly irrigation water demand for 420.0 hectares, reservoir losses (evaporation and filtration), and monthly environmental discharges. Thorough reassessment of the morphometric data for the Artikjur River and the data from the two canyons on the left bank of the Karkachun River was conducted related with the dam collapse of the Artik Reservoir. These canyons are intended for transporting water to the reservoir. Recalculations

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of all hydrological characteristics were performed based on these adjustments. All activities adhered to respective regulatory documents. The Artik Reservoir is designated for irrigating 420.0 hectares of agricultural land in Nor Kyank, Vardakar, Panik, Meghrashen, and Anushavan communities of the region. According to the information obtained from the enlarged Artik community, the irrigated land areas for each community, categorized by crop composition, are detailed below in Tab. 1.

Table 1

Actual lands utilized for agricultural (irrigated) crops (ha)

Name of the community	Autumn wheat	Vegetables/Greens	Potato	Orchards	Total
Nor Kyank	5	75	85	2	167
Vardakar	5	40	60	5	110
Panik	3	24	27	-	54
Meghrashen	5	20	29	-	54
Anushavan	3	14	18	-	35
Total	21	173	219	7	420

According to the information provided by the Artik community administration, the current irrigated land areas in 2023 stand at 420.0 hectares, designated as follows:

- 5.0% for autumn wheat,
- 41.2% for vegetables,
- 52.1% for potatoes,
- 1.7% for orchards.

Considering the crop composition, the geographical location of the agricultural lands, and the soil-climatic conditions, the designated area aligns with & requires Irrigation Regime No. 19, as outlined in the Manual on the norms and regimes of crop irrigation for the irrigated lands of the Republic of Armenia (2007). Using this data, a hydromodule graph was constructed, from which the annual water demand in the case of a 50% supply was derived, amounting to 1.6 million cubic meters. According to hydrological calculations, the annual environmental discharges are 0.638 million cubic meters.

According to the preliminary calculations based on the above, to meet 50% of the irrigation water demand for 420.0 hectares, it is necessary to reconstruct a reservoir with an earthen dam featuring a sandy clay screen. The dam's specifications should include a height of minimum 15.5 meters, a channel width of 6.0 meters, a dam length of 610.0 meters, and a volume of 1,817 million cubic meters, with a useful volume of 1,687 million cubic meters.

Environmental Overview.

Climatic Conditions of the area: The topography of the area is characterized by temporary water-bearing canyons with rugged terrain. The landscapes consist of mountain-meadow light brown soils, reaching elevations of 2800-3000 meters, frequently interspersed with bedrock or shingles. The average annual temperature in the region is 5.8°C, with the highest temperatures observed during the months of July and August, reaching up to 34°C. The average annual precipitation in mountainous areas is 600mm. Precipitation varies

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considerably, with approximately 40-45% occurring during the average annual temperatures and 40-45% during the winter months. The average monthly wind speed in the region ranges from 2 to 6 meters per second. The relative humidity of the air averages 66% annually. The freezing depth of the ground is 1 meter. The area experiences a temperate mountainous climate characterized by a prolonged, cold winter with a continuous snow cover. Strong winds, frequent fogs and blizzards are common occurrences. The prevailing wind directions are predominantly from the north and northeast, maintaining a consistent flow. The highest wind speed for 1% coverage can reach up to 27 m/s, for 2% coverage it is 25 m/s, at 5% it is 23 m/s, and for 20% coverage, it is 20m/s [10].

Table 2

List of flora in need of conservation [4]

N	Species name (plants)		Conservation status as per the RA Red Book
	Common	Lat.	
	Asteraceae		
1	Tragopogon armeniacus	Tragopogon armeniacus Kuth.-	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)
	Alliaceae		
	Malvaceae		
2	Alcea sophiae	Alcea sophiae Iljin	EN B 1 ab(iii) + 2 ab(iii)
3	Alcea karsiana	Alcea karsiana (Bordz.) Litv.-	EN B 1 ab(iii) + 2 ab(iii)
	Fabaceae		
4	Hedysarum elegans	Hedysarum elegans Boiss. et Huet	EN B 1 ab(iii) + 2 ab(iii)
	Iridaceae		
5	Gladiolus dzhavakheticus	Gladiolus dzhavakheticus Eristavi	- EN B 1 ab(iii) + 2 ab(iii)
	Lamiaceae		
6	Teucrium canum	Teucrium canum Fisch. et C.A.Mey.	CR B 1 ab(iii) + 2 ab(iii)
	Rubiaceae		
7	Asperula affinis	Asperula affinis Boiss. et Huet	- EN B 1 ab(iii) + 2 ab(iii)
	Valerianaceae		
8	Valeriana eriophylla	Valeriana eriophylla (Ledeb.) Utkin	EN B 1 ab(iii) + 2 ab(iii)

Water Resources of the area: The primary water body in the project area is the Karangu River, with a length of 55.0 km, serving as one of the tributaries to the Akhuryan River. The river network exhibits a density coefficient of 0.62 km/km2 and a flow coefficient of 0.42. The surface waters in the region are classified under the hydrocarbon category based on their chemical composition. These surface waters have low mineral content, with ion levels ranging from 100-200 mg/l. The water hardness is categorized as soft, with a calcium and magnesium ion content of 1.5 mg-3.0 eq/l, and a low degree of aggressiveness (bicarbonate ion content not exceeding 0.7 mg-eq/l). According to RA Hydrometeorology and Monitoring

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Center's summary document, the surface water flows in the requested area fall within the jurisdiction of the Akhuryan Water Basin management area.

Table 3

List of fauna in need of conservation [4]

N	Species name		Conservation status as per RA Red Book
	Common	Lat.	
INSECTA			
1	Gomphocerus armeniacus	Gomphocerus armeniacus (Uvarov, 1931) Orthoptera – Acrididae	VU
REPTILIA			
2	Darevskia unisexualis	Darevskia unisexualis, Darevsky, 1966	VU B1a
AVES			
3	Gypaetus barbatus	Gypaetus barbatus Linnaeus, 1758, Falconiformes- Accipitridae	VU D1
4	Neophron percnopterus	Neophron percnopterus Linnaeus, 1758, Falconiformes- Accipitridae	EN A2bcde+3bcde+4bcde
5	Gyps fulvus	Gyps fulvus (Hablizl, 1783) , Falconiformes- Accipitridae	VU D1
6	Aquila clanga	Aquila clanga, Pallas, 1811 Falconiformes- Accipitridae	VU C2a(ii)
7	Aquila nipalensis	Aquila nipalensis orientalis Hodgson, 1833, Falconiformes- Accipitridae	VU C2a(i); D
8	Aquila chrysaetos	Aquila chrysaetos (Linnaeus, 1758), Falconiformes- Accipitridae	VU D1
9	Coracias garrulus garrulus	Coracias garrulus (Linnaeus, 1758, Coraciiformes- Coraciidae	VU B1ab(iii) VU
10	Tichodroma muraria	Tichodroma muraria, Linnaeus, 1766 Passeriformes - Sittidae	DD
MAMMALS			
11	Spermophilus xanthoprymnus	Spermophilus xanthoprymnus, Bennet 1835	EN B2ab (ii, iii, iv)
12	Microtus (Sumeriomys) schidlovskii	Microtus (Sumeriomys) schidlovskii , Argyropulo, 1933	EN B1ab (ii, iii, v)
13	Vormela peregusna peregusna	Vormela peregusna (Guldenstaedt, 1770) Carnivora- Mustelidae	VU A2c+B1 b(iii)

Biodiversity of the Area. Flora: The Shirak region in general boasts diverse vegetation, influenced by the distinct natural conditions of the area. Forests account for only 3.5% of the river basin area, comprising mainly insular plantations of pines and poplars. The planned project area in the Artik region lies within the middle mountain steppe landscape zone, featuring a warm moderately dry climate and primarily occupied by agricultural lands, including arable land, gardens, mines and pits. Some areas exhibit cereal and cereal-grass steppes with various plant species such as *Festuca valesiaca, Koeleria albovii, Stipa capillata*, and others. The vegetation period spans 40-165 days. The necessary data regarding rare and endangered plant species in the Artik area is sourced from the Red Book of RA as

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presented in Tab. 2. The presented data also indicates the conservation status of each plant species according to the Red Book category classification (Critically Endangered (CR), Endangered Species (EN), Vulnerable Species (VU)).

There are no endemic plant species registered in the Red Book of the Republic of Armenia in the area immediately adjacent to Nor Kyank community, intended for the construction of the Artik Reservoir.

Fauna: The necessary information on rare and endangered animal species in the Artik area is also sourced from the Red Book of RA, presented in Tab. 3. The presented table also indicates the conservation status of each species according to the Red Book classification (Extinct Species (EX), Regionally Extinct Species (RE), Critically Endangered Species (CR), Endangered Species (EN), Vulnerable Species (VU), Data Deficiency (DD)).

There are no endemic animal species registered in the Red Book of the Republic of Armenia in the area immediately adjacent to Nor Kyank community, intended for the construction of the Artik Reservoir. However, given the number of red listed species of flora (8) and fauna (13) present in the potential area of reconstruction, it is necessary to continue the studies on the presence and distribution of mentioned species to evaluate the potential impact on the species during the construction phase, following the international environmental standards used largely for such works.

Historical & Cultural Assets: The list of monuments of history and culture of Shirak Marz of RA was approved on September 9, 2004 according to the decision N 1270-N "On approving the state list of immovable monuments of history and culture of Shirak Marz of the Republic of Armenia". According to the abovementioned decision, only 21 monuments (42 units) are included in the list of immovable monuments of history and culture of Artik city [2,9]. Tab. 4 summarizes the cultural units present in impacted communities, the full list of which can be found under the abovementioned GoA decision.

Table 4

The number of existing cultural assets per impacted community

Name of the community	Monument N	N of cultural & historical units
Nor Kyank	8	11
Vardakar	7	9
Meghrashen	8	11
Panik	6	13
Anushavan	8	20

Upon inspecting the sites of historical and cultural monuments, it is evident that the reservoir bed reconstruction poses no threat to the historical and cultural values in the area as the main asserts are located at a minimum 3-6km far from the planned construction area. However, during the actual construction works, there is a possibility of encountering items of archaeological significance, buildings, burial grounds, historical monuments and other artifacts. In such instances, work in that specific part of the reservoir must be halted immediately, and specialists should be summoned to assess the situation. Construction may resume only after obtaining the necessary professional opinion, in accordance with the

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relevant legislation of the Republic of Armenia. Nevertheless, given that the project suggests a reconstruction of a new hydro-junction, creating a reservoir with a dam, and constructing flood and irrigation water structures throughout the construction and operation of the reservoir, certain adverse effects on different environment components may arise (earthworks, construction activity, heavy traffic, storage facilities, etc). To address this, environmental assessment checklist should be developed upon acquired experience and tracked throughout the construction phase utilizing best practices and research methods.

Social Overview.

As of February 25, 2022, the Police and Passport and Visa Department of the Republic of Armenia reports a current community population of 53,206 people in Artik region [3]. This includes 26,661 males (50.2%) and 26,545 females (49.8%).

A breakdown of the community's population reveals that 97% of all population are Armenians, while the remaining 3% are ethnic minorities, including Russians, Yezidis, Kurds, Ukrainians and Greeks [6].

The Artik Reservoir is designed to irrigate the agricultural lands of five communities within the region, situated approximately 6-8 km from the reservoir. These communities, as mentioned earlier, include Nor Kyank, Panik, Vardakar, Anushavan and Megrashen, collectively covering a land area of 2612 hectares. The permanent population in the communities affected by the project is 8,975 people, with the current population standing at 8,581 individuals [11].

This represents approximately **16-17%** of the total population. Tab. 5 provides an overview of the population's summary data for the five impacted communities, including gender segregation, as below:

Table 5

Resident number in impacted communities [6]

Community name	N of permanent residents/persons	Factual N of residents /person	Including women
Nor Kyank	1859	1562	995
Vardakar	725	696	352
Panik	3136	2927	1590
Anushavan	1983	2148	937
Meghrashen	1272	1248	612
Total	8975	8581	4486

It is obvious from the Table 6, that in the impacted communities the number of women is higher than the number of men, comprising **52%** of the population, based on factual residents, which is another data showing that migration rate amongst men in these communities is relatively higher.

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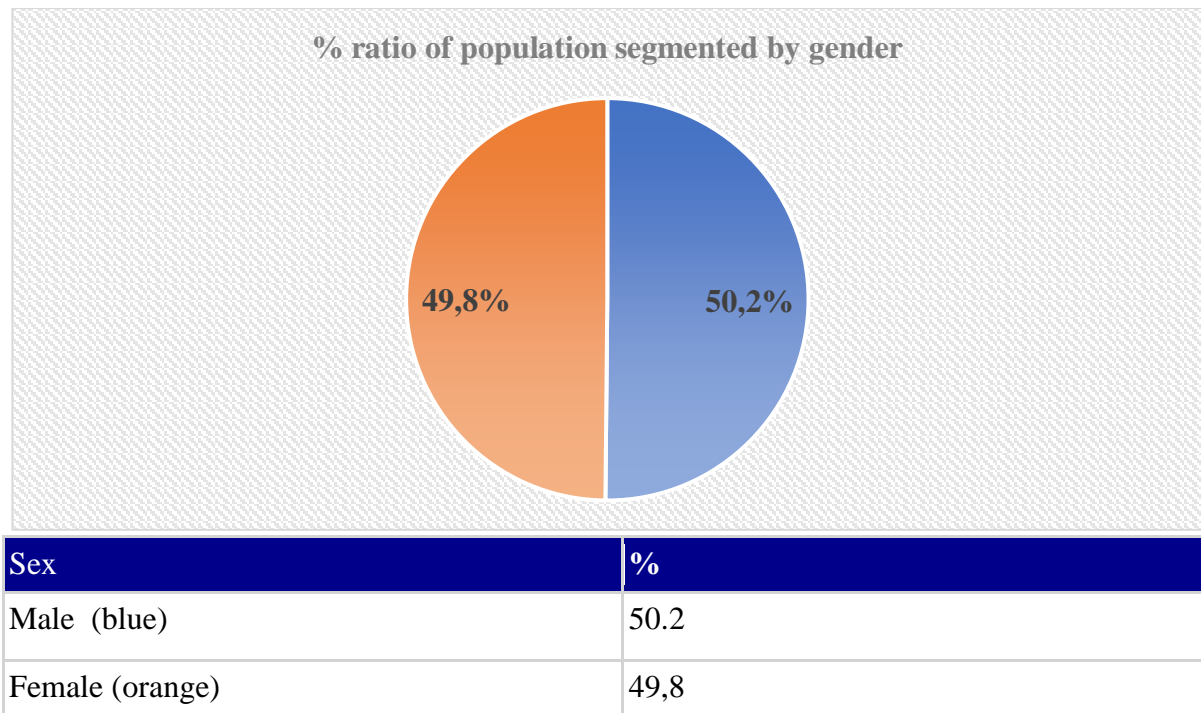| Sex	%
Male (blue)	50.2
Female (orange)	49,8

Fig. 1. The % of population ratio by gender in Artik expanded community

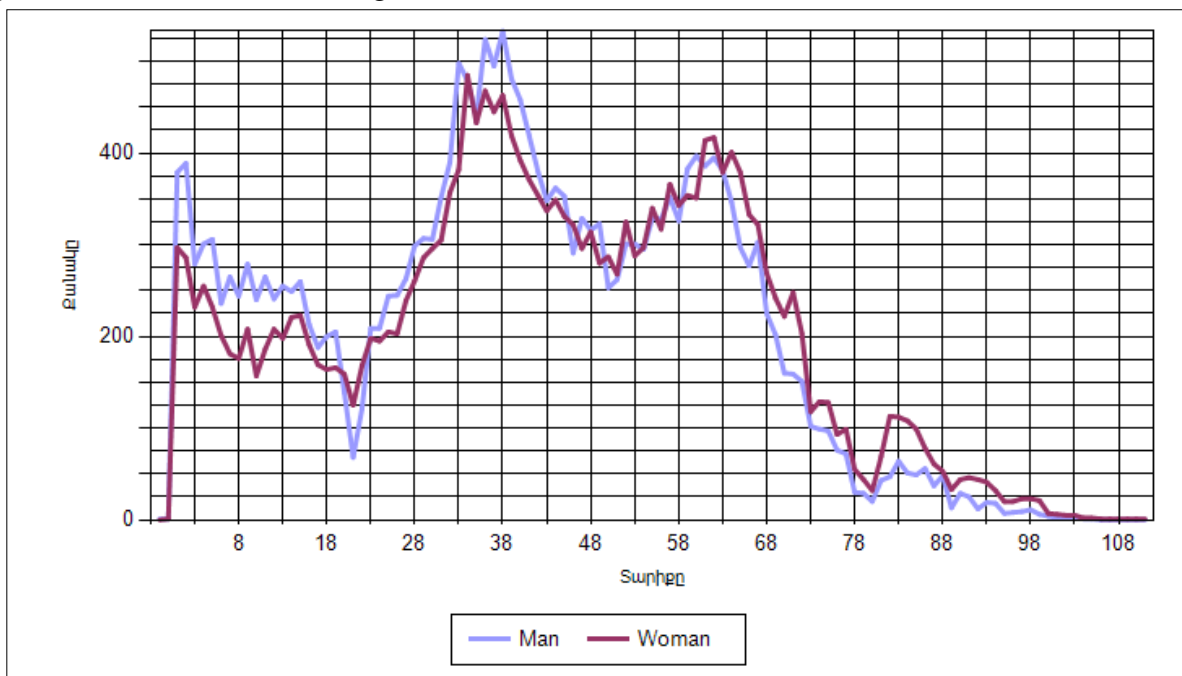Further data on percentage distribution of the population in expanded Artik region by gender is also visualized in Fig. 1.

Fig. 2 The sex-age graphical representation of Artik expanded community.

Within the frames of the initial assessment, it was also important to assess the occupation of the local population by the economy sector, and thus respective data has been collected and analyzed to reflect the existing situation in the expanded settlement of Artik.

The Tab. 6 clearly indicates that a significant portion of the employed population is engaged in agriculture, hunting and forestry, with particular emphasis on irrigated agriculture. Moreover, given that these communities are marked by the active labor migration of working-age males abroad, this leads to women taking on agricultural responsibilities in their farms.

However, the lack of water in the area hinders the community's ability to generate significant income. The land's favorable conditions make it suitable for cultivating grain crops, growing potatoes and raising livestock.

Although grain crop production and animal husbandry are essential for the economic development of the Artik community, their current progress is moderate. This is primarily attributed to the sectors' low level of capitalization and the absence of processing technologies.

Table 6

Employment profile by economic sectors in Artik expanded community in 2022 [6]

N	Indicator	Sector	Quantity/man
1.	Number of employed residents	Total	15 373
2.	Number of employed residents by sector	3.1 Agriculture, hunting and forestry	11 155
		3.2 Fishing and Aquaculture	-
		3.3 Mining industry	15/225
		3.4 Manufacturing industry, including processing of raw materials	5/35
		3.5 Production and distribution of electricity, gas, water	3/21
		3.6 Construction	7/30
		3.7 Trade, repair of automobiles, household goods and personal items	405/1550
		3.8 Provision of agricultural services	3/30
		3.9 Hotel and restaurant services	9/33
		3.10 Transportation and Communication	10/50
		3.11 Employees in local self-government bodies	1/156
		3.12 Education, including preschool education	16/237
		3.13 Health and Social Care	29/250
		3.14 Utilities and Personal Services	2/37
		3.15 Employees of SNCO's	18/268
		3.16 Employees in government agencies	42/1280
		3.17 Employees in public organizations	8/16

Tab. 7 summarizes the volumes of farm products & agricultural production by communities below, clearly showing that the five impacted communities are pioneers in agricultural production among all the communities of the Artik settlement.

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Table 7

Volumes of farm products & agricultural production by communities in 2022 [6, 11,12]

N	Name of the community	Cereals		Potatoes		Vegetables		Fruits & berries	
		Sowing area (ha)	Gross yield (ton)	Sowing area (ha)	Gross yield (ton)	owing area (ha)	Gross yield (ton))	Sowing area (ha)	Gross yield (ton)
1	Artik	250	535	8	20	12	15	23	20
2	Lusakert	95	209	7	15	3	12	0	-
3	Spandarian	220	484	35	20	20	3	3	2
4	Harich	150,5	331,1	35	15	18	2	3	1
5	Pemzashen	15	35	7	10	1	0,7	5	3,2
6	Getup	170	374	5	60	5	7	5,2	38,5
7	Great Mantash	246	541,2	80	20	64	1	-	-
8	Hovtashen	105	231	4	80	2	2	6	9
9	Panik	280	616	11	8,3	6	4	14	4
10	Hayrenats	470	1034	0,5	7	0,5	0,06	0,5	2
11	Tufaschen	251	552,2	0	0	0	-	1	1,5
12	Horom	360	792	20	15	2	13	2	1,5
13	Arevshat	350	770	60	25	40	20	1	0,7
14	Saralanj	250	550	22	12	11	1	0	0
15	Saratak	380	836	25	20	8	1	0,3	0,05
16	Lernakert	100	220	25	15	0	0	0	0
17	Nor Kyank	415	913	7	10	1	0,7	5,1	3,2
18	Nahapetavan	50	110	22	15	19	2	3	1,5
19	Meghrashen	450	990	10	5	5	2	10	300
20	Little Mantash	160	352	20	20	30	2	1	3
21	Vardakar	310	682	5	15	2	2	8	2
22	Haykasar:	239	525,8	5	25	0	0	0	0
23	Geghanist:	280	616	8	10	5	2	1	0,07
24	Anushavan	350	770	10	15	5	2	1	0,7
	Total	5946.5	13069.3	436,5	457.3	259,5	94,46	88,1	393,92

This change will not only enhance crop yield and diversify the range of crops but also impact the cost of the irrigation water tariff. Furthermore, the reconstruction of the reservoir bed does not necessitate acquisition/allocation of new lands or territories for the Phase 1, and thus is devoid of any adverse social implications, as there are no issues related to displacement and resettlement of the local population within the project area or flooding in the community area.

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It is obvious that the implementation of the project and reconstruction of the reservoir will lead to a shift from the mechanical irrigation method to a gravity system irrigation.

Conclusion

Based on the obtained data analysis, it is obvious that the significant portion of the employed population is engaged in agriculture & forestry activities, with particular emphasis on irrigated agriculture. The project's implementation will lead to the irrigation of approximately 420 hectares of agricultural lands, positively impacting the socio-economic conditions of the local population. The reservoir reconstruction and enhancement of irrigation water supply are expected to elevate living standards in the area, thereby contributing to a reduction in poverty rates among the local residents, without resettlement or displacement requirements.

Moreover, the communities possess favorable conditions to evolve into a touristic destination due to its geographical location and rich historical, cultural and ethnographic features. There are substantial foundations for the growth of historical tourism and other forms of tourism, such as agritourism, ecotourism & others. Nevertheless, the community has yet to fully leverage its tourism potential, and the following impediments to sector development warrant consideration:

(a) Absence of a proficient online platform for effectively promoting Artik, an inbound tourism agency within the community, and the lack of maps available in foreign languages.

(b) Insufficient infrastructures, including traditional-style guesthouses, walking paths, and geological and ethnographic museums.

(c) Despite the abundance of architectural monuments in the community, the absence of specialized guides hinders the community's recognition both within the republic and beyond.

To guarantee the future stability of the Artik reservoir's operation, it is crucial to conduct ongoing social studies throughout the construction stage and a specific period after operation. This involves collecting and analyzing data on the anthropogenic load & the impact it has for the economic and industrial wellbeing of the community (whether it continues to be positive or negative and to what scale). Simultaneously, it is imperative to conduct comprehensive qualitative surveys to assess the attitudes and opinions of key representatives & focus groups within the affected community. In summary, it can be concluded that the reconstructed reservoir will enhance the recreational amenities in the region and has the potential to foster the growth of tourism in addition to enhancing the living standards of the community residents at large.

References

1. Armenian Water Project Institute CJSC «Technical and economic feasibility study for the construction of new irrigation reservoirs», Book 2,3.
2. BSC - Business Support Center Report, 2017 «Baseline study of Artik region of Shirak marz, RA».
3. Data from RA Police Passport and Visa Department of the Republic of Armenia, 2022.
4. Data from Armenian Red Book on Animals & Plants, 2010 .
5. Folke, C. Resilience: The emergence of a perspective for socio-ecological systems analyses. Global Environmental Change 16, 2006, pp. 253-267.

6. Five-year development plans of Artik community (2017-2022, 2022-2026).
7. Henri Boyé and Michel de Vivo, «The environmental and social acceptability of Dams», Field Actions Science Reports, 2016, Special Issue 14, pp. 1-5.
8. The decisions of the Council of Elders of Artik Community of Shirak Marz, RA. 2022
9. RA Government Decision No. 1270 of September 9, 2004 «On approving the state list of immovable monuments of history and culture of Shirak region».
10. Data from RA Hydrometeorology and Monitoring Center on Artik meteorological station, 2022, https://www.armmonitoring.am
11. Official website of Artik community (www.artik.am)
12. Official website of Shirak regional administration (http://shirak.mtad.am/)

References

1. «Հայջրնախագիծ ինստիտուտ» ՓԲԸ Ոռոգման նոր ջրամբարների կառուցման նպատակով տեխնիկական և տնտեսական հիմնավորվածության ուսումնասիրություն (գիրք 2,3):

2. ՀՀ Շիրակի մարզի Արթիկ տարածաշրջանի էլակետային ուսումնասիրություն: Բի Էս Սի» Բիզնեսի աջակցման կենտրոնի հաշվետվություն, 2017թ.:

3. ՀՀ Ոստիկանության Անձնագրային և վիզաների վարչության տվյալներ, 2022թ.:

4. ՀՀ Կենդանիների և Բույսերի Կարմիր գիրք, 2010թ.:

5. Folke, C. Resilience: The emergence of a perspective for socio-ecological systems analyses. Global Environmental Change 16, 2006, pp. 253-267.

6. Արթիկ համայնքի հնգամյա զարգացման պլաններ (2017 -2022, 2022-2026թթ.)

7. Henri Boyé and Michel de Vivo, «The environmental and social acceptability of dams», Field Actions Science Reports, 2016, Special Issue 14, pp. 1-5.

8. ՀՀ Շիրակի մարզի Արթիկ համայնքի ավագանու 2022թ. որոշումներ:

9. ՀՀ Կառավարության 9 սեպտեմբերի 2004 թվականի N 1270-Ն որոշում Շիրակի մարզի պատմության և մշակույթի անշարժ հուշարձանների պետական ցուցակը հաստատելու մասին

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11. ՀՀ Շիրակի մարզի Արթիկ խոշորացված համայնքի պաշտոնական վեբկայք www.artik.am

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Մկրտչյան Ա.Ռ., Բաբայան Ա.Ռ., Մարգարյան Ա.Յա., Մկրտչյան Ս.Հ.
Ակադեմիկոս Ի.Վ. Եղիազարովի անվան Ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտ

Արթիկի ջրամբարը գտնվում է ՀՀ Շիրակի մարզում՝ Կարանգու գետի ավազանում, որի վերակառուցման նախագծանախահաշվային աշխատանքները

մեկնարկել են 2023թ.-ին: Այս նախաձեռնությունը ղեկավարվում է Ակադեմիկոս Ի.Վ Եղիազարովի անվան Ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտն ու Շուշիի տեխնոլոգիական համալսարան հիմնադրամը՝ ՀՀ ՏԿԵՆ Ջրային կոմիտեի պատվերով: Գյուղատնտեսական նշանակության հողերի ոռոգման համար անհրաժեշտ ջրամբարն առաջին անգամ է վերակառուցման ենթարկվում 1994թ. պատվարի փլուզումից հետո նպատակ ունենալով ապահովել Արթիկ խոշորացված բնակավայրի թվով 5 ագղակիր համայնքների Նոր Կյանք, Փանիկ, Վարդաքար, Անուշական և Մեղրաշեն, ոռոգելի գյուղատնտեսության զարգացումը: Արթիկ խոշորացված բնակավայրի բոլոր համայնքները հիմնականում ներգրավված են գյուղատնտեսության մեջ, սակայն ջրի սակավության և անհասանելիության պատճառով համայնքում գյուղատնտեսական գործունեությունից ստացվող եկամուտը մեծ չէ, իսկ աշխատանքային միգրացիան տարեցտարի աճում է

Տարածաշրջանը հարուստ է նաև ՀՀ Կարմիր Գրքում գրանցված բուսական և կենդանական աշխարհի ներկայացուցիչներով և պատմամշակութային հուշարձաններով, ինչը հնարավորություն է տալիս համայնքում զարգացնել նաև զբոսաշրջության տարբեր ձևեր: Հոդվածում ընդգծվում է ծրագրի շրջանակներում բնապահպանական և սոցիալական չափանիշների կիրառման կարևորությունը՝ հիմնվելով կատարված բնապահպանական և սոցիալ-տնտեսական վերլուծությունների և տվյալների վրա: Կարևորվում է կայուն բնապահպանական և սոցիալական հետագոտտությունների դերը նախագծի իրականացման բոլոր փուլերում: Առաջնային նպատակն է գնահատել Արթիկի ջրամբարի վերակառուցման ծրագրի հետ կապված ակնկալվող օգուտներն ու ռիսկերը՝ հատուկ ուշադրություն դարձնելով դրա բնապահպանական և սոցիալական բաղադրիչներին՝ ապագայում համայնքի կայուն զարգացումն ապահովելու նպատակով:

Բանալի բառեր. ջրամբար, պատվար, ագղեցության գնահատում, ագղակիր համայնք, շահատուներ, սոցիալ-տնտեսական պայմաններ

ОЦЕНКА ЗНАЧИМОСТИ ЭКОЛОГИЧЕСКИХ И СОЦИАЛЬНЫХ СТАНДАРТОВ ДЛЯ ПРОЕКТА РЕКОНСТРУКЦИИ АРТИКСКОГО ВОДОХРАНИЛИЩА В ШИРАКСКОЙ ОБЛАСТИ АРМЕНИИ

Мкртчян А.Р., Бабаян А.Р., Маргарян А.Я., Мкртчян С.Г.
Институт водных проблем и гидротехники имени академика И.В. Егиазарова

Артикское водохранилище, расположенное в Ширакском районе в бассейне реки Карангу, планируется реконструировать начиная с 2023 года. Эту инициативу возглавляет консорциум, в состав которого входят Институт водных проблем и гидротехники имени академика И.В. Егиазарова и Фондом Шушинского технологического университета по заказу Водного комитета РА.

Водохранилище, необходимое для орошения сельскохозяйственных земель, будет впервые реконструировано после после обрушения плотины в 1994г., с целью

A.R. Mkrtchyan, A.R. Babayan, A.Ya. Margaryan, S.H. Mkrtchyan

ASSESSING THE IMPORTANCE OF ENVIRONMENTAL AND SOCIAL STANDARDS FOR THE ARTIK
RESERVOIR RECONSTRUCTION PROJECT IN THE SHIRAK REGION OF ARMENIA

обеспечения развития орошаемого земледелия в 5 пострадавших населенных пунктах укрупненного поселения Артик: Нор Кянк, Паник, Вардакар, Анушаван и Меграшен. Все общины расширенного поселения Артик в основном занимаются сельским хозяйством, но из-за дефицита и недоступности воды доходы от сельскохозяйственной деятельности в общине невелики, а трудовая миграция увеличивается с каждым годом.

Регион также богат представителями флоры и фауны, занесенными в Красную книгу РА, а также памятниками истории и культуры, что дает возможность развивать в общине различные виды туризма.

В статье подчеркивается важность соблюдения экологических и социальных стандартов в рамках проекта, а также делается попытка внести ценную информацию в продолжающийся дискурс вокруг проекта, подчеркивая решающую роль устойчивых экологических и социальных исследований на протяжении всего его развития. Основная цель – оценить ожидаемые выгоды и риски, связанные с проектом реконструкции Артикского водохранилища, уделяя особое внимание его экологическим и социальным аспектам, стремясь в конечном итоге к сбалансированному и устойчивому результату.

Ключевые слова: водохранилище, плотина, оценка воздействия на окружающую среду, социальные условия, община, заинтересованные стороны.

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Submitted by the resolution of coordinating board
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