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DISTRIBUTION OF FORMS OF HUMUS RESERVES IN THE SOILS OF SPREADED SIEROZEM ZONES

A. Akhatov - c.a.c.s., associate professor,
B. Gafurov - c.a.c.s., associate professor
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

The article presents the effect of humic substances on the physical, water-physical, and chemical properties of the soil, as well as the release of various forms of humus reserves (total, potential, near, direct). Each form of reserves of humus formed organic substances and their different differences in the composition of humus. Calculated methods are given for them, as well as for the soils of the gray earth belt of healed, newly irrigated, and old irrigated soils. There is accumulation, humus content and distribution in the layers of the section profile, changes in the forms of humus reserves in the genetic horizons of the soil. In a typical irrigated sierozem, the content of potential reserves of humus and in the same row the proximal, direct forms of reserve increases. In the soil profile at a depth of 0-120 cm, the potential reserve of humus ranges from 556 to 148 mg / 100 g, the closest one is from 651 to 286, the immediate reserve from 103 to 66 mg / 100 gis humus. These figures show that over the years, the use of soil for irrigated agriculture, the degree of their cultivation and the amount of watering aggregates increased.

Key words: soil, clay fraction, humus, hydrolysable and non-hydrolysable humus, total, potential, near and immediate forms reserves humus.

Introduction. The positive effect of organic matter on soil properties and productivity is of great importance for the formation of humic water-resistant aggregate structures. They improve water, air, biological, physical, water-physical soil conditions and provide erosion resistance. Scientists of the Commonwealth of Independent States Alexander L.N. [1], Antipov-Karataev [2], Shein EP, Milanovsky E.Yu. [3], Batudaev A.P. [4], Tyurin I.V. [5], Grishina L.A. [6], Rusanov A.N. [7], Agisheva S.Yu. [8], Evseeva N.V. [9], Mamontov V.G., Gladkov A.A. Kuzelev M.M. [10, 11], Ponomareva V.V., Plotnikova T.A. [12,13], Kuznetsov R.V. [14], Sakbaeva Z.I. [fifteen] The elemental and chemical composition of organic matter Numerous scientific papers have been published about their oxidation levels and their role in productivity. Scientists from Uzbekistan Arslonov I.N., Ryzhov S.N., Toshkuziev M.M. [16.17], Ziyamukhamedov I.A. [18], Akhatov A., D. Murodova., D. Makhkamova., Akhatova L.A. [19,20,21], Shadieva N.I. [22], Kuziev Yu.M. [23], Sherimbetov V.Kh. [24], Ramazanov A., Akhatov A., Fayzullaeva M. [25] Humus and humic and fulvic acids contained in soils, as well as the amount of soil in various mechanical particles. In their work, it was reported that they spread in the soil layer, increase in size from large particles to smaller ones and accumulate in the iliac particles. Among the countries of Central Asia, especially in Uzbekistan [21], the author first identified soil colloids (<0.0001 mm), determined the amount of humus in them and indicated the maximum amount of humus in colloidal particles. Given the high role of humus and its high molecular weight acids in the formation of soil and fertility properties, NI Gorbunov [25] used some nutrients (K, P, Ca, Na) in the soil to maintain the plant's ability to absorb plants. depending on the sequence in which the elements are divided into general, potential, pancake (near), Blidzhashian (closer), immediate (labile) form.

In this regard, for the first time Akhatov A., Muradova D. and Akhatova L. [20] partially described in their scientific studies the first step in the allocation of humus to the reserve. The author continued his research to cover this issue in more detail.

Place of research: To demonstrate the reserve forms of humus in the soil and to study their accumulation and distribution in the soil, they were considered as examples of irrigated soils in a typical desert zone of the Tashkent region. Typical sandy loamy soils, recently irrigated typical sandy soils, typical sandy soils from ancient times.

Method of research: Separation of soil particles from soil N. I. Gorbunov [26], determination of the humus content according to I. V. Tyurin [5], composition of the humus group of V. V. Ponomoryov and T. A. Plotnikov [13] humus storage methods calculated according to the author methodology. For this, it is necessary to determine the amount of humus in the soil, the composition of the humus group of soil particles, as well as the amount of humus in the ileal particles and the hydrolyzed and non-hydrolysing part of humus, the amount of some water-soluble humic acids, i.e. lipid states.

Result of research: From the literature and published articles of Uzbek and foreign scientists, it is well known

Figure: 1 Humus storage layer at the top of the soil section

Table 1

Humus content in soils and their distribution by type of reserve

The name of soil	Layers, depth,sm	Humus%	Particle Size II ,,	Silt particles the amount of humus,%	Humus%		Reserve mg / 100 g				Of the total amount of humus,%		
					Not hydrolyzed	hydrolyzed	total	potential	close	direct	potential	close	direct
Typical cliffs	0-12	1,73	19,0	4,22	61,2	38,80	1730	844	802	84	48,55	46,36	4,86
	12-23	0,76	21,1	1,85	70,2	29,80	760	311	390	59	40,92	51,32	7,76
	23-46	0,60	18,0	1,44	71,7	28,30	600	276	259	65	46,00	43,17	10,83
	70-90	0,35	15,6	1,17	72,7	27,30	350	67	183	100	19,14	52,29	28,57
	135-165	0,28	14,2	0,90	74,4	25,60	280	82	128	70	29,28	45,71	25,00
Newly irrigated	0-28	0,90	15,0	2,23	67,5	32,50	900	497	335	68	55,22	37,22	7,55
	28-38	0,56	15,9	1,52	67,2	32,80	560	243	242	75	43,39	43,21	13,39
	38-71	0,42	14,9	1,31	68,6	31,40	420	159	195	66	37,85	46,43	15,71
	90-100	0,32	14,4	1,11	68,9	31,10	320	98	160	62	30,62	50,00	19,38
	145-165	0,28	12,2	0,97	70,4	29,60	280	96	118	66	34,28	42,14	23,57
Ancient irrigated	0-27	1,32	23,6	2,76	63,5	36,50	1320	566	651	103	42,88	49,32	7,80
	27-43	0,96	21,3	2,37	62,6	37,40	960	384	505	71	40,00	52,60	7,40
	43-83	0,71	26,6	1,93	62,6	37,40	710	144	513	53	20,28	72,25	7,46
	100-120	0,50	22,0	1,30	61,7	38,30	500	148	286	66	29,60	57,20	13,0
	170-190	0,35	21,7	1,02	60,9	39,10	350	65	221	64	18,57	63,14	18,28

that the content of humus in soils decreases or the soil remains unchanged. there have not been many studies of humus fluctuations in the past, and the conditions for this have only been created.

It is necessary to pay attention to the study of various types of reserves as a substance that improves soil properties (control of water, air, biological, physical, water-physical procedures) and water-resistant aggregates, as well as increasing water resistance and productivity (pic. 1) The process of increasing or decreasing the amount of humus in the soil depends on the accumulation or leaching of any stock and intake of irrigation water. In this regard, humus was divided into the following conservation forms:

1. The total amount of humus, determined by the method of IV. Turin - general reserve;
2. The main part of the humus content is a potential reserve;
3. Humus paired with the same particle - a close reserve;
4. Water-soluble humus - direct (labile) reserve.

Explains what forms of humus-containing substances are included in these allocated reserves. Common humus reserves include lignin, cellulose, glucose, chelates, quinones, proteins, proteins, high molecular weight organic acids, organic salts. Potential (hidden) reserves of humus are lignin, cellulose, glutamate, chelates, proteins and proteins. The closest humus reserves are partial proteins, highly insoluble molecules, organo-mineral, and trivalent organic salts. Direct reserves are water-soluble high molecular weight (humic and fulvic acids) and organic salts and organic salts that are readily soluble in an alkaline environment. We decided to apply the aforementioned humic substances to the French scientist Duchofour (1965), the terms module and myulus, in the form of humus . The total and potential reserves of humus can be called moderate humus, i.e. coarse humus, and the types of near and direct reserves are called humus, that is, small humus, since small humus accumulates in small mechanical particles and partially dissolves in water. Thin humus is involved in coating small mechanical particles, coating the surface of the aggregate with a thin film and the formation of waterproof aggregates, while coarse humus is located in the spaces between the aggregates. The study of the association of humus with the mineral part of the soil and their form determines the direction of soil formation and the process of fertility formation. The stock of humus in the soil, especially its proximity and direct forms, is considered a factor in the formation of aggregates, and potential reserves are the main resource of their formation.

Table 1 shows that the humus content in protected

Figure 2 The appearance of soil incision

and recently irrigated soils in the boggy region is low. The humus content in typical sandy loamy soils is 1.73%, with a sharp decrease towards the lower part of the shear and a gradual decrease in size compared to natural rocks (picture 2). In typical freshwater soils, the humus content decreases by about 1.5-2 times lower than in arable soils, the main reason for which is the impact of plowing, irrigation and harvesting.

The table shows that the humus content in typical old irrigated soils increases significantly in the sedimentary layers and in the lower layers compared with recently irrigated typical white soils .. Consequently, the effect of irrigation on the humus content in relation to recently irrigated soil is restored from ancient irrigated soils. The distribution of humus reserves in typical gray soils of the study was estimated at 100 g per milligram of soil in the intersoil and cross sections. In the potential (hidden) reserve, the main part of the humus content, there was a tendency to lower speeds from the upper layer to the lower natural stone. The potential supply of humus in these soils ranges from 844 to 65 mg / 100 g. n typical marsh soils, the potential humus reserve is maximum in sandy loam, and in the sublayer it has decreased by 2 times, followed by a gradual decrease in genetic material. The potential reserves of humus in freshly irrigated moist soils are significantly reduced compared with the reserves of humus and ancient irrigated soils, as shown in the table below. This means that the culture level of the newly irrigated soil is still quite low, since the proximity and direct forms of humus for cultivating the soil are not well formed. (convergence at 335 mg / 100 g, direct forms at 68 mg / 100 g). In a typical desert soil that has been irrigated since ancient times, the potential reserves of humus along with its proximity and direct reserves increase. The potential supply of humus at a depth of 0-120 cm in the notched layer is 566 mg / 100 g to 148 mg / 100 g, proximity - from 651 mg / 100 g to 286 mg / 100 g, direct reserve type 103 mg / 100 g, 66 mg / 100 g g of vibration. These figures show that the longer the soil is used for irrigated agriculture, the higher the level of soil culture will be, and the better its structure and the more water-resistant aggregation. These, in turn, are key factors in controlling soil fertility, water, air, and thermal conditions. Reserves are expressed as a percentage of total soil humus. The potential reserves of humus in observed typical wild soils are significantly reduced compared to typical sandy soils that are irrigated with recently irrigated typical gray soils. This is the only exception to the typical turf soil cover of the reserve.

The proximity and the immediate type of humus reserves are distributed over the soil layers, especially when the shape of the proximity reserve increases in the lower sedimentary layers, despite the total humus supply, from the ancient humus reserve in the lower genetic layers to the potential humus reserve. rotation conditions. Therefore, the study of humus in the soil can be explained by a detailed analysis of the humus reserves while explaining the decrease or increase in the humus content in the soil. Backing up the form of humus monitoring, tracking and analysis of soil, humus, which is growing to achieve clear and detailed data about the inevitable. In general, the surface of the studied soils accumulates in the form of a potential reserve, which decreases with the lower layers. On the contrary, the closest reserve accumulates in the lower layers. This is due to the fact that particles in the soil move from top to bottom. Direct (labile) spare parts also depend on the level of irrigation, leaching and soil culture. Therefore, we can say that the total humus content in moist and arid soils is associated with a decrease in the total humus content in the soil. The norm of water during irrigation must be strictly observed, otherwise humus can be washed away from the surface layer of the soil, which will lead to a decrease in the humus content by 50%. In agriculture, the rules of irrigation and irrigation and drainage measures must be observed, otherwise the loss of humus or adjacent parts of the humus supply leads to a decrease in the total humus content. Examples of methods for determining and calculating the patterns of stock of soil humus are given. For example: the humus content of 1.73% is found in the humus of the soil humus, and its conversion to milligrams is expressed in 1730 mg / 100 g of soil. To find the affinity reserves of humus, a soil particle is first isolated, and then the amount of humus in the soil is 4.22%, and when converted to milligrams - 4220 mg-100 g. The number of snakes obtained from the soil according to the method of N.I. Gorbunov (1978) was 19.0%. (4220x19): Approximately 100 = 802 mg / 100 g of humus is recognized as a backup form. The form of humus stock in labile soil can be calculated using the formula of the author below.x = ((Q-d) 100) / ((f V): 100)

: x - the amount of active humus in humus,%.Q- The total humus content in the soil is 1,73% при 1730 мг

/ 100 г. f - the amount of sludge particles extracted from the soil, 19,0%.v- the amount of sludge particles extracted from the soil, 4,22%, compose 4220 мг / 100 г.

d- total humus content in 61,2% not hydrolyzed part of the total amount of humus in 1059 milligrams

It was found that the humus content calculated on the basis of the general formula contains 84 mg / 100 g labile humus.

Conclusion: Given the current soil and climatic conditions, the amount of humus in the soil was determined, its group composition and the amount of humus in soil particles, as well as the hydrolyzed and non-hydrolysing part of humus, as well as the amount of water-soluble humic acids, i.e. lipids. In case of humus release, reserve forms. Along with the potential reserves of a typical humid soil humus, its proximity and direct supply form increase. It was found that potential reserves of humus at a depth of 0-120 cm of the notch layer are from 556 to 148 mg / 100 g, proximity is from 651 to 286 mg / 100 g, and the shape of the direct reserve is from 103 to 66 mg / 100 g.

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INNOVATIVE TECHNOLOGIES IN EVALUATION OF PROCEDURES IN RIVERBED

A.M. Arifjanov – DSc., professor, Sh.B. Akmalov -PhD
I.G. Akhmedov – doctoral researcher, D.E. Atakulov - assistant
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

Article deals with the use of modern GIS (geographic information system) in the study of the deformation processes in the river. The most difficult problem in obtaining information on erosion and accumulative process is rapid assessment of the process. In the researches analyzed the possibility of using GIS technologies in the assessment of deformation processes in the foothills of the river, which have a highly variable nature. This information helps to draw conclusions about changes and events in nature. Study included collection, analysis and delivery of data to users with using GIS. The deformation processes in the river bed were evaluated and analyzed using Landsat satellite data. The researches described how to achieve a quick assessment of their processes.

Key words: Remote Sensing, image analysis, satellite, method, map.

Introduction. Deformation changes are occurring the management of water resources, rivers and streams. It is important to identify these changes in a timely manner so that they can be prevented. Because the size and extent of changes are unstable, they require speed and accuracy, scientifically sound conclusions, and the development of useful measures. Targeted research is important around the world, with the aim of developing a variety of risk-based measures to remotely control land, creating a systematic, electronic, rapid and accurate network of ground water information. Establishment of a global system of land and water management through GAT systems, organizing global surveillance and analysis based on Earth satellites, thus reducing redundant resources, improving results accuracy, creating different models, databases, rural and water resources. Introduction to agriculture is important [1,2,3]. One of the important issues is the improvement of computational methods and technologies for river flow assessment and river deformation prediction. Today, these issues are being studied, such as accurate and reliable assessment of the situation, and economic efficiency. This requires the use of modern technologies as the development of these works [4,5,6]. Today, GIS has the ability to analyze data from a remote location without problems, and has increased its use in various fields.

Remote sensing technologies are a set of devices, techniques, and programs that help gather information about nature and the Earth. These data are collected on Earth by recording on active and passive sensors mounted on the Earth's satellite or pilot [7,8,9]. Active sensors emit light from them and capture them by means of absorption and return to the earth and various objects. Examples are radar sensors. Passive sensors are based on the absorption and return of sunlight to various objects and surface. Variation in the absorption capability of the objects allow for more detailed study of plant, water and other objects in the remote sensing by spectra. Satellite imagery can also explore areas that are difficult to navigate and explore. Since irrigation systems are relatively small, so far only linear maps have been generated using GPS (Global Position System) devices. Losses and their operational status have been studied locally. The launch of satellites with high-resolution sensors over the last 10 years has also enabled remote sensing in the water industry using their images [10,11,12]. This article presents the results of studies on river flow assessment using GIS technologies, determination of flow and river hydraulic and hydrological parameters.

Methods and materials. The Landsat archive-high-resolution satellite systems were used to assess the deformation processes in the river. The ability to easily analyze the Remote sensing data in GIS has increased its use in various fields. These images also explore areas that are difficult to navigate and explore. However, initially they were of low resolution and were not available in the water sector. Therefore, to date, there has been little research on the use of water in the water. Mostly, many studies have focused on land use and land classification by analyzing mid- and high-resolution images. ArcGIS plays an important role in this system. Specific information includes properties of an object (statistics, maps, geometry, etc.). The prospect of using this program in science is rapidly evolving as it has the advantage of incorporating it into all data [13,14,15].

One of the key factors in the evaluation of river processes is the change in river parameters over time. These studies used the ArcGIS application ArcMap. Originally, Landsat 8 satellite images were downloaded free of charge from GloVis US official website. The maps are made by date for each downloaded image. GPS and GPS data were used to verify the accuracy of the mapped maps. Initially, the geodetic survey was conducted to study the existing parameters of the Sox River. Nine invariants were selected for each kilometer along the length of the stream. At that point, 7 immutable points were selected in each station, and at these points measurements were performed using GPS [16,17]. For each student, the leveling works were completed and mapped (Table 1).

Subsequently, measurements were made with each GPS device and mapped to the table (Table 2). There was a difference between nivelir and GPS-based results. The maximum value of these differences was 2 meters.

Table 1

Geodesic measurements

№	Right			Centre	Left		
PC 12	659	657	656,8	565,38	656,48	657,7	658,55
PC 22	648,75	647	645,63	646,68	647,25	647,7	648,55
PC 32	638,23	637,09	636,11	636,18	634,78	634,58	635,8
PC 42	623,8	622,8	622,72	623,8	623,48	623,65	625,03
PC 52	613,97	612,02	612,47	612,32	613,12	612,12	612.4
PC 62	602,15	600,65	600,8	599,8	599,55	599,2	599,5
PC 72	590,9	588,45	588,6	588,95	586,7	586,6	588,8
PC 82	579	575,3	575,8	576	575,9	574,75	575,75
PC 92	567	564.3	564.85	565.3	564.7	566.6	567

Table 2

GPS data

№	Right			Centre	Left		
PC 12	659	658	656	658	655	656	659
PC 22	645	643	641	643	643	645	646
PC 32	634	633	635	632	632	632	633
PC 42	624	620	621	623	620	621	625
PC 52	611	610	611	612	612	611	612
PC 62	600	600	600	601	599	599	600
PC 72	593	591	588	590	587	588	589
PC 82	580	577	577	578	575	578	580
PC 92	569	565	565	566	564	565	568

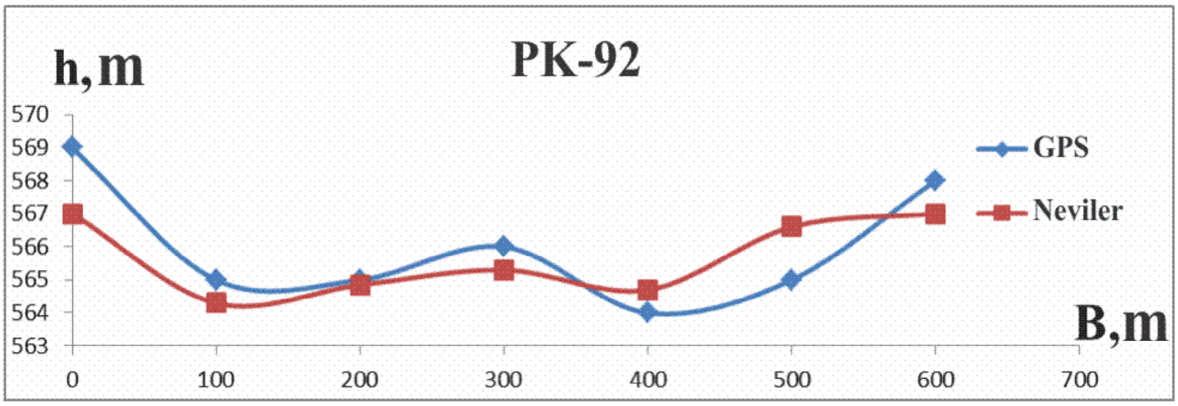

Fig.1. Cross-section of the Sox River PK-92

Results and discussion. On the basis of the values measured in our analysis phase, the cross-sectional surface for each stave was drawn (Figure1). The difference between Level and GPS is 1.5-2 meters. The map based on this data has been verified. At the same time, the width and width of the stream were measured and compared using the ArcMap application of ArcGIS (Figure 2). The results of the field experiments and satellite imagery were the same.

The last 4 years of Landsat 8 satellite image data have been downloaded for free from the GloVis USGS official website. Based on these data, water flow maps for the past 4 years have been made. Based on the maps, the flow area and the width of the pickets were determined (Table 3). Based on the average width of the Sox stream in the identified pickets, the average depth of each picket was determined from the linkage equation of river width and average depth. Determination of the marphometric connections of the river was analyzed based on the most commonly used computational methods to evaluate the processes in the river [18,19,20]:

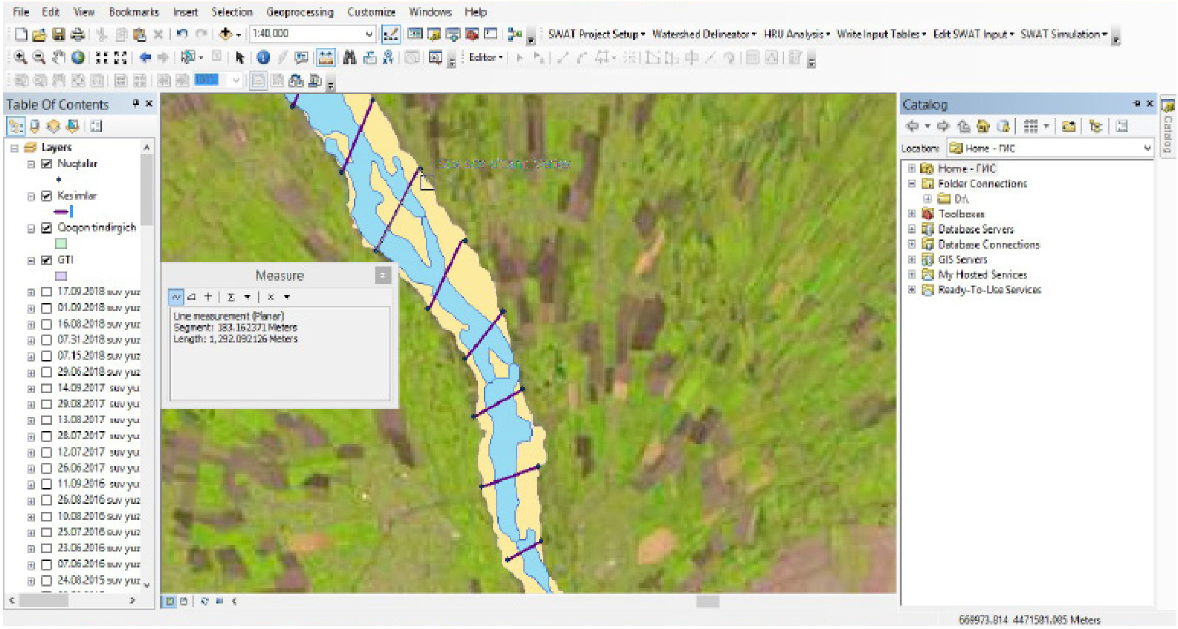

Fig.2. Measurement of leith and with of Sox in ArcMap

Table 3

River Marphometric Connections Table

Picket	Discharge m³/s	Water surface area, ha	Average width, m	Actual width, m	Slope	Average depth, m	Cross-section surface, m^2	Average speed m/sek
12	95	127.1	149.5	93	0.011	1.43	133.09	0.71
22	95	127.1	149.5	138	0.011	1.92	264.46	0.36
32	95	127.1	149.5	75	0.011	1.22	91.53	1.04
42	95	127.1	149.5	127	0.011	1.80	228.87	0.42
52	95	127.1	149.5	106	0.011	1.58	167.11	0.57
62	95	127.1	149.5	182	0.011	2.35	428.05	0.22
72	95	127.1	149.5	120	0.011	1.73	207.37	0.46
82	95	127.1	149.5	115	0.011	1.67	192.57	0.49
92	95	127.1	149.5	115	0.011	1.67	192.57	0.49

$$H=0.05B^{0.74}$$

Conclusion. Based on the data in the table we can see that the flow rates in the sampled sediments vary with cross-sectional surface, average depth and average velocities. In relatively large areas with average depth, average velocity is small. This indicates that the average flow rate is greater and more likely to be washed off at high velocities, whereas fuzzy particle sinking is observed due to the smaller velocity in the medium with a high flow rate. Based on the above processes, it is possible to evaluate the deformation processes in the river. The studies analyzed the last four years of river flow data.

In our research, we extracted and evaluated river formation based on a five-year observation of sedimentation processes using Landsat images. According to the analysis, the use of GIS in the remote sensing of the deformation processes in the basin allows the rapid detection of emerging processes. This allowed saving time and resources, creating a reliable and quality database. It shows the ability to map maps using Landsat images for many years and create a database based on these maps and predict the future based on hydraulic laws.

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JUSTIFICATION OF HYDRAULIC PARAMETERS IN THE DESIGN OF OPEN DRAINAGE

M. Otaxonov-assistant, D. Allayarov-assistant, I. Axmedov- researcher
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

In this article the tasks of open drainage are shown in improving the ameliorative condition of the sown areas. The scientific recommendations of scientists in the design and construction of drainage are considered. The aspects affecting the hydraulic processes occurring in the channels of open drainage are analyzed. The hydraulic parameters of open drainage used in the Syrdarya region are analyzed. The results of studies to improve the performance of open drainage are revealed. The effect of flow capacity on drainage efficiency is estimated. The results of calculations of the throughput capacity of the drainage flow in two sections are studied and disclosed. The bandwidth increase by 62 percent is justified, while the flow rate increases by 25 percent. From a hydraulic point of view, methods are shown to increase flow capacity. Scientific recommendations on the justification of hydraulic parameters in the design of open drainage are given.

Key words: drainage, course, expense, speed, stream, deposits, permeability.

Introduction. In ancient times, peasants have been working on water salinization, decreasing soil fertility, as well as cleaning the land from harmful salts. There were also issues regarding the disposal of wastewater from pastures through artificial collector drainage networks. Later, in 1929-1931, the leaching of arable land, in addition to removing salts from the soil, began to use a network of furrows to prevent the salinization of those areas. The openings of the openings have begun to be built with deep hydraulic calculations, and they have yielded a good effect. Various experiments have shown that deep drainage networks allow for the rapid and large removal of salts in the washing soil, reducing the level of groundwater to the required level [1,2. , 3].

The quality and quantity of harvested crops is primarily dependent on its reclamation status, and large-scale dehkan farms are working on saline areas in order to improve land reclamation, high yields, and improve the quality of products. . It is now difficult to make saline soils, especially in irrigated areas without leaching. At the same time, the saline drainage water must also be transported out of the area by the drainage ditches, creating artificial drainages [1,2,3].It is well known that the main task in leaching is to dissolve salts from the soil and remove them from the fields. For this purpose it is necessary to ensure good drainage system. To this end, in order to improve the reclamation state of irrigated land, prevent salinization and waterlogging, state programs are being developed and extensive work on cleaning, repairing, and drilling new, as required, [4,5]. The total length of the drainage network in the Syrdarya region is 16,189.8 km, of which 7479.13 km are open pavements and 8,709.87 km are closed-loop systems. The main trunk lines are Central Mirzachul, Shuruzak, Bayouut, Ettisoy, Sardoba, Railroad. The longest main trunk is the Central Mirzachul Drain, with a length of 84.70 km. In Syrdarya region, the repair and maintenance of 950-1100 km collector drainage systems is carried out annually [6,7]

It is known that worldwide irrigation and land reclamation, agriculture and drainage systems are widely used. At different times, A. N. Kostyakov, SF Averyanov, AP Vavilov, LP Rozov, VD Jurin, V.A. Kovda, VS Maligin, NA Besednov, NF Bespalov, AS Robochiev, Q. Mirzajanov, H.A. Scientists such as Akhmedov, F.Rahimboev, and collector made scientific recommendations in the design and construction of pits.

Issue. Currently, much attention has been paid to the construction and design of open fittings, their cleaning and maintenance, and the calculation of hydraulic parameters, which do not cover the interconnection of flow and drainage [7,8]. It is often recommended to design the minimum flow slope i = 0.0003. In the openings projected at such a slope, the flow rate is smaller than the rate of blurring, resulting in greater sediment deposition and greater plant growth. This complicates the implementation of spring agrotechnical measures, with the decline of run-off efficiency, the salinization of groundwater levels and critical salinization processes, and the depletion of wetlands from arable land.

Method of solution. When designing an open pit, the primary task is to perform hydraulic calculations to ensure its long-term efficiency, to assess the factors affecting the process, and then to calculate the costs of land and construction based on the hydraulic parameters. Hydraulic computations are primarily caused by atmospheric precipitation, wind and sand erosion caused by erosion of sand and soil particles that fall into the drainage bed, as a result of non-sinking of sediments, ie mudflow and flooding in the drainage system. is a prerequisite for preventing, that is, not washing [8,9]. We describe this condition as follows

$$\vartheta_{л} < \vartheta_{з} < \vartheta_{но}$$

Here it is $\vartheta_{л}$- velocity that does not drown mud in the stream; $\vartheta_{з}$-flow rate in open bed dump; $\vartheta_{но}$-flow rate that does not wash the open bed ditch core.

In order to determine the optimal hydraulic parameters of the open field under the above-mentioned conditions, the system of pipelines in the Khovos and Sayhunabad districts of Syrdarya region was carried out. The hydraulic parameters of the open drainage dumps, which are currently being used in natural conditions, have been studied in three ways, namely, rinsed, untreated and filled with dirt and vegetation. The results of the research were analyzed and the factors influencing the functioning of the openings in the optimal hydraulic mode were identified. The

Table 1

Hydraulic parameters of the ditch under field conditions

The name of the open bed furrow	Flow depth, m	Slope	Cross-sectional Surface, a^2	Flow,average speed m/s	discharge m^3/s
2-K-4	0,6	0,0047	1	1,16	1,16
СК-2-4	0,4	0,0011	0,94	0,43	0,41
ВШ-20А	0,6	0,0003	2,33	0,28	0,67

analysis of justification of the optimal hydraulic parameters for maintenance of hydraulic strength of openings is provided.

Results. Studies conducted in natural field conditions have allowed us to draw conclusions that it is necessary to provide the dynamic strength of the river in open bedways, and to correlate with the hydraulic parameters of the stream. The hydraulic parameters of the drain current are given in the following table (1-table).

Studies show that the bed of the open bed of 2-K-4 was undergoing washing (Figure 1). As a result, river depths have increased over the years. There is no need for cleaning in such holes. However, the continuation of the process will complicate the flow of water to the next sections after a while. The ditch SK-2-4 is operating normally. The wash condition is at the level of dynamic stability (Figure 2). As a result of VS-20A drainage mudflow, the depth of the river bed was significantly increased from the design depth and the efficiency of the operation decreased (Fig. 3). The bottom of the ditch is designed at a depth of 3 m below ground level with a slope of i = 0.0003. However, in a short period of time the river bed was raised to 1.5 meters.

The study also found that when justifying hydraulic parameters of the ditch it is necessary to consider the flow kinematic parameters.

The cross-sectional pattern of openings projected in our country is mainly trapezoidal and it is necessary to substantiate the following parameters in determining flow hydraulic elements (Figure-4).

b-width of the bottom of the ditch (width); B-width of free flow in the drainage ditch;h- the depth of the water flow in the ditch; the slope of the strike,

At present open-pit openings, the problem of changing the length and depth of water, the uneven mode of operation, and the hydraulic calculations taking into account the change in the surface area and velocity of the pavement according to water consumption is a problem. In the current method, the flow rate in the river is calculated as a conditional smooth motion when calculating flow velocity and depth using the formula Shezi.

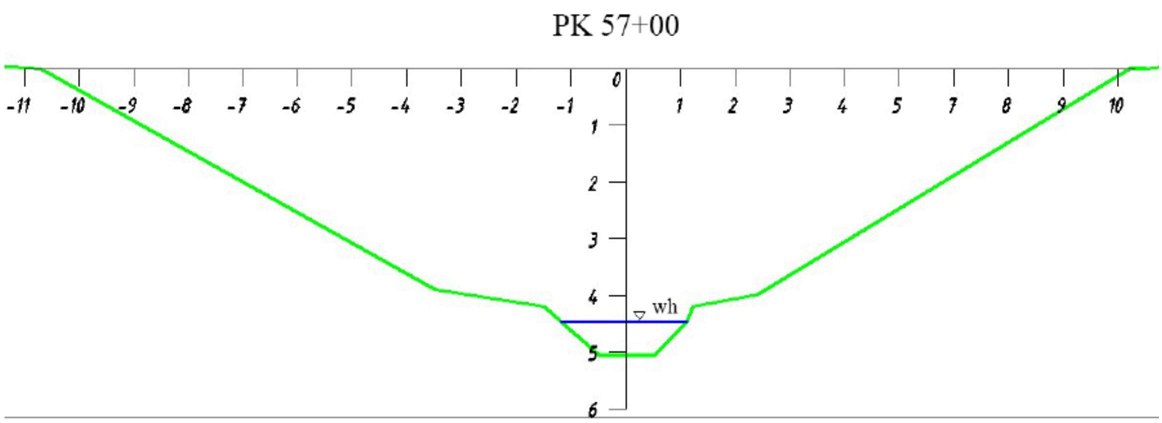

Figure 1. An open bed is a transverse section of the drain

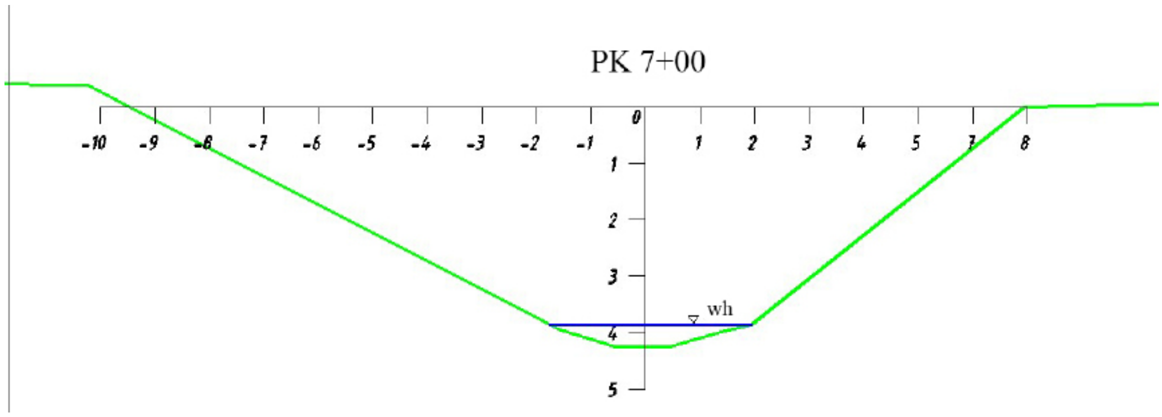

Figure 2. An open bed is a transverse section of the drain

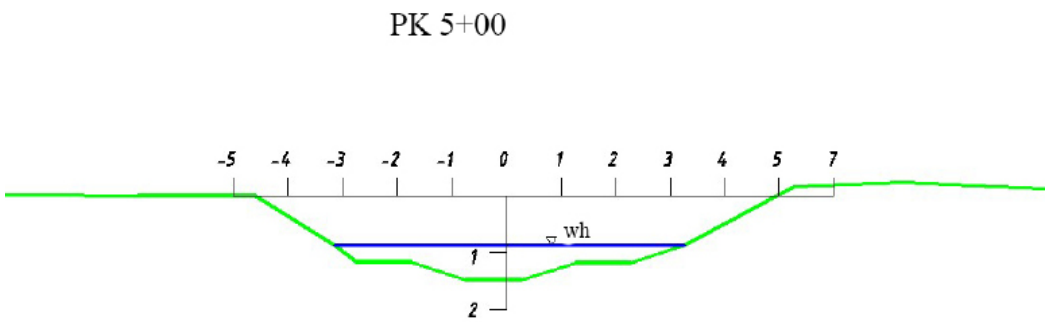

Figure 3. An open bed is a transverse section of the drain

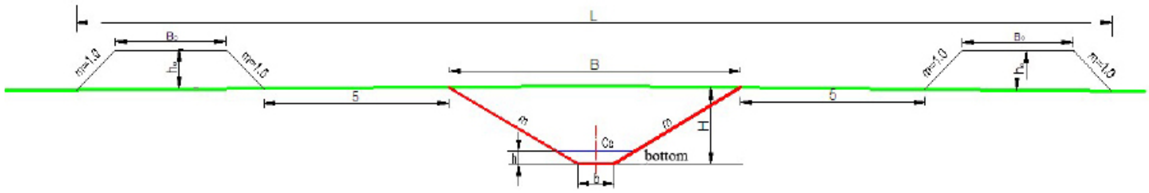

Figure 4. An open bed is a transverse section of the drain

determined in [9,10]. It should be noted that in the openings, the physical conditions of the flow are more difficult to fulfill than the conditions for the smooth movement.

Since 70-80 years in the open ditches, the width of the river bed has been projected at least b = 1 m. This was due to the fact that at that time it was not possible to excavate the river bed at a depth less than 1 m using excavators.

As an example, consider the hydraulic calculation of the open-pit 19-K-7-2A with a length of 1400 m. In the design, the water consumption is 0.2 m^3/s, the width of the river bed is b = 1m, the slope is i = 0.00046, and the slope coefficient is derived from BN and R [8,9,10], depending on the type of soil, m = 1.75, The hydraulic calculations were performed with the coefficient n = 0.03. As a result, the flow velocity = 0.29 m / s and the water depth h = 0.40 m were designed.

The above results show that the velocity of water in the drainage system is considerably low, which is caused by natural and man-made factors caused by sand and soil particles, water erosion caused by water erosion, erosion and other factors. As a result, over a period of time, the river shape rapidly changes, the river deformation occurs, the water velocity decreases, groundwater levels rise, the drainage efficiency decreases, and mechanical maintenance or repairs can be made in a short time. An effective solution to this problem is proposed from the hydraulic point of view and is addressed as follows. Hydraulically, it is necessary to increase the turbidity of the flow, ie, to increase the sediment flow in order to remove the sediments in the water.

It is clear from studies in this area [11,12,13,14] that the current carrying capacity depends on several factors. We consider the flow rate control from the available factors. That is, we can increase the flow capacity of the stream by increasing its velocity. The rate of flow in open ditches depends largely on its cross-sectional surface and slope. Reducing the cross-sectional surface and increasing the slope, along with increasing the flow rate, can significantly reduce the time and cost of digging the ditch. We will consider the hydraulic parameters of the drainage counts mentioned above with a new approach.

From the hydraulic point of view, under the condition of the depth of the drainage bed, in the following method [15,16], if we determine the width of the ditch, the standard value of the depth of the river bed for the problem considered is β = 0.5 m. As a result, by increasing the slope of the ditch from i = 0.00046 to i = 0.0009, we obtain an increase in flow velocity = 0.29 m / s = 0.39 m / s based on hydraulic calculations.

Given the variability of flow rates in the pipelines, the above-mentioned two-dimensional movement increases the flow velocity at depths up to h = 0.5 m, based on hydraulic calculations, as shown in the figure below (Figure 5).

Based on the studies carried out, the flow transportability was also evaluated [17,18]. Analysis of the calculated results shows that the flow rate increases by 25%. This result also increases the carrying capacity of the stream. We examine the carrying capacity of the current through the following formula [19,20].

$$S = \alpha \frac{\vartheta^3}{g \cdot R \cdot \bar{W}}$$

where S-flow carrying capacity, *a* = (d0 / d1) 3, d1-sediment particle diameter, d0-optimal diameter, that is,

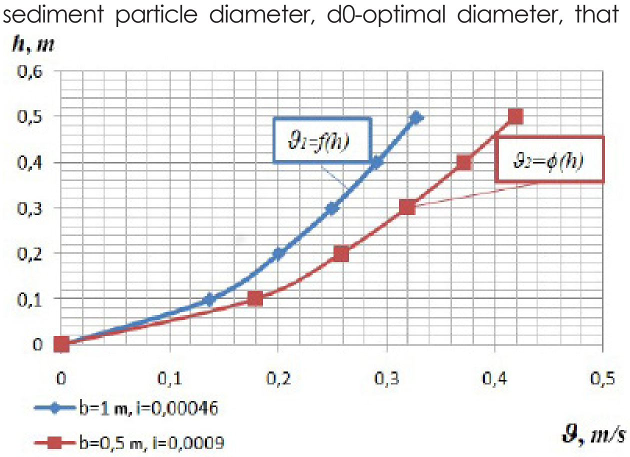

Figure 5. Graph of changes in flow rates in open bedways

diameter of the sediment particles whose velocity is equal to the flow rate, th-flow rate,--free-fall rate , R-hydraulic radius, W-average hydraulic magnitude. As can be seen from the formula, the carrying capacity of a stream increases with its velocity.

In the studied sections, ie, at the first section, the flow

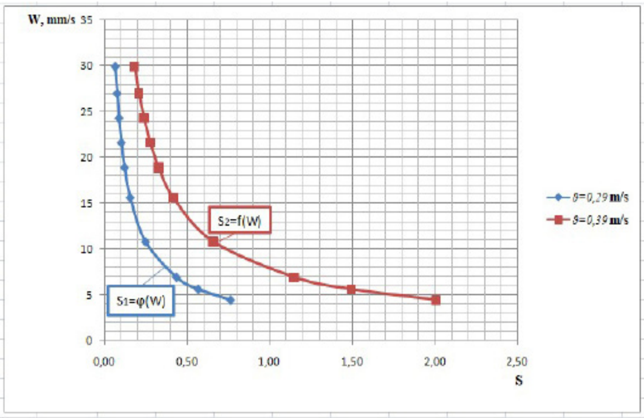

Figure 6. Graph of flow carrying capacity in open bed pits

rate = 0.29 m / s, at the second section, the flow rate = 0.39 m/s, we determine the carrying capacity of the sediment particle d = 0.08-0.275 mm. The divergence capacity of the two diagonal cross sections and the differences between them are shown in the figure below (Figure 6).

Research shows that the flow capacity of the stream increases with that of the proposed pipeline in the proposed pipeline. This means that we must pay close attention to the kinematic and dynamic parameters of the flow while ensuring the dynamic strength of the bedrock.

Conclusion.

1. It was found that the flow rate increased by 25% in the open pit under construction and its carrying capacity increased by 62%. This results in a reduction in the fading of the cross section of the ditch.

2. The design of these openings for efficient operation is based on the ability to determine hydraulic parameters, taking into account the dependence of the flow and the main shaft in the design.

3. It is recommended that in the design of the drainage it is necessary to determine the carrying capacity of the flow and take it into account when calculating the hydraulic parameters on the conditions of non-washing and fading.

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UDC: 644.612: 622.235.432.54

DESIGN AND DEVELOPMENT OF ARDUINO BASED AUTOMATIC PH RANGE MONITORING SYSTEM FOR OPTIMUM USE OF WATER IN AGRICULTURAL FIELDS

R.T. Gaziyeva - professor, E.O. Ozodov - assistant, S.Ya. Ismailov - master
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

his research aim was the intelligent pH range control system in agricultural watering pump stations based on Adriano pro mini microcontroller automation control with GSM control. This kind of intelligent control system which combination the pump unit with a water filter. It helps to control the salt level of the field with a reverse osmosis plant and supply the water if required. In this research embedding a control system into an automatic water pump controller depend upon the pH range. The intelligent pH range control system in the agricultural fields designed in the research had wonderful effort of man-machine interface, it is straightforward, cheap and convenient high degree of an automation system. Not only that this system helps to prevent wastage of water. This system is a prototype, which makes this self-sufficient, watering itself from underground water. This system can use saltwater from underground waters and give chance to economize pure water this side of this system makes it more environment-friendly.

Key words: ATmega328, Arduino IDE, GSM D800, watering, salt water, pump stations, watering automation control system, pH sensor.

Introduction. According to a recent survey, water has become a big issue because of less rainfall, increase in population many cities are facing this problem people have to suffer from this problem they do not have a sufficient amount for their daily needs [1].

The increasing demands placed on the global water supply threaten biodiversity and the supply of water for food production and other vital human needs. Water shortages already exist in many regions, with more than one billion people without adequate drinking water. In addition, 90% of the infectious diseases in developing countries are transmitted from polluted water. Agriculture consumes about 70% of fresh water worldwide; for example, approximately 1000 liters (L) of water are required to produce 1 kilogram (kg) of cereal grain, and 43,000 L to produce 1 kg of beef. New water supplies are likely to result from conservation, recycling, and improved water-use efficiency rather than from large development projects [2].

Water is essential for maintaining an adequate food supply and a productive environment for the human population and for other animals, plants, and microbes worldwide. As human populations and economies grow, global freshwater demand has been increasing rapidly.

In addition to threatening the human food supply, water shortages severely reduce biodiversity in both aquatic and terrestrial ecosystems, while water pollution facilitates the spread of serious human diseases and diminishes water quality [3,4,5].

World agriculture consumes approximately 70% of the fresh water withdrawn per year. Only about 17% of the world's cropland is irrigated, but this irrigated land produces 40% of the world's food. Worldwide, the amount of irrigated land is slowly expanding, even though salinization, waterlogging, and siltation continue to decrease its productivity. Despite a small annual increase in total irrigated area, the irrigated area per capita has been declining since 1990 because of rapid population growth. Specifically, global irrigation per capita has declined nearly 10% during the past decade [6,7,8,9].

The practice of applying about 10 million L irrigation water per ha each year results in approximately 5 t salts per ha being added to the soil.The salt deposits can be flushed away with added fresh water, but at a significant cost. Worldwide, approximately half of all existing irrigated soils are adversely affected by salinization [10].

The amount of world agricultural land destroyed by salinized soil each year is estimated to be 10 million ha. In addition, drainage water from irrigated cropland contains large quantities of salt [11,12].

The accumulation of salts in areas that could potentially be used in agriculture is a worldwide problem, covering 340 million hectares in all over the world .[13]

In the region located in arid and semiarid zones, a lot of problems, associated with irrigation and land reclamation. Irrigated agriculture is the basis of agriculture in the region (Volga region

Russian Federation, Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, Azerbaijan).

On background of a wide variety of natural irrigated area conditions; poor water management at various functional levels of irrigation systems creates many problems that worsen soil fertility and land quality, in agricultural use, and also leads to aggravation of environmental problems, expressed in salinization and pollution of irrigated soils, groundwater and water sources.

Considering the above facts, monitoring of water quality is considered one of the issues of rural culture.

The main indicator of water for irrigation of agricultural products is pH. The pH value is determined by the quantitative ratio in water of H + and OH- ions formed during the dissociation of water. If OH- ions prevail in water - that is, pH> 7, then water will have an alkaline reaction, and with a high content of H + ions - pH <7- acidic. In distilled water, these ions will balance each other and the pH will be approximately 7. When dissolved in water, various chemicals, both natural and man-made, this balance is violated, which leads to a change in the pH level.

A pH meter should be used to track the activity of cations, as well as to study the redox potential (ORP) in solutions. Based on the research, we can conclude about the quality of food.

Typically, the pH level is within the range at which it does not affect consumer water quality. In river waters, the pH is usually in the range of 6.5–8.5; in marshes, water is acidic due to humic acids — there the pH is 5.5–6.0, and in groundwater the pH is usually higher. At high levels (pH> 11), water acquires a characteristic soapiness, an unpleasant odor, and can cause irritation to the eyes and skin. Low pH <4 can also cause discomfort. It also affects the life of aquatic organisms. For drinking and household water, the pH level in the range from 6 to 9 units is considered optimal [14].

To increase fertility, it is logical to assume that irrigation for arid zones is one of the main indicators in rural culture.

The proposed system has the ability to control the pH by combining the pumping unit with reverse osmosis.

The system determines the operation of the filter based on quality indicators of the water source.

The solution of problem. To reduce these impacts to a minimum level, a system that will give the ability to combine the process of irrigation and water supply of drinking water in a pump unit.

The design combines a diffusion mixer and a reverse osmosis filter for a centrifugal pump.

This design is installed in a pumping station for individual use, which are very relevant in the above regions.

The pump station is designed for individual use for portable use in small villages and rural areas to produce the irrigation of small plots of land and the implementation of water supply consumer th.

The design consists of a centrifugal pump, a differential pH sensor, a diffusion mixer, reverse osmosis, and four two-position solenoid valves, shown in Figure 1 [15].

The system has two operating modes, the upper mode is a mode in which only reverse osmosis is activated and is used to reduce salinity to drinking water standards.

The lower mode is the diffusion mixing mode. A tank is installed in this part of the structure, where the pipes are connected from the source, from where salted water comes from and from reverse osmosis, from which filtered water comes. The proportions of the water in the tank are measured using a conductivity sensor.

Conductometric sensor detects, operation switching valve and the by gives the ability to control the salt level inside the tank. At a certain volume of water in the tanks, the lower valve automatically activates, which delivers this water to the irrigated place. The ratio of salt and filtered water is compiled according to a given sketch of the microcontroller of the system.

The principle of operation of the system consists of determining the level of salt and on the basis of this indicator the volume of work is established as the proportion of salt and drinking water. Signal set to the source conductometric sensor, is compared with a predetermined parameter E and the controller determines the volume range of the predetermined value.

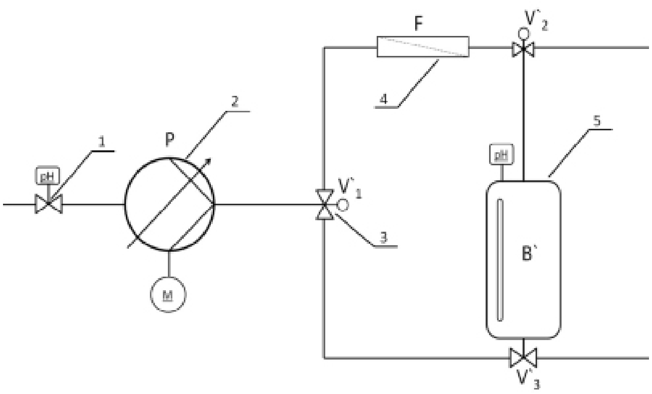
After determining the ratios, the proportion of water is controlled using valves to which a signal is supplied through the controller.

For the experimental stand, a board was assembled designed on the basis of Arduino elements in Fig. 2, and a diagram of the connection of the board elements is shown .

The board consists of an Arduino pro mini controller , an ULN 2003 amplifier for controlling two position valves, a SEN0116 conductivity meter, and a GSM SIM900D system for remote control and process monitoring [4].

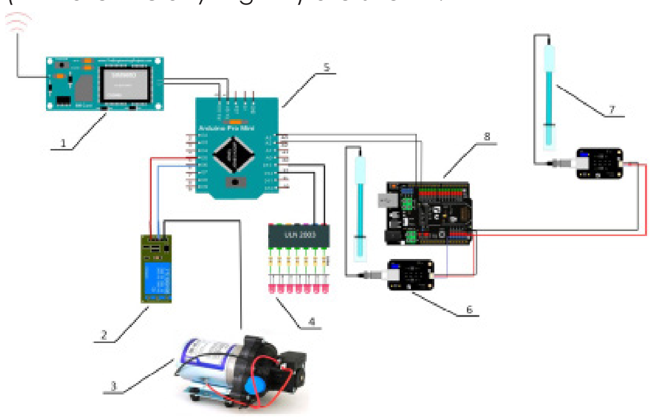
Arduino ID E software environment was used to calculate variable indicators by a sensor for comparing and compiling codes. The system responds to the command of the logical operation of comparison If variables are entered, the main parts of the sketch are shown on the Arduino ID E panel in Figure 3.

Comparison of the indicators of the sensors and the indicated values is compiled using the indicated aisles in the value operator, which is indicated by the sketch example in Figure 4, which shows all process changes. When comparing, the limits of pure water (`` Water Is neutral (safe) '' ) and with increased acidity ( `` water Acidity High``) are shown.



1 - conductometric sensor; 2-pump unit ; 3- two position solenoid valve; 4- reverse osmosis; 5 tank diffusion mixer

Figure 1 . Scheme of an automatic diffusion mixing system.



1- SIM900D; 2- executive mechanism relay module; 3-pump unit; 4- amplifier; 5- controller Arduino Pro mini; 6- BNC connector ; 7- pH sensor; 8- sensor module.

Figure 2. From the circuit board of the automatic control system.

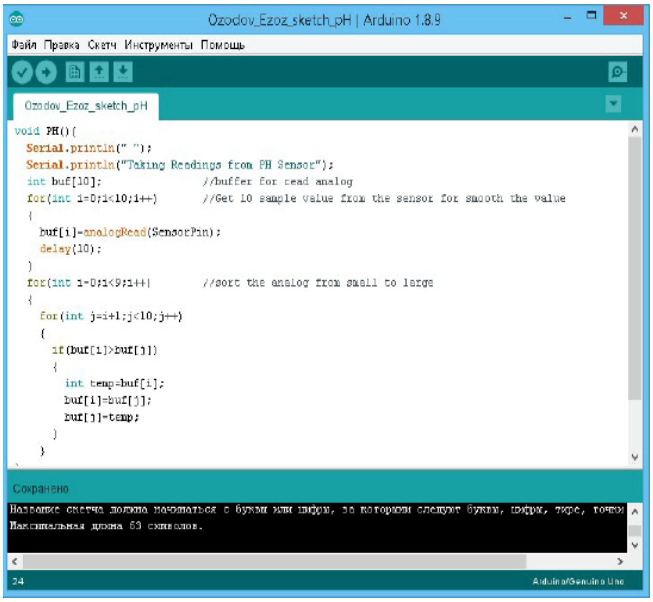


Figure 3. Code sketch of an automatic control system on the Arduino IDE platform

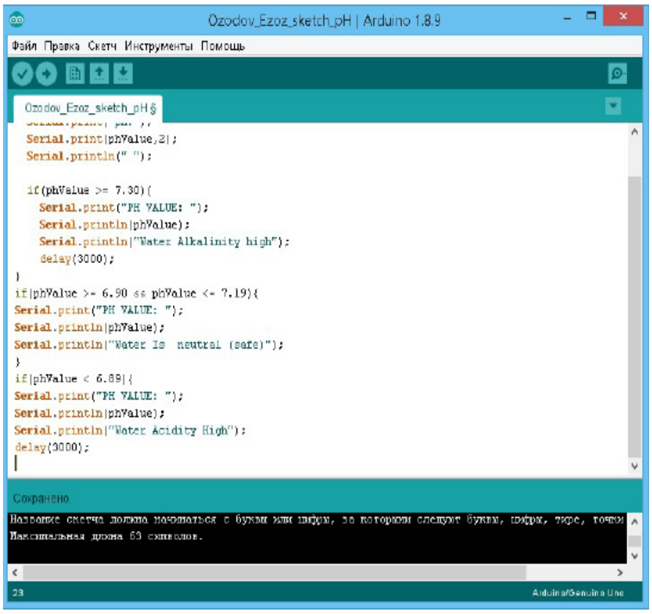


Figure 4. Sketch of code for comparing indicators on the Arduino IDE platform .

To increase the accuracy of the diffusion mixer in the Arduino IDE, the pH value and error are not more than 0.3 and compared with 7.00 and the difference was changed to "Offset" in the sample code. Correction was made using the operator "# define Offset 0.00" to "# define Offset (x)" the data value x is variable parameters with a tava waters s and further indicators of water are loaded into the controller [2] .

When calibrating , the equipment is connected in accordance with the schedule, that is, the pH electrode is connected to the BNC connector on the pH meter board, and then the connecting lines and pH meter boards are used when connected to the long port 0 of the Arduino controller . When the Arduino controller receives power, the sensitive element is activated. A sample code is downloaded to the Arduino controller based on the water composition of the region. The pH value of which is 7.00 or is adjusted at the input of the BNC connector [3].

The system is easily adaptable, for this, a base of the required value and calibration of the conductivity sensor are compiled, all indicators are loaded into the controller and the ranges of chapels of the required norms of sketch operators in the Arduino IDE are replaced .

Conclusion. This system is intended for small rural areas and for small populations. The design is designed to reduce the use of clean drinking water, but it should be noted that the minimum use of clean water depends on the salt in the water, which makes this system not perfect. The autonomous system compares the quality indicator and determines the ratio of liquids, which very favorably affects the fertility of the soil during irrigation.

In the absence of a developed system and the program is functional and within normal limits. Remote monitoring of the system makes it possible to collect data on the composition of water around the clock and when alerted, they will turn off the device.

The main problem of the system is the calibration of the sensors to the side of the optimal work point for which the dismantling of the controller is required.

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LAMINARY FLUID FLOW IN A PIPE AND DIMENSIONAL NUMBER OF REYNOLDS

Sh.A. Mengliev
Termez State University
Kh.F. Kholturaev
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

The article provides information on the mathematical modeling of the incompressible viscous fluid in the pipe. The study shows laminar and turbulent regimes of fluid motion, as well as the physical meaning of these regimes. Consider a straight round pipe with a diameter constant along the entire length. The flow rate on the walls of the pipe due to adhesion is zero, in the middle of the pipe, it has the greatest value. A cylinder with a characteristic length and a characteristic radius inside the liquid whose axis coincides with the axis of the pipe is considered and the flow of the liquid through the cylinder is studied. The calculation formulas for calculating the maximum flow velocity in the cylinder, the volume of liquid passing through the cross-section of the pipe, the coefficient of resistance to friction in the pipe along the flow length, and the maximum value of the tangential stress are derived. The results of comparison of empirical and semi-empirical formulas for calculating the coefficient of resistance to friction are presented [1]-[5].

Key words: Reynolds number, laminar flow, turbulent flow, parabolic flow, the friction force is the integral coordinate of the pipe, viscosity, density, bulk flow velocity, average speed, maximum speed, radius, Gegen, Poisal, Darcy-Weisbach, the volume of fluid resistance coefficient.

The flow of real fluids in many cases differs sharply from laminar flow. They have a special property called turbulence. In real flows, which occurs in pipes, channels, and in the boundary layer with increasing values of the Reynolds number, the laminar form of the flow becomes turbulent. Such a transition from laminar to turbulent flow is called the occurrence of turbulence, and they play a fundamental role throughout hydrodynamics. Initially, such a transition was detected in flows occurring in straight pipes and channels. In a straight pipe with a smooth wall and a constant cross section, each particle of liquid at small Reynolds numbers moves along a straight path. Due to the presence of viscosity, the particles of the liquid close to the wall move more slowly than away from the wall. The flow moves in the form of ordered layers moving relative to each other. However, observations show that for large Reynolds numbers, the flow goes into an unordered state or goes into a turbulent flow. There is a strong mixing in the liquid, this can be seen by introducing paint into the liquid moving in the pipe [2]-[4].

In 1883, Osborne Reynolds, studying the movement of water in a circular pipe, found that with an increase in the flow velocity, the steady laminar nature of the movement is disturbed. Perturbations appear that are expressed in the fact that the previously rectilinear movement of fluid particles, laminar in some areas becomes erratic, while maintaining the general direction of motion. A further increase in speed leads to chaotic motion throughout the flow. As is customary to say at the present time, the flow has turned from a steady-laminar into an unstable, disturbed-turbulent [2].

The presence of viscosity in liquids resists the movement of fluid layers relative to each other. In other words, in laminar (layered) flows, internal friction occurs due to viscosity; it is expressed by the number of tangential stresses at the boundaries of the layers, or is characterized by the number of tangential forces related to a unit area. Separate concentric layers of fluid relative to each other move in such a way that the velocity of the fluid will be directed in the direction of the main axis. The movement of this type of fluid is called laminar flow [1]-[7].

When the incompressible viscous fluid moves starting at the same value of the Reynolds number $Re = \rho UL / \mu$, the laminar flow passes into a turbulent one, the same value of the Reynolds number is called the critical Reynolds number, where ρ-density, μ- viscosity of the liquid, *U*- the maximum velocity of the main flow, *L*- the characteristic scale of the length.

From Fig. 1. it is seen that at, $Re<Re_{krt}$, laminar flow, and $Re_{krt}<Re$ and the flow goes into turbulent mode.

In [2], information is given on the forces acting on flows in a cylindrical tube. We will consider the flow of a fluid in a straight circular pipe with a constant diameter over its entire length, inside of which are located a bundle of tubes with a length and a radius .

In real liquids, the fluid adheres to the walls of the tube and transmits the shear stress to the surface of the streamlined fluid. Here the so-called internal

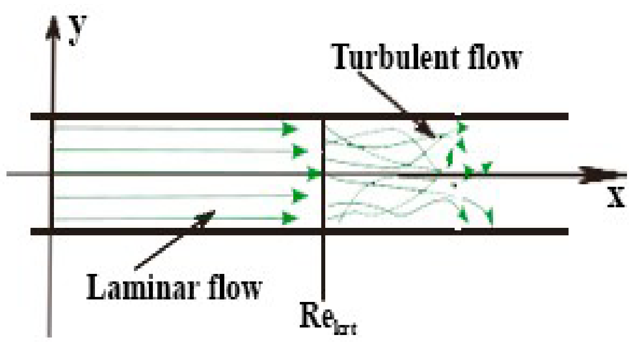

Fig. 1. The transition form laminar flow to turbulent

friction force appears, in liquids this force is viscosity. Viscosity is such a property of gases and liquids, which is the resistance leading to the movement of liquids by external forces. The presence of tangential stresses and adhesion of liquids to solid walls leads to qualitative differences between real and ideal liquids. Now we study the movement of liquids in a pipe inside of which tubes of the same length and radius are located. Taking into account the viscosity on the tube walls, the velocity is zero, reaches its maximum value in the middle of the tube. At a sufficiently remote distance from the tube entrance, the distribution of the flow velocity does not depend on the coordinate of the directional along the radius.

The movement of fluid in the pipe occurs under the action of a pressure drop in the direction of the pipe axis, but in each cross section perpendicular to the pipe axis, the pressure can be considered as constant. The movement of each fluid element is accelerated due to pressure drop and slows down due to shear stress caused by friction [2]-[7].

The pressure *p* is assumed to be constant, that is, it is assumed that over the section of the tube p_0, p_l=*const* [3].

In the direction of the main axis, a pressure force $p_0 n\pi y^2$ and $p_l n\pi y^2$ applied to the inlet and outlet bases of the tube, respectively, as well as the tangential force $2\pi n y L\tau$ acting on the lateral surface of the cylinder, act on the tubes. It is required to determine the maximum flow velocity in the tube, the volume of fluid flowing through the cross-section of the tube, the coefficient of tube resistance to friction along the flow length, as well as the maximum value of the tangential stress.

Equating the forces acting fluid in the tube, we obtain as an equilibrium condition in the direction of motion the equation (Fig. 2.)

$$\sum_{i=1}^{n} p_0 \pi y^2 = \sum_{i=1}^{n} p_l \pi y^2 + \sum_{i=1}^{n} 2\pi y L \tau \qquad (1)$$

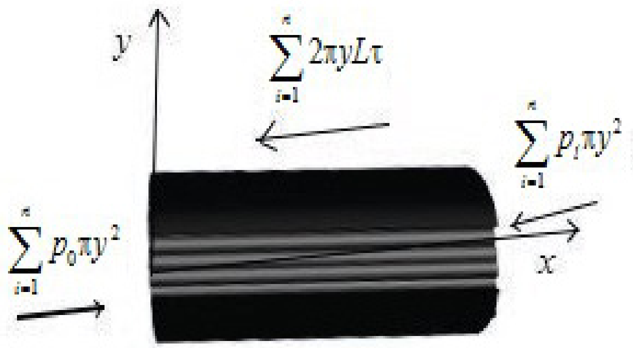

Fig. 2. In the tube is located a bunch of n tubes.

The projection of the internal friction force is taken with a plus sign, because the velocity gradient is negative (the velocity of the layer decreases with increasing radius *r*)

From the formula (1) we determine the tangent stress *τ*.

$$\tau = \frac{p_0 - p_l}{L}\cdot\frac{y}{2} \qquad (2)$$

In this case, the flow velocity *u* decreases with increasing coordinate *y* and is zero at *y=r*. Therefore, on the basis of the law of friction $\tau = \mu\frac{du}{dy}$ Hooke should take that $\tau = -\mu\frac{du}{dy}$. Substituting this expression in (2), we obtain

$$-\mu\frac{du}{dy} = \frac{p_0 - p_l}{L}\cdot\frac{y}{2}$$

from here, you can see that

$$\frac{du}{dy} = -\frac{p_0 - p_l}{\mu L}\cdot\frac{y}{2} \qquad (3)$$

Now, given that *y=r* with velocity *u(y)=0* and integrating equation (3) with this initial condition we have

$$u(y) = -\frac{p_0 - p_l}{4\mu L}y^2 + C \qquad (4)$$

to determine the constant *C* of equation (4), use the condition *u(r)=0* at *y=r*, or

$$u(r) = -\frac{p_0 - p_l}{4\mu L}r^2 + C = 0$$

from here you can see that

$$C = \frac{p_0 - p_l}{4\mu L}r^2 \qquad (5)$$

Substituting the value of the constant from (5) to equation (4) we have

$$u(y) = -\frac{p_0 - p_l}{4\mu L}y^2 + \frac{p_0 - p_l}{4\mu L}r^2$$

And in turn, we obtain an equation to determine the flow rate of the following formula

$$u(y) = \frac{p_0 - p_l}{4\mu L}(r^2 - y^2) \qquad (6)$$

Thus, we have a parabolic velocity distribution along the radius of the pipe (Fig. 3.). The greatest value of speed is in the middle of the pipe (*y=0*), where it is

$$u_{max} = \frac{p_1 - p_2}{4\mu L}r^2 \qquad (7)$$

The total amount *Q* of liquid flowing through the

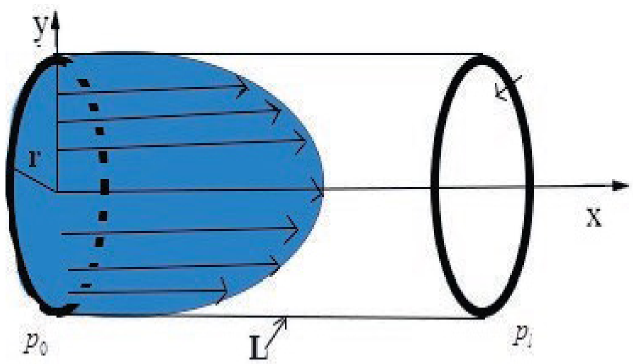

Fig. 3. Fluid flow rate for one tube

pipe section (fluid flow) is defined as the volume of the paraboloid of rotation (Fig.3.) and acreage is defined as follows.

Equation (6) is rewritten as follows:

$$u(y) = \frac{p_0 - p_l}{4\mu L}(r^2 - y^2)$$

from here, you can see that

$$u(y) = \frac{p_0 - p_l}{4\mu L}r^2\left(\frac{r^2 - y^2}{r^2}\right) = u_{max}\left(1 - \frac{y^2}{r^2}\right) \qquad (8)$$

The total liquid flow through a tube with a circular cross section on the basis of the Gagen-Poiseuille formula is determined as follows [1,2,3,4,7].

$$Q=\int_0^r u(y)2\pi y dy=2\pi u_{max}\int_0^r\left(y-\frac{y^3}{r^2}\right)dy=2\pi u_{max}\left[\frac{y^2}{2}-\frac{y^2}{4r^2}\right]_0^r$$

or given the formula (7), for the flow of liquid have the formula

$$Q=2\pi\cdot\frac{p_0-p_l}{4\mu L}\cdot r^2\cdot\frac{r^2}{4}=\frac{\pi(p_0-p_l)r^4}{8\mu L} \qquad (9)$$

Enter the average flow rate, the values of which are determined by the cross section of the tube as follows:

$$\bar{u}=\frac{Q}{\pi r^2} \qquad (10)$$

Equation (10) with the formula (9) is written as

$$\bar{u}=\frac{(p_0-p_l)r^2}{8\mu L}$$

by comparing the function $\bar{u}(y)$ with the maximum speed u_{max} determined by the formula (7) it can be seen that $\bar{u}(y)=\frac{1}{2}u_{max}$ or the average speed of the laminar flow in the tube is half the maximum speed [5]-[6] (Fig. 4).

Determine the pressure difference (p_0-p_l)

$$p_0-p_l=\frac{8\mu L\bar{u}}{r^2}$$

from here we have

$$p_0-p_l=\frac{8\mu L\bar{u}}{r^2}=\frac{32\mu\bar{u}}{2r}\cdot\frac{L}{2r}=\frac{32\mu\bar{u}}{D}\cdot\left(\frac{L}{D}\right) \qquad (11)$$

here *D*=2*r* is the diameter of the tube.

The pressure loss along the flow length is determined by Darcy-Weisbach equation

$$p_0-p_l=\sum_{i=1}^{n}\frac{\lambda_i}{2}\rho\bar{u}^2\left(\frac{L}{D}\right) \qquad (12)$$

here, λ- is the hydraulic loss ratio along the length of the pipe or the resistance coefficient of the pipe [8]-[9]. From the last equation we have

$$\lambda=\frac{(p_1-p_2)}{\frac{1}{2}\rho\bar{u}^2}\cdot\left(\frac{D}{L}\right) \qquad (13)$$

Substituting p_0-p_l the value of the formula (11) in the equation (13) we obtain, for the resistance coefficient of the pipe following formula

$$\lambda=\frac{32\mu\bar{u}}{D}\cdot\left(\frac{L}{D}\right)\cdot\frac{2}{n\rho\bar{u}^2}\cdot\left(\frac{D}{L}\right)=\frac{64\mu}{n\rho\bar{u}D}$$

or from here you can see that

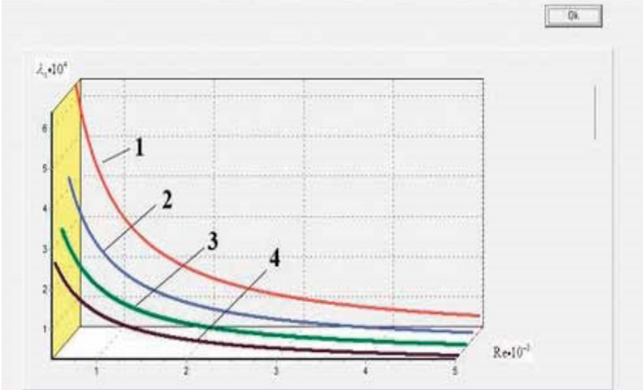

Fig. 4. The dependence of the resistance coefficient for smooth tubes on the number of tubes n and the Reynolds number Re: 1) n = 200, 2) n = 300, 3) n = 400, 4) n = 500.

$$\lambda=\frac{64}{n\mathrm{Re}}, \qquad (14)$$

Here is $\mathrm{Re}=\frac{\rho\bar{u}D}{\mu}$ - Reynolds number.

According to formula (14) to calculate the resistance coefficient, we present the results of calculations for various numbers of tube bundlesn. (4 fig.).

Figure 4 for *n* smooth tubes shows the results illustrating the dependence of the resistance coefficient λ_n on the Reynolds number Re.

A comparison of the obtained results shows that for all values of the Reynolds number the theoretical formula (14) holds. In computational experiments, the following range of variation of the characteristic parameters Re and λ_n: Re=500-5000, λ_n=0.0001-0.0007 was considered. From Fig. 4 it is seen that as the number of tube *n* increases, the resistance coefficient decreases.

Thus, it is shown that the motion of incompressible viscous flows in channels, pipes and in the boundary layer can be laminar and turbulent, and the physical meaning of the appearance of these modes is indicated. For the fluid flowing through the tube *n* inside the tube, the formulas for calculating the maximum velocity of the fluid volume flowing through the cross section of the tube, the coefficient of tube resistance to friction along the length of the flow, are derived.

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VIRTUAL WATER TRADE IN AGRICULTURAL PRODUCTS IN THE REPUBLIC OF UZBEKISTAN

M.R. Li - PhD
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

The article reveals the essence and justifies the relevance of virtual water research, provides a methodology for its calculation and analysis of the content of virtual water of agrarian crops and livestock products of the Republic of Uzbekistan, moreover comparative analysis of different sectors of the economy is given in this paper. The relationship between the contribution of agriculture to GDP and the income of the population is being proved in the paper. The scientific conclusions based on the results of the analysis, are worked out and the recommendations that help to conserve the limited water resources of the Republic of Uzbekistan are given.

Key words: virtual water, agrarian crops, livestock products, methodology, food production, import, export.

Introduction

Increasing water demand for food production is a major factor in the global freshwater deficit. The forecast shows, the need for food will increase by 70% till 2050, as a result, additional sources of water will be needed to cover the food scarcity, although it still exists [1].

Virtual water is the water needed to produce agricultural commodities [2]. According to UNESCO, virtual water trade mainly affects the agricultural sector (up to 80%), and explosives trade up to 6% of the total freshwater used in the world. According to some data, in 2009, the virtual water trade reached 1 625 km^3 / year, or about 40% of the total world water consumption. To present the volumes of virtual water that may be involved in the import-export sphere, the following numbers are to be shown. Thus, with the consumption for the production of about 1 t of grain of about 1000 tons of water, the annual export of 70 million tons of grain (for example, the United States) is equivalent to the export of about 70-100 km^3 / year of water, which is spent on the production of these volumes of grain. Thus, every resident of North America and Europe (excluding the countries of the former Soviet Union) consumes at least 3 m^3 of virtual water per day in the form of imported food, while in Asia this figure is 1.4 m^3, Africa - 1.1 m^3 (Zimmer et Renault). In particular, Saudi Arabia, being one of the largest producers of grain crops in the Middle East, announced its intention to reduce grain production by 12% in order to prevent groundwater depletion. At the same time, Saudi Arabia intends to support financial incentives for renting large areas of African land for agricultural production in the regions having enough water.

Materials and methods

According to Ashok Kumar Chapagain [3]: A nation can save its domestic water resources by importing a water-intensive product rather than producing it domestically or loose its domestic water resources by exporting them. The net national saving $\Delta S_{n,i}$ *(m^3/yr)* of a country *i* as a result of trade of product p is:

$$\Delta S_{n,i} = V_{p,i}\, T_{im,p,i} - V_{p,i}\, T_{ex,p,i}$$

Where $V_{p,i}$ is the virtual water content of product in the importing country *i*, $T_{imp,p,i}$ is the import of product in country *i* and $T_{ex,p,i}$ is the export of products from country *i*.

The national water saving can have negative sign, which means national water loss. International trade can save water globally if a water-intensive commodity is traded from an area where it is produced with high water productivity (resulting in products with low virtual water content) to an area with lower water productivity.

The global water saving ΔSg (m^3/yr) through the trade of a product p from an exporting country e to an importing country i, is:

$$\Delta S_{g,p,e,i} = T_{p,e,i}\left(V_{p,i} - V_{p,e}\right)$$

Where $T_{p,e,i}$ is the amount of trade (ton/yr) between the two countries, $V_{p,i}$ is the virtual water content of product in the importing country i, and $V_{p,e}$ is the virtual water content of product in the exporting country e.

The method used by us to estimate the virtual water content (VWC) is coming from the definition that the VWC of crops represents the amount of water used per production of the crop. The VWC of the crop is estimated from the actual production of crop multiplied on the norm of water usage per crop. The VWC of the crop is an indicator of the agricultural demand, which can be used to estimate the total demand for water in the region and the supply requirements. The VWC is calculated as follows.

$$VWC = NWU*P$$

Where, NWU is the norm of water used (l/kg) by the crop during the growing season, P is the amount of crop (kg) produced during the same period.

Calculation of the virtual water in crops grown in the Republic of Uzbekistan and analysis of the structure of foreign trade turnover by types of crops in terms of the virtual water content allows making conclusions about the existing reserves of water conservation in changing the structure of exports and imports of agricultural products.

Results and discussions. In the future, the problem of water deficit for food production will be exacerbated by competition for water resources between sectors of the economy. It is known that the use of water in the production of industrial products is more economically profitable than in the agricultural sector. Thus, 1 thousand tons of water is being spent as on the production of 1 ton of wheat at the cost of $ 200, or at the increase of industrial products at the cost of 14 thousands dollars. [4,5]

In this context, the industry is always more competitive, however, without the use of water in the agricultural

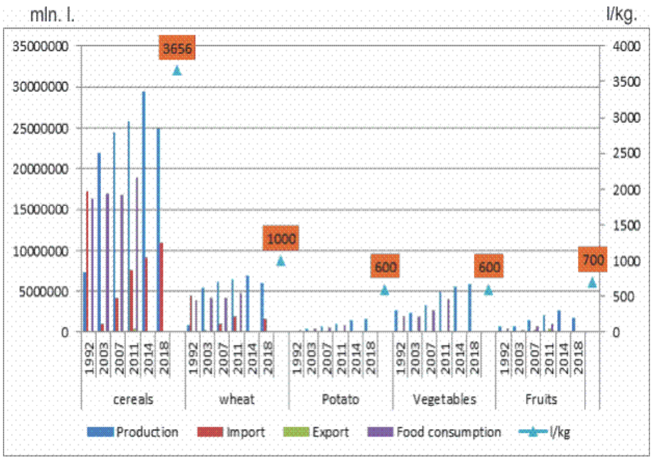

Fig.1. Virtual water content of agrarian crops (without processing) & water consumption rate (estimated by the author)

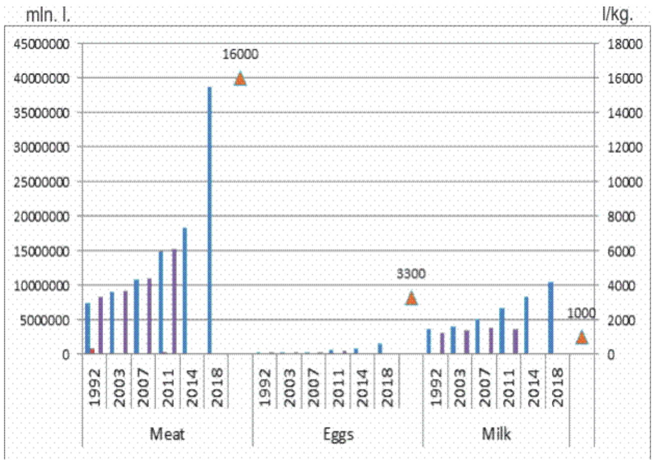

Fig.2. Virtual water content of animal products (without processing) & water consumption rate (estimated by the author)

sector, it is impossible to cover the needs of the growing population in food, and this dilemma cannot always be resolved in favor of industrial water use. And one of the ways to solve this dilemma is to increase the efficiency of water resources management in irrigated agriculture through the use of water saving technologies, increasing the efficiency of its use. The availability of water resources does not directly determine the absolute or relative value of GDP. At the same time, analysis showed that there is a direct relationship between the contribution of agriculture to GDP and the income of the population.

The needs of the growing population of Uzbekistan have led to the increase in both the production and the import of grain crops containing a large amount of virtual water. (Figure 1) For the same reason, there has been an increase in meat, eggs and milk production, but a positive result is a decrease in meat imports in terms of import substitution and negative in terms of water consumption for its production. (Figure 2)

A positive trend is that the government's efforts overcome the import dependence on wheat and reduce its production, while the production and export of less moisture-loving crops, such as fruits and vegetables is increasing.

The government needs to make further efforts to ensure food security by maintaining a balance between import substitution and water conservation challenges.

Conclusion:

The potential of water trade in the Republic of Uzbekistan is very limited, and the use of shared water resources is usually governed by specific agreements or general principles of international law, rather than trade rules. However, virtual water trade can help the Republic of Uzbekistan, with limited domestic water reserves, to import water-intensive goods. Trade can also facilitate access to technology, goods, services and related investments necessary to provide basic water supply and sanitation services, as well as to clean and safely dispose of industrial waste. In addition to these positive interactions, trade can have a negative impact if it stimulates economic activities that harm the aquatic environment, and internal regulation is not strong enough to protect this resource (for example, some types of irrigation subsidies).

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INNOVATIVE DEVELOPMENT AT POULTRY ENTERPRISES IN CONDITIONS OF GLOBALIZATION OF AGRICULTURAL MARKETS IN UZBEKISTAN

M.E. Rakhmataliev - PhD
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

The increase of economic efficiency of entrepreneurial activity in the sphere of production of poultry farming based on introduction of innovative technologies is considered, the methodology of management of the innovative development of a poultry farm adapted to branch features is developed.

The proposed model provides to the organization of innovation activity for systematic monitoring of the R&D industry market. In addition, it provides the implementation of a preliminary assessment of innovation in terms of its scientific and technical viability, efficiency and feasibility, the formation of a database of sectorial innovations, the coordination of the analyzed innovation project with the enterprise strategy and its inclusion in the innovative program of the poultry farm.

Proposals are presented on improving the organizational structure of poultry enterprises.

Key words: innovative development, globalization of agrarian markets, the efficiency of entrepreneurial activity, the introduction of innovative technologies.

Introduction

Poultry farming is one of the most important branches of agriculture, significantly affecting its economy. The highly innovative activity of the poultry product sub-complex is largely due to the intensive scientific and technological development of the enterprises of material, technical and

Breeding-breeding support for poultry farming. Factors contributing to the deepening and acceleration of innovative processes in poultry farming, scientists are relatively rapid genetic progress, a good adaptive ability of the bird, as well as a higher level of trans-nationalization of the industry.

Despite the ongoing research work, the national innovation system lags behind its foreign

competitors. Institutional problems of poultry development during the transformation of the national economic system make it unlikely for domestic poultry enterprises to pursue an active innovative strategy in the form of technological leadership [1].

The actual state of the organization of innovation activities at the majority of poultry enterprises in the Surdarya region does not allow them to reach a modern level of susceptibility to innovation.The authors assessed the formalization of intra-firm mechanisms of innovative development based on the method of content analysis. The performed analysis shows that Surkhandarya poultry enterprises mainly implement imitation strategies, paying insufficient attention to R&D [2].

In conditions of intensive technical and technological development of production, the model of organization of innovation activity is a subsystem of the process of strategic management [3]. The author's model is oriented toward the analysis of feasibility, the evaluation of efficiency and the selection of innovative projects in order to form an innovative program of the enterprise. Sectorial features of the innovative development of poultry enterprises require the adaptation of the system of economic analysis of innovations. Figure 1 suggests a system of indicators for assessing the economic efficiency of innovation, modified by incorporating performance indicators that take into account industry characteristics.

Methods and materials. At the stage of preliminary assessment of the innovation project and analysis of scientific and technical solvency, commercial, production, organizational, managerial and financial feasibility, NTO staff calculates the integral performance indicators (indicators of the group I). Based on the results of monitoring the industry innovation market, NTO selects and prioritizes innovations based on the I-th group of performance indicators, after which the head of NTO offers the company's management to carry out a comprehensive economic analysis of innovations in the working group.

The working group of experts in the process of evaluating sectorial performance indicators from the III group not only calculates the potential effect of innovation, but also analyzes the need for additional capital costs and changes in technical and technological conditions, and also makes a conclusion on the feasibility and feasibility of including the project in an innovative program (Figure 2).

Then follows the stage of implementation of innovation with the necessary current and retrospective analysis of costs and effects from the introduction of innovation in the enterprise. The natural result of innovation is the change in the position and potential of the poultry enterprise, as well as the adjustment of further goals and priorities for its innovative development.

Results and discussion. A feature of world poultry farming is the pace of innovative development of the industry accelerated in relation to other branches of animal husbandry, which, along with the imitative nature of the innovative strategies of domestic poultry enterprises, makes it necessary to create in the industry

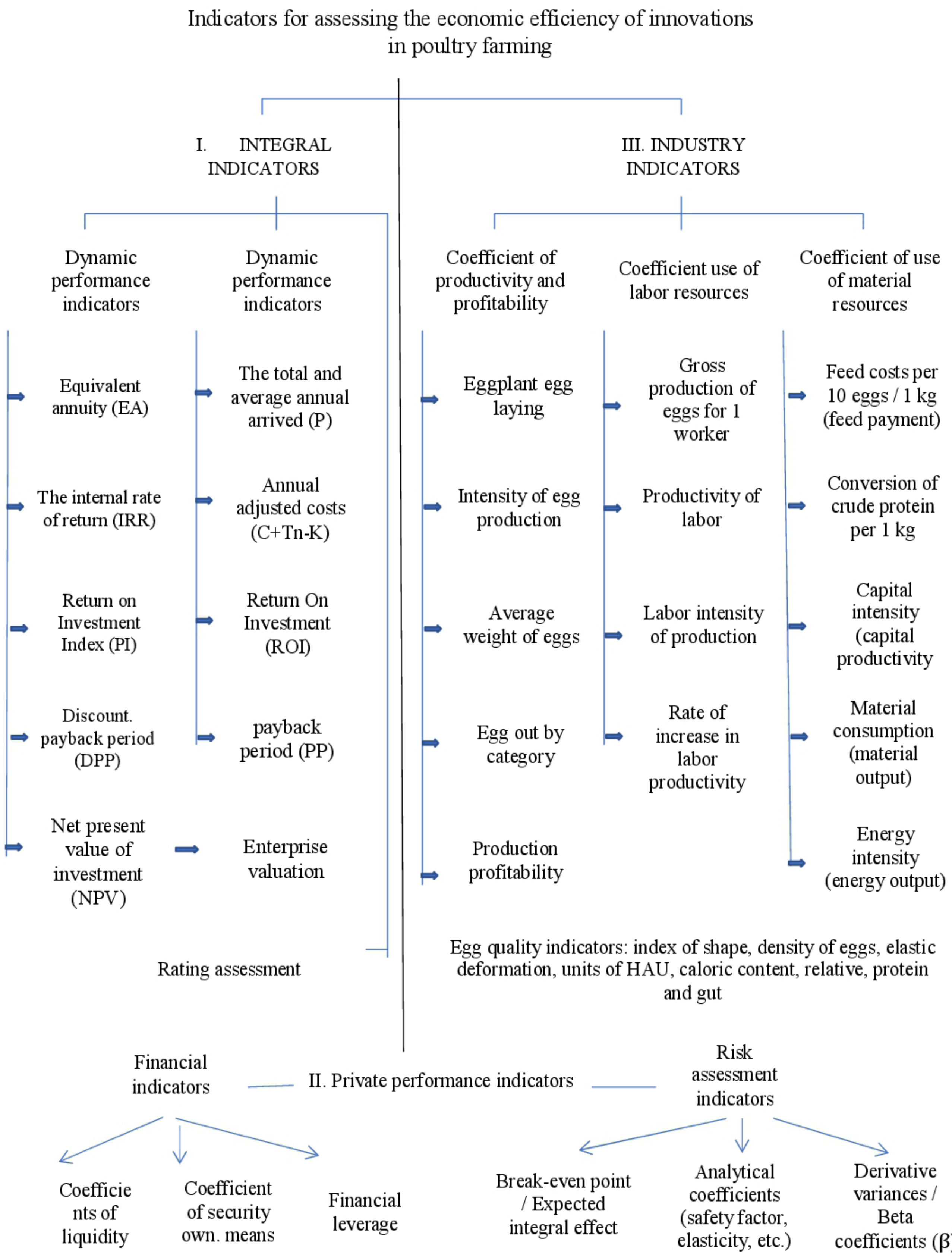

Figure1. System of indicators of integrated assessment of the effectiveness of innovative projects at a poultry farm

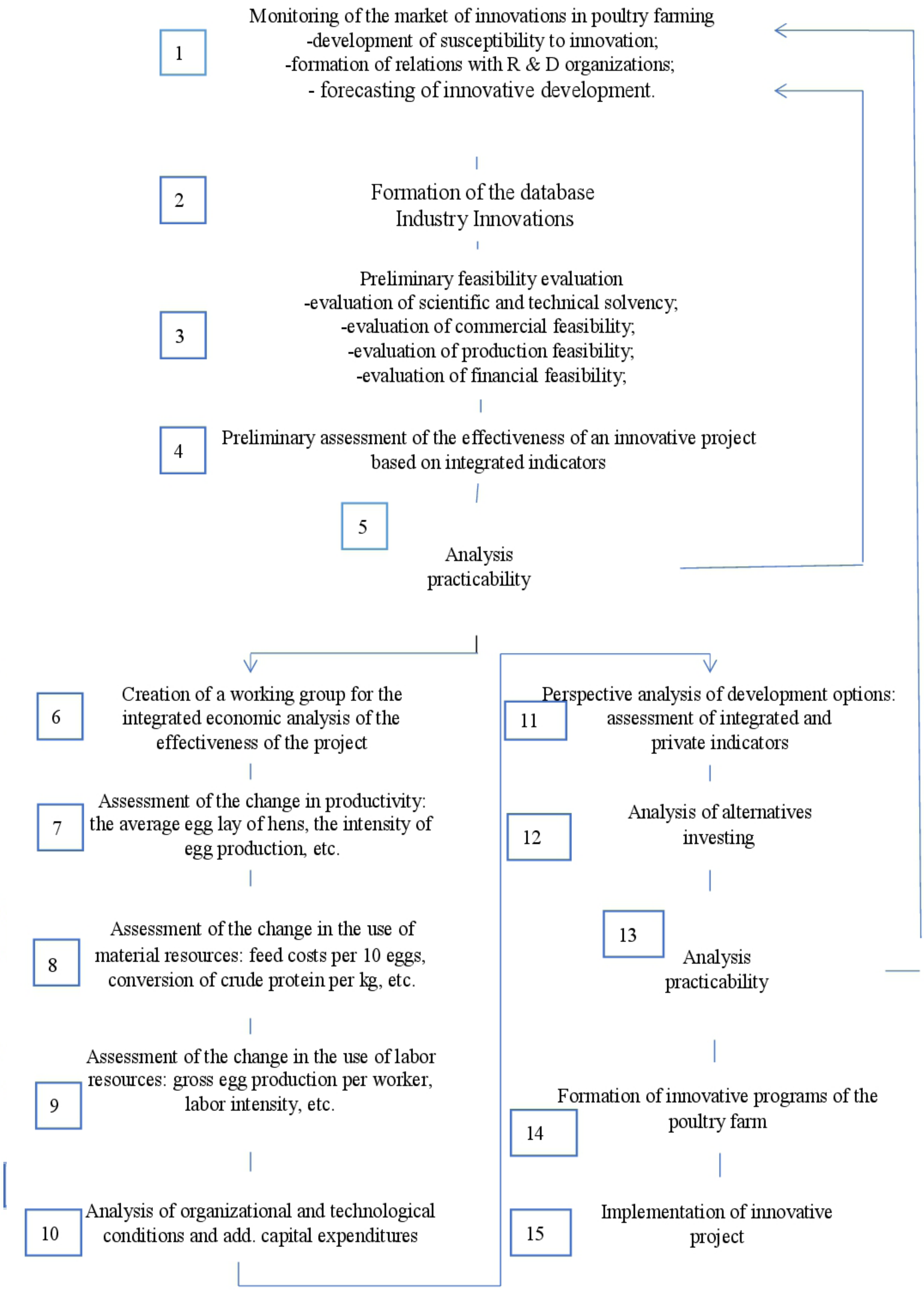

Figure 2. Methods of managing innovation development in poultry enterprises.

developed mechanisms for the transfer of innovations.

The presented methodology for assessing the economic efficiency of sectorial innovations is based on the differentiated complex approach of the model of economic analysis and the author's system of performance indicators for egg production [4].

Using the methodology adapted to the specifics of the sub complex will increase the quality and speed of making managerial decisions in the field of innovation and investment.

Conclusion. The authors carried out an assessment of the economic efficiency of applying innovations in egg processing, poultry feeding, introduction of new crosses, and some other industry innovations [5] as tests of the third and fourth stages of the proposed methodology.

Thus, in order to increase the competitiveness and economic efficiency of the poultry product sub complex it is recommended to use an institutional framework. Authors created scientific and technical subdivisions at poultry farms to strengthen the institutional framework. It gives acceleration in the innovative development of poultry production. In addition, it proposes to use a system of indicators and an algorithm for assessing the economic efficiency of innovations at poultry farms to justify management decisions. The system should include projects in the innovation program acceptance.

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DETECTION OF URBANIZATION RATE IN TASHKENT CITY DURING THE POST-SOVIET PERIOD USING NDVI, NDBI AND BUILT UP INDEX

B. Alikhanov, U. Uzbekov, A. Pulatov, T. Ilyasov
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

Urban transition is highly increasing in the developing countries like Uzbekistan. Consequently, it is elevating many social and ecological implications, corresponding air pollution, destruction of natural habitat of endemic animals and plants, social tensions, problems with infrastructure and soil sealing around the world. Therefore, studies on urban growth are becoming more important. In this article, main objective was to research the change of built up area in Tashkent city and surrounding areas during the period from 1992 to 2018. Landsat 5 TM and Landsat 8 OLI remote sensing images were used to examine urban transition using different indexes, in Tashkent city during 1992-2018. Results showed 1.6 % increase in urban areas, whereas land covered by vegetation, agriculture and city parks decreased by 5.8 % within 26 years.

Key words: Urbanization, Normalized difference vegetation index, Normalized Difference Built-up Index, Built-up Index, Urban Index, Index-based Built-up Index, Enhanced Built-up and Bareness Index, Tashkent City.

INTRODUCTION

Urbanization refers to the process of migration from rural areas to cities. It also means the growth (both population and territorial) cities and emerging of new cities. Although the two concepts are sometimes used interchangeably, urbanization should be distinguished from urban growth: urbanization is "the proportion of the total national population living in areas classed as urban", while urban growth refers to "the absolute number of people living in areas classed as urban". The United Nations projected that half of the world's population would live in urban areas at the end of 2008. It is predicted that by 2050 about 64% of the developing world and 86% of the developed world will be urbanized [5]. That is equivalent to approximately 3 billion urbanites by 2050, much of which will occur in Africa and Asia. Notably, the United Nations has also recently projected that nearly all-global population growth from 2017 to 2030 will be by cities, about 1.1 billion new urbanites over the next 13 years [5].

Urbanization is an inevitable process of human civilization. Countries and empires always were built and governed in large capitals, which were the centers of science, government and military forces.

Urbanization leads and have direct relationship with industrialization, consumerism and rationalization. Urbanization is not merely a modern phenomenon, but a rapid and historic alteration of human social roots on a global scale, whereby predominantly rural culture is being rapidly replaced by urban culture. The first major change in settlement patterns was the accumulation of hunter-gatherers into villages many thousand years ago. Village culture is characterized by common bloodlines, close relationships, and common behavior, whereas distant bloodlines, unfamiliar relations, and competitive behavior characterize urban culture. This unprecedented movement of people is forecast to continue and intensify during the next few decades, growing cities to sizes unthinkable only a century ago. As a result, the world urban population growth curve has up until recently followed a quadratic-hyperbolic pattern [2].

Uncontrolled and rapid urban sprawl in developing countries, like Uzbekistan have many social and ecological implications, corresponding air pollution, destruction of natural habitat of endemic animals and plants, social tensions, problems with infrastructure, soil sealing and many other problems.

Main objective of this article is to research the change of built up area in Tashkent city and surrounding areas during the period from 1992 to 2018.

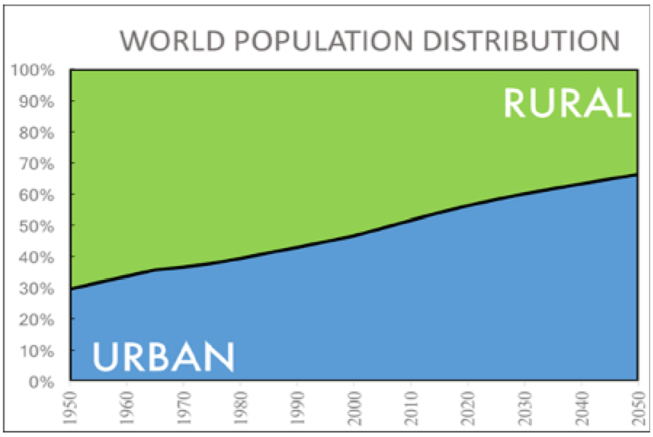

Figure 1. World population distribution according to UN in 21th century

Sub objectives

1. Apply NDVI index for study area
2. Apply index for study area
3. Calculate change area of built up index for study area using enhanced built up index

METHODOLOGY

Methods

Landsat 5 TM and Landsat 8 OLI remote sensing images were used for image processing. Landsat 5 TM is a multispectral satellite with eight spectral bands, two of which are thermal bands with 100x100 spatial resolution. Other spectral bands, including three visible, one near infrared and two short-wave infrared with 30x30 spatial resolution. Landsat 5 contain thematic mapper sensor that was launched in 1985 and ended its mission in 2012 due to sensor mistakes in Landsat 7 ETM and collapse of Landsat 6 during its launch to the atmosphere. We decided to download image for June 1992 because it has small cloud cover and relatively high image quality.

Landsat 8 OLI is the latest satellite in this series of USGS launches. It has 11 spectral bands, two of them are thermal and nine belong to visible, near infrared, shortwave infrared, panchromatic and cirrus. All spectral bands of Landsat 8 OLI have 30x30 spatial resolution, except thermal bands, which have 100x100 meters of pixel size. Landsat 8 OLI was launched in 2013 and returns to its initial place every 16 days [7].

We decided to download image for 2018 June month, because it is the latest year with high quality image and beginning of summer was chosen because vegetation reaches its peak biomass.

Layers of images were stacked together in Erdas Imagine software and processed in ESRI ArcGIS.

Normalized difference vegetation index (NDVI) is most widely used remote sensing index to detect vegetation cover of land surface. It ranges from -1 to +1 indicating absolutely no vegetation to very high aboveground vegetation biomass. It also often used for classification of land surface, because several range values of NDVI represent different classes, from glaciers, asphalt, water to bare soil, scrubland and forests [3]:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

There are many indexes for the analysis of built-up area. Normalized Difference Built-up Index (NDBI), Built-up Index (BU), Urban Index (UI), Index-based Built-up Index (IBI), Enhanced Built-up and Bareness Index (EBBI) are most common indexes for analysis the built-up areas. These different indexes having their own formula, own calculation method. The build-up areas and bare soil reflects more SWIR than NIR. Water body does not reflect on Infrared spectrum. In case of greenie surface, reflection of NIR is higher than SWIR spectrum. NDBI varies from -1 to +1, where negative values represent [6]:

$$NDBI = \frac{SWIR - NIR}{SWIR + NIR}$$

For better result, we decided to use Built-up Index (BU). Build-up Index is the index for analysis of urban pattern using NDBI and NDVI. Built-up index is the binary image with only higher positive value indicates built-up, that allows BU to map the built-up area automatically [4]:

BU=NDBI-NDVI

Study area

Study area is Tashkent city, the capital of Uzbekistan and its surrounding area Zangiota district. Coordinates of Tashkent city lies between 41°18′N and 69°16′E. Coordinates of Zangiota district lies between 41° 56′ 12.84″ N and 69° 37′ 14.52″ E. The territory of the capital on 2018 is 334.8 km2 and the territory of Zangiota is 220 km^2, summing up to 555 square kms for the study area. Total population for Tashkent city and Zangiota district is more than 2.5 million people according to 2018 census.

Tashkent features a Mediterranean climate with strong continental climate influences. As a result, Tashkent experiences cold and often snowy winters not typically associated with most Mediterranean climates and long, hot and dry summers. Winters are cold and often snowy, covering the months of December, January and February. Most precipitation occurs during these months, which frequently falls as snow. The city experiences two peaks of precipitation in the early winter and spring. The slightly unusual precipitation pattern is partially due to its 500 m altitude. Summers are long in Tashkent, usually lasting from May to September. Tashkent can be extremely hot during the months of July and August. The city also sees very little precipitation during the summer, particularly from June through September.

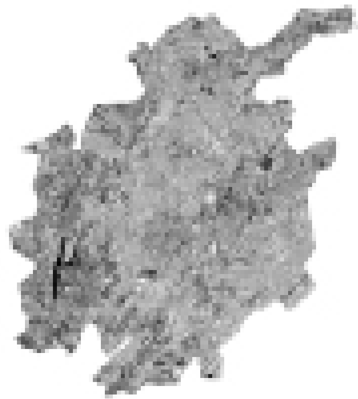

Figure 2. Panchromatic satellite image of study area

Table 1.

Land classes in 1992 and 2018 in hectares

Year	Urban	Bare soil, sparse vegetation, mixed	Vegetation
1992	19767	25010	15172
2018	20100	25500	14284

Figures 1, 2, 3 and 4 represent results of NDBI and NDVI for 1992 and 2018 respectively. In both urban and vegetation index analysis for classes were given same gradient colors, depicting urban in red and vegetation in green. As it can be seen from these maps, both indices similarly represent urban and non-urban areas except small mismatches. Figures 5 and 6 show the result of detected built-up areas, subtracting NDVI from NDBI. Final map was divided into three land covers: urban, bare soil and vegetation.

Analyzing red colors, we can see that some changes considering general land rise of urban area and decline of vegetation cover in research area while bare soil (or sparse vegetation and mixed urban and vegetation) areas remain unchanged.

Table 1 represents the total areas of classes in 1992 and 2018 in hectares. Urban areas show small changes (+300 hectares) comparing to the first year of independence. Same pattern shows bare soil, adding +500 hectares. While vegetation cover shows negative trend declining from 15K to 14K (-1 K hectares). The main reason behind this can be the intensive cutting of trees in Tashkent city and general reducing of urban parks during the post-soviet period.

Conclusion

The results show that there are some changes in land cover change in Tashkent city and surrounding Zangiota district during the post-soviet period. Urban areas show slight increase, as well as bare soil and mixed regions, while land, covered by vegetation, agriculture and city parks decreased within 26 years. This maybe caused due to tree cutting in the city. In spite of the fact, that city is growing constantly last 10-15 years and becoming modern megalopolis, satellite image analysis shows that urbanization rate and increase of built-up area is not very significant. NDVI and NDBI both show the same land cover patterns. They both detect urban and vegetation areas and transition classes between them.

RESULTS

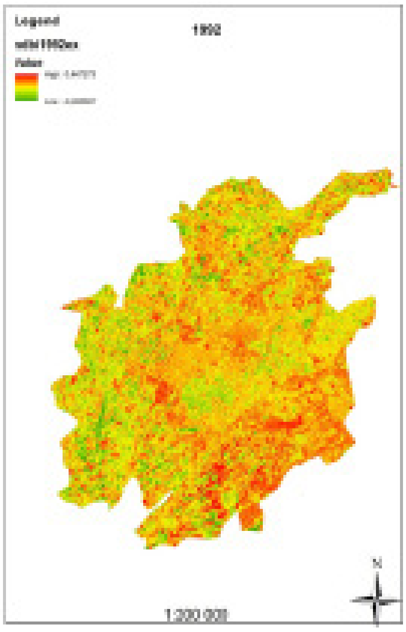

Figure 3. NDBI index in Tashkent city

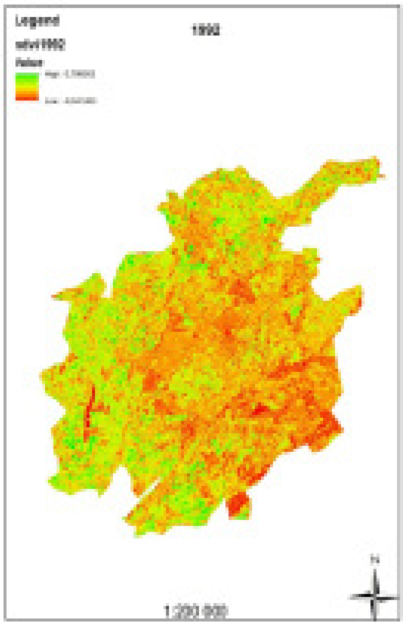

Figure 4. NDVI index for 1992

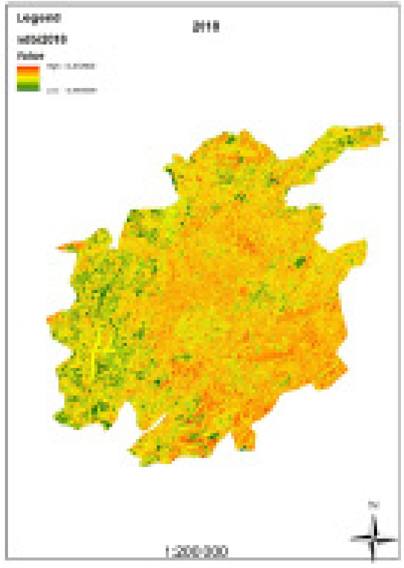

Figure 5. NDBI index in Tashkent city in 2018

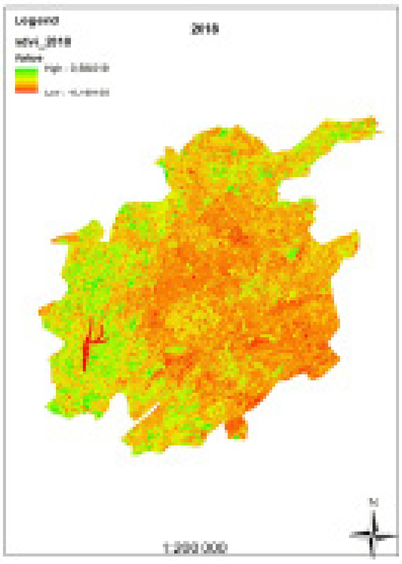

Figure 6. NDVI index in Tashkent city in 2018

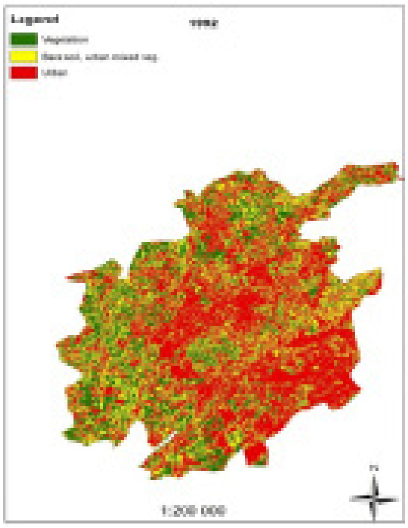

Figure 7. Built-up index in 1992

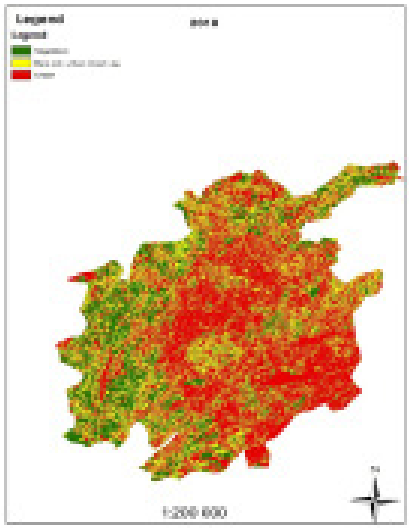

Figure 8. Built-up index in 2018

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RESEARCHING LAWS FOR THE DISTRIBUTION OF RANDOM QUANTITIES BASED ON EXPERIMENTAL DATA OF COMPLEX TECHNICAL OBJECTS

Tuganov G.Sh. – researcher, Makhmudov N.A. – Ph.D., professor,
Abijanov Z.F.- instructor, Bahriddinov Z.Sh.- instructor,
Academy of Armed Forces the Republic of Uzbekistan

Abstract

There are many methods of diagnosis of complex technical systems, which are used to predict the upcoming faults, operated in combat units of equipment. One of the main diagnostic methods including statistical processing of vibration data on certain operating times of the engine is given. Generalized and systematized the data of the power plant is given in the Laplace function, where a histogram, which can be described uniform distribution of informative value for predicting malfunction of aviation equipment on future flights.

Key words: statistical mathematics; technical condition; stochastic data; flight data recorders; distribution law; mathematical expectation.

Introduction The purpose of the statistical processing of generalized data of engine parameters is to find signs of future serious malfunctions that can lead to obvious accidents. Statistical processing of all current engine parameters is a low-cost and low-time method of classical diagnostics, the relevance of which has not yet been lost to this day. This path is a classic synthesis and processing of random data that are recorded by on-board recorders [1, 2, 3, 4, 5]. After decryption is completed, all control parameters are viewed for tolerance control, whether there is an amplitude in the observed channel or not, one way or another, such a method cannot establish a "prediction" for upcoming flights. Oscillography of engine data is not the only way to assess the technical condition of a gas turbine engine; in addition, there are other ground-based monitoring tools (GBMT) for providing diagnostics of the behavior of the main flow components of the engine.

All available on-board and even ground-based means are insufficient to provide a targeted assessment of the state of the engine according to current parameters. To do this, it is recommended to conduct thorough, complementary operations to detect developing wear of various engine components [6,7,8,9].

Combined methods of analyzing engine data give a great chance of detecting future malfunctions. Despite such complementary control methods, it should be said that accidents have not decreased, and the human factor, lack of knowledge of the nature of failures (NF) today do not allow the engineering staff to relax, and this is an impetus for further research on the flight safety and human lives.

Setting goals Based on the current situation, we propose to follow the way of a simple and cost-effective method, i.e. to summarize all the data as ground-based automated control, on-board flight control, but also all manual recorded data on the forms, control logs of the various stages of maintenance, etc. Next, classify all the controlled data by the importance and most importance of the parameters with the dependencies and make a synthesis that would show the value of the dispersion of the engine parameters, the intervals of these stochastic data, in addition, the probability of these bursts at specific time sections of the flight with high accuracy. The obtained statistical processed data in the future will help us to use even more accurately and precisely the parameters that determine changes in the characteristics of the technical condition, so that, based on the results of selected characteristics, make decisions on the further use of gas turbine engines or take careful control. The installation of additional sensors on vulnerable areas of the engine today is not allowed without notification of the Mil Design Bureau [5,10,11]. So therefore, having all of the tools that are currently being used as data mining tools, have all the necessary sources of information and most efficiently stabilize engine degradation in the opposite direction, i.e. towards ensuring reliability and reliability when used as directed [12,13,14,15].

And only the innovative method of using those old, but important tools according to the new method, announces a new innovative approach for predicting the engine for further effective operation according to the technical condition of the gas turbine engine. Thus, this method is one of the ways to extend the life of the engine. Which can help to operate for a long time at the current state. Only if data processing is carried out, as a thorough monitoring of engine readings to prevent aircraft accidents.

Research Methodology. And so, the statistical data of the helicopter engine has been collected and summarized on operating time in various conditions of the aerodrome and flight areas, where the analysis of flight data (BUR) issued by the on-board recorder is performed according to engine control parameters, one of which is vibration [16, 17].

When processing in a mathematical way, it is necessary to compile a table of intervals:

1. take into account the number of measurements or observations of the vibration value;

construct intervals of vibration values and distribute equally on the number of observations, i.e. for 50 observations.

2. Determine the intervals by the number of measurements of certain values of mechanical vibrations in the gas turbine engine along the horizontal axis of the flight direction [18, 19, 20].

Table 1.

Statistical distribution of a gas turbine engine vibration parameters

I	*[0-3]*	*[3-6]*	*[6-9]*	*[9-12]*	*[12-15]*	*[15-18]*	*[18-21]*	*[21-24]*	*[24-27]*	*[27-30]*
n_x	*1*	*2*	*5*	*6*	*11*	*10*	*7*	*4*	*3*	*1*

Table 2.

Probabilistic distribution of vibration values for making a histogram

X	*1,5*	*4,5*	*7,5*	*10,5*	*13,5*	*16,5*	*19,5*	*22,5*	*25,5*	*28,5*
W	*0,02*	*0,04*	*0,1*	*0,12*	*0,22*	*0,2*	*0,14*	*0,08*	*0,06*	*0,02*

Table 2.

Statistical distributions for T and T2

T	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
W	*0,02*	*0,04*	*0,1*	*0,12*	*0,22*	*0,2*	*0,14*	*0,08*	*0,06*	*0,02*
T2	*1*	*4*	*9*	*16*	*25*	*36*	*49*	*64*	*81*	*100*
W	*0,02*	*0,04*	*0,1*	*0,12*	*0,22*	*0,2*	*0,14*	*0,08*	*0,06*	*0,02*

1. Using table 1, it is necessary to show that it is close to the normal distribution and construct a histogram of its relative observation frequencies. In the bottom line, the number of observations or measurements is n = 50 and based on this, make a table. 2.

And so we move on to data processing, first we replace the variable using the formula of arithmetic progression $a_1=1,5$, $d=3$, then the general formula has the meanings:

$$x_n=a_1+d(n-1)=1,5+3(T-1)=3T-1,5 \qquad (1)$$

now we write the statistical distributions for T and T2:

1,5 = 3T-1,5, from here, T = 1; 4,5 = 3T-1,5.

Consistently, according to table 2, 3T = 6, T = 2, we similarly find other values of T and compose the table. 3:

Next, the product and we have the mathematical expectation:

$$M(T)=\sum_{i=1}^{10} T_i W_i \qquad (2)$$

Using formula (2), we substitute the values of the statistical distributions of the second row of the table. 3.

$$M(T)=\sum_{i=1}^{10} T_i W_i = 0,02+0,08+0,30+0,48+$$
$$+1,10+1,20+0,98+0,64+0,54+0,2=5,54$$

Next, we derive the mathematical expectation of the square product of the statistical distribution:

$$M(T^2)=\sum_{i=1}^{10} T_i^2 W_i \qquad (3)$$

In accordance with formula (3), we substitute the data of statistical distributions of the third row of the table. 3:

$$M(T^2)=\sum_{i=1}^{10} T^2{}_i W_i = 0,02+0,16+0,90+1,92+$$
$$+5,5+7,2+6,86+5,12+4,86+2=34,54$$

Hence, to simplify the calculation, we transform the mathematical expectation into a more simplified form:

if, according to the formula (1) $x=3T-1,5$ то,

$$M(x)=3M(T)-1,5 \qquad (4)$$

thus, we substitute the values in formula (4) and derive the mathematical expectation:

$$M(x)=3\cdot 5,54-1,5=15,12\approx 15$$

Then we find the average square deviation by:

$$\sigma^2(x)=n^2\left\{M(T^2)-[M(T)]^2\right\}=9(34,54-30,69)=34,65 \qquad (5)$$

and find the variance in vibration,

$$\sigma(x)=\sqrt{D(x)}=\sqrt{34,65}=5,88\approx 5,8 \qquad (6)$$

Where, σ (x) is the average square deviation;

M (x) is the mathematical expectation;

D (x) is the dispersion in vibration.

If the obtained smooth curve is close to the Gaussian curve, then it is possible to process the statistical data of the gas-dynamic parameters of the engine using the normal distribution law, provided the expected values and the mean square deviation of the engine vibration are known. Consider the functions, therefore,

$$f(x)=\frac{1}{\sigma\sqrt{2\pi}}\cdot e^{-(x-15)^2/(2\sigma^2)} \qquad (7)$$

suppose $\frac{x-15}{5,9}=U;$

then, $f(x)$– is the Gauss function, it is a function of the normal distribution law of random gas turbine engine vibration and $f(x)=\frac{1}{5,9\sqrt{2\pi}}\cdot e^{-\frac{U^2}{2}}\approx 0,17\cdot Z_n$

where, $Z_n=\frac{1}{\sqrt{2\pi}}\cdot e^{-\frac{U^2}{2}}$

The values Z_n are given in the table [17]. Using these values, we now make a table 4.

Note that the results obtained can be compared with the probabilities of getting a random variable in a given section,

$$P(\alpha<(x)<b)=0,5\left[\Phi\left(\frac{b-m}{\sigma\sqrt{2}}\right)-\Phi\left(\frac{\alpha-m}{\sigma\sqrt{2}}\right)\right], \qquad (8)$$

Table 2.

Function of the normal law of distribution of random values of vibration of a gas turbine engine

№	x	U	Z_n	f(x)	h f(x)
1	1,5	-2,29	0,029	0,005	0,02
2	4,5	-1,78	0,082	0,014	0,04
3	7,5	-1,27	0,178	0,030	0,09
4	10,5	-0,76	0,299	0,051	0,15
5	13,5	-0,25	0,387	0,066	0,20
6	16,5	0,25	0,387	0,066	0,20
7	19,5	0,76	0,299	0,051	0,15
8	22,5	1,27	0,178	0,030	0,09
9	25,5	1,78	0,082	0,014	0,04
10	28,5	2,29	0,029	0,005	0,22

where,

$$\Phi(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt \qquad (9)$$

Laplace function, the values of which are given in table. [17] and *m = M (x) = 15*; using this table, we find an example:

$$P(0<x<3)=0{,}5[-\Phi(1{,}44)+\Phi(1{,}80)]=0{,}5[-0{,}9583+0{,}9891]=0{,}02;$$

further,

$$P(3<x<6)=0{,}5[-\Phi(1{,}08)+\Phi(1{,}44)]=0{,}04;$$
$$P(6<x<9)=0{,}5[-\Phi(1{,}72)+\Phi(1{,}08)]=0{,}09;$$
$$P(9<x<12)=0{,}5[-\Phi(0{,}35)+\Phi(0{,}72)]=0{,}15;$$
$$P(12<x<15)=0{,}5[-\Phi(0{,}35)+\Phi(0{,}35)]=0{,}19;$$
$$P(15<x<18)=0{,}5[-\Phi(0{,}36)+\Phi(0)]\approx 0{,}19;$$
$$P(18<x<21)=0{,}5[-\Phi(0{,}72)+\Phi(0{,}39)]=0{,}16;$$
$$P(21<x<24)=0{,}5[-\Phi(1{,}08)+\Phi(0{,}72)]=0{,}09;$$
$$P(24<x<27)=0{,}5[-\Phi(1{,}44)+\Phi(1{,}08)]=0{,}04;$$
$$P(27<x<30)=0{,}5[-\Phi(1{,}86)+\Phi(1{,}44)]=0{,}02$$

Research and discussion results In the course of the study, a miniature seismic sensor of mechanical vibrations was used to obtain the amplitude - frequency characteristics of the vibration velocity of a gas turbine engine. The transmission of measurement data as a function of time v (t) from a helicopter is transmitted via the Wi-Fi protocol to a specially developed application for Android (picture 1). After receiving the signals, the program processes the signals of mechanical vibrations of the aircraft engine. The installation location of the sensor is selected from the condition of the place where there are high amplitude-frequency sinusoids. Based on

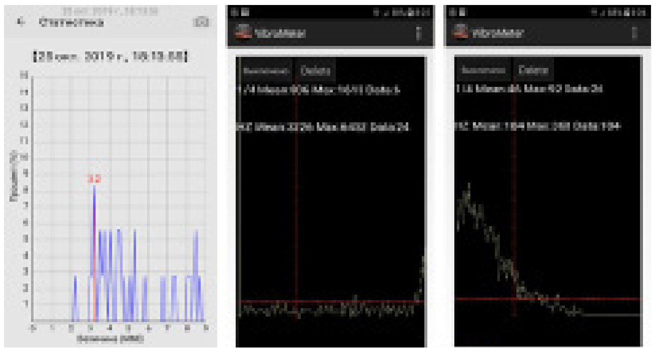

Figure 1. Application of a vibrometer with statistics of measurements of data of vibration of the engine

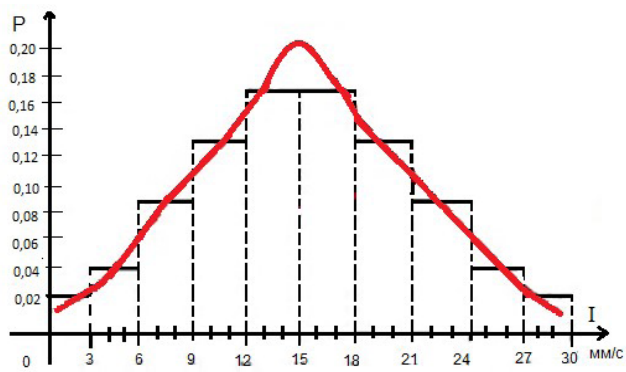

Figure 2. Distribution of vibration data of the gas turbine engine of the Mi-8 helicopter

Table 5.

Distribution of vibration values of technical objects

I	[0-3]	[3-6]	[6-9]	[9-12]	[12-15]	[15-18]	[18-21]	[21-24]	[24-27]	[27-30]
P	0,02	0,04	0,09	0,15	0,19	0,19	0,15	0,09	0,04	0,02

the stored signal data, we obtain the table. 5, in which the distribution of the vibration values of the helicopter engine is compiled and based on this table we construct a histogram 1 of the normal distribution of vibration values for the period of operation in the conditions of mountainous desert areas of Uzbekistan.

Comparing the values of W and h · f (x) (or W and P), we make sure that the given statistical distribution of vibration data of complex technical objects like the helicopter's gas turbine engine can be considered subordinate to the normal law.

Conclusion Studies have shown a selection of statistical data on the vibrational characteristics of a gas turbine engine TV3-117VMA or a distribution of vibration parameters under dusty conditions of an airfield from (0-3) with a probability of P = 0.02 to (27-30) with P = 0.02 proceeds in accordance with the law of normal distribution for our operating conditions is optimal and does not require calibration or additional control measurements using ground-based vibration testing values.

With an increase or deviation from these boundaries, we can assume implicit wear occurrence in the bearings of the engine mounts requiring immediate inspection with the removal of the engine. In such cases, borescopes and endoscopic instruments are used for the accuracy of the information. Deviations from the optimal distribution of values suggests the occurrence of negative phenomena in the engine mounts associated with high loads on the bearing cages due to violation of the rules of operation of the gas turbine engine. It should be noted, given the structural and methodological flaws of the system, it can measure short-term vibrational bursts, which in turn can lead to a false response of the signal.

Obviously, the wear of the bearings proceeds uniformly without intensive imbalance and the graphite gaskets are tight for the current period of operation. Thus, the gas turbine engine is suitable for the next flight of the flight and can be operated for a resource according to its technical condition.

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