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Ecological assessment of drinking water resources using the residual chlorine and analysis by probabilistic mathematical methods: On the example of Nukus city and Amudaryo district

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Abstract
Annotation: This article covers the current environmental situation of drinking water resources in Nukus and Amudarya districts of the Republic of Karakalpakstan, using the minimum allowable amount of residual chlorine.
The purpose of writing this article is to create axiomatic models of the values of residual chlorine obtained from experiments on objects # 1 and # 2 as a whole elemental "random phenomena".
The advantage of using this method is that, through the frequency of occurrence of residual chlorine in drinking water, it is possible to create a similar probabilistic pattern to determine the level of contamination of drinking water resources.

Keywords: Drinking water resources, Nukus city, Amudarya district, residual chlorine content, allowable amount, relative frequency of occurrences, natural and man-made factors

Introduction

It is known that, the provision of clean drinking water to the population and their timely delivery is considered one of the most pressing issues not only in our country, but also around the world. Therefore, sources of drinking water resources are specially protected and require constant monitoring. That is, 95% of the water consumed in the country comes from rivers and reservoirs, which are protected by the relevant authorities. Many canals and ditches, permanent pumping stations have been built in the country to provide timely and adequate water supply to consumers [1]. We know that because the physical, chemical and biological properties of water resources are rapidly changing, it is also important to predict the future ecological status of water resources through environmental monitoring in assessing their quality.

If we look at history, in ancient times the locals considered water resources to be very sacred and they protected open and closed water basins from pollution and used water resources in open water basins without additional treatment [3].

Over time, however, the natural and man-made factors that pollute water resources have increased, and many laws have been enacted around the world to protect them from pollution, and additional measures are being taken to protect them from pollution.

In general, it is currently not possible to use open water resources directly as drinking water. That is, they require additional cleaning. In other words, the most common methods today are mechanical and chemical (widely used in practice). In some countries, biological methods are also widely used.

We know that in the process of purifying drinking water, large amounts of specific sedimentation chemicals are used to remove unwanted substances from the water. After cleaning, drinking water is disinfected with liquid chlorine or chlorinated lime to remove pathogenic microorganisms and harmful substances [3]. It should be noted that after the purification of drinking water by such methods, the minerals in the water are lost. The amount of chemicals used depends on the level of water pollution. That is, the more harmful substances and microorganisms in the water, the greater the amount of chemical compounds that must be used. Using the above methods, firstly, takes a short time and, secondly, is very effective.

Because in order to meet the needs of the population in water in a timely manner, it is very important to clean water resources in a short time and deliver it to the population as soon as possible. If we look at this situation from two perspectives, we can see the pros and cons. With this in mind, we studied the amount of residual chlorine in drinking water resources of the population of Nukus city and Amudarya district in 2015, 2016, 2017, 2018 and 2019. We studied it by looking at quantitative change processes as a whole phenomenon. Through regular study and observation of objects, we have created a model with probabilistic mathematical calculations that is likely to occur in the future but can help determine the compositional change of drinking water.

The aim of the research

The aim of this paper is to treat the values of residual chlorine obtained from experiments at objects # 1 and # 2 as a single elementary "random event" and to construct axiomatic models for their "probabilities". Basically, the result we expect is to create a similar probabilistic pattern to determine the level of pollution of drinking water resources through uncertain values of the frequency of occurrence or non-occurrence.

Materials and Methods

Research materials: Drinking water resources at facilities # 1 and # 2 and their residual chlorine substances, the study of this process was carried out in the "Central Chemical-Bacteriological Laboratory of Tuyamoyin - Nukus Department." Also, the scientific sources of the following scientists were widely used in writing this scientific article. These are Tleumuratova B.S., Mambetullaeva S.M. “Systemic ecology”, Sh.Q. Farmonov, R.M. Turgunbayev, L.D. Sharipova, N.T. Parpiyeva's "Probability Theory and Mathematical Statistics", O. Arifjanov's "MODELING OF ECOLOGICAL PROCESSES".

We know that chlorides are always present in natural waters, and they also provide water hardness. However, the permissible amount of residual chlorine was determined to be 250–350 mg / l [5; 7].

If the amount of chloride ions in the water increases, the water will be co*-ntaminated with wastewater. With this in mind, we can determine the level of water pollution. For example, in 2015, 2016, 2017, 2018, and 2019, two objects (# 1 and # 2) were tested n times under the same conditions. Let us consider the whole event and denote it n_y, and let m_n be the relative frequency of occurrence. In this case it is as follows [7; 2; 5]:

$$m_n = \frac{n_y}{n};$$

The accuracy of the study of this process in this way is confirmed by experiments and relevant theories. In this case, regardless of how many times n is performed, the frequency m_n is close to 1/2 in the experimental results. Even if it has $n \to \infty$ (this information is taken from B.V. Gnedenko's “Kurs teorii veroyatnostey” (Moskva, 1969). Here's how we approached the process. That is, in 2015, 2016, 2017, 2018, and 2019, experiments were conducted in # 1 and # 2 facilities under the same conditions. We can understand this as follows. That is, if there were 12 months in a year, we did the probabilistic mathematical calculations using the average values of each month.

Result and Discussions

In determining the frequency (ny) of random values from the experiment, we obtained the following results.

Object # 1 (Nukus city)

(2015 year) $m_n \approx 0{,}75$

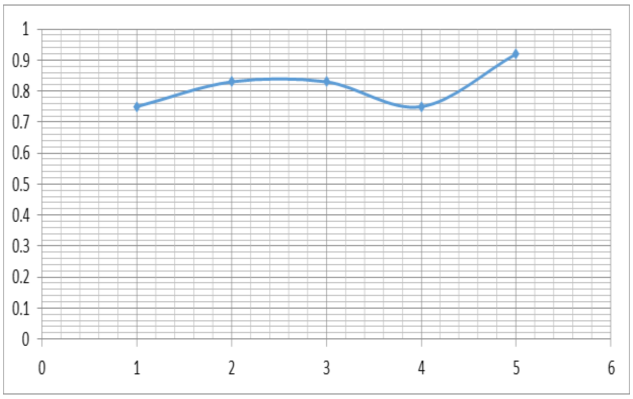
(2016 year) $m_n \approx 0{,}75$

(2017 year) $m_n \approx 0{,}67$

(2018 year) $m_n \approx 0{,}75$

(2019 year) $m_n \approx 0{,}92$

Diagram 1



Object 1: The relative frequency of occurrence of residual chlorine substances

Object # 2 (Amudarya district)

(2015 year) $m_n \approx 0{,}75$

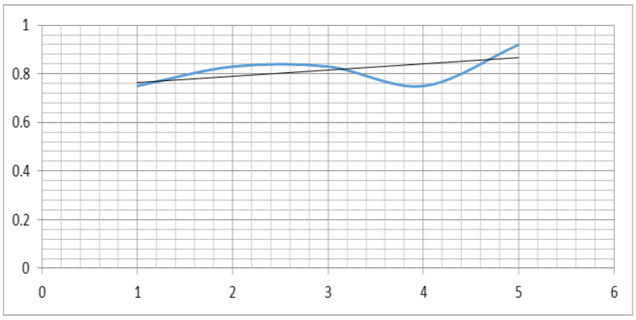
(2016 year) $m_n \approx 0{,}83$

(2017 year) $m_n \approx 0{,}83$

(2018 year) $m_n \approx 0{,}75$

(2019 year) $m_n \approx 0{,}92$

Diagram 2



Object 2: The relative frequency of occurrence of residual chlorine substances

This means that the relative frequency of events that we expected was not close to 1/2, but higher than we expected.

If we look at such random values, the growth rate of numbers over the years is not the same. That is, the increase in numbers is not sequential. In other words, we can see that the increase in numbers is not consistent, and if one year n_y increases, the second year n_y decreases significantly compared to the previous year. The contamination of these resources shows such random values because the human factor is higher than the natural factor.

It should be noted that due to the imperfection of these probabilistic methods, the data presented in some literature give rise to differing views [6]. In this we can see that the principal difficulties arise as follows:

These ideas cannot be substantiated by conventional mathematical concepts, because it is difficult to give a definitive definition of the independence of experiments in the first place. Second, m_n is not a simple quantity it is a different experience accepts different values in series [4; 6]. Hence, the relation cannot be substantiated within the concept of the limit of numerical sequences, since m_n is a quantity in the simplest sense.

No, it's a "random quantity." But such values do not make it difficult for us to study the situation. Because it is these mathematically probabilistic methods these serve to create models of these events (not the event itself). More specifically, it creates similar events that reflect processes that are explicit or uncertain. And the most important thing in using this method is to be able to get a definite elementary result in the experiment of studying the phenomenon. That is, we should not have difficulty in collecting exact values while studying objects.

Conclusions

Based on the relative frequency of occurrence of these phenomena, we can conclude that it is always important to create random mathematical methods and randomly repetitive empirical methods of random events occurring in the general hydrobiological, hydrochemical and hydroecological conditions of drinking water at facilities. It is very important to create any concrete models that serve to study the general state of resources through observations and the like.

Because the provision of clean drinking water to the population is one of the most pressing issues in the world today.

Taking these concepts into account and analyzing the experimental results based on these possible mathematical methods, it can be seen that the state of drinking water resources is improving, even if the amount of waste products in its composition does not decrease from year to year. The difference between 2016, 2017, and 2018 in terms of water resources over a five-year period is not significant. However, if we do not take them into account, then the difference between them is 0.17.

If the composition of water resources is maintained as in 2019 and the work on their protection from polluting sources is further increased, we can scientifically predict that in the next five years the content of residual chlorine in drinking water will not reach 100% of the permissible level 250 mg / l (n_y). In other words, we can see a significant reduction in water pollution.

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