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The Process of Assessing the Environmental Safety of Drinking Water Supply

Klymenko L. P.[1*], Krysinska D. O.[2*]

[1]*Doctor of Technical Sciences, Professor, Rector of the Petro Mohyla Black Sea National University, Mykolaiv, 68 Desantnykiv, 10, 54000, Ukraine*
[2]*Lecturer of the Ecology Department, Petro Mohyla Black Sea National University, Mykolaiv, 68 Desantnykiv, 10, 54000, Ukraine*
**rector@chmnu.edu.ua*

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Abstract: The authors have analyzed various Ukrainian and international methodological approaches to determining the environmental safety of drinking water supply. It has been found that the most effective is the use of environmental risk assessment, which appears to be the main tool for environmental safety assessment. On the basis of the analyzed methods, the complex one, which is expressed in the form of the process of assessing the environmental safety of drinking water supply, has been created.

1. Introduction

Building process diagram of assessing the impact of a negative factor on the environment or its components is a common practice in environmental, technical, mathematical research, as it allows to identify, classify and structure factors, determine the level of risk manifestation of negative consequences, and therefore assess the level of danger and make necessary decisions.
The advantages of using process diagram of assessing environmental safety are reflected in the works [1-7]. In these works, process diagram of presented in the form of block diagrams for assessing environmental safety and risks of the impact of various chemicals on ecosystems and their subsystems, as well as living organisms that live in this environment and are directly affected.
Taking into account the experience of previous scientists, we propose to assess the environmental safety of drinking water supply using process diagram.
It is worth noting that the ecological safety of drinking water supply (ESDWS) is understood as a state of drinking water supply, in which the safety ranges of the risk of negative effects are established, while minimizing adverse effects on ecosystem components, primarily on humans, provided that the necessary scientifically reasonable economic and energy costs are used.

2. Materials and methods

In our study, the determination of the environmental safety of drinking water supply was carried out through calculations of the environmental risk as the main tool for assessing environmental safety in general, using methods [8,9], combined into a comprehensive approach that takes into account carcinogenic and non-carcinogenic effects, where the range of safety of factor effect is ultimately determined.

The goal of environmental safety is to reduce morbidity, mortality, to increase the duration and quality of human life. The quality of drinking water is one of the main factors of impact on a human in the systems of environmental safety of drinking water supply. It depends on the initial quality of water of the water supply source, water treatment technology, technical condition of water supply networks, etc.

Absolute achievement of this goal is possible with the constant control and monitoring of sources of influence and factors which disrupt the state of ecological systems. In the case of environmental safety of drinking water supply, the first stage of control should be carried out by the state and organizations responsible for collecting data on the state of water bodies that are sources of water supply. At the same time, it is important to continuously monitor those enterprises that discharge wastewater and to introduce new approaches to water intake, which will consist in permitting its implementation, downstream of the discharge site. Thus, there will be a natural process of stimulating enterprises to improve the quality of treatment of wastewater, which, when mixed with water, will immediately become a new resource for production.

From the point of impact of the level of environmental safety of drinking water supply on a human, it is most effective to conduct the assessment through the quality of drinking water, but the ACL coefficient and methodological approach to comparing the values of monitoring data and standard are considered to be ineffective due to the lack of understanding of the impact mechanism, the manifestation of harm in case of exceeding the standardized value. The most effective tool, which at this stage of development of scientific research as for the assessment of the impact of anthropogenic activities on the human body, is environmental risk. Figures 1-3 show the process diagram of determining the environmental safety of drinking water supply - block diagram 1 and environmental risk assessment - block diagram 2 for carcinogenic effects, block diagram 3 for non-carcinogenic.

The block diagram 1 (fig. 1) is a universal tool for assessing ESDWS. At the first stages of the assessment, after the establishment of the affecting factors on the object of study, the collection and analysis of monitoring and statistical data begins. After the formation of the database, the intermediate indicators of the average annual, average daily doses of the values, which are necessary for further calculations, are determined.

One of the main stages of the process diagram is the stage "Determination of the environmental risk of carcinogenic and non-carcinogenic", the calculations are performed using block diagram 2 (fig. 2) [8] and block diagram 3 (fig. 3) [9], which are mandatory components of the assessment of ESDWS. After establishing the values of environmental risks, if necessary, modeling and/or forecasting is carried out, which will allow to predict a change in the trend of the indicator in the future, or to create a statistical series, in the case of absence of real monitoring data.

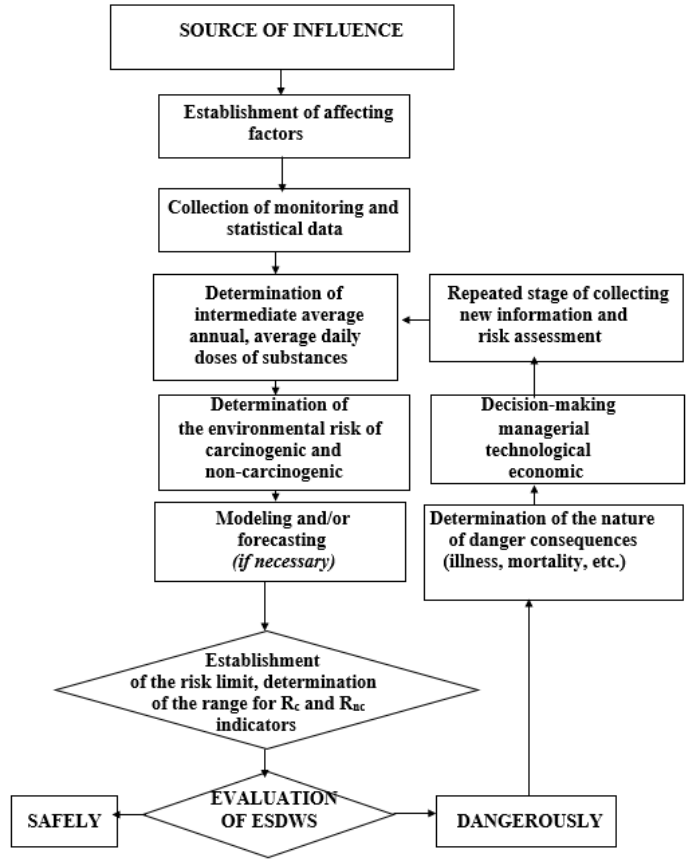

Fig. 1. The process diagram of assessing the environmental safety of drinking water supply

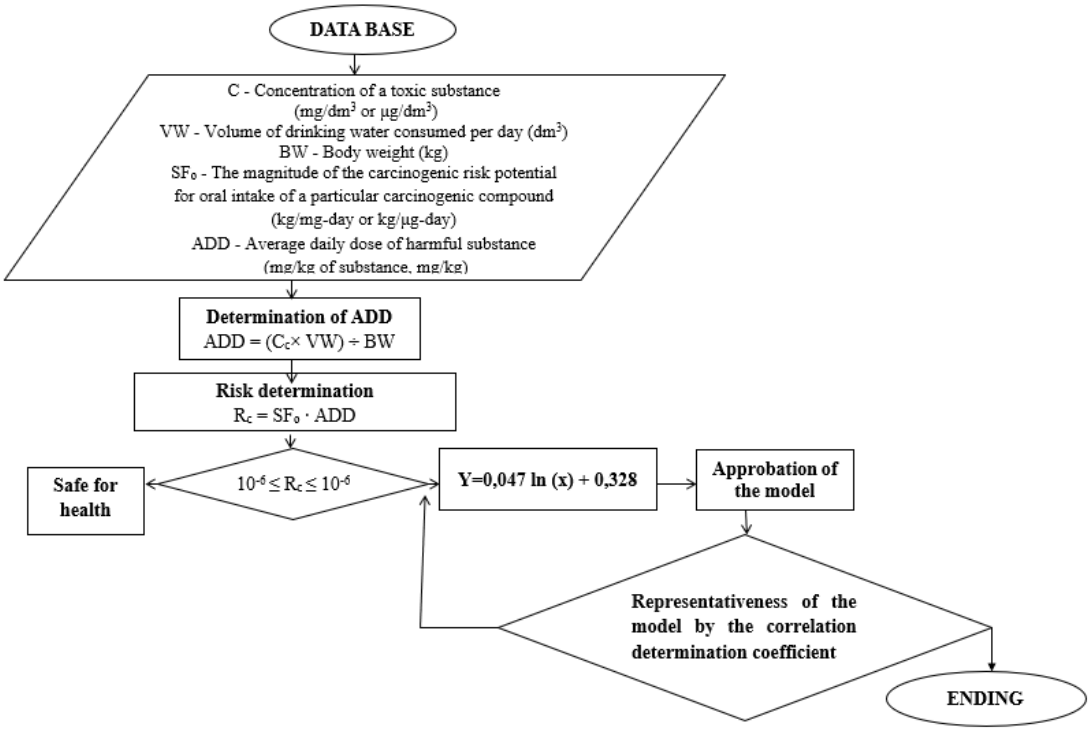

Fig. 2. The process diagram of assessing the potential carcinogenic risk

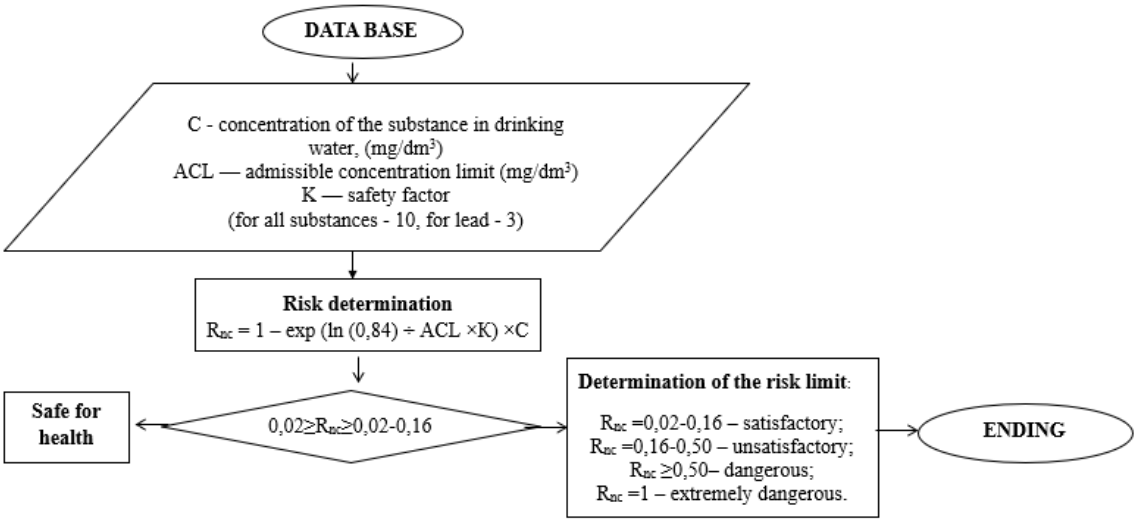

Fig. 3. The process diagram of assessing the potential non-carcinogenic risk

3. Results and Discussion

In the process of establishing the risk limit, the range of impact safety for indicators, which will be determined by the limits, is determined:

$$0.00001 \leq R_c \leq 0.00001 \text{ - for carcinogenic impact factors;}$$

$$0.16 \leq R_{nc} \leq 0.02 \text{ - for non-carcinogenic impact factors.}$$

The novelty of the proposed method of determining the level of environmental safety of drinking water supply is that as a result of the assessment we will obtain not just a number which will show the excess of the ACL standard for a particular substance in drinking water, but a complex value that will characterize the impact on a human.

4. Ending and conclusions

The final step towards establishing the level of ESDWS is the assessing of the risk limits, namely, within the range - "safely", outside the range "dangerously". To reduce conceptual confusion, for clarity and intelligibility of wording, we suggest using only two levels of safety assessment - "safe" and "dangerous" for assessing ESDWS. In the case of a safe assessment result, the system and its components are in a state of sustainable development. In the case of a hazardous one, it is necessary to take a number of urgent measures, ranging from determining the nature of the consequences of the hazard, making decisions on replacing technologies, management and economic costs, completing with reassessing the risks until a “safe” result is achieved.

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