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Sustainable development of the Republic of Moldova on reducing water pollution through the prism of software tools

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***Abstract* — The paper addresses the issue of sustainable development in the field of water resources. A description of two Goals of the Moldova 2030 Strategy is provided: SDG6 and SDG14, both of which prioritize the reduction of water pollution. It shows how these goals complement one another. In order to successfully achieve these Goals, certain international practices for the elaboration and development of software tools must be implemented. The practices mentioned above allow the creation of models for predicting the water quality of aquatic ecosystems. The study of the most frequently used methods and software tools for controlling water pollution currently used is presented. Hence, it is proposed to use software tools to improve the situation of water pollution in the context of sustainable development.**

Keywords — aquatic ecosystem; pollutants; prediction scenarios; software tools; sustainable development

I. INTRODUCTION

The rapid industrialization of countries has contributed to economic development, but it has also caused ecosystem imbalances by accumulating pollutants, which has a negative impact on the future of all humanity. All environmental factors are being impacted, but the effect on water is particularly concerning. As a result, an increasing number of countries are working to develop pollution-control strategies and techniques [1].

National and international institutions of analysis and research have developed studies and scenarios for long-term development across the time horizon of the 21st century (eg UN: Agenda-21 and Agenda -30; EU: Development Strategies 2020, 2030) [2].

Rio de Janeiro hosted the World Conference on Environment and Sustainable Development (Earth Summit) in 1992. This global gathering defined concrete programs that were brought together in an initiative known as Agenda 21. These programs also address the protection of water resources [2].

One of the central promises of the 2030 Agenda for Sustainable Development is that access to safe drinking water sources must increase as sustainable development progresses.

Water pollution does not contribute to sustainable development, but rather contrary has a negative impact on it.

Access to water is the basis of public health, and therefore is a critical point for long-term development. Society cannot evolve and strive to sustainable development while so many people live without safe drinking water.

To control water pollution worldwide, a number of software tools have been successfully applied, which can predict the degree of pollution, as well as identify the main pollutants. Some of these tools are WASP, Ansys CFX, GWLF, SMS, AQUATOX, CE-QUAL-W2, QUAL2K, WMS, HEC-RAS, etc.

II. PROBLEM FORMULATION

Currently in the Republic of Moldova there is a major degradation of water quality. The water of the main rivers in the country has a different quality index than national and international standards. In order to improve water quality, all national legislation in the field of water resources is constantly linked to the basic directives of the Council of Europe's [3].

Two interdependent aspects are investigated as a part of assessing the impact of contaminants on aquatic ecosystems [4]:

1. Quantitative characteristics of human activity's impact (amounts of pollutants).
2. The ability of the environment to "resist" this impact - the ability of the environment to neutralize the effects of the impact of planned activities without changing the structure and functioning of the ecosystem, as well as the ability to reproduce resources, etc.

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The water quality in the Dniester and Prut rivers during 2020 recorded high concentrations of the following pollutants: total phosphorus, nitrate nitrogen, ammonium nitrogen, nitrite nitrogen, mineral phosphorus, petroleum products.

As a result, based on the registered indicators, quality classes III, IV and V (moderately polluted - polluted - highly polluted) were established according to GD 890/2013 for the waters of the Dniester and Prut rivers [5].

Obviously, all the pollutants mentioned above have a direct impact on human health, simply because surface water is a source of drinking water for approximately 35% of the country's total population. Consumption of water with a high nitrite content can lead to methemoglobinemia, especially which affects children aged 0-1 years, particularly those fed artificially; causes cancer of the esophagus, stomach, liver, intestines, colon, bladder, and other organs [6].

It should be noted that not all methods and software tools can be applied in all conditions. Thus, different tools may handle spatial and temporal dimensions differently. The number of water quality parameters simulated in the same way can make a difference. Also, the way transport processes are modeled differs between software packages.

Based on the foregoing, the problem of the paper has been formulated, which consists in the analysis of two Goals of the Moldova 2030 Strategy on reducing water pollution, as well as the analysis of the main methods and software tools that ensure water pollution control.

III. Solving the Problem

Following the familiarization with all the Goals of the Moldova 2030 Strategy [3], it was concluded that the reduction of water pollution is related to the achievement of SDG6 and SDG14 objectives.

Among the targets of the SDG6 we can mention the minimization of water pollution from industrial processes, increasing the protection of water-related ecosystems. The objectives also include issues related to the sustainable management of water resources, including appropriate international cooperation and the involvement of local and regional communities in water management [7].

Even though the Republic of Moldova is not a maritime country, and SDG14 focuses globally on oceanic and maritime ecosystems, the conservation and sustainable use of the country's internal water resources and river ecosystems must be a key pillar of sustainable development. River pollution caused by urban and industrial activity presents problems for farmers who use water for irrigation, tourism entrepreneurs and others [8].

Thus, in the case of the Republic of Moldova, SDG14 largely corresponds to SDG6 targets.

Target 14.1 - Water pollution reduction, including through land-based activities, is a relatively important target. It is directly related to targets 1.5 (resilience of the poor to climate risks), 2.4 (resilient agricultural practices), 3.9 (reduction of mortality and morbidity caused by hazardous chemicals) and 6.6 (protection of water-related ecosystems).

Based on the description of the two objectives, Table 1 shows the comparative analysis between SDG6 and SDG14.

TABLE I. COMPARATIVE ANALYSIS BETWEEN SDG6 AND SDG14 OBJECTIVES

Nr.	**Priority policy areas**	
1	**SDG6**	Natural resources and Environmental Protection Waste management Regional development Disaster Management and Civil Protection Clean Water and Sanitation
2	**SDG14**	Natural resources and Environmental Protection Waste management Agriculture and Rural Developmentл
Relevant national policy documents		
1	**SDG6**	Moldova 2020 National Development Strategy Strategy on biological diversity of the Republic of Moldova for the years 2015-2020 and the related Action Plan Water Supply and Sanitation Strategy for 2014-2028 The program for the development of water management and hydro-improvement in the Republic of Moldova for the years 2011-2020 National Regional Development Strategy 2016-2020
2	**SDG14**	Moldova 2020 National Development Strategy Moldova 2020 National Development Strategy The strategy on biological diversity of the Republic of Moldova for the years 2015-2020 and the related action plan The environmental strategy for 2014-2023 and the related action plan

The Republic of Moldova should significantly monitor, prevent and reduce the pollution of its surface waters, including rivers. The Dniester River flows

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directly into the Black Sea, while the Prut River has a confluence with the Danube.

According to the latest data of observations and measurements, since 2017, the quality of drinking water in Moldova has been consistently low. At least, this is what the results of the laboratory investigations of the 850 water samples, carried out by S.A. "Apa-Canal Chisinau" specialists, show. The test results show that rural areas have the worst situation. The quality of drinking water from underground sources does not correspond even according to bacteriological indications. Most groundwater sources are affected by livestock farms, landfills, fertilizer and waste dumps [10].

The main purpose of environmental risk assessment is to alert people to the danger of human activities to aquatic ecosystems. It is based on comparing the effects of the impacts of the planned activities and the response of ecosystems to them in order to assess the effectiveness of mitigation measures.

Pollution can be prevented or reduced, for example, by using software tools, that generate certain prediction scenarios based on mathematical models. These scenarios can predict the presence of both pollutants obtained from diffuse pollution sources and those from point pollution sources [9].

For rational consumption and management of water resources it is necessary to have a surface water monitoring system [10].

An essential tool in calculating the water quality class, as well as determining the spatial-temporal evolution of pollutants in order to prevent exceptional situations, is the mathematical and numerical modeling of river systems.

As with the whole of nature, not all situations for aquatic ecosystems are known, because the rate of change is much higher than it was 5-10 years ago.

It is critical that our practices are in line with the laws of nature, the implementation of software tools must be sustainable. In order for the system to be adaptive, vulnerability indicators and progress indicators must be monitored. Adaptation is local, wich means that what is good here may not be useful elsewhere, or that some good practice must be replicated in similar situations in other regions.

Adaption methods include:

a) implementation of technologies that ensure the survival of all living things;
b) implementation of strategies that contribute to improving the quality of life by ensuring quality water.

At the moment, a number of software tools, such as AQUATOX, SMS, CE-QUAL-W2, Ansys CFX, WASP, etc., are widely used globally to control water pollution the application of which is an efficient method in determining the spatial-temporal evolution of pollutants. Some of these tools are only developed at the national or regional level, with the goal of solving a certain problem related to the water resources of those areas, and others can be used internationally.

Table 2 presents the main features of the analyzed dynamic simulation software instruments.

TABLE II. CHARACTERISTICS OF DYNAMIC SIMULATION SOFTWARE INSTRUMENTS

Nr.	Name of software tool	Description
1	AQUATOX	determines the behavior of various pollutants, such as nutrients and organic chemicals
2	WASP	allows the user to investigate 1, 2 and 3 dimensional systems and a variety of types of pollutants
3	CE-QUAL-W2	two-dimensional, longitudinal / vertical, hydrodynamic and water quality model
4	Ansys CFX	industry-leading fluid dynamics calculation software for turbomachine applications
5	QUAL2K	one-dimensional model of water quality for rivers and streams
6	GWLF	model that provides the ability to simulate leakage, sediment and nutrient loads (N and P) from a river basin
7	MONERIS	model that calculates nitrogen and phosphorus emissions into surface water in different ways
8	WMS	graphic system for simulating hydrographic and hydraulic basins in two-dimensional space. It can be used to model both the quantity and quality of water
9	SMS	software package for surface water modeling. The modeling process includes river hydrodynamics, rural and urban floods, wave modeling, following the dynamics and physical properties of water particles, determination and analysis of pollutants
10	WQRRS	simulates DO, total dissolved solids, P, NH3, NO2-, NO3-, alkalinity, total carbon, organic components and a number of aquatic biota, including plankton, algae, coliform bacteria, and several species of fish. It shapes the hydrodynamic shape, determines depths and speeds
11	MIKE 11	one-dimensional, easy-to-use, fully dynamic modeling tool for detailed analysis, design, management and operation of both simple and complex river and canal systems
12	InfoWorks ICM	the first software platform on the market for complete and truly integrated 1D / 2D hydrodynamic modeling of both rivers and sewerage systems
13	HEC-RAS	software that allows the user to perform a constant one-dimensional flow, non-uniform flow calculations in one and two dimensions, sediment transport / mobile bed calculations and water

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		temperature / water quality modeling

To understand the differences between different tools for water pollution control, Figure 1 shows a comparative analysis of the main software tools used for the dynamic simulation of water quality parameters.

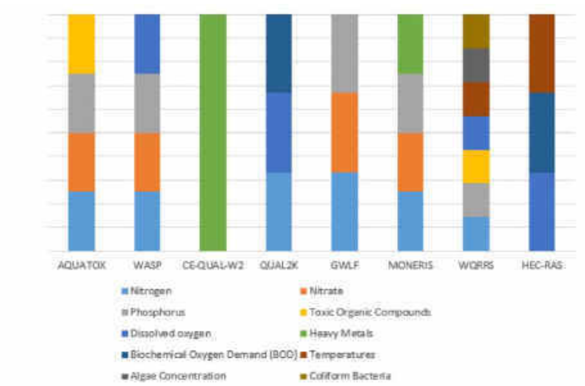

Figure 1. Comparative analysis of software tools for dynamic simulation of water quality parameters. [12]

The figure shows that nitrates can be modeled using the following software tools: AQUATOX, WASP, GWLF, MONERIS. Nitrogen can be modeled using: AQUATOX, WASP, QUAL2K, GWLF, MONERIS, WQRRS. Phosphorus compounds can be identified using: AQUATOX, WASP, GWLF, MONERIS, WQRRS. Heavy metals are modeled with only two software tools: CE-QUAL-W2 and MONERIS. It can also be seen that different software tools can model a different number of pollutants, so CE-QUAL-W2 models only heavy metals, whereas WQRRS can model coliform bacteria, algae concentration, temperature, dissolved oxygen, toxic organic compounds, phosphorus and nitrogen.

In order to achieve the Goals of the Moldova 2030 Strategy analyzed in the paper, the software tools described can be used.

Based on the large number of software tools available, a study is required to identify the most appropriate.

CONCLUSIONS

Two Goals of the Moldova 2030 Strategy for reducing water pollution were analyzed. Thus, it was discovered that the Republic of Moldova's Strategy Goals are partially correlated with the 2030 Agenda for Sustainable Development.

A study on the water quality of the Dniester and Prut rivers was conducted, revealing a high level of pollution from various contaminants. An important aspect for reducing the degree of water pollution is the use of software tools, which would allow to determine the spatio-temporal evolution of pollutants in aquatic ecosystems.

It was discovered that software tools are not only an important method for determining water quality, but also allow the development of scenarios for predicting water pollution, which will significantly contribute to the Republic of Moldova's sustainable development.

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