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PRELIMINARY INVESTIGATIONS CONCERNING MONITORING OF WATER POLLUTION LEVEL

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ABSTRACT

The aim of this paper is to develop an effective tool based on artificial intelligence techniques for monitoring and characterization of surface waters. Monitoring of the pollution in the aquatic environment consists in the recording of the concentrations of different chemical compounds from water, compounds that exceed the limits of maximum concentrations allowed by the regulations in force. From the chemical point of view, the quality of aquatic environment is determined by analytical control, followed by storing the results of laboratory analysis and creation of a database in order to ensure the optimal conditions for life and reproduction of aquatic organisms. The expert system will use the multitude of data obtained, allowing finally the improvement of methods for interpretation of physical and chemical parameters according to European legislation in force. This improvement can be achieved by AI algorithms.

KEYWORDS: pollution, monitoring, surface water**,** expert system

1. Introduction

In aquaculture, water, natural food or fodders and physiological state of fish are the three important components of fishes farming technologies. The optimum level of performance in fish production is achieved by maintaining a balance between environmental quality, the quality and quantity of fodders intake and the quantity and quality of fish stock.

The goal of the water quality management is to ensure an environment without stress, to accomplish the physical, chemical and biological standards necessary for healthy fish and a performance of production.

The paper aims to design and implement an expert system for monitoring an aquatic system designed to detect and evaluate the water quality, an intelligent system, information using the knowledge of water surface domain, very specialized, which uses the human consultants.

Expert system includes the monitoring of water quality, the health status of the biological material and evaluation of natural productivity from the Farm of Research-Development Brates. It belongs to the Institute of Research - Development for Aquatic Ecology, Fishing and Aquaculture, Galati. This system consists of a database and some software models that after their processing answers the questions of the user. The Farm of Research Development Brates is located in the north of the Galati city and has a total area of 321 ha from which: breeding ponds 198.2 ha; wintering ponds 59.2 ha; parking ponds 0.3 ha; reproduction ponds 30 ha; 4.3 ha pre-maturation ponds; embankments (dams) and drains 29 ha.

The profile of the Farm of Research Development Brates is the research and implementation of specific technologies of aquaculture [1, 2]. The biological material used in the specific technologies of farming, is represented by the species of sturgeons, carp, catfish, pike, species from the East-Asian complex: grass carp, silver carp, bighead carp. Figure 1 presents an overview of the Farm of Research Development Brates.

Fig.1. *Farm of Research Development from Brates.*

2. Materials and methods

An important issue related to water use is the fight against pollution. In assessing the environmental conditions in an aquatic pond, no matter of its use, but even more in the case of its capitalization through pisciculture, the knowledge of the physical and chemical characteristics of water is indispensable, being known the fact that the fish species assume certain environmental needs.

It is known that the fishy ponds are conditioned by humans through the administration of fertilizers, in order to obtain a high potential natural trophic level that lead ultimately to a better fish production. An important role of providing the natural trophic base of lakes is that the main biogenic elements, nitrogen and phosphorus, derived by fertilization with mineral nitrogenous and phosphatic fertilizers and the organic natural ones [3, 4].

The aim of the paper is to design and implement an expert system for monitoring an aquatic system that will include: monitoring of water quality during the periods of reproduction, breeding and development of different aquatic organisms being necessary to know the conditions provided by the natural environment, conditions which can be considered optimal to each species. During the reproduction period, as well as during the following stages of fish life, it should be a rigorous control of quality of the specific life environment, the water. This systematic monitoring leads implicitly to identify any modifications of the water composition that could cause a real disequilibrium in the ecosystem, known as pollution; for the assessment of the physical and chemical quality of water it is necessary the identification of concentration for different components that exceed the maximum allowed limits, established by the law for surface waters (Category II, the water is considered optimal for fish farming using). For the assessment of impurification or water pollution level, a careful study is required of each ecosystem, which can be achieved only using the analytical methods with those provided by artificial intelligence.

2.1. Expert System

Monitoring with artificial intelligence is a complex task which requires the optimal configuration to ensure maximum extraction of information on water quality from the data collected. To achieve an optimal level and an efficient cost, complementary techniques for design or instrumentation are necessary.

Artificial intelligence includes technologies of expert system, artificial neural networks, genetic algorithms and fuzzy logic [5, 6].

Expert system is designed to solve environmental-water problems, at a performance level of human experts based on their expertise.

The expert system is an intelligent system, which uses computer knowledge in the field of surface water, very specialized, which uses human consultants. This system consists of a knowledge base and some software models which resort to the information from the database and after processing offer the answers to uses questions.

The central element of the intelligent processing is the artificial reasoning, able to imitate human reasoning.

The expert system reproduces the reasoning of human experts on the knowledge available to them in some manner, possibly improves this knowledge and explains its own reasoning lines.

The modality through the system uses its knowledge presents a special importance, since the expert system has knowledge and also, means of an effective use of knowledge to be considered sufficiently qualified in terms of water quality and classification. Creating and using an expert system consists in analytical control of the pollution level and characterization in aquatic environment used by classical methods for analytical data interpretation using neural networks [5].

The expert system will be able to memorize knowledge through data acquisition and exploit the knowledge from the field of surface water (fishy water, according to Order MAPM 1146 / 2002 for approval of the Normative on the reference for the classification of surface waters quality [7].

From the annual statistics data will be calculated the generally coefficients of pollution on the main water ponds in the nursery Brates. From analysis is found the pond with the highest level of pollution.

From the monitored accumulations will be accomplished the assessment of the quality of surface waters (ponds) based on the processing of analytical data obtained according to the monitoring program.

Classification of water quality regarding the integrated approach of the water quality assessment from the chemical, biological and microbiological point of view and corroboration of the water quality data with the specific sediments data, will ensure the connection between the introduced data and stored knowledge so to achieve results: conclusions, solutions, recommendations, advice, statistical graphs and diagrams, analysis reports elaboration etc. Figure 2 presents the architecture of the expert system for monitoring of surface waters.

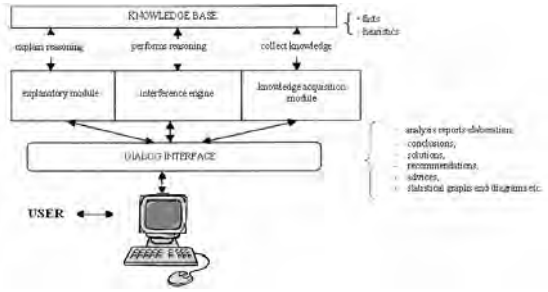

Fig. 2. *Architecture of the expert system*

2.2. Water quality by an expert system

Water flow in plant and animal world, is accompanied by numerous chemical transformations, physicochemical and biological ones, on the water and other aquatic components dissolved in water without which life is not possible.
Water quality can be defined as a conventional set of physical, chemical, biological and bacteriological characteristics, expressed in value terms, which allow classification of the sample in a given category, receiving thus the appropriation to serve a particular purpose.

For determining water quality, from the multitude of the physical, chemical and biological characteristics which could be determined by laboratory tests it is used practically a limited number, considered most significant [8]. The global surveillance system of the environment provides the monitoring of water quality through three categories of parameters: basic parameters: temperature, pH, conductivity, dissolved oxygen; indicators parameters of the persistent pollution: cadmium, mercury, organic-halogenated compounds and mineral oils; optional parameters: total organic carbon (TOC), biochemical oxygen demand (CBO) anionic detergents, heavy metals, arsenic, boron, sodium, cyanide, total oils, streptococcus. Brates Nursery quality evaluation will be based on processing the analytical primary data obtained monthly in the sections for surveillance. Quality classification of the control section will be under OM 1146/2002 – Normative on the reference for the classification of surface waters quality.

The quality of surface water will be determined for the following groups of indicators: oxygen regime, nutrients, salinity, metals, inorganic and organic micro-polluters; overall included. The inclusion of supervision sections in quality classes will be both in terms of physical and chemical indicators and the biological point of view.

Among the various functions performed by the expert system, for environmental applications we can withhold the following: the interpretation, simulation and planning. Formation of an expert system in surface waters field will be made by means of modern technologies of information that will ensure: production of all types of data to answer the needs of actions for implementing the state policy in waters domain; data management and conservation by promoting harmonization of procedures for acquisition, storage, transmission, processing and dissemination of data; easier access to relevant and useful information for the general knowledge [9, 10].

In water quality field, the European standardization is organized by two technical committees of standardization, namely CEN/TC 164 and CEN/TC 230, and at the international level there is the ISO/TC 147. Romanian correspondent of the three international standards committees is CT 52, Water quality. Standardization in water quality field contains vocabulary, sampling, measures of water characteristics and their expression, as well as chemicals used to treat water intended for human consumption. Elements of physicochemical quality and frequency of monitoring are in accordance with HG no.202/2002 to approve the Technical norms for quality of surface waters that requires protection and improvement to support the fishy life [7, 11].

2.3. Expert system applications

Interpretation of results will be achieved in accordance with the norm on the classification of surface water quality in order to establish the ecological status of water bodies (Ord. No. MEWM. 161/2006) and correlated with data from literature for use with fishing waters. Evolution in time of these parameters can be achieved by: displaying of synoptical schemes; periodical recording of quantities and their subsequent playback in various forms (graphs, tables, files); displaying of monitored parameters that have exceeded the allowable limits; elaboration of the analysis; conclusions; recommendations etc.

It must be mentioned the advantages, but also the limitations of such a system. The advantages include: using the explanatory facilities, of certainty factors; flexibility offered to the knowledge base through the fact that the rules and facts can be replaced, modified, updated without the question during the sequence of operations (of course on condition that is monitored the overall logic of the model, avoiding inconsistencies as a result of the successive additions); through the reproduction of expert reasoning, it offers the possibility of its use by non-experts also; once created, the expert system runs faster than the specialist; continuous learning and training of users regarding the fact that the expert system is always an excellent teacher for all types of users, in addition, the expert has a support in system

and can take advantage of collaboration with the expert system.

Following the comparison from Table. 1, there are two reasons for deciding to build an expert system: replacement of an expert; expert assistance in its work.

Tab.1. *Comparison between expert system and human expert*

Factor	**Human expert**	**Expert system**
Available time	Only in working days	Anytime
Spatial location	Only local	Everywhere, especially in environments unsuitable for human
Information safety	Irreplaceable	Replaceable
Perish	Yes	No
Performance	Variable	Permanent consistency
Work speed	Variable	Fast
Cost	High	Acceptable

Reasons for developing expert systems able to assist the experts in their work are: help the expert in performing routine tasks in order to improve the productivity; help the expert in performing difficult tasks in order to a better control of complexity; making available for expert the information difficult to be procured at the right time. Figure 3 presents the scheme of a Monitoring system in fisheries.

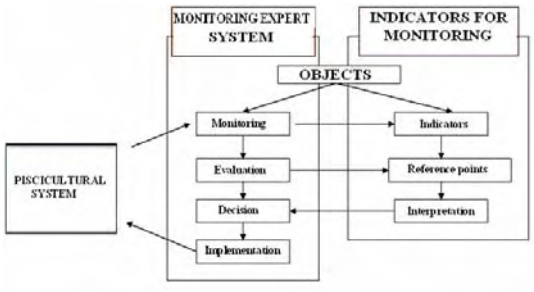

Fig. 3. *Monitoring system*

3. Conclusions

An important aspect of this preliminary study is the validation and verification of the expert system. These phases are essential in developing any successful expert system.

In this paper is described the development of an expert system on computer to be used by experts and non-experts in order to improve water management from the fisheries in Brates Nursery.

The accomplishment and operation of presented expert system demonstrate the feasibility of putting into operation a system that would serve to control the quality of surface waters.

Expert system for monitoring of surface waters will be tested by using physico-chemical parameters recorded in a section of the Brates Nursery; through the expert system will be defined the input and control variables, defining the conditions for interface, designing rules base, setting rules of interface, designing unit for calculating and setting the rules of transformation in actions, and developing the expert decisions. Interpretation of the achieved results will be under the Normative on the classification of quality of surface waters in order to establish the ecological status of water bodies (Ord. No. MMGA. 161/2006) and correlated with data from literature for waters with fishy use.

The expert system will be able to memorize knowledge, establish connections between knowledge and to interfere conclusions, solutions, advice, tips, causes of those phenomena on the basis of facts and processing of uncertain knowledge. Expert system solves problems using a reason similar with the human one. This system can be used both for the management activity and for the operational one in order to control the operational process or to support decisional process.

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