American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-03, Issue-03, pp-155-167
www.ajer.org

Research Paper Open Access

Development of the model of optimized parameters of quality of the raw water

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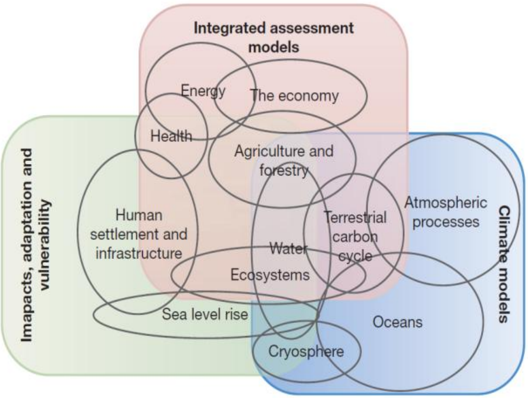
Abstract: - The models can be mathematically relatively simple to analyze, but to be applicable and successful in the future, it is necessary to continuously update the input data, must be of good quality and it will reflect the change in raw water quality over time.

Keyword : – *drinking water, model, environmental aspects, optimization.*

I. INTRODUCTION

Water shortage affects many communities in the world and prevents their current and future development. Problems with water are increasingly associated with social, economic, environmental, legal and political issues at different levels of government, and often have an international dimension (Biswas, 2008). Re-use of water is one of the key elements to increase the availability of water, and to preserve the sustainable use of water resources (Figure 1.).



Source: Richard H. Moss, et al., The next generation of scenarios for climate change research and assessment, Nature, 2010

Figure 1. The next scenario for climate change research and assessment resources

The United Nations (UN) in 1977. organized the Conference about Water in Mar del Plata, Argentina, considered a turning point in the approach to water management (eg, Lee, 1992). The conference is a recognized global problem - the existing water management policies have been unsuccessful in achieving the goals of management (Heathcote, 1998).

Table 1., defines seven sustainability criteria for the planning of water.

Table 1. Sustainability criteria for water planning

Criteria	Characteristics
Criterion 1. Basic human needs for water	A basic water requirement will be guaranteed to all humans to maintain human health.
Criterion 2. Basic needs for water	A basic water requirement will be guaranteed to restore and maintain the health of ecosystems.
*Criterion 3.*Water quality standards	Water quality will be maintained to meet certain minimum standards. These standards will vary depending on location and how the water is to be used.
*Criterion 4.*Renewable water resources	Human actions will not impair the long-term renewability of freshwater stocks and flows.
*Criterion 5.*Data collection and availability	Data on water resources availability, use, and quality will be collected and made accessible to all parties.
*Criteria6 and 7.*Institutions, management and conflict resolution	Institutional mechanisms will be set up to prevent and resolve conflicts over water.
	Water planning and decision making will be democratic, ensuring representation of all affected parties and fostering direct participation of affected interests.

Source: Gleick, P.: *Water in crisis: Paths to sustainable water use*, Ecological Applications, 8(3), 1998, pp. 571–579

The World Summit on Sustainable Development in Johannesburg in 2002, countries have been invited "to develop a management strategy and efficient development and utilization of water resources by 2005 and to assist the developing countries" (Knezevic, B., 2005).
Developed an approach of integrated water resources management, which includes the management and development of water resources in a balanced and sustainable manner, taking into account social, economic and environmental factors and interests.
The idea of the concept of IWRM has been to every country, if it is to establish and achieve their national goals of sustainable development must ensure investment in water infrastructure (water intakes, transport pipelines, irrigation systems, hydroelectric plants, reservoirs, etc.). This approach involves integrated management of surface and groundwater, as well as the quantitative and qualitative characteristics of water resources.
In the developed countries of the EU (eg. France, Spain) was needed over 50 years to establish the current level of water management that is in line with the principles of integrated water resources management and the Water Framework Directive (Hassing and others, 2009).
In underdeveloped and developing countries, this process is much slower place (the result of many factors which slow down the reforms and the establishment of IWRM). Table 2 provides an overview of the developing countries that have adopted the IWRM concept.

Table 2. The records of the adoption and use of IWRM concept

Country	Documents
Angola	• the concept of IWRM and water efficiency roadmap - Ministry of Water and Energy (draft 2007)
Argentina	• IWRM Roadmap - Subsecretariat of Water Resources (2007)
Brazil	• National Water Policy (Law No. 9433) - The Government of Brazil (1997) • National Plan for Water Resources - Ministry of Environment (Ministry of Environment , SRH / MMA) , the National Water Council (National Water Council , CNRH) and the National Water Agency (National Water Agency , ANA) (2007)
Egypt	• National Plan for Water Resources - Ministry of Water Resources and Irrigation (2004)

Indonesia	• National Water Act 7/2004 - The Government of Indonesia (2004) • IWRM plan - Directorate General of Water Resources Ministry of Public Works (2006)
Jordan	• National Water Policy - Ministry of Water and Irrigation • National Strategy for Water - Ministry of Water and Irrigation (2003) • National Master Plan - Ministry of Water and Irrigation (2004)
China	• National Water Act - (2002) • Law on Prevention and Control of Water Pollution - (1996) • Act on the national flood control - (1997) • National legislation on water and soil conservation (1991) • IWRM plan - The planning process began in 2002 and is still ongoing.
Colombia	• National Development Plan 2006-10 - Department of National Planning (2006)
Serbia	• National Water Policy • National Water Act - Ministry of Agriculture, Forestry and Water Management (1991) • Environmental Protection Act - Ministry of Agriculture, Forestry and Water Management (2004) - WATER Master Plan - Ministry of Agriculture, Forestry and Water Management (2002)
Syria	• National Water Policy - The Government of Syria • National Water Act (No. 31) - The government of Syria (2005) • IWRM and Water Management Plan effectiveness - partially implemented
Honduras	• IWRM Action Plan - Water Platform of Honduras (2006)
Croatia	• Water Act (OG 107/95, 150/05) - The Ministry of Agriculture, Forestry and Water Management • Law on Financing Water (Fig. 107/95, 19/96, 88/98, 150/05) - The Ministry of Agriculture, Forestry and Water Management • National Environmental Strategy to National Action Plan (NEAP) (OG 46/02) - The Ministry of Agriculture, Forestry and Water Management • the concept of IWRM and Water Efficiency Plan

Source: Report of UN-Water, Status Report on Integrated Water Resources Management and Water Efficiency Plans, Prepared for the 16th session of the Commission on Sustainable Development - May 2008.

II. INTEGRATED WATER RESOURCES MANAGEMENT

The aim of the introduction of integrated management of water resources, to achieve the economic benefits and social gains from the use of water resources. [1]

Integrated water resources management can be considered in terms of two basic categories (GWP, 2004):

• natural structure - determined by the availability and quality of water

• social composition, ie. human factor - determine the use of water resources, production of waste water and pollution of water resources.

In addition to the integration over the general sector policy, IWRM requires integration among sub-sectors - the "needs" of water management such as water supply, quality, environmental protection, water control, irrigation,

[1] Integrated water resources management is achieved by:

Economic efficiency, equity in the available water (access to sufficient quantities of good quality water is a fundamental human right that must be universally recognized) and environmental sustainability (use of water resources must be done in a manner that does not jeopardize their use by future generations).

flood control, navigation, hydropower, and recreation (Figure 2. shows this correlation).

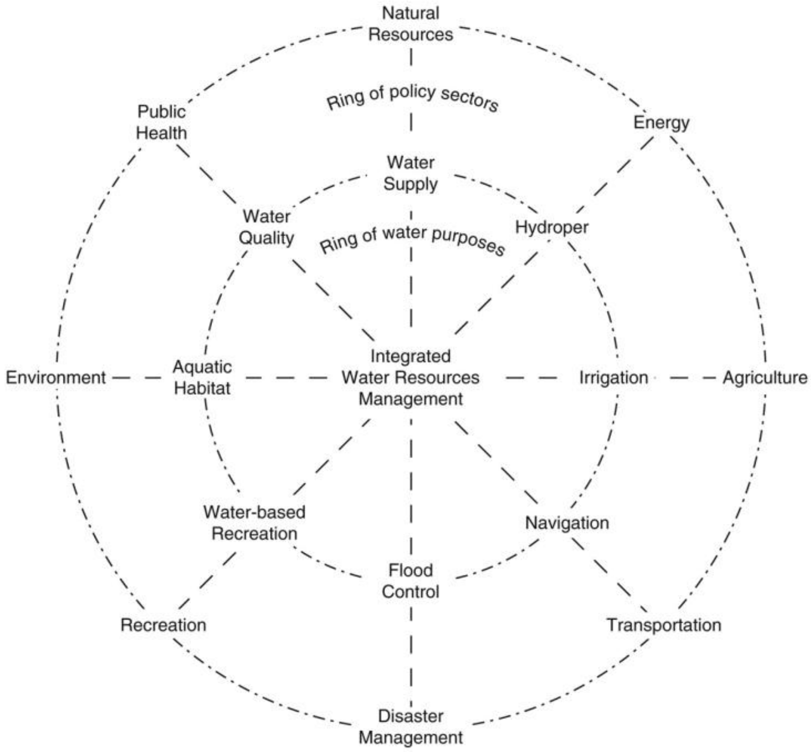


Figure 2. Integrated water management by sector

Source: Grigg, N. S.; *Integrated water resources management: balancing views and improving practice*, Water International,Vol. 33, No. 3, September 2008, pp. 284.

When integrated water resources management is crucial management of the entire space (not just water) as the hydrological cycle, ie. movement of water depends on the composition of the water - land - air - vegetation. Management of water resources is mainly oriented so. "Blue water". The drainage area to manage all water resources, including water used by vegetation so. "Green water" ("get lost" in the process of evaporation and transpiration).

To supply systems to meet the consumer must gradually change their priorities: instead of expanding and opening new sources, it is necessary to reduce losses in the network (internal reserves) and the irrational use of water by consumers. In this way, increasing the economic efficiency of water supply (Prodanovic, 2003). The concept of water changes from water supply system that meets the consumer (demand driven consumption) the system begins to operate water consumption (demand managed consumption).

In the process of implementation of EU directives on water management in Serbia must be made in the reorganization of the water sector through changes in the management of water resources:[2]

• Integration of social interests, public and private organizations in the field of production, protection and regulation of water requires a new organization of water management.

Coordinates the activities of various institutions to the achievement of the aims of sustainable water management. It is necessary to establish institutional mechanisms to ensure integration and cooperation between different water users, stakeholders and the public.

- • *Access management at the river basin (catchment area) must be installed in the water legislation.*

[2]Basic principles of reorganization and institutional strengthening are: organization of water management at the river basin (catchment area), legislative support, the provision of financial resources, exchange of information on water quality and quantity. Access control at the level of the river basin (catchment area) must be installed in the water legislation (the basis for the organization of water management, planning, management and decision-making, integration and coordination of activities, funding, implementation of management decisions, licensing, inspection activities, enforcement of penal provisions and other activities) . Muskatirovic, J.: Implementation of the policy of integrated management of water resources in Serbia, Institute for Water Resources "Jaroslav Cherni", Belgrade, http://www.jcerni.co.yu/srpski/projekti/mon4.pdf.

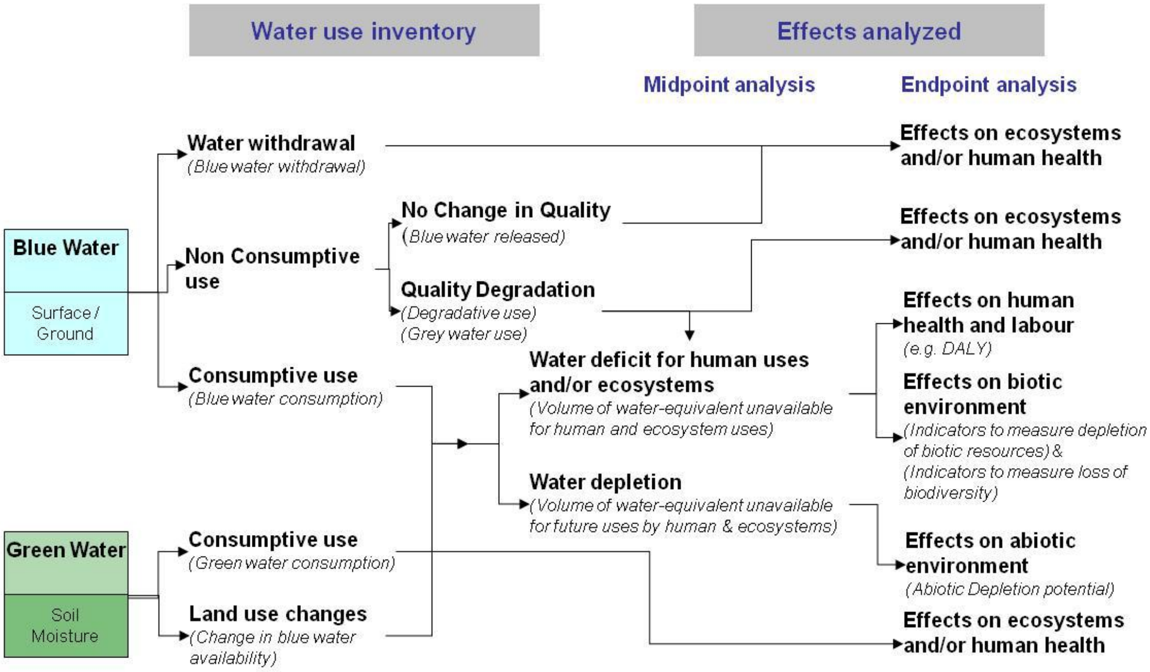


Figure 3. Use of the water and the effects of it

Source: Sonia Yeh, GouriMishra, and Jacob Teter, Institute of Transportation Studies University of California, Davis, Presentation to LCFS Sustainability Workshop, December 15, 2010

Such legislation is the basis for the organization of water management, planning, management and decision-making, integration and coordination of activities, funding, implementation of management decisions, licensing, inspection activities, enforcement of penal provisions and other activities.

- • *Providing funding for water use based on the principles of sustainable development requires a new water treatment as a resource*.

To policy development companies comply with policies to protect water and ecosystems, water has become an economic category. With the introduction of the economic cost of water and collection of water services can provide secure sources of financing, as well as the continuous flow of funds for water supply, drainage and water treatment (eg, protection from the harmful effects of construction of water infrastructure, environmental protection, etc.).

- • *Develop awareness of the water as a natural resource*.

It is necessary to establish public awareness on sustainable use and protection of water and ensuring meaningful participation of all sections of the population in decision-making processes in the field of water.[3]

III. BASIC POSTULATES OF MODEL

The quality of water in artificial lakes is a key characteristic that changes over time. Because often talks about the process of aging reservoirs, which must be taken into account at all stages of the design and operation of the system, so that these processes under control. In addition to the environmental and aesthetic impact on the environment, the waters with the highest quality water enriched or degraded - if the process of eutrophication out of control, water quality affects the purpose of accumulation.For example, uncontrolled growth of phytoplankton and algae creates serious problems at treatment plants, a negative impact, and in cases where the reservoirs used for recreation and tourism. Increased amounts of gases that result from the anaerobic decomposition of organic matter (CH_4, H_2S, NH_3, and other). Alter the taste and smell of the water, which prevents the use of the reservoir for recreational and tourism purposes and degrades the environment. The figure shows the impact of human activities and the need for water resources management.

Although a very important aspect of water quality and its modeling is only in recent decades intensely developed and implemented. The main reason for this is the complexity of the dynamics of physical, chemical and biological processes in the lake ecosystems, which can only at this stage of development of science and technology can be adequately reviewed and a mathematical model.The second, equally important reason, have

[3]*Questionnaire to measure attitudes and knowledge of the Water Framework Directive, the Ministry of Agriculture, Forestry and Water Management / Directorate of Water*

limited opportunities autopurification water and their last decades more intense pollution, which follow the increasingly stringent requirements in terms of quality of supplied water (hydro- reservoirs, 2003).

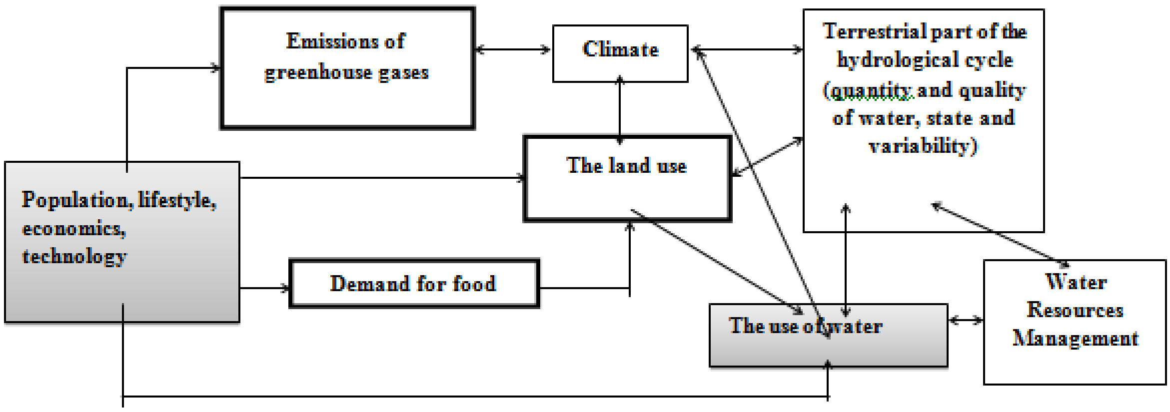


Figure 4. The impact of human activities and the need for water resources management
Source: Oki, 2005.

Lakes are among the first aquatic ecosystems that are generally modeled. The achieved accuracy of simulations of hydrodynamic phenomena in the lake in previous models can be considered satisfactory and the results of simulations of inert chemical components (Blumberg, 1998). Results of the simulation of behavior of nutrients and dissolved oxygen in the lake water are less precise (DiToro, 1980). All known experience, primarily eutrophication models, show that one of the same model still need to be modified on a case-by-case basis, and every lake ecosystem has its own specific features. The phenomenon that is very important for a lake to another to not be.It is possible to construct a large model that would in itself involve a large number of features and phenomena, but that requires a large amount of data required for its calibration. After data collection is the most costly phase of the formation of the lake ecosystem model that is often a limiting factor in its creation.When speaking about the differences in the application of the same model in different lake systems, the main reason is the large variation in chemical and biological processes. With relatively simple assumptions, the physical processes are more easily adapted solutions, while the practice has shown that biological processes are difficult to adapt to using the available mathematical „tools" (Sekulic, 2004).
The first step in developing the model is that the available data on the quality of raw water well examined and systematized the analysis of available time, place and type of parameters.
The next step is to start work on the model.

Modeling should be understood as a process in which alternating gather information, develop model and study the behavior of the system, check the agreement of the results with the observations, the observed differences, gather new information and suggestions, the model improves, and there is a new round of analysis, etc.. Figure 5. presents the model selection - is very important problem definition, model selection, simulation and application, and Figure 5.shows application of the model through a process of monitoring, management and development.
In time the model becomes more reliable and better describes the real system, and the participants in this business and how to acquire and useful knowledge. Any other approach is wrong and does not give good results, an attempt to create a model once in its final form fails or leads to long delays and expenditure of time and resources (Obradovic, 1999).

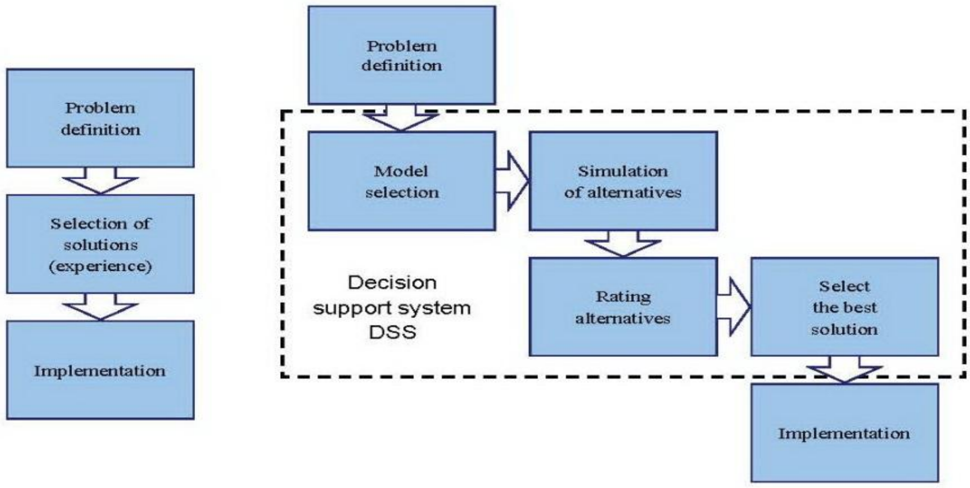


Figure 5. Display selection model

Source: Milicevic, D., Milenkovic, S., Potic., O. FACTA UNIVERSITATIS Series: Architecture and Civil Engineering, Vol. 8, No 2, 2010, pp. 250

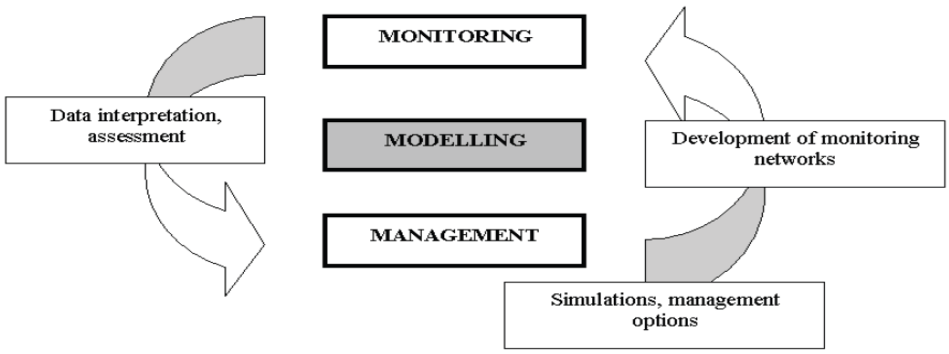


Figure 6. Application of the model - the process of monitoring, management and development

Source: Milicevic, D., Milenkovic, S., Potic., O. FACTA UNIVERSITATIS Series: Architecture and Civil Engineering, Vol. 8, No 2, 2010, pp. 250

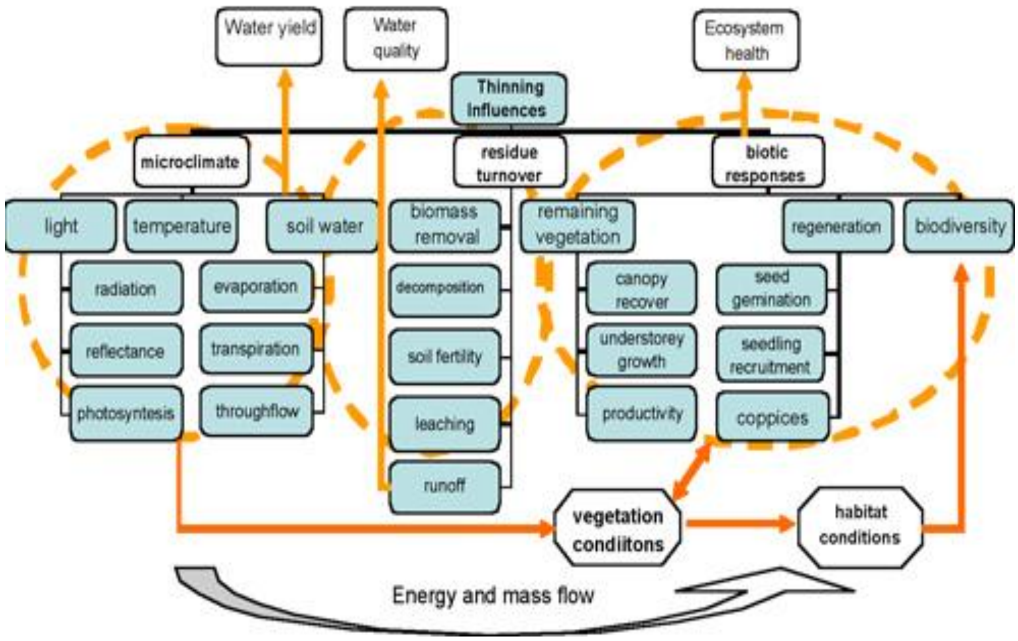


Figure 7. Schematic effects on water yield, water quality and ecosystems

Ecosystem response may be driven by changes in microenvironment and energy (light, organic matter) and mass (water and nutrients) flow.

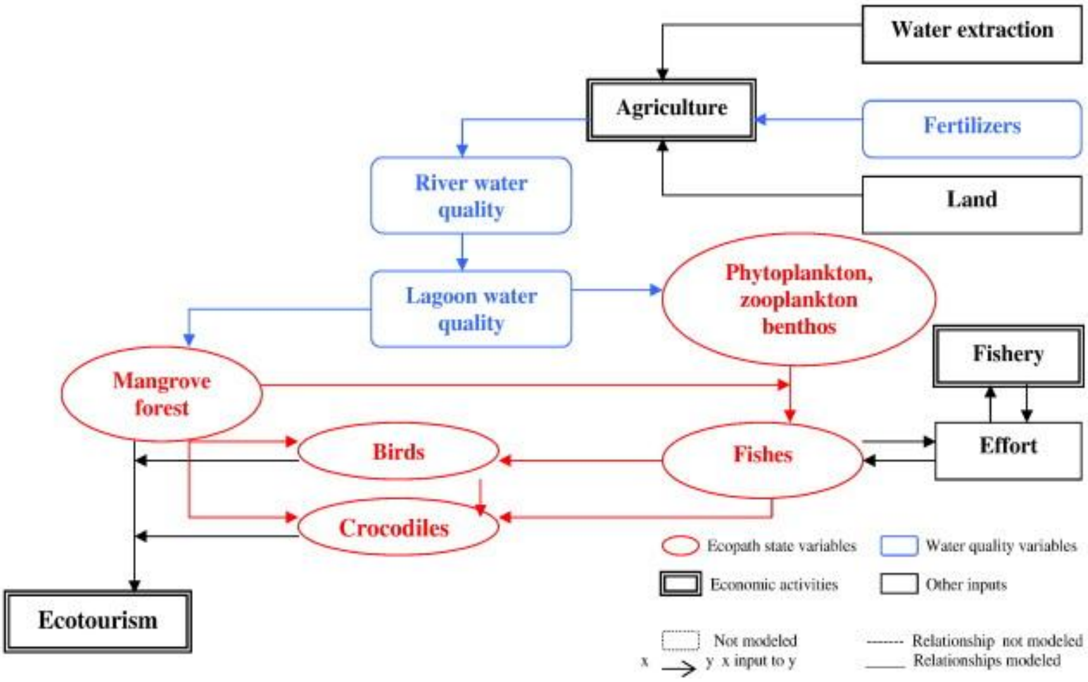


Figure 8. Scheme ecological-economic model

Source; V.S. Avila-Foucat, An *ecological–economic model for catchment management: The case of Tonameca, Oaxaca, México*, Ecological Economics, Volume 68, Issues 8–9, 15 June 2009, Pages 2224–223

Aquatic ecosystems have some specific features that complicate the design and development of their model and quite different from similar processes in other engineering disciplines. Description of processes in aquatic ecosystems requires a large, interconnected system of algebraic and differential equations, and often requires an interdisciplinary approach. Many processes, especially in the lower layers of the water mass, are poorly understood, and as a rule, collection of data for a better understanding of them is a very expensive process. Some parameters or conditions of aquatic ecosystems, such as temperature or the concentration of some of the inorganic compounds, can be adequately described using the continuum mechanical laws. However, other conditions and parameters, for example, change the number of populations in an ecosystem, are discrete, movable and resizable so unacceptable to the standard model's techniques.Timeframe phenomena that occur in aquatic ecosystems measured by years or even decades so that their validity is not practical for some shorter intervals. In many scenarios, the possible occurrence of, for example. spillovers or large inflow of water system models can not help or they result unusable.

Massive fund of various information from time series of different concentrations of the compounds, the weather conditions to geographical data about aquatic ecosystems are necessary to create and test the model, or get a satisfactory solution. They are very rare cases that the model designers are very familiar with both of the two dominant phenomena in any aquatic ecosystem - hydrodynamics and ecology. Therefore, there are very few models that equally, or well enough describe both phenomena (Sekulic and other, 2004).

In assessing the impact of impoundment on water quality, it is necessary to reliably determine the temperature regime in the reservoir. Hydrodynamic characteristics of the flow and temperature distribution in terms of stratification significantly affect other quality parameters (primarily in dissolved oxygen, biological oxygen demand (BOD).

The dilemma exists in the choice of model type, ie, whether you choose a model that relies on describing the hydrodynamic flow or so called. "Ecological ” model. In the hydrodynamic model, simulates a small number of parameters, but to observe their interplay (interaction) through the analyzed period. When "environmental model, it is possible to simulate a larger number of parameters which are observed independently of each other (no interaction). When deciding on the choice of the model, an important factor in the decision are the parameters that we know (9.).

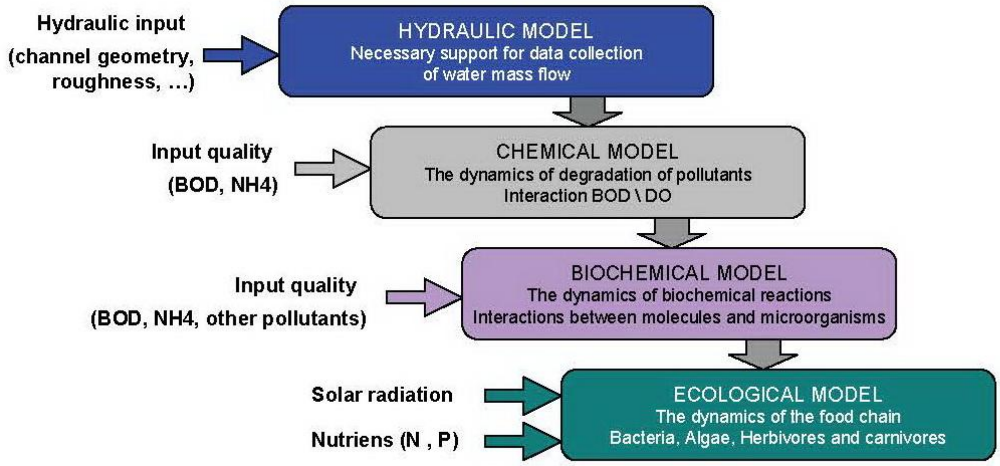


Figure 9. The structure of the model based on the quality of water
Source: Milićevic, D., Milenkovic, S., Potic., O. FACTA UNIVERSITATIS
Series: Architecture and Civil Engineering, Vol. 8, No 2, 2010, pp. 252

Thus, the crucial point for the selection of the mathematical model is a good knowledge of the real system being modeled and processes which are dominant. With this in mind, decided to ecological type of model that will analyze the following parameters:
a) Microbiological parameters: total coliforms as a notification (MPN) in 100 ml of water, the total number of air mesophilic bacteria were incubated 48h/37^{o}C in 1 ml of water.
b) Biological parameters: enzyme phosphatase activity mmol/s/dm^3 pNP (30°C), saprobic index, chlorophyll Chl "a", oligotrophic bacteria, heterotrophic bacteria by Khola, the degree of self-purification O/H
c) Physico-chemical parameters: temperature, turbidity, organic matter as KMnO4 consumption, total organic matter in the water, iron, manganese, oxygen, ammonia, nitrite, nitrate, phosphorus, chloride, the rest of the fumes, electrical conductivity.
The new solution (model) must be connected in a well designed functional unit, which can precisely manage ("Precision Process Technology") - the integration of the production phase in the logical production units to enable them to precisely manage for maximum use of natural resources, auxiliary materials, energy, etc. . Realization of these principles of action, the selected process technology will be fully integrated into the principles of sustainable development (10).

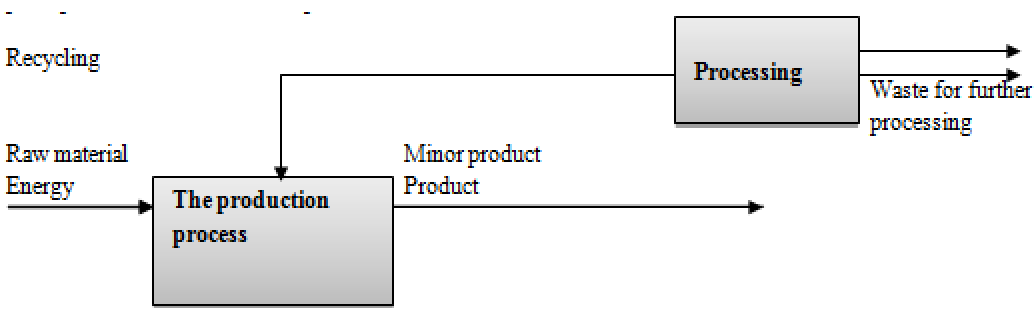


Figure 10. The general scheme of "closed" ("clean") process technology

IV. SELECTION OF CONTROL POINTS IN THE SYSTEM

The content and concentration of a large number of water quality parameters during treatment and distribution depend on many factors - the implementation of the Water Framework Directive (Figure 11.).
Setting goals monitoring parameters that indicate of water quality are divided into two groups:

1. The parameters in which the concentrations of specific concentration of the substantially water inlet and uncertain, which vary in the course of distribution: e.g. arsenic, cyanide, fluoride, hardness, pesticides, sodium, selenium, sulfates, total soluble matter.
2. The parameters that may vary in concentration in distribution of: parameters that may participate in the reactions (which change the concentration) within the distribution system, but where the distribution of concentration in highly dependent on the concentration at the entrance of the system: for example,

aluminum, the residuals of disinfectants and disinfection by-products, iron, manganese, fluoride, color, turbidity, odor, taste, pH, characteristics for which the distribution system is the main source: eg. corrosion products (cadmium, chromium, lead, zinc, copper).

The frequency of sampling depends on the key characteristics of their variability, the aesthetic characteristics and the impact on human health. For microbiological parameters, sampling and analysis are much more common.A sufficient number of parameters must be collected during a representative period information to be provided to these programs can be statistically processed, and the significant changes in the trends identified, treatment options as compared to the recommendations monitored. The required number of samples depends on the desired level of precision with a known degree of confidence. (Dalmatia, B., Agbaba, J.2006.)

The accuracy of any laboratory analysis depends on the sampling method. The sample must be characteristic of the tested water (and the test parameters) otherwise the result is of no consequence. Sampling must be done professionally, in a prescribed manner.

Sampling points should provide data that are sufficiently representative of the quality of the water when it comes. To establish these points, short-term research monitoring is necessary.

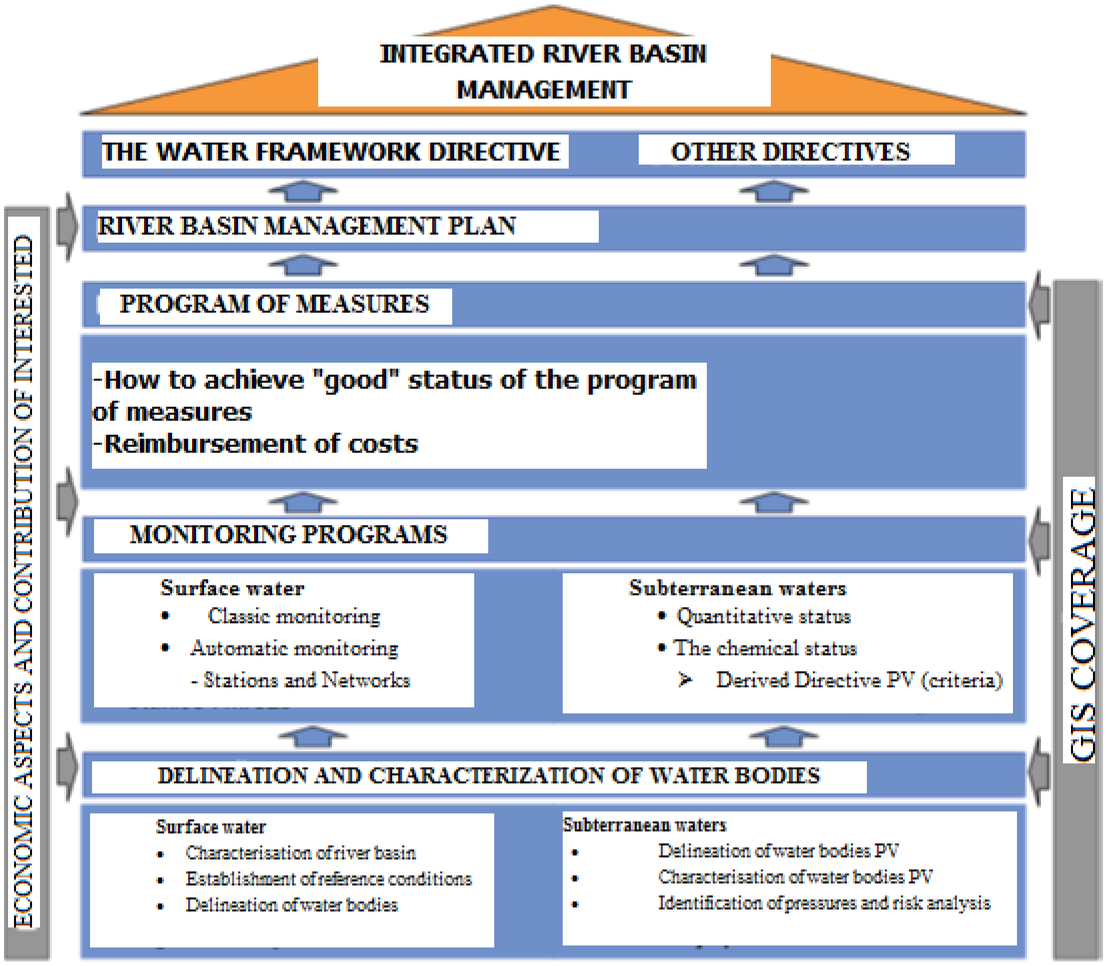


Figure 11. The implementation of the Water Framework Directive

Source: Milicevic, D., Milenkovic, S., Potic.,O. - FACTA UNIVERSITATIS

Series: Architecture and Civil Engineering, Vol. 8, No 2, 2010, pp. 249

In addition to official control, it is necessary that the manufacturer (and supplier) performs its own control, which includes the systematic control: the source, ie. the raw water, the purification process for optimal production, produced and delivered water at representative points.

Sampling points are: Raw water (source) device for the treatment of (process control, no performance monitoring), Treated (treated) water inlet water in the distribution system, tank, representative composite and/or random samples of points of distribution system, Points that represent the quality of water available to consumers, Consumer taps for specific research (eg., corrosion products or verification of distribution sampling points), Point at which previous research has shown satisfactory quality.

Place of sampling in the distribution system should be set up to enable the monitoring of residual disinfectants and determine the microbiological quality of water. For routine bacteriological tests, the sampling should be taken of the relevant precautions, including all national safety requirements.
Distribution systems can be open, closed and mixed. Supply can be from multiple sources (wells). At the same time, the source can be both surface and ground water, and water that has undergone processing or directly from the source without treatment except disinfection, pumped into the distribution network.
Depending on the distribution system, the WHO proposes a sampling.

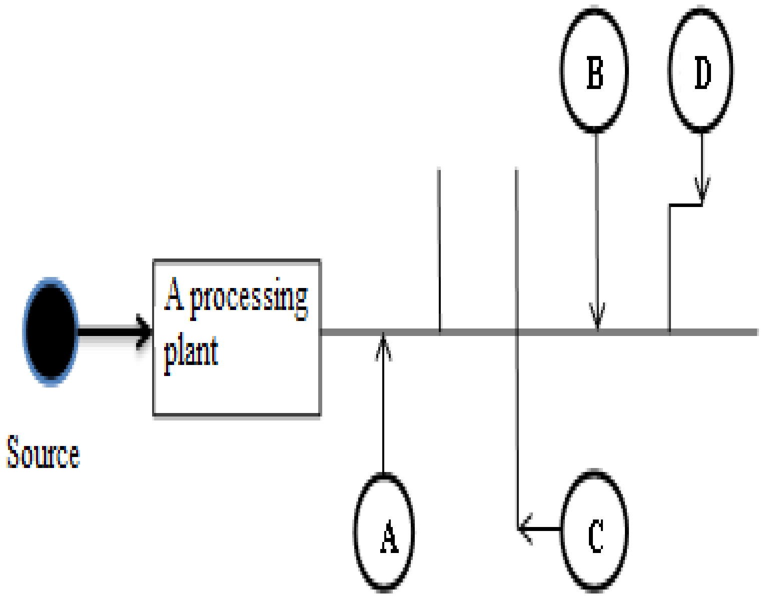


Figure 12. Open distribution system
Source: WHO, 1983

A - Sampling clean water after the treatment plant, is used to verify the effectiveness of the system and to show the input water quality in the distribution system; B - Is the sample of water from the central water pipe; C - Represents the water sample in one of the branches of the central water pipe; D - Represents a sample of water at the end of the system.

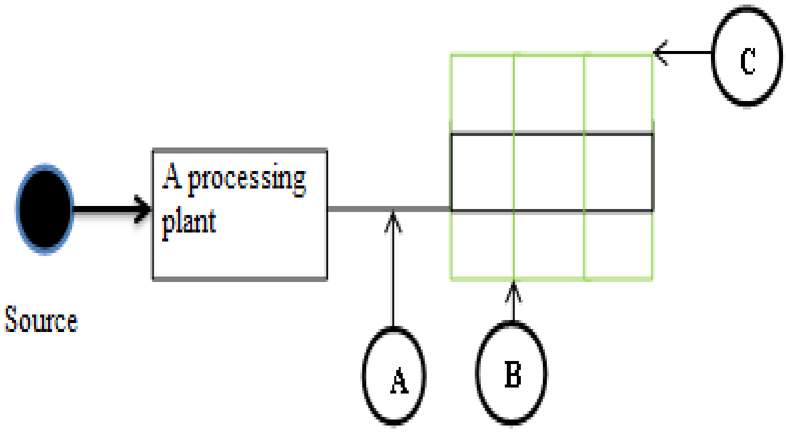


Figure 13. Closed distribution system
Source: WHO, 1983

A - Sampling clean water after the treatment plant, is used to verify the effectiveness of the system and to show the input water quality in the distribution system; B - Represents the water sample in one of the branches of the central water pipe; C - Represents the water sample at the end of the system.

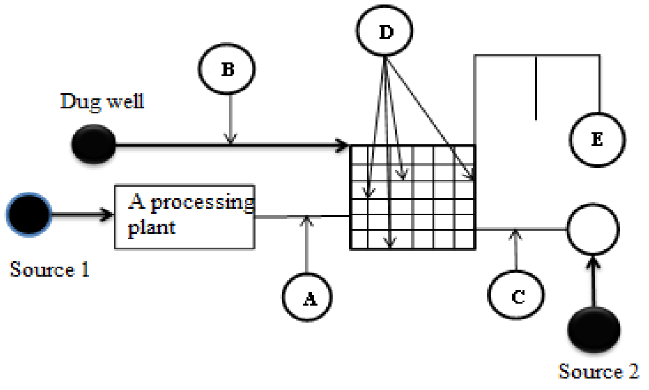


Figure 14. Mixed distribution system
Source: WHO, 1983

In this case there are three sources of water, and the system has a "closed" distribution zone and other "open" type. A - Sampling clean water after the treatment plant, is used to verify the effectiveness of the system and to show the input water quality in the distribution system; B - Is the quality of well water that enters the system; C - The point is the quality of the water after passing through the reservoir, (in some cases, it is also important to take samples before the tank); D - Point represents the water in the main system (the similar point in the network should have the same value; E - Is the quality of the water in an open system (in this simple case, the samples are taken from secondary branches and at the end of the system).

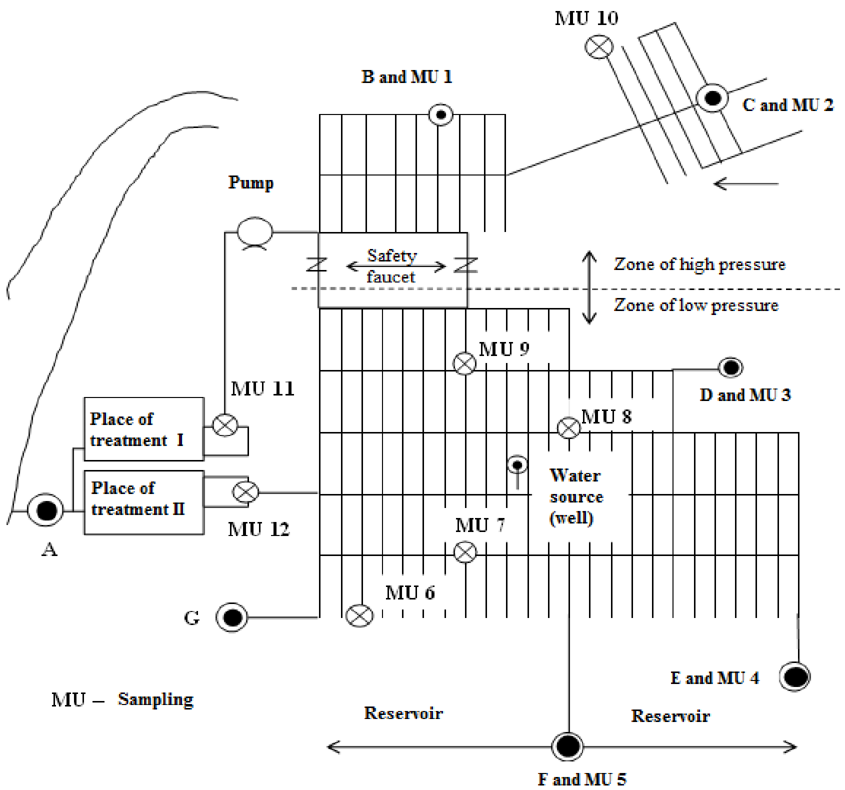


Figure 15. The combined system of branches and loops
Source:B. Dalmatia 2000.

Sampling "A" is the entrance to the distribution system. Sampling "B" main tube, position "C" is a "dead spot" water main. Places "D" and "E" are in the branches and the "deadlock" branch. Samples taken from the position of "B" and "E" requires a complete analysis. Place "F" is under the influence of the water tank. Point "G" is a "dead spot". The numbers are marked for sampling of the distribution system.

V. CONCLUSION

A key aspect of model selection parameter optimization of the quality of the raw water is a good knowledge of the real system being modeled. With this in mind, we decided to use environmentally friendly type of model.
Based on the research results presented ecological models, it is concluded that the presented models have great potential and that with further updates can turn into a very good tool for the prediction quality of the raw water and an estimate of funds required in the process of obtaining drinking water.

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