BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI

Volumul 64 (68)

Numărul 4

Secţia
HIDROTEHNICĂ

2018 **Editura POLITEHNIUM**

BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
PUBLISHED BY
„GHEORGHE ASACHI” TECHNICAL UNIVERSITY OF IAŞI
Editorial Office: Bd. D. Mangeron 63, 700050, Iaşi, ROMANIA
Tel. 40-232-278683; Fax: 40-232-211667; e-mail: bulletin-ipi@tuiasi.ro

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BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
BULLETIN OF THE POLYTECHNIC INSTITUTE OF IAŞI
Volumul 64 (68), Numărul 4 2018

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BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
BULLETIN OF THE POLYTECHNIC INSTITUTE OF IAŞI
Volume 64 (68), Number 4 2018

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HYDROTECHNICS

C O N T E N T S

BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Volumul 64 (68), Numărul 4, 2018
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EPANET BASED HYDRAULIC MODELLING OF THE WATER SUPPLY SYSTEM OF A LOCALITY WITH POPULATION OF UNDER 10,000 INHABITANTS

BY

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Received: October 14, 2018
Accepted for publication: November 18, 2018

Abstract. The computer model of a water supply system is a mathematical representation of a real physical system. The paper presents the hydraulic modelling of a branched distribution network within a water supply system. The hydraulic simulation was performed over a day's duration using the EPANET program. Due to pressures exceeding the maximum permissible value, it was proposed to install two pressure reducing valves.

Keywords: hydraulic simulation; water supply system; storage tank; distribution network; pressure reducing valve.

1. Introduction

A water supply system is a complex of engineering works that ensure the abstraction of water from natural environment, the correction of its quality, its storage, its transportation and its distribution at parameters that must comply to users' demands (that is pressure, flow and other requirements).

The overall diagram of a water supply system includes: the abstraction stage (this being the catchment of water from a source), the treatment plant (a

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facility where, by means of physical, chemical and biological processes, the water quality is enhanced in order to be compliant to the consumers' requirements), a water tank (provides the water storage for the hourly/daily compensation of consumption, or for provision of water for fire fighting needs), and a distribution network (that provides the conveying of water from the tank to the users' connections).

The distribution network consists of pipes, nodes and a network supply source (water tank, pumping station). In a locality with a distribution system towards users (mainly residential homes), system that is arranged along the streets, the network's shape is similar to the street network shape. According to the configuration of pipelines that are forming a network, we can have: ring-shaped networks (specific to large localities), mixed networks (specific to large and small localities) and branched networks (specific to small localities).

For water distribution networks in rural areas an optimal solution means to provide connection pressure for supplying the Groundfloor+4 type buildings (maximum), for higher buildings the pressure being provided by means of boosting pumps (hydrophores). The shape of the network may change over time due to extensions of served area or the conveyed flows, or due to retrofitting carried out in order to increase the system's operational safety and quality.

The choice of distribution network type is made through optimization conditions, this meaning to make sure that water distribution service is carried out in compliance to law, at a minimum total costs of works, with minimum total annual expenditure, but also at a minimum total energy cost. In order to fulfill all these conditions, the optimal solution is the gravity supply of the network.

2. The Hydraulic Modelling of Water Supply Systems

Hydraulic modelling of water supply systems is commonly used in engineering design or in order to analyze various operating scenarios. In the course of the operation, the simulations performed on the hydraulic model can be used to develop long-term development plans, fire fighting studies, protection against hydraulic hammer events, increasing of transport capacity, water quality research, energy management, day-to-day operation of the system, training of operating personnel, and as well for the establishing of procedures needed for fast responses procedures in case of emergency situations (failures) (Alexandrescu, 2013).

The computer programs used for the analysis of water distribution systems and which are available on the market are: EPANET 2.0, InfoWorks WS or WS SIM (2005), Pipe2012 software, WaterNet-CAD program and the Urbano Canalis & Hydra software.

EPANET 2.0 is a software used by specialists around the world for modelling water distribution systems. This is a software that can be free downloaded from the Internet and underlies many modelling programs. It allows the modelling, the calibration and the analysis of water supply systems in terms of functionality and water quality.

The program developed by the US Environmental Protection Agency is achieveing hydraulic simulation over extended periods of time and a water quality analysis in pressure networks. It consists of an application that runs under Windows OS and a "toolkit" that allows the EPANET to adapt in order to serve various specialized applications. Moreover, the piping of a water supply system can be transferred from AutoCAD towards EPANET via the EPACAD software.

The hydraulic analysis engine of this program offers the following benefits (Alexandrescu, 2013):

– no limit as regards the size of analyzed networks;

– calculates linear head losses by several methods: Hazen-Williams, Darcy-Weissbach and Chézy-Manning;

– takes into account local head losses generated by various hydraulic devices;

– is able to achieve the modelling of pumps (with and without variable speed drive);

– calculates energy consumption and pumping costs in water systems;

– is able to model different types of valves, such as closing valves (at different valve positions), pressure control valves, flow control valves, or anti-return valves;

– allows the storage tanks to have any shape (a volume variation graph may be required depending on the tank's height if the tank is not cylindrical; for a cylindrical tank, a variation law of diameter vs. height may be adopted);

– the nodes may have different types of requirements, each with its pattern of variation over time;

– can control the pumps and valves according to the tank's water level or as a time function; also, more complex controls can be adopted, controls based on certain rules.

Under EPANET program, a water supply network can be made out of pipelines, nodes, pumps, valves and water tanks. EPANET tracks the flow variations in each pipe, the pressures in each node, and the amount of water in tanks. EPANET is running under Windows, and includes an integrated environment able to edit network input data, it runs hydraulic and water quality simulations, and is able to display results in different forms. These include color coded network maps, data tables, and variation graphs. The location and the sizing of pumps, pipes and valves, the minimizing of pumping power consumption, flow analysis, vulnerability study and operator training for various possible operating situations are just some of the EPANET capabilities.

When using EPANET for modelling a hydraulic water distribution system, some important steps must be observed (Rossman, 2000):

1. drawing of distribution network diagram (as in Fig. 1) or importing of a basic network description from a text type file;

2. editing the properties of each element that makes up the system (pipe's length, diameter and roughness, elevation, working pressure and consumption consumed in a node etc.);

3. description of the system's operation;

4. selecting a set of analysis options;

5. running a hydraulic analysis;

6. viewing the results of the analysis.

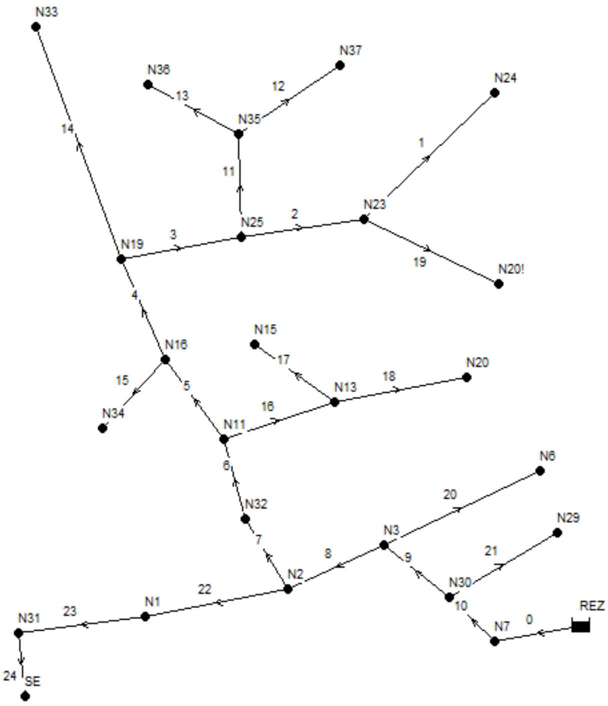

Fig. 1 – Water supply diagram (nodes numbering and flow directions).

Output data calculated for pipes are *Q* (l/s), water velocity (m/s), head losses (expressed in m/km) and the Darcy coefficient λ. In nodes, several parameters cand be dispalyed: the pressure (m.w.c.), the piezometric head, the location elevation (m) and the water flow rate demanded by the consumer connected to that node (l/s).

3. Case Study – Hydraulic Modelling of the Water Supply System of a Locality with Population of under 10,000 inhabitants

The present paper considers a simplified scheme of a water supply system of a locality counting approximately 3,500 inhabitants, namely a scheme consisting of a storage tank (volume – 400 m^3) which supplies by gravity a downstreams branched distribution network.

The water tank (located near the locality, at elevation 464.00 m) ensures the storage of the amount of water necessary to achieve the hourly compensation of consumption flows with the supply flows and to provide a water reserve for fire fighting operations.

The distribution network comprises all pipelines, installations and auxiliary constructions that are designed to convey water from the tank to the furthest consumption point, by ensuring water flows and presures at the required service values.

The diagram of the water supply system (Fig. 1) is developed by means of the EPANET 2.0 graphical interface.

The geometric features of the network are loaded directly into EPANET software (HDPE PN10 high density polyethene pipes, with diameters between 90 and 140 mm) together with the initial hydraulic parameters (the absolute roughness for the new HDPE pipes is 0.007 mm). The EPANET software performs hydraulic simulation for a water temperature of 10°C, which corresponds to a kinematic viscosity coefficient of 1.31×10^{-6} m^2/s.

The variation in hourly flow over a day depends on the number of inhabitants. On basis of hourly variation coefficients for the daily water consumption graph corresponding to a rural locality with population of under 10,000 inhabitants, the flow chart of the flow rate consumed in each node was implemented in EPANET (Fig. 2), in relation to the daily average flow consumed in the node (STAS 1343, 2006).

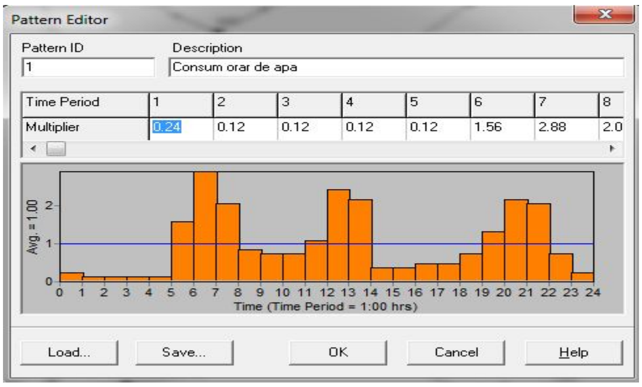

Fig. 2 – Graph: hourly variation of flow consumed in every node.

In the drinking water supply system of the locality, the flow provided to consumers is considered to be uniformly distributed (Normativ NP 133, 2013). The analysis was performed over a day, starting at midnight. Consumer flows vary every hour according to the graph in Fig. 2. The time increment used in the hydraulic modelling was 5 minutes. Figs. 3 and 4 show the pressure values in nodes (mWC), at peak hours when water consumption is maximum (13.00 hours) and respectively at midnight when consumption is minimum (00.00 hours).

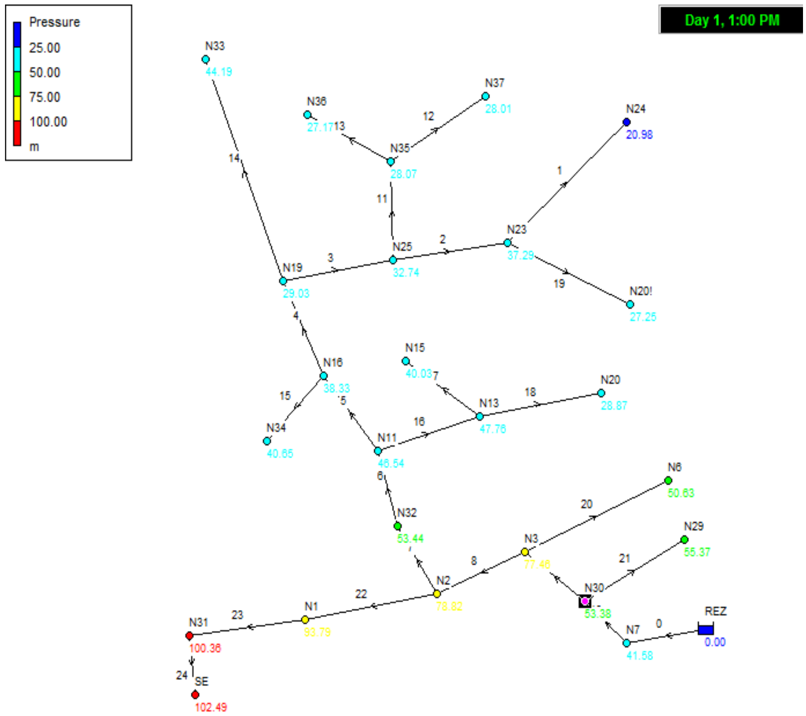

Fig. 3 – Pressure variation in network, at peak hours (13.00 hours).

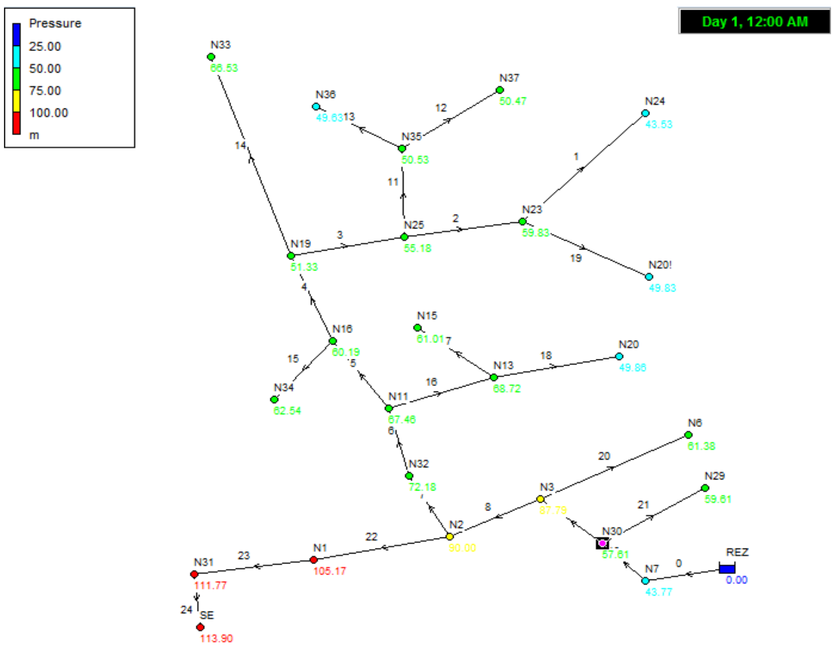

Fig. 4 – Pressure variation in network at midight (00.00 hours).

The output data, the pressures, calculated for network nodes, contain values greater than 60 mWC (the maximum pressure that is to be provided in a water supply system), in certain nodes.

In this situation, a 2nd digital simulation was performed in order to correct the above mentioned negative influences on the system, when two pressure reducing valves are adopted (symbol-PRV), valves that maintain pressure in upstream node below a certain prescribed value. The valve 1 is placed on the N30-N3 section, where the characteristics of the respective pipe (diameter D_i = 123.4 mm) are introduced and the pressure of 60 mWC is prescribed. The valve 2 is placed on the N2-N1 section with pipe diameter D_i = = 96.8 mm and the value of 50 mWC is prescribed as reduced pressure.

Figs. 5 and 6 show the pressure variation (mWC) in all nodes of the water supply network for the two time intervals, assuming the location of the two pressure relief valves.

From the comparative analysis of results shown in Figs. 3,...,6, it results that the increasing in pressure depends on the terrain configuration, where in some areas the network pressure exceeds 60 mWC. At peak hours (13.00), these pressures decrease as water consumption is high, and when water consumption is low, during night time (00.00 hours), the pressure values are the highest.

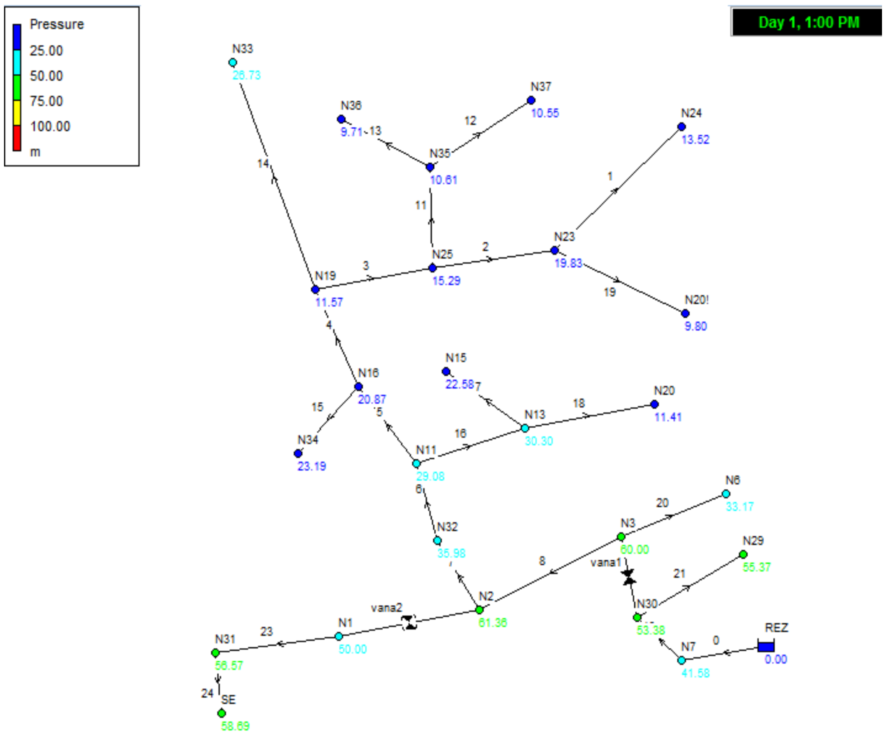

Fig. 5 – Pressure variation (mWC) at peak hours (13.00 hours), when pressure reducing valves are adopted.

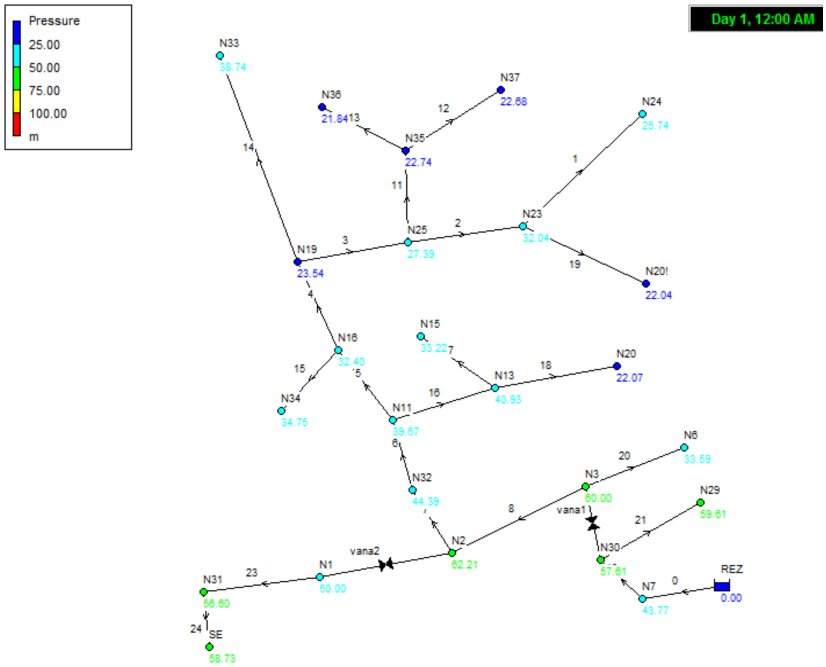

Fig. 6 – Pressure variation (mWC) at midnight (00.00 hours), when pressure reducing valves are adopted.

In the second digital analysis, where the water consumption is maximum, it can be seen that the pressure in the nodes of the network meets the minimum pressure condition for connection, this being 8 mWC for Groundfloor+1 buildings.

4. Conclusions

This paper refers to the modelling of water conveying via a water supply network of a locality with population below 10000 inhabitants. Digital calculations were performed by means of EPANET 2.0 software.

As hourly water flows vary at consumers over a day, pressures in network nodes vary as a function of hourly consumption, while maintaining maximum values at nighttime and minimum values during peak hours.

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MODELAREA HIDRAULICĂ CU AJUTORUL PROGRAMULUI EPANET A SISTEMULUI DE ALIMENTARE CU APĂ A UNEI LOCALITĂȚI CU O POPULAȚIE SUB 10000 DE LOCUITORI

(Rezumat)

Modelul pe calculator al unui sistem de alimentare cu apă este o reprezentare matematică a unui sistem fizic real. Lucrarea prezintă modelarea hidraulică a unei rețele ramificate de distribuție din cadrul unui sistem de alimentare cu apă. Simularea hidraulică s-a realizat pe durata unei zile cu ajutorul programului EPANET. Din cauza presiunilor care depăşesc valoarea maxima admisă s-a propus amplasarea a două vane de reducere a presiunii.

BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Volumul 64 (68), Numărul 4, 2018
Secţia
HIDROTEHNICĂ

ENVIRONMENTAL IMPACT ASSESSMENT PRODUCED BY THE INTEGRATED SOLID WASTE MANAGEMENT SYSTEM IN VASLUI COUNTY

BY

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Received: October 14, 2018
Accepted for publication: November 18, 2018

Abstract. The paper describes the technical requirements for the construction of a new landfill in Vaslui County, for municipal waste and domestic waste, which corresponds to the most advanced technologies in the field.

The Integrated Waste Management System has a key role to play in developing sustainable waste management at the local level, which must ensure the achievement of the targets set for different timeframes within the strategic objectives.

Waste collection, transport, treatment, recovery and disposal activities are described, including the monitoring of these operations and the monitoring of landfills after their closure.

Waste treatment is carried out by physico-chemical, chemical and biological processes, related to waste processing, in order to reduce the environmental risk factors, to reduce the storage areas, as well as to valorise them.

The system, with all its components, leads to a significant positive effect for the environment and generates economic and social benefits for the county of Vaslui.

Keywords: ecological deposit; environmental risks; selective collection; pollution; leachate.

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1. Introduction

Like many other countries in Central and Eastern Europe, Romania has inherited from the Communist period serious environmental problems caused by excessive industrial policy that did not take into account the impact on the environment and the health of the population. The worst problems are encountered in water quality, waste management and air and soil pollution.

At present, the issue of waste management is becoming increasingly acute due to its growing and diversification, as well as to its negative impact on the environment. Landfilling on soil without meeting minimum requirements, discharging into the watercourses and their uncontrolled burning represents a number of major risks for both the environment and the health of the population.

A landfill is defined as a site for final disposal of waste by landfilling on soil or underground storage. Deposits can be classified by:

A. Nature of the waste disposed of:
- landfills for hazardous waste (class a);
- landfills for non-hazardous waste (class b);
- landfills for inert waste (class c).

B. Storage period:
- final landfills;
- temporary storage of waste.

C. How to build:
- landfills made by filling;
- open or closed landfills;
- landfills made by supporting a hill or filling a valley;
- underground storage;
- landfills in abandoned mining areas;
- landfills made in caves or grottos.

The present paper refers in particular to non-hazardous waste landfills, category in which domestic waste deposits are registered.

Regarding waste disposal, in Vaslui County domestic waste was dumped mainly in uncontrolled landfills, which led to substantial pollution. Table 1 presents an overview of non-compliant landfills operating in the county.

Table 1

Deposits in Vaslui County

Deposits in Vaslui county	Designed capacity, [m^3]	Designed Surface, [ha]	Year of closure
Vaslui	400,000	6.9	2006
Huşi	560,000	5.5	2006
Bârlad	750,000	6.41	2006
Negreşti	40,000	0.5	2009

Source: Vaslui Environmental Protection Agency, 2007

In order to be able to choose the most efficient integrated waste management system, four potential storage sites were identified: Roşieşti, Albeşti, Costeşti and Bogdăneşti, presented in Fig. 1. The sites are located in the central part of the county, southeast of the town of Vaslui. The distance to Vaslui is 14 km (Albeşti), 21 km (Costeşti), 26 km (Roşieşti) and 29 km (Bogdăneşti). The surface area of the sites varies between 100 m,...,150 m altitude above sea level.

The most suitable site is considered to be the one from Rosiesti. It is located in the center of the county, the morphology is favorable, the loess soil has a low hydraulic permeability and high thickness, there are no erosion or landslides and there are springs. There is an access road and electricity.

Fig. 1 – Potential locations of the deposit (left) and geological map of them (right).

2. Analysis of Components of Integrated Waste Management System in the Study Area

The integrated solid waste management system in Vaslui County provides the construction of municipal solid waste management infrastructure, with the following components:

1. Selective waste collection at fixed locations and specialized road transport.

2. Centralized sorting of waste at the sorting station built on the site of the Rosiesti landfill.

3. Solid waste storage:

– temporary storage through four transfer stations built at: Vaslui, Bârlad, Huşi and Negreşti;

–final storage.

4. Waste composting.

5. Closure of non-compliant landfills.

There are a variety of equipment that can be used to collect residues and recyclable materials. Regarding residues and recyclable materials, additional clarification is needed regarding the following aspects:

– containers;

– collection points (for residues and recyclable waste);

– trucks.

Selective collection of recyclable waste is a measure to achieve the recycling and recovery targets set by Directive 94/62/EC on Packaging and Packaging Waste, as amended by 2005/20/EC. The collection of recyclable waste is carried out following the same requirements as for the collection of residues.

The Roşieşti site (Fig. 2) is located in an agricultural area, about 3 km away from the DN24 national road. Access roads are paved county roads and communal roads. The Idrici River, a railway line and the Roşieşti Station residential area must be crossed. The surface is almost flat and the slope is about 5% in the south, with an artificial barrier and waterproofing with geomembranes for the base of the landfill.

Fig. 2 – Landfill from Roşieşti.

The landfill is equipped with a collecting system and a leachate treatment plant by biological method and precipitation with lime milk and aluminum sulphate. Purification of leachate is made directly to the emissary (Idrici River) through a pipeline system.

The works for building the first ecological landfill cell included:

– the construction of the dykes (Fig. 3);

– reprofiling, leveling and compaction of existing soil;

– the construction of the base sealing system (Fig. 4) consisting of a mineral sealing layer, a geomembrane (Fig. 5) and geotextile (Fig. 6);

– realization of a drainage layer with drainage pipes (Fig. 7);

– making a permeable geotextile layer with a density of ≥ 400 g/m^2 (filter mattress);

– realization of the waste layer from constructions.

Fig. 3 – Dams and drains of the deposit.

Fig. 4 – The sealing mineral layer.

Fig. 5 – Mounting the geomembrane.

Fig. 6 – Mounting the geotextile.

Fig. 7– Mounting the leachate drainage layer.

3. Environmental Impact Assessment

3.1. Identified Environmental Risks

Natural hazards that can have a major impact on the landfill are:

– **earthquakes** (in terms of seismicity, the studied landfill is located in the seismic area with the terrain acceleration a_g = 0.24 g and control period T_c = = 0.7 s);

– geomorphological risks (**landslides**, compaction etc.);

– climatic risks (storms, drought, floods) etc.).

Table 2 presents the effects of natural hazards and their impact on the environment.

Table 2
Natural Hazards and Impact on Environmental Factors

Nr. crt.	Risc	Effect	Impact on environment
1	earthquake	– destruction of the deposit slopes; – destruction of waterproofing layers; – destruction of drainage and waste gas collection systems	– discharges of waste, leachate and water collected on the landfill on adjacent land; – leachate infiltration into the soil and subsoil and the infiltration of rainwater into the mass of waste, phenomena accompanied by soil, groundwater and surface water pollution; – the formation of gas bags and the production of fires and explosions, accompanied by atmospheric pollution
2	landslides	– unlikely due to the small slope of the land	
3	compaction	– in the case of closed deposits, can destroy the layers of waterproofing of of the deposit cover	
4	storms	– waste disposal on land adjacent to the landfill	– soil pollution with waste.
5	floods	– destruction of the deposit slopes; – trapping waste and scattering them; – dissolution of pollutants in the waste composition.	– pollution of water, soil and groundwater.

In addition to the risks of pollution caused by natural factors, a risk of high occurrence is the risk of fire.

A risk analysis for waste disposal includes:

– environmental and health risks arising from pollutant emissions from waste;

– risks that may result from the damage to contamination prevention systems.

A malfunction of contamination control systems such as: cracking of concrete or asphalt in service areas in the deposit, deterioration of landfill waterproofing, wastewater collection and treatment systems or deposit gas, transforms that objective into a source that transmits pollution on various pathways to receptors.

The experience gained in exploiting the objectives of waste management systems has highlighted certain accidents with a probability and a certain frequency of occurrence.

The following matrix (Table 3) presents the main accident hazards that can occur in landfills, the probability of occurrence and the severity of their consequences.

Table 3
Risk matrix

		Consequences		
		Reduced	Significant	Serious
Probability	Probable	–cracking of concrete platforms; – the subsidence of the deposit base.		
	Low probability	– contact between the leachate collection / treatment system and rainwater	– ignition of waste (fires); – the presence of insects and rodents.	
	Unlikely	– breakage or leakage from rainwater and leachate collection basins; –clogging drainage or leachate collection pipelines		– explosion in the gas storage system, followed by fire.

3.2. Emissions of Pollutants from the Deposit Activity

SURFACE WATER and UNDERGROUND WATER

Pollutants: suspended solids, CBO_5, NH_4+, NO_3-, NO_2-, SO_4^{2}-, phenols, CN-, heavy metals.

Sources: leachate from landfill, surface water collected by the drainage system, wastewater from the administrative pavilion, rainwater that cleans the surface of the service area of the landfill and which can dissolve pollutants contained in accidentally fallen waste from trucks or from public utility area or lost fuel from vehicles and waste handling equipment.

Impact mitigation measures:

– drainage and disposal of wastewater;

– leachate treatment plant;

– monitoring soil quality and water quality in control drilling around the deposit

AIR

Pollutants: powders, CH4, CO2, H2S, NH3, COV.

Sources: Waste gas generated by the waste biodegradation process, powders generated by waste handling, storage and atmospheric turbulence and exhaust gases from motor vehicles and their own equipment.

Impact mitigation measures:
– waste gas extraction and burning system;
– spraying the waste and access roads during periods of drought;
– the daily coverage of deposited waste;
– technical verification of mobile operating equipment.

SOIL

Pollutants: powders, N-NH4+, N-NO3-, SO42-, phenols, petroleum products, heavy metals.

Sources: waste handling, daily coverage with ground, fluid loss from vehicle engines and storage equipment.

Impact mitigation measures:
– the technical verification of the equipment used in the storage process;
– respecting working instructions.

3.3. Risk Assessment

When arranging landfills, measures must be taken to reduce other noxes and hazards, such as: smell and dust emission, wind-driven particles, noise and traffic, poultry, parasites and insects, aerosol formation, fires, explosions, landslides.

The deposit must be equipped in such a way that noxious emissions from the site are not dispersed on public roads and in neighboring areas.

Many types of matrix are used in the environmental impact assessment. The most commonly used are the matrices (Table4) presenting the activities on one axis and the environmental parameters on the other.

Table 4

	Geosphere		Hydrosphere		Biosphere		Atmosphere		Human use			
	soil	subsoil	groundwater	surface water	fauna / flora	human	climate	air	socio-economic	cultural objectives	recreation	landscape
Operating activities									B			
Emissions of pollutants into the air	X	O	X	O	X	X	O	X	O	O	X	O

Table 4

Continuation

	Geosphere		Hydrosphere		Biosphere		Atmosphere		Human use			
	soil	subsoil	groundwater	surface water	fauna / flora	human	climate	air	socio-economic	cultural objectives	recreation	landscape
Waste gas collection system					B	B	O	B				
Emissions of odors					O	X					X	
Noise emissions					O	X					X	
Exhaust gas generated by engines							O					
Leachate	X	O	X	O								
Vibrations generated by motors					O	O			O			
Waste generation	O											
Wastewater	O				O							
Traffic					O	X	O	X	X		X	

Where: O – insignificant impact; X – significant impact; B – benefits to the environment and the population.

The elements that will impact on the population, the atmosphere and the recreation areas during the operation of the landfill are the storage gas, flue gas, exhaust gases, odors, noise and vibrations, and traffic intensification. The impact of odors and noise will be felt, first of all, by landfill operators, drivers and crew members entering the deposit, and to a lesser extent by residents in residential areas. The realization of the new ecological landfill in Vaslui County will have a beneficial effect on the socio-economic environment.

3. Conclusions

The current waste management system in Vaslui County is not an integrated system that complies with the legislative provisions and ensures the achievement of the objectives and targets set by the county waste management plans (CWMP).

The regional approach of waste management involves the implementation of an integrated waste management system (managing) at the level of each county.

The main problems of waste management in Vaslui County are:

– the absence of selective collection services;

– the equipment in use is outdated or inadequate for selective collection;

– almost all of the collected waste is stored, including fractions that could be recycled or composted;

– all existing landfills in the county are non-compliant. They are also polluting and dangerous: they discharge significant amounts of leachate into groundwater and surface water, fires threaten the safety of the population, pollute the air and pose health risks. Access to deposits is generally not controlled and the use of old methods is still widespread;

– existing landfills must be closed, sealed and integrated into the landscape in order to reduce potential risks to human health and the environment;

– waste management services are inadequately funded and the principle „the polluter pays" is not applied (principle subject to constraints of supportability);

– the public is not sufficiently aware of waste issues and there is no advice on this issue.

The technical measures of the integrated waste management system foreseen in the project contribute to minimizing the environmental impact generated by improper waste management.

The technical solutions proposed in the project lead to reducing the environmental impact. Are described the measures taken to prevent, reduce and prevent these significant environmental impacts.

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EVALUAREA IMPACTULUI DE MEDIU PRODUS DE SISTEMUL INTEGRAT DE MANAGEMENT AL DEŞEURILOR SOLIDE ÎN JUDEŢUL VASLUI

(Rezumat)

Lucrarea descrie cerinţele tehnice pentru construirea unui nou depozit ecologic în judeţul Vaslui, pentru deşeurile municipale şi deşeurile menajere, care corespund celor mai avansate tehnologii din domeniu.

Sistemul integrat de gestiune a deşeurilor are un rol cheie în dezvoltarea unei gestionări durabile a deşeurilor la nivel local, care trebuie să asigure îndeplinirea ţintelor prevăzute pentru diferite perioade de timp în cadrul obiectivelor strategice.

Sunt descrise activităţile de colectare, transport, tratare, valorificare şi eliminare a deşeurilor, inclusiv monitorizarea acestor operaţii şi monitorizarea depozitelor de deşeuri după închiderea lor.

Tratarea deşeurilor se realizează prin procedee fizico-chimice, chimice şi biologice, aferente prelucrării deşeurilor, în scopul diminuării factorilor de risc asupra mediului, al reducerii spaţiilor de depozitare, precum şi al valorificării lor.

Sistemul, cu toate componentele sale, conduce la un efect pozitiv semnificativ pentru mediu şi generează beneficii economice şi sociale pentru judeţul Vaslui.

BULETINUL INSTITUTULUI POLITEHNIC DIN IAȘI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iași
Volumul 64 (68), Numărul 4, 2018
Secția
HIDROTEHNICĂ

THE POSSIBILITIES TO IMPROVE ENERGY CONSUMPTION IN WASTEWATER TREATMENT PLANTS

BY

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Received: October 24, 2018
Accepted for publication: November 29, 2018

Abstract. The technical name indicates the size of of the sewage treatment plant at 2Quz.orar.max .(unitary sewerage system) and at 1Quz.orar.max (separate sewerage system), including taking into account the prospective flow.. These flows cause great problems in the first years of operation for two reasons: big differences in actual flows and very large differences between Q zi min ;Qzi max.

In normal way 99 percent of sewerage systems are systems with branched grids and with unic waste water track .

The paper work proposes to carry out a transformation of the gravitational sewerage network into a nodal network, which by means of automation can be used in the same sewerage network to use different water transport routes to capitalize the volume of sewerage network compensation. so the flow Qzi.med will be at the entrance to the wastewater treatment plant.

This leads to the efficiency of the treatment and the reduction of the power consumption of the blower station

The paper work also shows the possibilities of reducing the energy consumption of the second main consumer in the waste water treatment plant, resp. The wastewater pumping station.

Keywords: waste water treatment plants; energy consumption.

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1. Introduction

As they increase in population the localities have an increase in the dynamics of the flow / waste water needs, within the locality's administrative division. If the total locality area has residential, social, economic areas, then, depending on the inhabitant's day program, with their movements during the day, there is also the displacement of the waste production. In this case the public sewerage network (RCP), sized at $Q_{uzormax}$, in order to meet any flow rate produced at any given time, operates at certain times at the projected flow rate, but for a very long time it operates below this flow rate, any network having remarkable capacity available for transport.

2. Presentation of the Proposed Solution

Given the access to measurement technique of the network state (real-time flow rate) and transmission of this information to dispatchers due to the speed work of computers related to the network characteristics (sections, roughness, slopes, flows etc.) it is possible to know at any moment the flows state in the sewage systems.

Given that the flow rate in the sewage treatment plant is the public sewerage network final flow and knowing that this flow is conditioned by the transport time (length and water speed in the collector), it is possible to modify the "fixed" state of the branched public sewerage networks and transform it into nodal networks, thus capitalizing on the storage capacities of the public sewerage network.

In this way, the gravitational network with fixed paths is transformed into a dynamic branch network (nodal network), greatly diminishing the maximum flow rate in the sewage treatment plant.

3. Presentation of Nodal Network

The dynamically branched (nodal) networks (Fig. 1) are networks that (in a plan view) act in the same way as the static ones, only that they have nodes that can receive water from "n" directions and allow discharge from the node also in "n" controlled directions. The network control nodes have instrumentation that can transmit the flow from the node to the dispatcher; the dispatcher analyzes the overall situation, makes the decisions and sends it by radio or G.S.M. to the equipment of the node, equipment (electro-station, etc.) which regulates the flows on each outlet of the water from the node (Klauss, 1998; Tobolcea & Crețu, 2010a; Tobolcea & Crețu, 2010b).

This type of network allows the use of existing compensation volume in the public sewer network. The network has the great advantage of being able to attenuate $Q_{or.max}$ in the public sewerage network respectively $Q_{or.max}$ can be obtained at the entry to the Treatment Station.

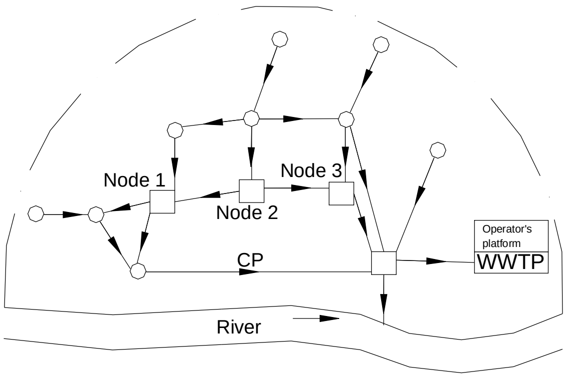

Fig. 1 – Diagram of a Dynamic Branched Sewer Network:
CP – main collector STAU – wastewater treatment plant

The transformation of the public sewerage network (RCP) from a branched network into a nodal network is based on a study of flows (and if possible on the quality of the sewage water) on the branched network sections.

A branched network is based on the principle that in a node it can receive water from "n" directions, but it goes mandatory on single direction from the node (Fig. 2 *a*).

The nodal network is based on the principle that in a node can enter water from *n* sections and can also discharge waters on *n* sections (Fig. 2 *b*).

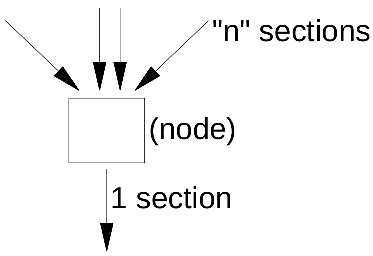

Fig. 2 *a* – A node from a branched network.

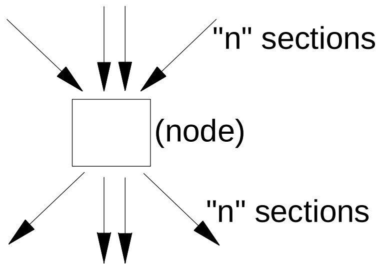

Fig. 2 *b* – A node from a nodal network.

From the branched network, a number of "i" nodes are to be nominated in order to modify the network into a nodal (gravitational) network. In this situation, the node is equipped with flow meters for the entering water and equipments and flow rate control devices on the downstream exits (electro-sluices and electro-valve) (Fig. 3).

It can be seen in the above figure what an important advantage in the treatment plant operation is the leveling of the influent flow, and what great advantages are achieved by the considerable sludge reduction for the necessary objects and respectively the reduction of the technological equipment.

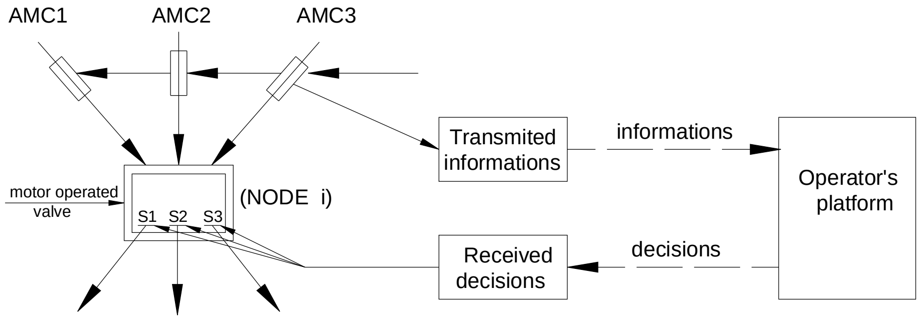

Fig. – Equipment of a NOD with input flow meters and adjustment devices.

4. Flow Compensation Options

In this situation, it is strictly necessary to solve this desideratum, which is possible in the following variants:

– Option I: sewerage flow compensation in the public sewerage network;

– Option II: sewerage flow compensation in specific constructions and facilities upstream of the wastewater treatment plant (Negulescu, 1978; Crețu, 2013; Tobolcea *et al.*, 2013).

Option I - sewerage flows compensation in the public sewerage network

Flow compensation in the sewerage network can be done as follows:

I.A Compensation by keeping the branched gravity sewerage network

In this situation the compensation is only made when the network has pumping stations located in different places (by geo-topographic and network layout), pumping stations which can be equipped with compensating basins in such a way that at maximum flows or storms), the reservoirs (tanks or polders) to store flows and, at minimum networks flows, the pumping stations to pump from the clearing basins the flow differences required in the public sewerage network. Thus, at the entrance to the treatment station constant flows can be obtained. When there are several pumping stations, it is necessary to create a dispatcher that pools the information from the public sewerage network and the pump stations buffer basins which are then processed in order to make decisions by remotely automating and transmitting the operating system mode.

I.B Compensation with transformation of a gravitational branched sewerage network into a gravitational nodal network

This option proposes to compensate the flows in the public sewerage network by increasing or decreasing the water path from the producer to the treatment plant. Also, in this situation, the flow hydraulic conditions can be monitored throughout the collector.

This is extremely effective when applying to existing networks because:

– most networks were designed before 1989, when an over-dimensioning was made on the basis of the five-year programs;

– after 1989 due to water consumption measuring, the water consumption decreased at least 3 times;

– there are very large reserve volumes when designed in a unitary system;

– instead of water running on "2 ... n" sections at a lower speed than the self-cleaning speed, circulation on a collector is preferred, cumulating the flows and increasing the speed above 0.7 m/s;

– it requires a minimum investment;

– there are computational programs for automatic sewerage management.

Option II - Compensation of sewerage flows in specific constructions and installations upstream of wastewater treatment plants

Overview

In this situation the compensation can be achieved with the minimum of the objects from Fig. 4.

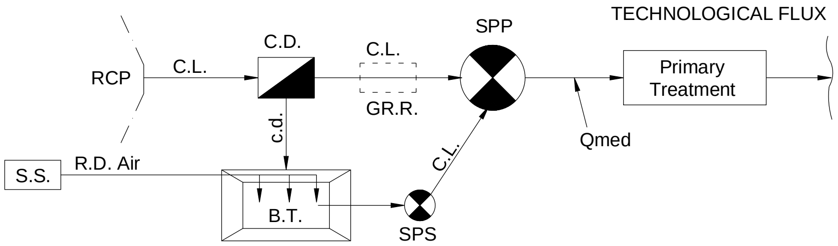

Fig. 4 – Constructions and installations for flow compensation:
RCP – public sewerage network; C.L. – link channel; C.D. – spill chamber;
C.D. – spillway; B.T. – buffer pool; S.S. – blower station; R.D. air – air distribution network; SPS – secondary pumping station; GR.R. – coarse bar screen;
SPP – main pumping station Q_{med} – influent average flow.

Taking into account the flow variation in the public sewerage network, hydraulically we can operate in the following hypotheses:

– hypothesis 1: $Q_{or.uz.} > Q_{uz.med}$ (Fig. 5 *a*);

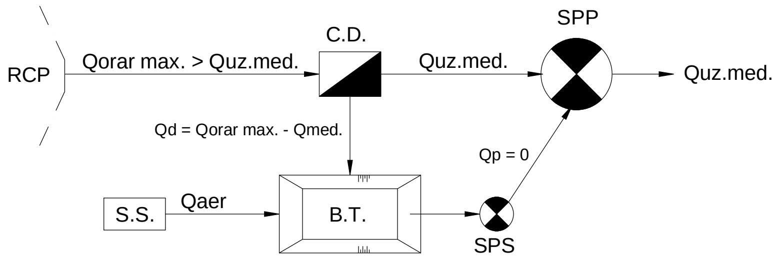

Fig. 5 *a* – Operating hypothesis 1 $Q_{or.max.} > Q_{uz.med}$.

– hypothesis 2: $Q_{or.uz} \equiv Q_{uz.med}$ (Fig. 5 *b*).

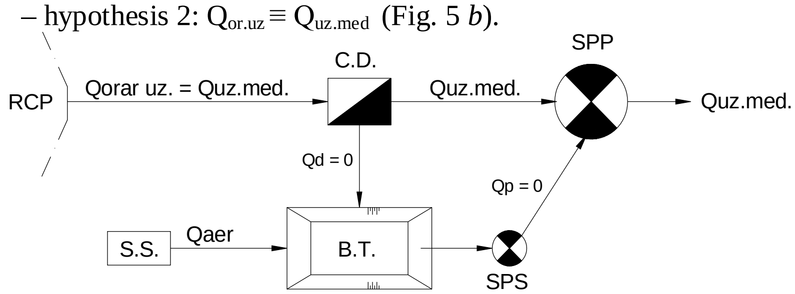

Fig. 5 *b* – Operating hypothesis 2 $Q_{or.uz} \equiv Q_{uz.med}$.

Q_{inf} – flow entering in the wastewater treatment plant, (m^3/s); $Q_{inf} = Q_{zimax} = K_{zi} \times Q_{zi\,med}$; $Q_{zi\,max}$ – the daily maximum used water flow rate set according to SR 1343/1 – 2006; $Q_{zi\,med}$ – the daily maximum used water flow, (m^3/s):

$$Q_{zimed} = 0.8 \cdot \frac{K_s \cdot K_p}{86400} \cdot \left[\frac{1}{1000} \cdot \sum_{z=1}^{n} U_z \cdot \left(n_{spi} + N_s + N_{im} \right) \right] \quad \text{(mc/s)}$$

where: K_s a coefficient that takes into account the technological needs of the water supply system; K_s = 1.02 for underground drinking source without reatment plants; $1.10 \geq K_s > 1.07$ for treatment plants that can serve a population of up to 100,000 inhabitants; K_p – loss coefficient in the treatment plant and on the water distribution network; K_p = 1.10;

$$n_{spi} = n_{gi} + n_{pi} \quad \text{(l/person day)}$$

where: n_{gi} is the specific water demand for household needs, (l/person day); n_{pi} – specific water demand for public needs (l/person day); n_{spi} – cumulative specific water demand.

N_s – water demand for sprinkler and street washing, (m^3/day);
N_{im} – water demand for small industry according to the prospective plan, (m^3/day);
K_{zi} – daily flow non-uniformity coefficient;
Z – urban comfort area
U – prospective population

$$K_{zi} = \frac{K_{zi1} \cdot U_1 \cdot n_{sp1} + K_{zi2} \cdot U_2 \cdot n_{sp2} + K_{zi3} \cdot U_3 \cdot n_{sp3} + K_{zi4} \cdot U_4 \cdot n_{sp4}}{U_1 \cdot n_{sp1} + U_2 \cdot n_{sp2} + U_3 \cdot n_{sp3} + U_4 \cdot n_{sp4}}$$

$Q_{or.max}$ verification flow – maximum hourly flow, (m^3/day);
$Q_{or.max} = K_0 \times Q_{zi.max}$ (m^3/s);
K_0 = non-uniformity hourly flow coefficient, (m^3/s);

Table 1
Values K_0 of the Hourly Variation Coefficient

Total number of inhabitants / zone	K_0
≤ 10,000	2.00…3.00
15,000	1.30…2.00
25,000	1.30…1.50
50,000	1.25…1.40
100,000	1.20…1.30
≥ 100,000	1.15…1.,25

Based on this information and the daily flow rate coefficients in the case of constant drinking water supply, a chronogram of influent flows can be made. (Fig. 5 *c*) (Tobolcea & Creţu, 2010a; Tobolcea & Creţu, 2010b; Indicativ NP 133-2013).

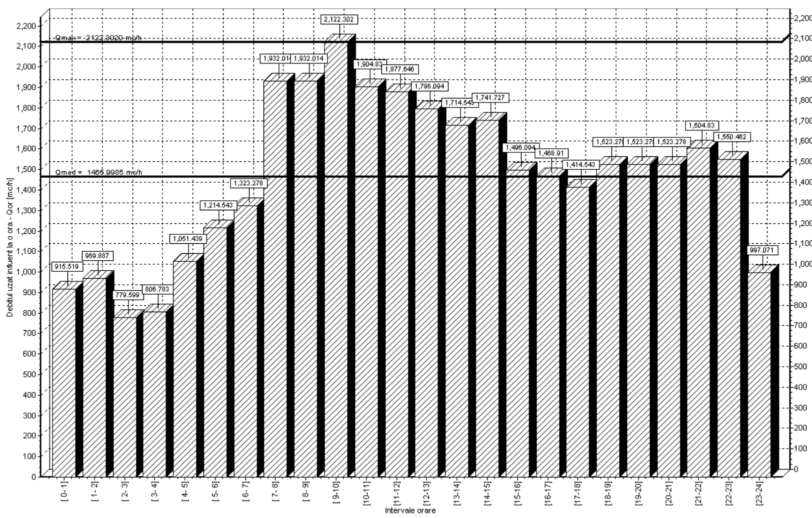

Fig. 5 *c* – Chronogram of influent flows.

– hypothesis 3: $Q_{or.uz} < Q_{uz.med}$ (Fig. 5 *d*);

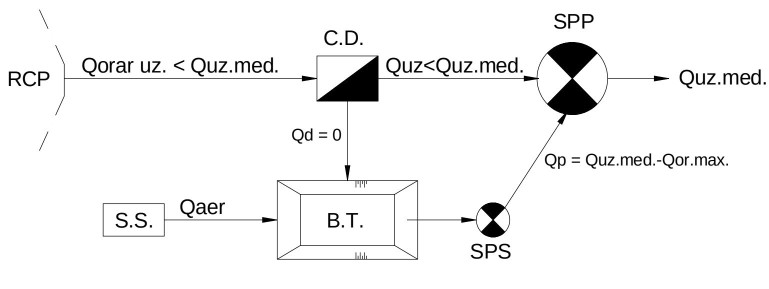

Fig. 5 *d* – Operating hypothesis 3 $Q_{or.uz} < Q_{uzmed}$.

Option III - Total - represent measures both in the public sewerage network and in the treatment plant (option I + option II).

5. The Necessity to Apply the Solution

Sizing and checking flows for a sewage treatment plant are in accordance with the technical regulations in force in the wastewater legislation (Tobolcea *et al*., 2013; Crețu & Tobolcea, 2017).

a) *Over-dimensioning of wastewater treatment plant objects and equipment* by designing to 2 $Q_{uz.or.max}$ leads to the following difficulties:

– very high investment values;

– exaggeration of buildings and installations.

A sewage treatment plant works very well when the flows and pollutants amount are those in the project. The higher the investment, the worse the station will work by increasing the retention/treatment time and by making unjustified costs.

b) Establishing the design flows for the waste water treatment plant is conditioned by the flow forecasting and population development. These have an overwhelming importance on the flow forecast.

In the current sizing practice at design flow rates (Q_{zimed}), the prospective flows for 20,...,25 years, require Quzormax at least 5 times higher than the initially Q_{zimed}. If this is added, the fact that the technical rules indicate for the unit sewerage systems a design flows of 2 $Q_{uzormax}$, then the design flows and the investment realizations are 10 times higher than the current requirements.

c) *Failure to create so many treatment modules*, and even if they are done, they are not justified to stay idle for a very long time.

d) *Wastewater treatment plants should be regarded as business centers* so that the water treatment costs are optimal and minimal in value. This can only be achieved by correlating flows, quantities of pollutants and treatment costs.

e) *Wastewater treatment plants can not be independent business centers* – the cost of waste water treatment is strictly conditioned by the operation of the *public sewerage network, which ideally has to bring into the station as influent flow a constant flow at any hour of the day / night*. This greatly reduces operating costs.

f) Modulation is a operating solution but not of investment.

In the current design and implementation applications it is found that the construction of compensation basins within the treatment plant is mainly made with the target of rain flows in the first 15 minutes but can also be used to compensate the waste flow when there is no rain. (*e.g*. wastewater treatment plant in Homocea, Vrancea County and Alexandria, Teleorman County, Figs. 6 *a* and 6 *b*).

Fig. 6 *a* – Compensation basin – Homocea.

Fig. 6 *b* – Compensation basin – Alexandria (the empty basin).

6. Conclusions

The minimum costs of treating waste waters will be obtained for a constantly influent flow in a waste water treatment plant.

This is necessarily achieved by correlating the functioning of the public sewerage network with the needs of the station. There must be no separation of production activities strictly on the sewerage network and strictly on the waste water treatment plant.

Compensation of waste water flows produced in the sewerage network leads to particular savings in wastewater treatment and total removal of the risk degree on the treatment plant.

As a result:

a) starting the transformation of the gravitational networks into nodal networks, having collector compensation capacities (*e.g.* sewerage network of Iasi municipality);

b) public sewerage networks have pumping stations – in the new European programs they have the money allocated for the dispatching of the waste water transport (*e.g.* the sewerage network of Vaslui municipality);

c) the construction/existence of compensation basins on the sewerage networks.

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POSIBILITĂȚI DE EFICIENTIZARE A CONSUMURILOR ENERGETICE ÎN CADRUL STAȚIILOR DE EPURARE

(Rezumat)

Normele tehnice indică dimensionarea STAU la 2 Quzormax (sistem unitar) şi la 1Q_{uzorma}x (sistem separativ), inclusiv luarea în considerare a debitelor de perspectivă. Aceste debite de dimensionare pun mari probleme în primii ani de funcționare din două motive: diferențele mari față de debitele reale şi diferențele foarte mari între Q_{zimin} şi Q_{zimax}.

În mod curent 99% din sistemele de canalizare sunt sisteme cu rețele gravitaționale ramificate, cu trasee unice pentru epele uzate.

Lucrarea propune realizarea unei transformări a RC gravitațională în RC nodală, care prin automatizare să poată ca în aceeaşi RC să folosească trasee diferite de transport a apelor. Astfel la intrarea în STAU sa fie debitul Q_{zimed}.

Acest lucru conduce laeficientizarea tratării şi micşorarea consumului energetic al stației de suflante.

Lucrarea prezintă şi posibilitățile de reducere a consumului energetic la al doilea consumator principal din STAU, respectiv SPAU.

BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Volumul 64 (68), Numărul 4, 2018
Secţia
HIDROTEHNICĂ

IMPACT OF MANAGING INTERNAL NUTRIENT LOADS ON THE RESTORATION OF EUTROPHIC FRESHWATER

BY

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Received: October 16, 2018
Accepted for publication: November 29, 2018

Abstract. In the last decades, the eutrophication has become the primary water quality issue for most of the freshwater ecosystems in the world. It represents one of the most visible examples of biosphere’s alteration due to human activities affecting aquatic ecosystems. Consequently, the removal of phosphate and ammonium gains great importance in water treatment.

This paper presents some restoration methods of eutrophic ecosystems; their implementation should impose a targeted management approach as a part of an integrated management plan, according to the EU Water Framework Directive. The success of the implementation of internal phosphorus management measures requires studies of a range of factors affecting viability of the method used, and the potential adverse effects on humans, biotic and abiotic factors.

Keywords: eutrophication; nutrients; sediments; restoration; freshwater; ecosystems.

1. Introduction

The process of degradation of environmental factors across the globe has seen a steady ascendant course over the past decades, an increasingly worrying trend, with the amount of pollutants reaching figures that go beyond

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imagination and continue to grow in almost geometric progression. A general threat to all surface waters, not spectacular but more dangerous by consequences than acute pollution, is the progressive, often latent, almost unnoticed pollution, but which accumulates the effect of small sources with diffuse pollution and takes chronic forms.

Such a pollution type is eutrophication - process of evolution of water quality, especially characteristic of artificial lakes, which brings particular problems from the water treatment technologies point of view.

The eutrophication process should not be judged by one criteria or another, but with a set of criteria. In fact, the syntheses elaborated did not subordinate to this vision, reaching the view that this type of organic pollution concerns the abiotic compartment of the ecosystem, at the biotic level, only its effects being felt.

The abundant literature that appears continuously on the concrete cases of eutrophication is increasingly perceived by the difficulties of interpretation and typology of the basins affected by this process (Fig. 1).

We consider that only analyzing a number of essential and edifying components of the subsystem and integrating them into a complex image of the ecosystem, dominated by a complex systemic interpretation, associated with a cyber-vision can lead us to a correct understanding and interpretation of the eutrophication process.

The rapid and non-controlled increase in human activity has accelerated the eutrophication process, altering the geochemical cycles of nitrogen, phosphorus and carbon.

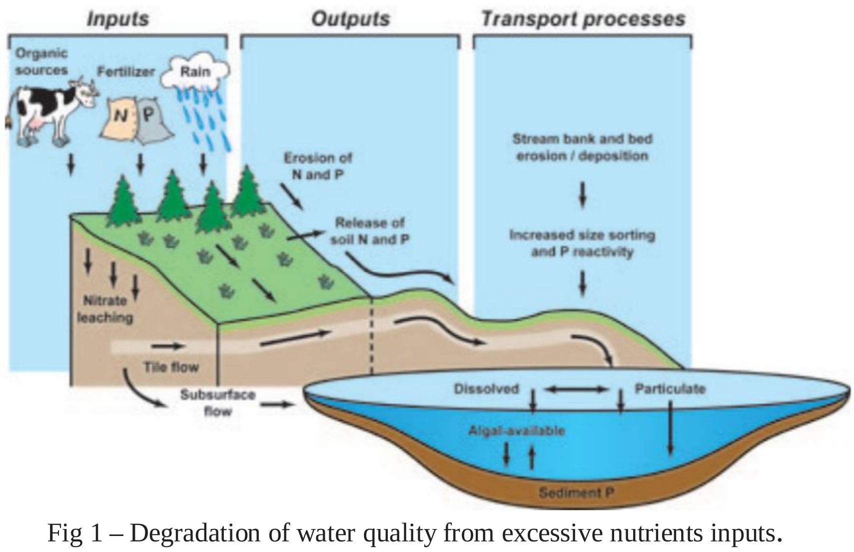

Fig 1 – Degradation of water quality from excessive nutrients inputs.

In addition to natural sources, nutrients can enter into aquatic ecosystems via point and nonpoint sources resulting from anthropogenic origins: municipal and industrial sewage discharges, runoff from fertilizers and manure applied to agricultural land, and diffuse sources in catchment areas. The greater relevance have the nonpoint sources.

Due to its excess bioavailability, phosphorus (P) is the most important nutrient responsible for the eutrophication of water bodies, resulting in increased aquatic plant and algal growth.

Phosphorus control is more feasible than nitrogen control, because there is no atmospheric source of P that is bio-available. The proliferation of aquatic plants and the subsequent decomposition of organic matter usually lead to low dissolved oxygen concentrations in bottom waters and sediments with low water renewal rates.

High loadings of nutrients from anthropogenic sources resulted in hypoxic/anoxic conditions through-out the world, in stratified rivers, lakes, reservoirs, etc.

The impact is ecological, affecting the quality of recreational tourism in the area. Water users are less likely to swim, boat, and fish during heavy algal blooms due to health risks, unfavourable appearance, or unpleasant smell.

Property values can decrease with declines in water quality. The potential annual value losses in recreational water usage were approx. 2.2 billion dollars annually, as a result of eutrophication only in the U.S. freshwaters.

The importance of reducing dissolved P in the water and controlling its release from the sediment in order to counter algal blooms has been recognized. The use of phosphate inactivation agents as a restoration tool, their capacity and application methods are as important as the individual results obtained in different areas from the world, regarding all water quality problems identified.

A conceptual model was conducted as a process to determine remediation technique, highlighting the need of an integrated approach to eutrophication management.

2. Experimental

In Europe, action against eutrophication was brought about by conventions and legislation, which were followed over the past decade by far more comprehensive legislation (directives), which addresses all surface waters and groundwater (Fig. 2).

Lake restoration efforts were traditional focused on reducing nutrient inputs from the catchment, mainly those relating sewage discharges and diffuse runoff from agricultural land.

Catchment remediation works including:

• restricting stock access to the lake;

• enhancing riparian buffer zones;

• installing constructed wetlands on the main inflow, have been previously used.

Fig 2 – Water pollution sources.

Phosphorus release from the sediment to the lake water may be so intense and persistent that it prevents any improvement water quality for a considerable period after the loading reduction. Highly P-saturated lake sediments are often slow to respond to reduced external loads because sedimentary stores of P can act as a buffer to changes in water column P concentrations.

External nutrient loading, over time, increases the concentration of nutrients in the sediment that can be released back into the overlying water column (Fig. 3). After receiving elevated external inputs of P for decades, some wetland systems are greatly impacted by internal P flux, a phenomenon referred to as “phosphorus legacy”.

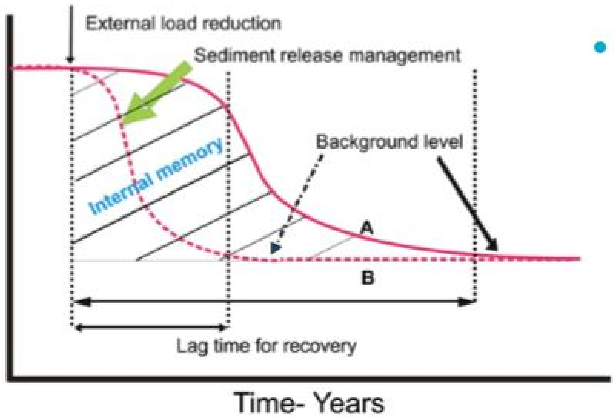

Fig 3 – **A** – relationship between water P column and internal P memory due to legacy phosphorus; **B** – relationship between water P column, internal P memory and implement of sediment release management.

The sediment plays an important role in the overall nutrient dynamics of shallow lakes. When entering the sediment, P becomes a part of the numerous chemically and biologically mediated processes and is ultimately either permanently deposited in the sediment or released by various mechanisms and returned in dissolved form to the water column via the interstitial water.

For the release of P from lake sediments are responsible numerous mechanisms. Parameters such as dry to weight ratio, organic content, and content of iron, aluminum, manganese, calcium, clay and other elements with capacity to bind and release P may all influence sediment – water interactions. Many factors are involved in the release of P from the sediment to water column. Sustained high concentrations of water column nutrients have been observed in many lakes, despite large reductions in external loads, especially from point source inputs. The remove of sediments is recommended when the internal nutrients load need to be reduced for macrophyte control, or to remove toxic substances from the lake bed.

Hypolimnetic withdrawal is suitable for lakes that are stratified over summer, and become anoxic in the layer of hypolimnion. The disadvantage is the impact of this technique on downstream waters, including eutrophication, oxygen depletion and odor development. Additionally hypolimnetic withdrawal has a large initial investment and it would be more expensive if that water had to be treated to reduce the phosphate concentration.

The method of restoration represents the return of a disturbed system to some pre-disturbance state that is both self-regulating and integrated into the larger landscape.

3. Results and Discussions

The *chemical restoration methods* mainly aim at reducing the P release from the sediment by improving the P binding capacity and thus creating P limitation on the phytoplankton.

During the last years, different solid adsorbents were used to reduce P levels entering the water bodies. Materials included iron oxides, red mud, fly ash, carbonates, etc.

The use of each one could have many disadvantages, their performance in reducing P being much affected by the pH solution.

In addition, the stoichiometry of the reacting species with the phosphate anion is greater than 1:1 in most cases.

In our days, alum, calcite, lanthanum modified clay and modified zeolite are materials commonly used to restore eutrophic water bodies.

Their properties and effectiveness under a range of physiochemical parameters occurring in the laboratory and field applications are very important.

Lanthanum (La) is a rare earth element which is in relative abundance in the earth’s crust compared to other rare elements. Also, it is very potent in removing P from the water with the previously reported ratio of 1:1, compared to sodium aluminates, which reached the inefficient ratio of 7:1, in order to achieve similar phosphorus uptake.

In studies at constant pH, the removal of ortophospate was found to be directly proportional to the concentration of added lanthanum. Essentially complete removal of phosphate was observed at a La(III)/PO_4^{-3} molar ratio of slightly less than 0.9.

This strongly suggests that phosphate removal occurs through a purely chemical reaction between the Lanthanum and the orthophosphate and not through adsorption of phosphate on a precipitating metal hydroxide.

In one phosphate precipitation experiment with wastewater where the residual phosphate concentration was less than 0.01 mg/l P, an extraction-flame photometric method was used to determine the residual La concentration.

This method was sensitive at La concentrations as low as 0.5 mg/l La. No interference from other residual species was found.

The turbidity data obtained in these orthophosphate precipitation experiments are also plotted in Fig 4.

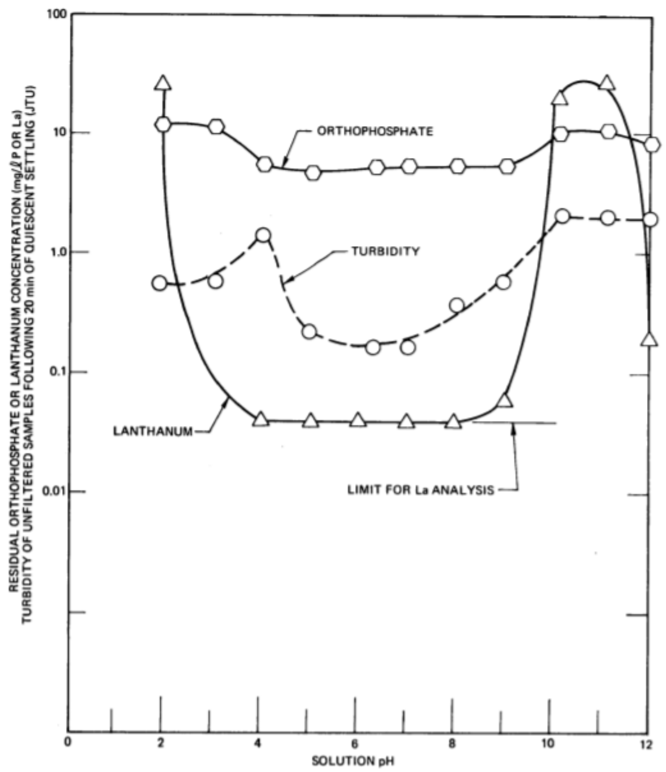

Fig 4 – Precipitation of orthophosphates with Lanthanum at a 0,5:1 La-to-orthophosphate molar ratio.

At low pH values, where no turbidity develops, no removal of phosphate is observed. At higher pH levels, the La – phosphate reaction results in the formation of precipitates which agglomerate into large readily settle-able flocks.

The mass balance calculations used to estimate the theoretical binding of mobile P have shown that the mass of La present in the sediment could potentially bind 42% of P-mobile present in the top 4 cm or 17% of P-mobile present in the top of 10 cm.

Also, a modified zeolite, named Z2G1, has been developed in New Zeeland as a new sediment capping agent. Natural zeolite is a porous alumino-silicate material that has a large specific absorptive surface area due to a fine porous structure, and is also a good cation absorbent. For this modified zeolite it was used an Al salt for improved P uptake capacity, being the only sediment capping material able to remove both P and N.

It is designed to be applied in a granular form which improves the settling rate and thus the accuracy of the treatment of the areas at the lake bed. Also, the Z2G1 does not release Al into the water column and absorbed cationic metals, so the cation retaining abilities of zeolite were still in effect and besides there was absorption of NH_4^+ from the overlying water and the stopping of NH_4-N release from the sediment.

In conclusion, Z2G1 needs to be tested in a lake to give more clear conclusions about its usability as a lake restoration method as well as for its long term effects after several or many years of usage in this scope.

Aluminium salts are very common in water treatment and have been used in water clarification and lake water restoration as flocculation agents for a long time.

Alum or aluminium sulfate is the most preferable flocculants used in Europe and U.S. Aluminium acts an active barrier system capturing and inactivating the potentially mobile P from the lake bottom sediments. Alum is at its optimal performance at pH values above 6 and up to 8, effective in precipitating suspended particulates and to a lesser extend in absorbing and removing soluble forms such as phosphorus fractions. Alum is effective under anoxic conditions adsorbing the dissolved reactive phosphorus and then the resulting flock settles on the bottom sediment.

Applied to the lake water as an acidic solution, alum must first be buffered, usually with sodium bicarbonate to maintain pH above 6,5.

Mineralization of dead organisms like zooplankton by heterotrophic bacteria might explain the increase in ammonium, though mortality of heterotrophic bacteria from alum dosing should not be discounted.

The increase in the surface ammonium which coexisted with the decrease in phosphate the day after the dosing may have led to a reduction in N limitation of phytoplankton.

Calcium carbonate natural precipitation is an effective natural cleaning process in hard-water lakes that acts against eutrophication trapping dissolved P and algae cells as it occurs. During algal blooms the increase of pH promotes the forming of $CaCO_3$. Calcium cations and hydrogen carbonate anions which have elevated concentration at the time, form carbon dioxide and $CaCO_3$ which precipitate and co-precipitate P to the sediment in the process.

Adding calcite, as seed to promote P precipitation, lowers the interfacial energy of Ca-phosphate interaction and the precipitation of calcite bound P is faster.

Calcite has a few advantages as a phosphorus binding agent. It's an easily affordable and available non-toxic material and exists naturally in sediments. The most widespread way to apply calcite in water is with an active barrier system. It is recommended especially for application on anaerobic sediment – water interface and for efficiently adsorbing the excess P that is released.

The difference in the interaction with P of precipitated calcite and that used in an active barrier system is the very much faster adsorption of orthophosphates that is achieved with the calcite in an active barrier system.

4. Conclusions

As far as the efficacy and the terms of sediment capping are concerned we have a fast reduction of phosphate concentration in the sediment pore water present inside the calcite active barrier.

Still there is disadvantage in the stability of an active barrier that being a few in-lake conditions, such hydrodynamics and bioturbation.

These two factors can significantly diminish the efficiency and sustainability of this sediments capping technology.

Phosphorus removal alone may not alleviate eutrophication and recognize the importance of simultaneous control of P and N.

Controlling only phosphorus inputs to freshwaters and ignoring the large anthropogenic inputs of nitrogen can reduce algal uptake of N and thus allow more N to be transported downstream where it can exacerbate eutrophication problems in estuarine and coastal marine ecosystems.

Many lakes have recovered after the reduction of phosphorus discharge to the lakes and their tributaries. Also, there are many examples of no effect of an advances wastewater treatment due to the presence of diffuse pollution sources, which were not reduced.

A eutrophication model of a lake or reservoir should always be developed with an indication of all sources of nutrients and organic matter and with possibilities to predict the effect of a certain reduction of the nutrient discharge from all sources.

Before the decision to proceed to a restoration method, simultaneous monitoring of external and internal nutrient loads should initially be carried out.

The conceptual model (Fig. 5) suggests that, to achieve our goals regarding water quality, a P-inactivation agent should be applied, followed by simultaneous and continuous monitoring of catchment and sediment nutrient loads, until the requirements are fulfilled.

The use of chemical methods may be viewed as a treatment for mitigating eutrophication and not a solution for the factors begetting eutrophication. The determination of total phosphorus in sediments cannot predict the potential ecological danger related to eutrophication process. The bio-available sediment fractions transported in the water column intensifying eutrophication should be also evaluated.

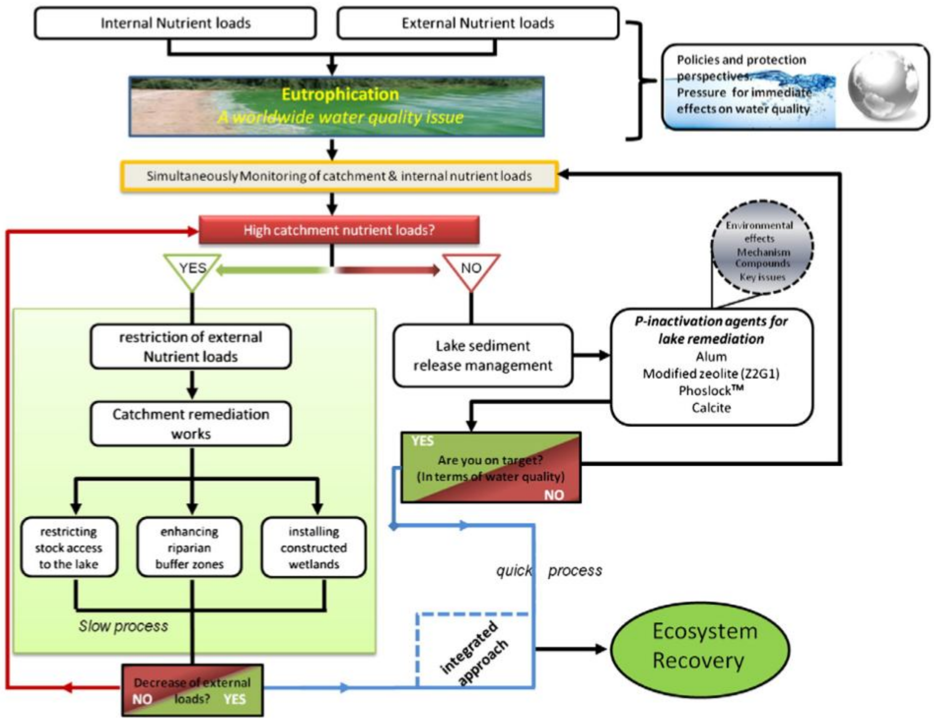

Fig 5 – Conceptual model of an integrated approach to eutrophication management.

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IMPACTUL MANAGEMENTULUI ÎNCĂRCĂRILOR INTERNE DE NUTRIENŢI ASUPRA RESTAURĂRII APELOR DULCI EUTROFIZATE

(Rezumat)

În ultimele decenii, eutrofizarea a devenit principala problemă a calităţii apei pentru majoritatea ecosistemelor de apă dulce din lume. Reprezintă unul dintre cele mai vizibile exemple de alterări ale biosferei datorate activităţilor umane care afectează ecosistemele acvatice. În consecinţă, îndepărtarea P şi a N câştigă o importanţă mărită în tratarea apei.

Lucrarea prezintă câteva metode de restaurare a ecosistemelor eutrofe; implementarea lor ar trebui să impună o abordare a managementului orientată spre un management integrat, în concordanţă cu Directiva FWD a Uniunii Europene. Succesul aplicării măsurilor de management al fosforului necesită studii privind o serie de factori care afectează viabilitatea metodei utilizate şi a potenţialelor efecte adverse asupra omului, a factorilor biotic şi abiotici.

BULETINUL INSTITUTULUI POLITEHNIC DIN IAȘI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iași
Volumul 64 (68), Numărul 4, 2018
Secția
HIDROTEHNICĂ

RESEARCHES ON THE ENVIRONMENT DEGRADATION IN THE "NATURAL SITE ONICEŞTI – MITEŞTI"

BY

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Received: October 24, 2018
Accepted for publication: November 29, 2018

Abstract. The European ecological network "Natura 2000" in Romania is present on the middle and bottom of River Moldova by "Site of Community Importance ROSC10363 River Moldova between Oniceni and Miteşti ". Much of the natural reserve is affected by degradation phenomena, especially in the lower section of the Moldova River, between Timisesti and Mitesti. In the researched river sector are located ballasts, bridges, water catchments, river undercrossing structures, etc. These objectives influenced the way of riverbed development, which caused the degradation of the riverine and riparian habitat. Natural risk factors and anthropogenic risk factors have contributed to the degradation of the environment in the research area. The most influential influences were given by the frequent floods of the last 15 years, the work done in the river bed, the exploitation of the ballast, the absence of maintenance works on the river bed, etc. The paper proposes a series of works in the minor riverbed and in the riparian area in order to improve the conditions for optimal development of the flora and fauna protected by the natural reserve.

Keywords: natural site; rehabilitation; river habitat; settlement; shore defence.

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1. Introduction

Romania has a "National network of protected natural areas" consisting of parks, natural sites, nature reserves and monuments. These are designated by Law 5/2000, Government Decisions of Romania (GD 2151/2004, GD 1143/2007, etc.). Romania has 30 parks, of which 14 are National Parks and 16 are Natural Parks. Romania has 585 Natura 2000 sites, of which 437 are of Community importance as an integral part of the European ecological network. Also, Romania has 926 nature reserves and monuments designated by Law 5/2000 (Lengyel & Duluță, 2016).

The European ecological network Natura 2000 is present on the middle and lower course of the Moldova River through the "ROSC10363 Moldova River Community Site between Oniceni and Miteşti". The natural reserve is affected by degradation phenomena, especially in the lower section of the Moldova River, between Timişeşti and Miteşti localities. The degradation of the environment occurs in the river bed, in the riverine area and in the adjacent area of the river (Luca *et al.*, 2015). Natural and anthropogenic risk factors contribute differently to the degradation of the riverbed and riverbed habitat.

In the last period of time there has been a change in concepts concerning the design of river regularization works. The new concepts aim to work together with human activity in changing the parameters of the river bed. Through the research, new river regulation theories have emerged. Theories rely on building work to meet the demands of the river and the habitat existing in the bed. The new flow regulating concepts aim to ensure favourable living conditions for the flora and fauna existing in the riverbed and its shores.

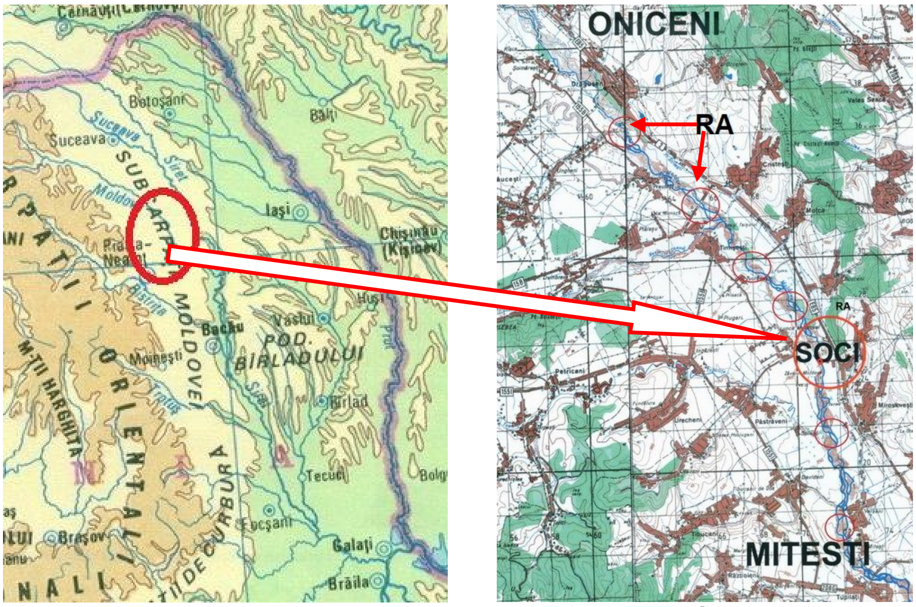
The impact of anthropogenic risk factors has been felt in the last period of time. Studies and researches conducted at both international and national levels highlight the influence of anthropogenic risk factors on the current climate evolution (Luca, 2012).

The aim of the paper is to investigate the natural and anthropogenic risk factors that contribute to the degradation of the river and riparian environment on the Moldova River in the area of Oniceni – Miteşti natural site.

2. Research Material and Methods

The study and research area is located on the Moldova River, on the sector between Oniceni and Miteşti. The land adjacent to the river and the river bed is part of the "ROSC10363 Community Site of the Moldova River between Oniceni and Miteşti" (Fig.1).

The "Oniceni - Miteşti" natural site is located in the Moldova River, in the counties of Suceava, Iaşi and Neamț. The surface of the site is 3,215.00 ha. The coordinates of the site are: N 470 17 '22 "; longitude E 260 29 '3 ". The altitude of the site is at least 235 m, maximum 339 m and average 271 m (Black Sea reference). The bio-geographical region is of the "Pontic Steponic Panonic Pontine Alpine".



a *b*

Fig. 1 – Framing of the research area in the "Oniceni - Miteşti natural site": *a* – localization of the natural site on the Moldova River; *b* – location of the research area in the natural site; RA – research area.

The Moldova River presents to the research sector the following parameters: length – 160 km, hydrographic basin area – 3,567 km^2, thalveg slope on the study sector 1.30‰. The river presents a meandering route with significant morphological changes in the research sector. An exception is represented by the construction site of the sub-crossing construction of the Timişeşti - Iaşi, where the river has a rectilinear route. The considered river sector has an NW - SE orientation. The Moldova River presents in the research area two separated beaches through an island (Fig. 2)

a *b*

Fig. 2 – General view of the Moldova riverbed in the research area: *a* – view of the right arm upstream; *b* – downstream view of the two arms and confluence.

The research methodology covered three main stages:

– Stage I: documentary study on the constitutive structure of the natural site;

– Stage II: field research on the influence of natural and anthropogenic risk factors on the study area between Timisesti and Mitesti localities;

– Stage III: processing and interpretation of theoretical and experimental data with the following conclusions and directions of research.

The field research was carried out by surveying, geotechnical, hydrological, climatic and environmental (fauna and flora) studies. The research was conducted on river sections, and in different time periods (annually, seasonally, following natural or artificial events, etc.).

3. Results and Discussions

The "Oniceni-Miteşti" natural site is located on the Moldova River and contains habitats such as rivers, lakes, arable land, grassland and deciduous forests. A series of protected species are present in the natural site, namely:

– the mammalian species listed in Annex II of Council Directive 94/43 / EEC; among these are *Lutra lutra* and *Spermophilius citellus*;

– species of protected amphibians and reptiles (Annex II), namely *Triturus cristalus, Bombina bombina and Bombina Variegata*;

– species of protected fish, namely Barbus meridionalis, Rhodeus *sericeus amarus, Gobio uranoscopus, Sabanejewia aurata and Cobitis taenia*.

The "Oniceni-Miteşti" natural site is among the few sites designated for *Spermophilius citellus* and *Lutra lutra*. The site is of great importance for the *Bombina* and *Triturus* amphibian species. The wetland of the natural site, made up of the Moldova River and its extensive meadow, is a habitat for conserved species, especially *Lutra lutra* and *Spermophilius citellus*.

The location of the "Oniceni-Miteşti" natural site is characterized by the presence of human activities. The main activities are agricultural, zootechnical, hydro-municipal (water catchments, adduction pipelines, water drilling, waste water disposal, etc.), river bed ballasts, etc. Wastewater, domestic and industrial wastewater are discharged into the river bed. The presence of hydro-technical constructions in the bed causes the alteration of the living conditions of flora and fauna. Human activity continuously degrades quality parameters of the "Oniceni - Miteşti" natural site.

The Moldova River has the ability to dilute and disperse impurities and pollutants discharged into the water. But the possibilities of self-restoration of the natural quality of the river are not unlimited. Exceeding certain limits of pollution can cause major and irreversible changes in aquatic ecosystems (Bica, 2000; Tockner *et al*., 1999).

There are a number of natural and anthropogenic risk factors on the researched river sector. The action of some risk factors has intensified over the last 20 years. The forms of natural risk acting on the river sector can be defined in the following forms:

1. Hydrological risk is defined by torrential precipitations, maximum flows, high frequency of peak flows, flood rate overrun levels, etc.

2. The hydraulic risk on the studied river sector is represented by the maximum flow rate in the analysis sections, erosion rates, sedimentation rates, hydrodynamic erosion depths, etc.

3. The geotechnical risk on the researched river sector is represented by the structural state of the rock that constitutes the minor bed. In this case, the geotechnical risk is represented by the alternation of ballast, sand and gravel layers found in the base of the minor bed, but also in the major riverbed, respectively the riparian area.

4. The biological hazard is represented by the degradation phenomena of the river bedside and riparian habitat. In this case it may be mentioned: partial or total degradation of the habitat areas of the fish protected by the natural site; the degradation of the riparian area where there are species of protected amphibians and reptiles.

Hydrological risk factors are most representative over the past 20 years. The main factor is represented by floods with flows reaching and exceeding the calculation probabilities imposed on the design of the bed constructions (bridges, adjustments) and on shore (shore defence works, dykes). Hydrological risk factors affect locally, but also along the river bed morphology and indirectly, the habitat existing in the minor and major river bed.

With regard to hydrological risk factors, the high frequency of floods has been mentioned over the past 20 years. In the research we used the climatic and hydrological data (maximum flows) taken from the nearest hydrometer station on the Moldova (SH Tupilați). Hydrological and hydraulic parameters in characteristic sections on the researched river section were calculated for a correct analysis. The analysis of transit flows was analyzed at characteristic intervals of 10 years, 25 years and 55 years.

The analysis shows that torrential rainfall is much more frequent in the last 20 years in the river basin of Moldova. The precipitations generated maximum flows in the years 1992, 2005, 2008, 2010, 2014 and 2016. Thus, in the analysis section, Soci recorded a flood with Q_{max} = 1154 m^3/s in 2005; in 2010 there were two floods: first in summer with Q_{max} = 660 m^3/s; the second in autumn with Q_{max} = 965 m^3/s (Fig. 3).

The flows and levels calculated with the probabilities of calculation in the Soci section of the Moldova River are given in Table 1 (Luca, 2012).

The maximum flow rate of 1402 m^3/s was recorded in 1991 at the SH Tupilati (SH - Hydrometer Station). The historical minimum flow rate of 0.85 m^3/s was recorded in 1987. The ratio between historical maximum and minimum historical flow is about 1649. High values of the coefficient of torrentiality are present also in the case of monthly average flows (about 170,...,175) and even annual ones (about 5,...,6).

Table 1
Flow and Computing Levels (Luca, 2012)

p, [%]	1%	2%	5%	10%	50%
$Q_{p\%}$ [m^3/s]	1810	1555	1200	940	28,8
H [m]	257,15	256,95	256,50	255,90	253,10
p – calculus probability					

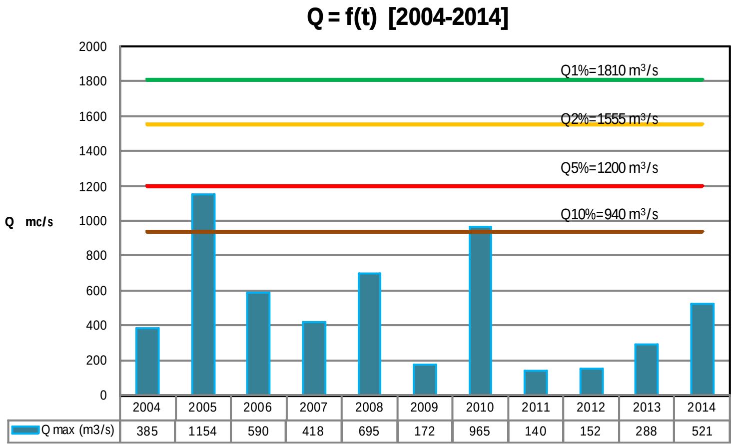


Fig. 3 – The frequency of annual maximum flows during the 2004 - 2014 periods in the Soci section, Moldova River (Luca, 2012).

Solid flows are directly proportional to liquid flows, increasing the latter by increasing the amount of slurry conveyed in suspension and crawling (Luca, 2012). The sludge flow rate, determined for the period 1959 - 2014, records average annual values of 33.29 kg/s. The minimum annual value was recorded in 1950 (0.986 kg/s in SH Tupilați) while at the other extreme, the highest value was recorded in 2014 at SH Tupilati (203 kg/s) (Luca, 2012).

The forms of anthropogenic risk acting on the researched river sector can be defined in the following forms: technological risk, management risk, bed exploitation risk, riverine exploitation risk, legislative risk. Of these an important influence is the risk of using the bedrock through the ballast extraction process.

On the Moldova River, between the localities of Timişeşti and Tupilați there are at least seven ballasts on a distance of about 20 km. The gravel pits intensively extract the mineral aggregates from the minor riverbed, but also from the riparian area. Random operation of the ballast resulted in important morphological changes of the minor river bed. These changes have spread to the bank of the river and to the adjacent land occupied by properties, municipal objectives (undercrosing pipes, electric pylons, bridges, water catchments). The unlimited exploitation of large quantities of mineral aggregates in the minor riverbed threatened the riverine area, through erosion phenomena, shoreline collapse, partial and total degradation of works in the river bed (Fig. 4).

a *b*

Fig. 4 – Anthropic risk factor – ballasts in the morphological modification of the river bed of Moldova: *a* – anthropic modification of the river flow paths; *b* – partial blocking of the flow through the right arm of the river in the research area through ballast deposits.

The process of mobilization of alluviums by exploiting the ballast caused the increase of the turbidity of the river water. The mobile bed of the Moldova riverbed on the research sector was evaluated at values of 2,...,3 m (Luca, 2012). Topographic surveys carried out in transverse and longitudinal sections in the riverbed revealed a deepening of the bed, especially after 2005. The important morphological modification of the Moldova riverbed on the research sector was determined by the corroboration of two risk factors: the high frequency flow rates (natural risk) and ballast extraction (anthropic risk). If the natural risk factor acted before 2004, the anthropic risk factor became dominant after this year.

The technological risk factor was manifested by the behaviour of the type of shore regulation and defence adopted on the researched river section. On the river of Moldova, in the Soci area, a construction of the undercrossing of the Timişeşti - Iaşi pipeline is realized. The undercrossing is done through three pipes: the first one has a diameter of 800 mm and the second and the third one have a diameter of 1,000 mm. The river section of the undercrossing area was calibrated and linearized. Also, the left and right banks are equipped with shore defence works over a length of 400,...,450 m.

The analysis carried out in the study and research area between 2004 and 2015 showed that the river and river habitat was heavily affected by the technological risk factor. The flow characteristic of the river bed does not ensure the living conditions required by the habitat mentioned in the natural site. The riparian area of the Moldova River is degraded by cutting plantations of trees and shrubs, intensive pasture and the absence of restoration works of the green area. The extension of the agricultural land to the bank of the river allowed the destruction of the habitat areas of mammals and reptiles (Fig.5).

a *b*

Fig. 5 – The anthropic risk factor – the exploitation of the riparian area of the Moldova river: *a* – the anthropic modification of the left bank; *b* – the state of the right bank in the valley area.

River bed in the area of undecroassing construction does not have favourable characteristics for habitats of the natural site species. Negative impacts on the natural site occur through the current structure of the bed in the undecroassing area. Influences are produced by the high water velocity and the presence of shore defence made of concrete. The calibrated album does not allow for the resting, breeding and feeding areas of aquatic fauna. The flora is influenced by the presence of the mobile ballast layer in the bed base. The major river bed provides limited conditions for the development of flora and fauna in the undecroassing area (Fig. 5).

On the River Moldova, studies and researches were carried out between 2004 and 2015 on the behaviour of shore defence works (Luca, 2006; Luca, 2012). The research results highlighted the following:

– hydrodynamic erosion caused the descent to rise by about 2.0,...,4.0 m;

– the pipe cover height was reduced to about 2.0,...,3.0 m;

– defence works on the left and right bank have been degraded in the proportion of 60%,...,95%;

– the left bank of the river is affected by strong erosion current.

The accumulation of natural risk factors in the study area (floods, maximum flows, high frequency of peak flows, erosions, noncohesive rocks in the basin of the riverbed) with the anthropic ones (ballast exploitation, deforestation, absence of regulation and shore defence, the extension of the arable land) caused excessive degradation of the riverbed in the transverse and longitudinal plane.

The hydrotechnical works made in the river bed lead to a series of hydromorphological and ecological disruptions. Deregulations occur in the minor river bed, and especially in the major bed. Also, an interruption of connectivity between the minor and the major riverbed occurs. The interruption of lateral connectivity (the major bed - minor bed) in a watercourse is manifested through various aspects:

a – modification of natural habitats and terrestrial biocenoses in major alluviums;

b – numerical reduction of aquatic species whose development cycle is related to securing lateral connectivity (*e.g.* reproduction for certain species of fish).

Conclusions of research on the study section call for rehabilitation works in the riverbed and riverine area to allow for the maintenance of living conditions for the habitat of the natural site. Among these works can be mentioned:

– replacing rigid concrete shelter made of concrete slabs with an elastic construction that adapts more effectively to the foundation ground and protects the habitat from the bed;

– carrying out regularization works to reduce the speed of the water and to achieve favourable conditions for the protection of the river habitat;

– the realization of riverside vegetation strips and riverside areas to ensure river sanitation and habitat conditions in the coastal area.

4. Conclusions

1. Some of the natural and anthropogenic risk factors influence the living conditions of the flora and fauna in the natural site of Community importance Oniceni - Miteşti located on the lower course of the Moldova River.

2. The morphological modification of the riverbed of the Moldova River on the research sector and implicitly the living conditions of the studied site was determined by the corroboration of two risk factors: high flow rate (natural risk) and ballast extraction (anthropogenic risk).

3. During the period 2004-2016 a series of floods with high flow rates and high frequency at shorter intervals, which morphologically modified the bedrock and eroded the works, were produced on the Moldova River in the sector of the location of the natural site shore defence.

4. The unrealistic ballast exploits carried out in the research area have induced an extremely high anthropic risk, which influences the living conditions of the habitat within the natural site located on the Moldova River.

5. The cumulation of natural risk factors (floods, erosions, non-cohesive rocks) with the anthropic ones (ballast exploitation, deforestation, absence of regularization works and shore defence) caused excessive degradation of the riverbed.

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CERCETĂRI PRIVIND DEGRADAREA MEDIULUI ÎN „SITUL NATURAL ONICEŞTI – MITEŞTI" DE PE RÂUL MOLDOVA

(Rezumat)

Rețeaua ecologică europeană Natura 2000 în România este prezentă pe cursul mijlociu şi inferior al râului Moldova prin „Situl de importanță comunitară ROSC10363 Râul Moldova între Oniceni şi Miteşti". O mare parte din rezervația naturală este afectată de fenomene de degradare, în special pe sectorul inferior al râului Moldova, între localitățile Timişeşti şi Miteşti. Pe sectorul de râu cercetat sunt amplasate balastiere, poduri, captări de apă, construcții de subtraversare a râului etc. Aceste obiective au influențat modul de amenajare a albiei râului, situație ce a determinat degradarea habitatului fluvial şi riveran. Factorii de risc naturali şi factorii de risc antropic au contribuit la degradarea mediului din zona de râu cercetată. Cele mai importante influențe au fost induse de viiturile frecvente din ultimii 15 ani, lucrările realizate în albia râului, exploatarea balastului, absența lucrărilor de refacere a albiei râului etc. Lucrarea propune o serie de lucrări în albia minoră a râului şi în zona riverană în scopul îmbunătățirii condițiilor de dezvoltare optimă a florei şi faunei protejate prin rezervația naturală.

BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Volumul 64 (68), Numărul 4, 2018
Secţia
HIDROTEHNICĂ

CONSIDERATIONS ABOUT IMPLEMENTATION ENVIRONMENTAL MANAGEMENT SYSTEMS

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Received: October 14, 2018
Accepted for publication: November 18, 2018

Abstract. The purpose of this work is to evaluate the role of certifications of Environmental Management Systems (EMS) and how they are becoming increasingly strategic in the management of organizations from an environmental point of view.

Furthermore, we want to highlight how the adhesion by companies to these management systems can be configured as an advantageous method to reduce the environmental impact of production activities and how it can represent a valid tool through which to introduce innovations techniques, improving performance, reducing energy and other resource consumption and essentially becoming more competitive on the market.

All this can make the application of Environmental Management Systems extremely interesting with a view to optimizing interventions and sustaining a sustainable development policy.

The certification process according to the ISO 14001 standard was evaluated of a company operating in the waste sector, highlighting both the specific environmental and management problems that emerged and the advantages deriving from the use of certifiable organizational models. All this is possible above all in light of recent voluntary regulations what are the international ISO 14000 standards, regarding Management Systems Environmental (EMS).

Keywords: environmental management; environmental standards.

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1. Introduction

During the last decades the problems of pollution and deterioration of the natural resources have worsened considerably. This has led to an intensification of environmental policy initiatives, both nationally and internationally, and the need to pursue sustainable development, is a development capable of guaranteeing the needs of the present generations without compromising the capacity of future generations.

The reasons that led to this increase in attention are attributable to environmental aspects and impacts, unfortunately negative, such as:

- thinning of the stratospheric ozone layer;
- global warming;
- acid rain;
- soil degradation;
- air pollution;
- pollute groundwater, rivers, lakes and seas;
- excessive production of waste;
- ecological disasters.

In our country the legislation on environmental matters, deriving almost exclusively since the transposition of EU directives, it is evolving in an increasingly restrictive and binding sense, with increasingly incisive controls and increasingly heavy sanctions. For companies, therefore, the difficulties are growing, having to adapt to legislation in continuous evolution. The environmental regulations cannot, therefore, be disregarded as the negative consequences can be significant both in terms of costs related to environmental accidents, accidents at work, sanctions, and in terms of negative image, bad relations with employees, hostility of the local population.

2. Environmental Management Systems (EMS)

The ISO 14001 standard defines the environmental management system as the part of the general management system that includes the organizational structure, planning activities, responsibilities, practices, procedures, processes, implement, achieve, review and maintain environmental policy.

The main objectives of an EMS are:

• the ability of the company to carry out its activities responsibly in ways that guarantee respect for the environment;

• the ability to identify, analyze, forecast, prevent and control environmental effects;

• the ability to continuously modify and update the organization and improve environmental performance in relation to changes in internal and external factors;

• the ability to activate, motivate the initiative of all the personal.

2.1. The Stages of an EMS

The environmental management system, which is part of the general management system of the company, is divided into six phases that are overall aimed at the continuous improvement of environmental performance (Guido *et al*., 1995), (Fig.1).

These phases are:

1. initial environmental examination
2. environmental policy;
3. planning;
4. realization and operation;
5. checks and corrective actions;
6. management review.

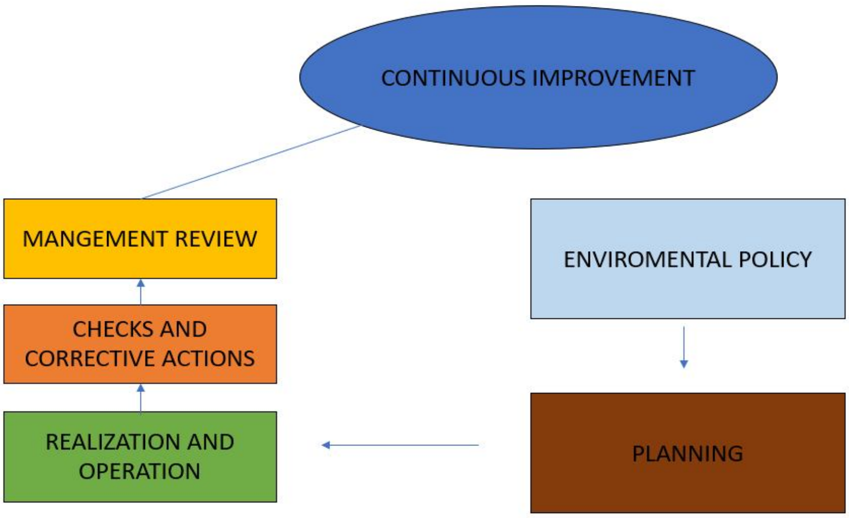

Fig. 1 – The stages of an EMS.

An organization that does not have any EMS must carry out an initial environmental examination to establish the starting situation and then decide on the improvement actions. However, this analysis may also be appropriate for an organization that has already implemented an EMS (Giarratano & Riley, 1993).

The exam will deal with:

- check the legal and regulatory requirements;
- evaluate the experience deriving from the analysis of accidents that have already occurred;
- identify significant environmental aspects;
- analyze all existing procedures and practices in the environmental field.

2.2. Environmental Policy

The environmental policy is a declaration of principle that establishes the company's commitment to environmental protection, compliance with the legislation in force on the subject, continuous improvement and sets out the general principles on which this commitment is based and the consequent strategic decisions.

It establishes the result to which to strive, in terms of the levels of responsibility and performance required of the organization, in comparison with which any consequent action will be judged.

Environmental policy must be simple, understandable and appropriate to the nature, size and environmental impacts of the activities, products and services provided by the individual organization. (Robert & Robinson, 1998).

It must necessarily be documented (Fig. 2).

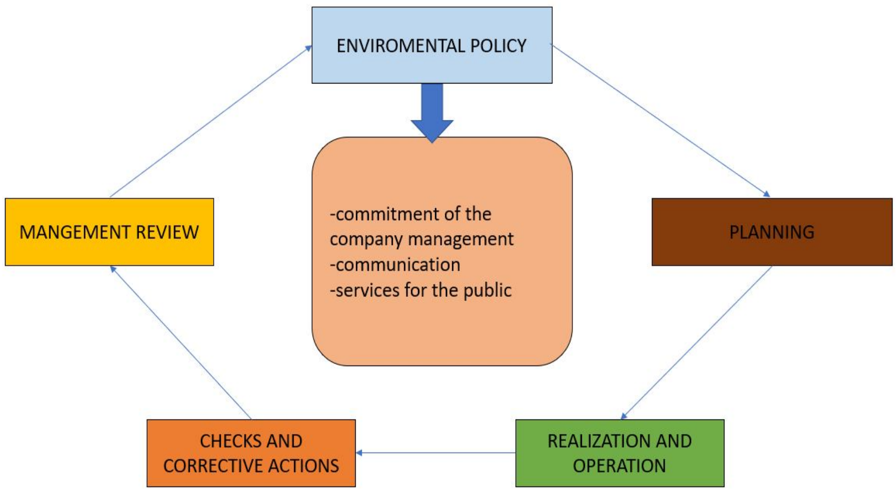

Fig. 2 – Environmental policy phase.

With the environmental policy the company is committed to:

- comply with the legislation and regulations applicable to the activities and processes of their establishment;
- research and implement continuous improvement of environmental performance;
- search for technological and plant solutions that prevent pollution;
- make its environmental policy public;
- make public their environmental commitments

Therefore, the environmental policy must offer the organization the methodology and the general reference framework to establish and re-examine its objectives and targets on particular sectors within which to develop its own improvement dynamics.

2.3. Planning

In the planning phase, the desired environmental objectives and results are identified taking into account the initial situation, environmental policy, legislative requirements, available resources, technological alternatives, stakeholders' points of view and commitment to continuous improvement.

It corresponds to the PLAN phase of the Deming circle (Puppe, 1993; Miller & Tyler, 1994).

This phase describes all the activities to be implemented or fulfilled within the planning (Fig. 3), which are:

• *environmental aspects*: all company activities and processes must be taken into consideration to identify those that have or may have significant environmental aspects;

• *legal prescriptions*: takes into consideration the constraints and prescriptions of a legal nature regarding the products, processes and emissions of the company;

• *environmental objectives and targets*: takes into consideration the objectives and the environmental results that each company must set;

• *environmental management program*: takes into consideration the development methods of the environmental program, taking into account the system control methods.

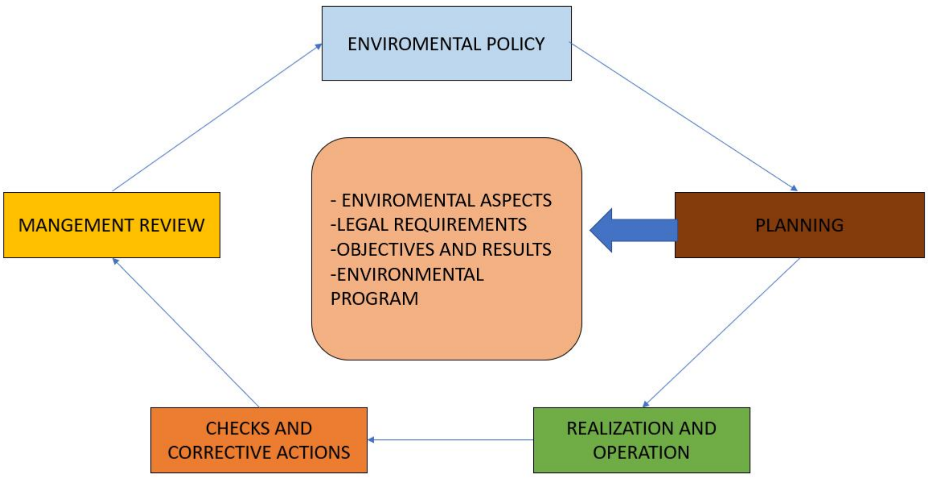

Fig. 3 – Planning phase.

2.4. Realization and Operation

In the implementation and operational phase, in accordance with environmental policy, the objectives and the environmental management program are implemented and developed. This is the operational phase and corresponds to the DO phase of the Deming cycle, (Fig. 4).

The requirements to be implemented take into consideration the following points (Gün, 1998; Welford, 1995):

•*organizational structure and responsibilities*: the tasks, responsibilities and authorities of the organizational structure must be defined, documented and communicated in order to facilitate environmental management by making it effective;

•*training, awareness and competence*: the company must prepare and implement procedures to provide training and education to all the resources whose activities can have consequences in terms of environmental aspects;

•*communications*: the company must prepare and implement documented procedures both for internal environmental communications between the different levels and for the receipt, documentation and response to external communications produced by interested parties;

•*Documentation of the environmental management system*: the environmental management system must be defined and documented to describe the essential parts, the relative interactions and the correlations between documents and activities.

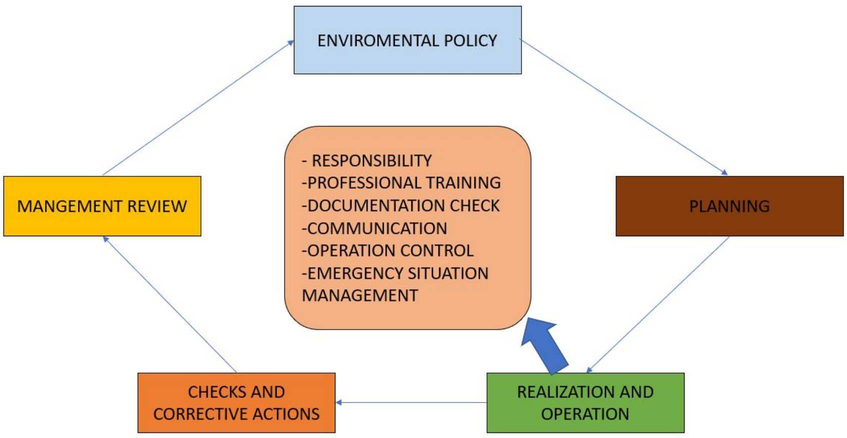

Fig. 4 – Realization and operation phase.

•*Control of documents*: procedures must be established and applied to check all the documents of the environmental management system to ensure that they are reviewed and/or periodically modified, available, identified and located in the respective archives.

•*Control of activities*: the company must plan and plan monitoring, control and regulation activities in order to prevent exceeding emission limits or the occurrence of non-compliance with the company's environmental policy.

•*Training and reactions to emergencies*: the company must work to evaluate the possibilities of accidents and emergency situations and to define the answers to these conditions. We must also prevent these events and minimize the environmental impact of these situations.

2.5. Checks and Corrective Actions

The control phase is necessary to have feedback on the validity of everything that has been planned, to verify the congruence between the expected results and the goals achieved and, finally, to adopt corrective actions. The logic is to check to identify the elements of the environmental management system that do not comply with the requirements of the ISO 14001 standard.

It is the phase corresponding to the CHECK phase of the Deming circle

Key elements of this verification process are (Fig.5):

- Monitoring and measurements;
- Non-compliance, corrective and preventive actions;
- Environmental records;
- Audit of the environmental management system.

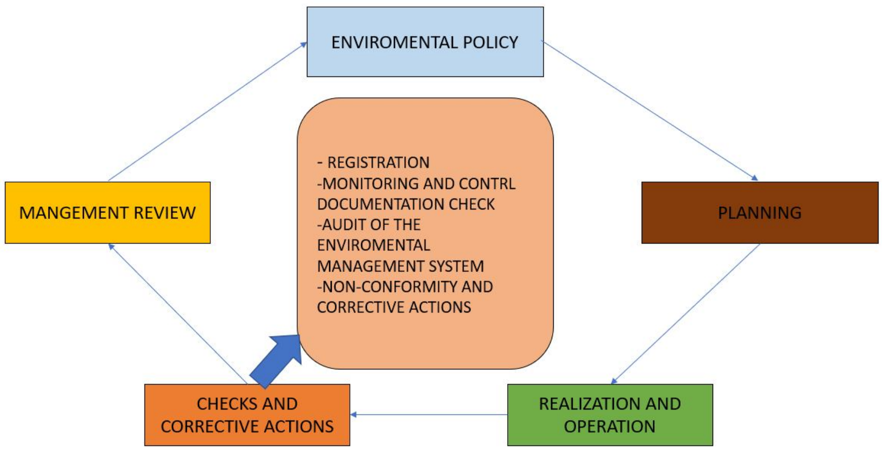

Fig. 5 – Checks and corrective actions phase.

2.6. Management Review

The moment of re-examination corresponds to the last phase of the Deming cycle and represents the premise to continue towards the continuous improvement of the environmental management system. The management review involves, in fact, the preparation of an improvement plan, in which all the activities are described and planned (corrective actions, preventive actions, environmental projects) (Fig.6).

The company management, with a defined frequency, reviews the entire environmental management system to ensure continuity, adequacy, effectiveness and validity (Welford, 1995).

For the purposes of this review, documents and information are required to verify the progress made but also any incidents that may occur, such as:

- environmental policy;

- environmental objectives and results achieved;
- environmental programs and their implementation;
- environmental audit reports;
- external communications;
- environmental non-conformities;
- environmental corrective and preventive actions;
- accidents and environmental policy complaints

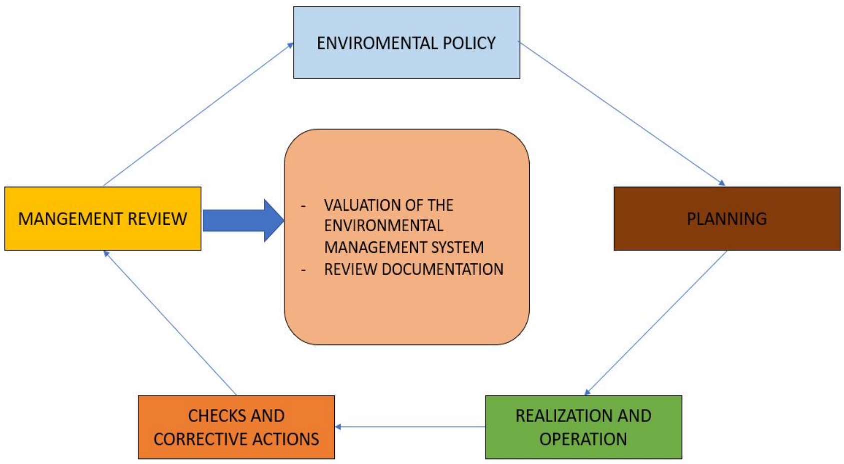

Fig. 6 – Management review phase.

3. Certification Procedure for an EMS

When the company has developed all the requisites required by the ISO 14001 standard, and has adapted them to its own reality, it is ready to be certified.

The certification process of an environmental management system consists of:

•*Presentation of the certification application*: with it, general information on the company and on the main environmental aspects are provided on specific certification bodies' documents.

•*Preliminary investigation*: it is a verification carried out by the certification body by examining the documents presented by the company, in order to assess whether the model of the environmental management system is adequately defined and documented with respect to the criteria indicated in the ISO 14001 standard.

•*Evaluation visit*: carried out at the company by assessors of the certification bodies to verify the application of what is documented by the company.

•*Issue of certification*: it is issued by the technical certification committee, based on the preliminary documentation and the report of the assessment visit. Once all the conditions for granting the certificate have been satisfied, the committee transmits the proposal to the council for final resolution.

•*Monitoring of the EMS*: in order to verify the correct maintenance of the environmental management system, surveillance visits are carried out.

•*Renewal*: after three years the certification is renewed if all the requirements are maintained, including the improvement of environmental performance.

4. Checks of an EMS

The assessment verifications are conducted by an accredited body, for the purposes of certification, they are also called third-party audits, as they are conducted by an organization external to the organization, accredited at national level to perform this function, autonomous and independent both from the customer (or the organization that commissions the audit), both from the subject (or the organization subject to the audit), and from any consultants.

The procedures for conducting an EMS audit are reported in the ISO 14011 standard; this standard describes the arguments and the steps to be followed for the completion of a verification, such as:

• the choice of audit objectives;

• the process of selecting the members of the audit team.

• the definition of the tasks and responsibilities (for example of the head of the verification group, of the other assessors who make up the group, of the client, of the subject of the audit);

• the verification start phase to check if all the minimum requirements exist;

• the verification preparation phase;

• the actual management phase of the audit.

The verification is considered finished when all the activities included in the plan have been completed. It will be the task of a special Technical Committee of the certification body to decide whether or not to certify the organization that has presented itself, on the basis of the results emerged from the verification report and based on the procedures on the conduct of the verifications issued by the accreditation body and by the certification body itself.

The certification is valid for three years. During this period, some data are sent surveillance (or maintenance) visits. At the end of the three years for the maintenance of the certification a renewal visit is necessary.

5. Conclusions

Through the implementation of an EMS an overall management system of environmental issues can be created that allows the company to address them in a global, systematic, coherent way, integrated with a view to continuous improvement of environmental performance.

The most important potential benefits associated with an environmental management system they can be:

• *Lower costs to comply with environmental protection legislation*: in Italy the legislative system is characterized by a significant use of legislation as a command, control and sanction tool; the use of an EMS helps to comply with laws and regulations thus reducing the risks of administrative and criminal penalties.

• *Lower costs of waste disposal and lower consumption of resources*: for waste disposal companies must bear significant costs. An EMS induces the company to reduce the waste produced by it in all its phases through the introduction of technical and managerial improvements to reduce the quantities of waste destined for final disposal and therefore the related costs.

• *Lower costs associated with environmental accidents and sanctions*: the introduction of prevention systems produces the result of avoiding often significant costs resulting from the occurrence of undesirable events.

• *Better relations with public authorities and the local population*: companies that adopt an EMS make considerable efforts to improve their environmental performance and this determines a favorable attitude of public authorities and the local population. Consequently every initiative or request of the company is welcomed with greater favor and relations with the public administration can be more streamlined and less bureaucratic.

• *Greater possibility of obtaining financial incentives, economic incentives, simplifications or other advantages in administrative procedures*: environmental policy is increasingly oriented towards economic incentives to encourage investments and initiatives in favor of the environment.

The creation of an EMS can bring significant competitive advantages above all towards the less dynamic competitors, improving on one side the efficiency of the organization and on the other the corporate image and the relationships with customers, public institutions.

Even if the implementation of an EMS requires a considerable commitment, the following considerations can be reported:

• they are available at different levels (community, national, regional, and local) considerable financing possibilities able to cover on the one hand the total amount of costs incurred to reach EMS certification (both quality and environmental assurance);

• it is precisely the medium-small organizations that have the possibility of developing an effective and effective EMS, with important returns to optimize work and reduce costs. These results are possible because in these organizations the organizational structures are generally not very complex, the roles and responsibilities are transparent and well known, the staff has different functions and the communications are faster.

In the management of the composting process it is possible to identify technological problems that can influence the outcome of the process, both in terms of economic and environmental balance. Some critical factors, which vary according to the type of material treated, being intrinsic to phases or operations that are characteristic of the composting process, are well identified. This category includes the production of leachate, the potential aerodispersion of dust and pathogenic microorganisms, but above all the emission of unpleasant odors.

In conclusion, we also want to highlight how the adhesion by companies to this management system is configured as an advantageous method to reduce the environmental impact of production activities and how it can represent a valid tool through which to introduce innovations techniques, improving performance, reducing energy and other resource consumption and essentially becoming more competitive on the market.

All this can make the application of Environmental Management Systems extremely interesting with a view to optimizing interventions and sustaining a sustainable development policy.

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CONSIDERAȚII DESPRE IMPLEMENTAREA SISTEMULUI DE MANAGEMET AL MEDIULUI

(Rezumat)

Scopul acestei lucrări este de a evalua rolul certificărilor de management de mediu (SMM) şi modul în care acestea devin din ce în ce mai strategice în managementul organizațiilor din punct de vedere al mediului.

Mai mult, dorim să subliniem cum aderarea întreprinderilor la aceste sisteme de management poate fi configurată ca o metodă avantajoasă pentru a reduce impactul asupra mediului al activităților de producție şi cum poate reprezenta un instrument valid prin care să introducă inovații tehnice, să îmbunătățească performanța, să reducă energia şi alte consumuri de resurse şi devenind, în esență, mai competitive pe piață. Toate acestea pot face ca aplicarea sistemelor de management de mediu să fie extrem de interesantă în vederea optimizării intervențiilor şi a susținerii unei politici de dezvoltare durabilă.

Procesul de certificare conform standardului ISO 14001 a fost evaluat de către o companie care operează în sectorul deşeurilor, evidențiind atât problemele specifice de mediu şi management care au apărut, cât şi avantajele care decurg din utilizarea modelelor organizaționale certificabile.