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HYDROTECHNICS

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CONTRIBUTIONS TO THE CALCULATION OF OSCILLATING GATE FLAPS PLACED ON WASTE PIPES IN THE DISCHARGE POINT IN OPENED EMISSARIES
I. HYDROSTATIC CALCULATIONS

BY

I. COJOCARU and ŞT. POPESCU

Abstract. A mathematical model is proposed that describes the operation of an oscillating gate flap located at the end of the easte pipe from a pipe network that discharge water into a natural emissary. The mathematical model deduced by the authors solves the problem of water level determination in the waste pipe, when the gate flap opens at a known water level in emissary. It is presented an example of calculation for a given field situation.

Key words: water; gate flap; discharge; level; mathematical model.

1. Introduction

In hydrotechnics practice there are a large number of situations where it is necessary to discharge water collected from different types of pipe networks (draining network, drainage network, sewerage network), in natural emissaries. The essential feature of natural emissaries to these situations is that in the natural course, in the discharge point, it is registered a variability of water surface levels depending on hydrological water flows. In this regard, different situations may occur, during water discharge from pipe network:

1° water level in emissary is located above or at the upper generatrix of waste pipe;

2° water level in emissary is located under or at the lower generatrix of waste pipe;

3° water level in emissary is located between the upper and the lower generatrix of waste pipe.

That is why in this situation (direct discharge in natural water course) is always required a gate flap at the discharge point. However, gate flap usage raise a series of questions: which are essential elements of gate flap construction; water and to what value of pipe level the gate flap will open; which is the value of pipe level which allows the flow discharge and which is the opening angle of the gate flap, etc.

This paper is intended to answer to the first two questions.

2. Mathematical Model

The principle scheme of water discharge in an emissary through a gate flap can be seen in Fig. 1. There have been used the following notations: Z_{Ie} – the lower edge level of disc gate flap; Z_{Se} – the upper edge level of disc gate flap; $Z_E^{\max}$ – the maximum water level in emissary (at $N_{\max}$); $Z_R^{\max}$ – the field level where the lowest inspection chamber is placed; Q – the water flow discharged in emissary.

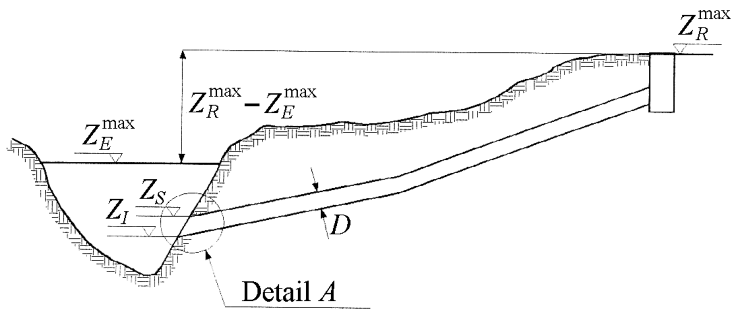

Fig. 1 – Scheme with the calculation elements.

In principle must be assured

a) the discharge of design water flow;

b) preventing reverse flow;

c) automatic operation of gate flap, without human operator intervention.

In the closed position, gate flap plan makes the angle α_0 with a vertical plan perpendicular to the waste pipe axis (Fig. 2). Thus, in case of circular pipe with inner diameter D, *the oscillating gate flap* has elliptical disc form, which, at the top, has a bearing (a joint) with horizontal axis, placed with the eccentricity e and the spindle diameter (rotation), d.

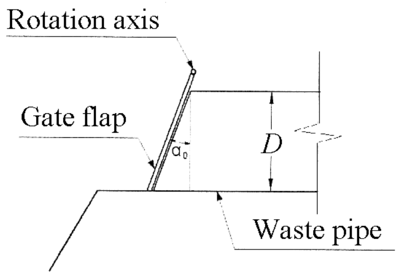

Fig. 2 – Detail *A*: the oscillating gate flap in the discharge trap area.

The sealing – resting surface between the aget flap and the pipe, sectioned under the angle α_0 , have a shape like an elliptical crown with the width δ, $\delta \geq \delta'$, where δ' is the wall thickness of the waste pipe. The elliptical crown is delimited on the inside, by the ellipse with the semiaxis a_i and b_i , and on the outside, by the ellipse with the semiaxis a_e and b_e; the size of these semiaxis can be evaluated with the following relations:

$$a_i = \frac{D}{2\cos\alpha_0};\; b_i = \frac{D}{2};\; a_e = \frac{D}{2\cos\alpha_0} + \delta \text{ and } b_e = \frac{D}{2} + \delta. \tag{1}$$

The weight of the gate flap is given by the relation

$$G = \pi k_r \gamma_{\mathrm{OL}} a_e b_e \chi, \tag{2}$$

where: χ is the thick of the top flange plate which is made the gate flap; γ_{OL} – specific weight of steel; k_r – coefficient that takes into account the weight of mobile components of joint and/or weight of reinforcement bars of gate flap disk.

The center of mass of the gate flap, M, is situated on the large axis of the elliptical disk, at the distance ε from the center of gravity of the disk, G; distance ε satisfies the conditions

$$0 < \varepsilon < \frac{k_r - 1}{2k_r}(a_e + e). \tag{3}$$

The angle α_0 and the width δ must satisfy the sealing condition under the action of weight's gate flap only

$$\frac{G\sin\alpha_0}{\pi(a_e b_e - a_i b_i)} \geq \sigma_{\min}, \tag{4}$$

where $\sigma_{\min}$ is the unitary compressive stress to be achieved in backing plate.

Next, we address the issue determining water level, Z_R, which provides in various hypotheses, gate flap opening.

2.1. The Issue Formulation of Gate Flap Opening

The gate flap opens when the active torque, M_a, becomes larger than resistant torque, M_r,

$$M_a \geq M_r. \tag{5}$$

These torques are given by the forces of hydrostatic pressure, P, acting on the surface of gate flap, the gravitation force, G_f, and the friction force in bearing, F_f.

Force F_f is tangential to the spindle beraing of diameter d, and its size is given by

$$F_f = \mu F_{Ra}, \tag{6}$$

where: μ is the coefficient of friction in bearing; F_{Ra} – the component of reaction force in the long of the large axis of the gate flap.

Hydrostatic calculations were undertaken in the following two *hypotheses*:

a) The water level in emissary, Z_E, is lower than lower edge level of disk gate flap, Z_{Ie}, ($Z_E \leq Z_{Ie}$).

b) The water level in emissary is higher than upper edge level of disk gate flap, Z_{Se}, ($Z_{Se} \leq Z_E \leq Z_E^{\max}$).

2.2. Determination Force of Hydrostatic Pressure and Centre of Pressure

In the closed position, the surfaces of the gate flap may be assimilated with an elliptical surface, S, located in the plane $yO\zeta$ inclined with the angle

$90° – \alpha_0$ with respect to the plane level yOx and oriented with large axis parallel to the axis $O\zeta$ (Fig. 3).

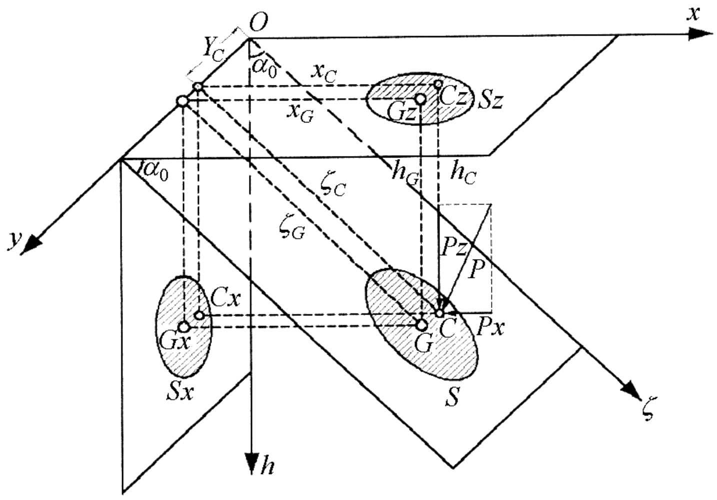

Fig. 3 – The projections of gate flap section.

The size of pressure force, P, and the position of center of pressure, C, are given, respectively, by the relations [1]

$$P = \gamma A h_G; \quad \zeta_C = \zeta_G + \frac{r_G^2}{\zeta_G}, \tag{7}$$

where: γ is the water specific weight; A – the area of the surface S; h_G – the depth appropriate to center of gravity, G, of the surface S;

$$\zeta_G = \frac{h_G}{\cos\alpha_0}, \quad r_G^2 = \frac{I_{yG}}{A};$$

I_{yG} – the moment of inertia of the surface S with respect to the parallel axis to Oy, passing through point G; r_G – the radius of gyration of the surface S.

For the elliptic surface, S, with semiaxis a and b, because [2]

$$A = \pi ab \text{ and } I_{yG} = \frac{\pi}{4} a^3 b,$$

the relations (7) may be written as

$$P = \pi\gamma ab h_G, \quad \zeta_C = \frac{h_G}{\cos\alpha_0} + \frac{a^2 \cos\alpha_0}{4h_G}. \tag{8}$$

2.3. Determination of Water Level, Z_R, at the Opening of gate Flap in Hypothesis a)

The forces and moments of these forces in relation to the bearing axis (Fig. 4) are determined as follows:

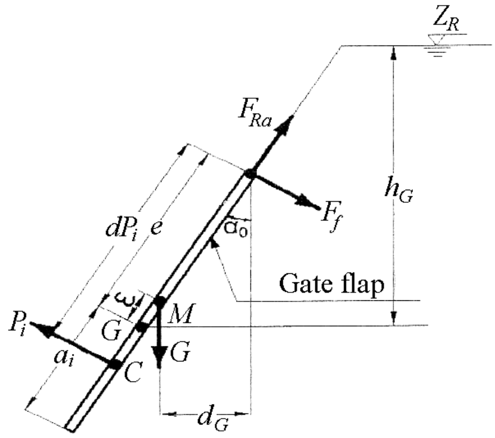

Fig. 4 – Forces and moments arms in hypothesis a).

a) the size of pressure force, P_i, acting on the inner surface of the gate flap, using the first relation (8), where $a = a_i$ and $b = b_i$, is

$$P_i = \pi\gamma a_i b_i h_G, \tag{9}$$

with

$$h_G = Z_R - Z_G \quad \text{and} \quad Z_G = Z_I + \frac{D}{2}; \tag{10}$$

b) moment arm of force P_i

$$d_{P_i} = e + \frac{a_i^2 \cos\alpha_0}{4h_G}; \tag{11}$$

c) moment arm of force G

$$d_G = (e - \varepsilon)\sin\alpha_0; \tag{12}$$

d) size of reaction force

$$F_{Ra} = G\cos\alpha_0. \tag{13}$$

From equations (9), (11) and, respectively (6), (12), (13) it results the expressions of active and reactive torques

$$M_a = P_i d_{P_i} = \pi\gamma a_i b_i h_G \left(e + \frac{a_i^2 \cos\alpha_0}{4h_G} \right), \tag{14}$$

respectively

$$M_r = G d_G + F_f \frac{d}{2} = G\left[(e-\varepsilon)\sin\alpha_0 + \mu\frac{d}{2}\cos\alpha_0 \right]. \tag{15}$$

Using the expressions (14) and (15) in the inequality (5), it results the unknown h_G, namely

$$h_G \ge \frac{1}{e}\left\{ \frac{G}{\pi\gamma a_i b_i}\left[(e-\varepsilon)\sin\alpha_0 + \mu\frac{d}{2}\cos\alpha_0 \right] - \frac{a_i^2 \cos\alpha_0}{4} \right\}, \tag{16}$$

then, from relation (10), the water level, Z_R , at the opening of gate flap in hypothesis a) may be obtained

$$Z_R = h_G + Z_I + \frac{D}{2}. \tag{17}$$

2.4. Determination of Water Level Z_R at the Opening of Gate Flap in Hypothesis b)

Compared with the hypothesis a), on the outside surface of the gate flap, in addition, acts the pressure force P_e (Fig. 5); so, were determined

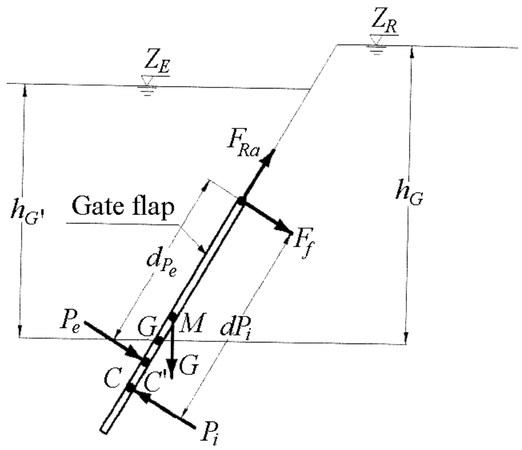

Fig. 5 – Forces and arms of moments in hypothesis b).

a) the size of pressure force, P_e, acting on the outer surface of the gate flap, using the first relation (8), where $a = a_e$ and $b= b_e$,

$$P_e = \pi\gamma a_e b_e h_G^{'}, \tag{18}$$

with

$$h_G^{'} = Z_E - Z_G = Z_E - Z_I - \frac{D}{2}; \tag{19}$$

b) the moment arm of pressure force P_e,

$$d_{P_e} = e + \frac{a_e^2 \cos\alpha_0}{4h_G^{'}}. \tag{20}$$

The active torque, M_a, is given by relation (14), and from relations (15), (18) and (20) it results the following expressions for the resistance torque:

$$\begin{aligned} M_r &= P_e d_{P_e} + G d_G + F_f d = \\ &= \pi\gamma a_e b_e h_G^{'}\left(e + \frac{a_e^2 \cos\alpha_0}{4h_G^{'}}\right) + G\left[(e-\varepsilon)\sin\alpha_0 + \mu d\cos\alpha_0\right]. \end{aligned} \tag{21}$$

Having in view the expressions (14), (19) and (22) the inequality (5) becomes

$$\begin{aligned} h_G \geq {} & \frac{1}{e}\cdot\frac{a_e b_e}{a_i b_i}\left[e\left(Z_E - Z_I - \frac{D}{2}\right) + \frac{a_e^2\cos\alpha_0}{4}\right] - \\ & -\frac{1}{e}\left\{\frac{a_i^2\cos\alpha_0}{4} + \frac{G}{\pi\gamma a_i b}\left[(e-\varepsilon)\sin\alpha_0 + \mu d\cos\alpha_0\right]\right\} \end{aligned} \tag{22}$$

and from relation (17) it results the water level Z_R at the opening of gate flap in hypothesis b).

3. Results and Discussions

Numerical results were obtained with **Clapet_Batant.m** MATLAB program, for the following Input:

a) *Constructive and functional parameters of the arrangement*

Z_I = 38.55 m, $Z_E^{\max}$ = 40.20 m, $Z_R^{\max}$ = 44.70 m, Z_F =37.33 m;
D = 1.20 m, L_{CD} = 262.15 m, k = 2.5 mm, ν = 1.31e^{-6} m^2/s;
Q_0 = 1.922 m^3/s, Q_{at} 0.3235 m^3/s, ρ =1,000 kg/m^3, γ =9,810 N/m^3.

b) *Constructive and functional parameters of gate flap*

χ = 5 mm, δ = 20 mm, γ_{OL} = 77,500 N/m^3,
d = 15 mm, e = 0.70 m, k_r = 1.15, ε = 0.02 m,
μ = 0.010, α_0 = 20° = 0.3491 rad, τ =1.5.

Running the **Clapet_Batant.m** program, the following output resulted.

a) *Auxiliary operand*

b_i =0.60 m, b_e = 0.62 m, a_i = 0.6385 m, a_e = 0.6585 m;
A_i = 1.2036 s.m, A_e = 1.2826 s.m, G = 571.5724 N, d_G = 0.2252 m ;
Z_{Ie} = 38.531 m, Z_S = 39.75 m, Z_{Se} = 39.769 m, Z_G = 39.15 m.

The results of hydrostatic calculation in case a ($Z_E \le Z_{Ie}$ = 38.531) are given in Table 1.

Table 1

h_G, [m]	P_i, [kN]	M_a, [kN.m]	M_r, [kN.m]	Z_R, [m]	Observ.
0.600	7.084	6.504	0.13965	≤ 39.75	$Z_R \le Z_S$

It must be noted that the complete filling of the waste pipe, h_G = 0.60 m, active torque, M_a = 6.504 kN·m, is much larger than reactive torque, M_r = = 0.13965 kN·m, so the oscillating gate flap will open even when the waste pipe is partially filled.

b) *The results of hydrostatic calculation in case b*: $Z_{Se} \le Z_E \le Z_E^{\max}$.

It was considered the worst case, Z_E = $Z_E^{\max}$ = 40.20 m, when the following values for the characteristic elements resulted:

$$h_G^{'} = 1.05 \text{ m}, P_e = 13.212 \text{ kN}, M_r = 14.443 \text{ kN·m},$$

and also the data tabulated in the Table 2.

Table 2

h_G, [m]	P_i, [kN]	M_a, [kN.m]	Z_R, [m]	Observ.
1.05	12.397	10.534	40.2 = Z_E	$M_a < M_r$
1.1514	13.595	11.443	40.301	$M_a = M_r$
1.25	14.759	12.325	40.40 = Z_E + 0.20	$M_a > M_r$

From Table 2 it must be noted that for $Z_R \ge Z_b$ = 40.301 m, with $Z_b < Z_R^{\max}$, condition (5) is verified, so even in the worst case regarding the water level in emissary, the gate flap will open for a water level in the waste pipe below the field level where the lowest inspection chamber is placed.

4. Conclusions

The proposed mathematical model and the simulations have highlighted the following conclusions:

1. In hypothesis a) the gate flap positioned on the waste pipe opens, under the influence of internal pressure, at level values in inspection chamber calculated with the relations (16) and (17).

2. In hypotesis b) the gate flap positioned on the waste pipe opens, under the influence of internal pressure, at level values calculated with the relations (22) and (17).

The proposed method may be applyed in any situation of water discharge from pipe network in natural emissaries and, based on them, can be established the necessary data base to design oscillating gate flaps.

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CONTRIBUŢII LA CALCULUL CLAPEŢILOR BATANŢI
POZIŢIONAŢI PE CANALELE DE EVACUARE ÎN PUNCTUL
DE DESCĂRCARE ÎN EMISARI DESCHIŞI
I. Calcule hidrostatice

(Rezumat)

Se prezintă modelul matematic care descrie funcţionarea unui clapet batant aflat la capătul conductei de evacuare a unei reţele ce descarcă apa într-un emisar natural. Modelul matematic stabilit rezolvă problema determinării cotei din conducta de evacuare la care se deschide clapetul, la diferite niveluri ale apei în emisar. Este prezentat un exemplu de calcul pentru o situaţie de teren dată.

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CONTRIBUTIONS TO THE CALCULATION OF OSCILLATING GATE FLAPS PLACED ON WASTE PIPES IN THE DISCHARGE POINT IN OPENED EMISSARIES
II. HYDRODYNAMIC CALCULATIONS

BY

ŞT. POPESCU and I. COJOCARU

Abstract. The paper represents a continuation of the paper [2], that describes the operation of an oscillating gate flap in hydrodynamic regime, located at the end of the waste pipe from a pipe network that discharges water into a natural emissary. The mathematical model, for hydrodynamic operating, deduced by the authors, solves three problems: a) determination of the opening angle of the gate flap; b) establishing of head losses characteristic regardless of the water level in emissary and in the waste pipe and, most importantly, c) calculation of the level in the waste pipe that ensure discharge design flow at a known water level in emissary. It is presented an example of calculation for a given field situation.

Key words: water; gate flap; discharge; level; mathematical model.

1. Introduction

In hydrotechnics practice there are a large number of situations where it is necessary to discharge water collected from different types of pipe network [2], in natural emissaries.

In the paper [2] was solved the problem of water level determination in the waste pipe that opens the gate flap. Now we intend to present a mathematical model and an example of calculation for solving the following problems: a) determination of the opening angle of the gate flap; b) establishing of head losses characteristic regardless of the water level in emissary and in the waste pipe and, most importantly, c) calculus of the level in the waste pipe that ensure discharge design flow at a known water level in emissary. To solve these problems, the equations must be deduced in hydrodynamic operating regime of the aggregate waste pipe–gate flap–emissary.

2. Mathematical Model

Considering the scheme of water discharge in an emissary through a gate flap [2], in main, must be assured

a) the discharge of design water flow;

b) preventing reverse flow;

c) automatic operation of gate flap, without human operator intervention.

Next, we address the following issues:

1° The dependence of the opening angle, α, *versus* the discharged water flow in emissary, Q.

2° Determination of characteristic of head loss of oscillating gate flap.

3° Determination of water level, Z_R , which provides the discharge of design water flows.

2.1. The Dependence of the Opening Angle of the Oscillating Gate Flap *versus* the Discharged Flow

The gate flap will open by rotating it around the fixed joint under the action of the active torque, M_a , created by hydrodynamic forces, which oppose the resistant torque, M_r , created by gravity and friction forces; at dynamic equilibrium the following condition must be satisfied:

$$M_a = M_r . \tag{1}$$

Hydrodynamic calculations were undertaken in the hypothesis b) [2] namely: the water level in emissary is higher than upper edge level of disk gate flap, Z_{Se} , ($Z_{Se} \leq Z_E \leq Z_E^{\max}$).

In the equilibrium state, for an opening angle, α , and an discharged water flow, Q, on the gate flap will act bearing forces $F_{z\alpha}$ (which includes Archimedes power, F_{Ah}), the resistance force, $F_{x\alpha}$, the gravity force, G, and friction in joint force, F_f (Fig. 1).

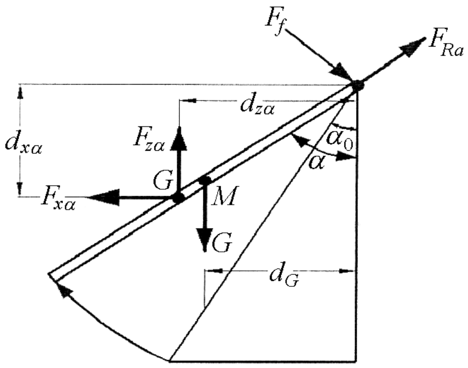

Fig. 1 – The forces acting on the opened gate flap.

For an imposed water level in emissary, Z_E , size of forces $F_{z\alpha}$ and $F_{x\alpha}$ present, the following relations [1], [3] may be written:

$$\begin{cases} F_{z\alpha} = F_{z\alpha}(\alpha, Q) = \dfrac{\rho}{2} C_z(\alpha) A_m(\alpha) \left[V_l(\alpha, Q) \right]^2, \\ F_{x\alpha} = F_{x\alpha}(\alpha, Q) = \dfrac{\rho}{2} C_x(\alpha) A_m(\alpha) \left[V_l(\alpha, Q) \right]^2, \end{cases} \tag{2}$$

where: α is the position angle of gate flap plane in relation to the normal plane to stream direction regarded as the axis of the pipeline); ρ – water density; $C_z =$ $= C_z(\alpha)$ and $C_x = C_x(\alpha)$ – the bearing coefficients and, respectively, the resistance coefficients (depending on the angle α); $V_l = V_l(\alpha,Q)$ – average water velocity around the lateral surface of the gape flap; $A_m = A_m(\alpha)$ – area of gate flap master section, given by gate flap projection, positioned by the angle α, on a plane perpendicular to the axis of the waste pipe (the plane is considered vertical),

$$A_m = A_m(\alpha) = \pi a_e b_e \cos\alpha. \tag{3}$$

The bearing coefficient, C_z, can be evaluated as a function of the angle, α, with the following relation [1]:

$$C_z = C_z(\alpha) = 2\pi\cos\alpha. \tag{4}$$

For the variation of resistance coefficient *versus* the angle α , $C_x(\alpha)$, from the statistical processing data from [3] (Diagram 10.4, chart b, for $\alpha \in [0°, 75°]$) has resulted the following exponential correlation:

(5) $$C_x(\alpha) = 1.18683\mathrm{e}^{-1.6902\alpha},$$ for angle α in radians.

Velocity V_l may be evaluated with relation (10.4) from [3] namely

(6) $$V_l = \frac{V}{1 - \tau\, A_m / A_c},$$

where: A_c is the area of cross section in emissary in front of the gate flap, S_c ; V – the average velocity in the cross section S_c ; τ – correction coefficient that takes into account the influence of the lateral surface's shape of the gate flap and its relative thickness, χ/a_e ; for a disk with $\chi/a_e << 1$, it will be adopted the value $\tau = 1.5$.

To evaluate the area A_c it is accepted that the cross section, S_c , has a rectangular shape, with depth $Z_E - Z_F$ and width $b_e + 2\Lambda$, where Z_F is the bottom of the emissary; Λ – the lateral deviation of the stream induced by the gate flap presence, deduced from the relation $\beta = \Lambda/b_e$, $\beta \in [0.20,0.25]$; consequently

(7) $$A_c = b_e(1+2\beta)(Z_E - Z_F).$$

By substituting in relation (6) expressions (3) and (7) and velocity V evaluated with the equation of continuity

(8) $$V = \frac{Q}{A_c},$$

we may reveal the velocity dependence V_l *versus* the angle α and flow Q

(9) $$V_l = V_l(\alpha, Q) = \frac{Q}{b_e(1+2\beta)(Z_E - Z_F) - \tau\pi a_e b_e \cos\alpha}.$$

Considering relations (2),…,(5) and (9) were deduced the following expressions for the bearing force and the resistance force:

(10) $$F_{z\alpha} = F_{z\alpha}(\alpha, Q) = 2\pi\Phi(\alpha)Q^2\cos\alpha,$$

repectively,

(11) $$F_{x\alpha} = F_{x\alpha}(\alpha, Q) = 1.18683\Phi(\alpha)\mathrm{e}^{-1.6902\alpha}Q^2,$$

where

(12) $$\Phi(\alpha)=\frac{\pi\rho a_e\cos\alpha}{2b_e\left[(1+2\beta)(Z_E-Z_F)-\pi\tau a_e\cos\alpha\right]^2}.$$

The friction force in bearing, F_f, is tangential to the spindle bearing of diameter d, and its expression is given by [2]

(13) $$F_f=\mu F_{Ra}.$$

Accordingly to the gate flap position given by the angle α, projecting the forces on large axis direction of gate flap, it results

(14) $$F_{Ra}=F_{Ra}(\alpha,Q)=\left[G-F_{z\alpha}(\alpha,Q)\right]\cos\alpha+F_{x\alpha}(\alpha,Q)\sin\alpha.$$

The moments arms of forces G, $F_{z\alpha}$ and $F_{x\alpha}$ depend on angle α as follows:

(15) $$d_G=d_G(\alpha)=(e-\varepsilon)\sin\alpha,\ d_{z\alpha}=d_{z\alpha}(\alpha)=e\sin\alpha,\ d_{x\alpha}=d_{x\alpha}(\alpha)=e\cos\alpha.$$

Writing the equations of moments with respect to the axis of the bearing, and considering relations (14) and (15), it result active and resistant torque expressions namely

(16) $$M_a=M_a(\alpha,Q)=e\left[F_{z\alpha}(\alpha,Q)\sin\alpha+F_{x\alpha}(\alpha,Q)\cos\alpha\right],$$

respectively

(17) $$M_r=M_r(\alpha,Q)=G\left[(e-\varepsilon)\sin\alpha+\frac{\mu d}{2}\right]+ +\mu\left[F_{x\alpha}(\alpha,Q)\sin\alpha-F_{z\alpha}(\alpha,Q)\cos\alpha\right]+\frac{d}{2}.$$

Considering the expressions (10) and (11) for the forces $F_{z\alpha}$ and F_{xa}, the previous relations become:

(18) $$M_a=M_a(\alpha,Q)=2e\Phi(\alpha)\left[\pi\sin\alpha+0.59341\mathrm{e}^{-1.6902\alpha}\right]Q^2\cos\alpha,$$

respectively

$$M_r = M_r(\alpha, Q) = G\left[(e-\varepsilon)\sin\alpha + \frac{\mu d}{2}\right] + \\ +\mu d \Phi(\alpha)\left[0.593415\mathrm{e}^{-1.6902\alpha} - \pi\cos^2\alpha\right]Q^2. \tag{19}$$

Substituting the expressions (18) and (19) of torques M_a and M_r in the equality (1), it results the following equation in the unknown α:

$$\Phi(\alpha)\left[\pi\cos\alpha(2e\sin\alpha+\mu d\cos\alpha) + 0.59341\mathrm{e}^{-1.6902\alpha}(2e\cos\alpha - \mu d\sin\alpha)\right]Q^2 - \\ -G\left[(e-\varepsilon)\sin\alpha + \frac{\mu d}{2}\right] = 0, \tag{20}$$

from which, finally, it results the correlation between the position angle of the gate flap and discharged flow

$$\alpha = \alpha(Q), \text{ for imposed } Z_E. \tag{21}$$

2.2. Determination of Head Loss Characteristics of Oscillating Gate Flap

Head loss of oscillating gate flap is defined by the relation

$$h_r^b = \zeta \frac{V_0^2}{2g}, \tag{22}$$

where: $\zeta = \zeta(\alpha)$ is the head loss coefficient of oscillating gate flap; g – the gravitational acceleration;

$$V_0 = \frac{4Q}{\pi D^2} \tag{23}$$

– the average velocity in terminal section of waste pipe.

The coefficient ζ depends on the opening angle of gate flap, $\alpha - \alpha_0$, and the ratio of gate flap's length, $l_{cl} \approx b_e$, and the gate flap's width, $b_{cl} \approx a_e$,

$$\frac{l_{cl}}{b_{cl}} \approx \frac{b_e}{a_e} = \frac{D/2+\delta}{D/(2\cos\alpha_0)+\delta}; \text{ for } \alpha_0 = 20^\circ, \ \frac{l_{cl}}{b_{cl}} \approx \frac{0.62}{0.6585} = 0.942 \cong 1.$$

From the statistical processing data from [3] – Diagram 4.23, chart b, for $l_{cl}/b_{cl} \cong 1$ and $(\alpha - \alpha_0) \in [15°, 75°]$, has resulted the following exponential correlation:

$$\zeta = \zeta(\alpha) = 36.7704\mathrm{e}^{-3.3951(\alpha-\alpha_0)}, \text{ for } \alpha, \alpha_0 \text{ in radians.} \tag{24}$$

Substituting the correlation (21) in the above relation, for Z_E imposed, was deduced the formal dependence of head loss coefficient of the gate flap ζ, *versus* the discharged water flow, Q,

$$\zeta = \zeta(Q) = \zeta(\alpha(Q)) = 36.7704\mathrm{e}^{-3.3951(\alpha(Q)-\alpha_0)}, \text{ for } \alpha_0 \text{ in radians.} \tag{25}$$

The head loss characteristic of gate flap, $h_r^b = h_r^b(Q)$, for Z_E imposed, was deduced by substituting expressions (23) and (25) in relation (22)

$$h_r^b = h_r^b(Q) = \frac{3.037235}{D^4}\mathrm{e}^{-3.3951(\alpha(Q)-\alpha_0)}Q^2, \text{ for } Z_E \text{ imposed.} \tag{26}$$

2.3. Determination of Water Level Z_R which Permits the Discharge of Designed Water Flows

The level, Z_R, in storage tank, which provides the water flow discharge, Q, is given by the waste pipe characteristic

$$Z_R = Z_E + M_{CE}Q^2, \tag{27}$$

where M_{CE} is the resistance moment (hydraulics) of waste pipe.

The resistance moment, M_{CE}, results from the following relation:

$$M_{CE} = \frac{0.0826}{D^4}\left[\frac{\lambda L_{CE}}{D} + \zeta(Q)\right], \tag{28}$$

where: λ is the head loss coefficient; normally, the coefficient λ is evaluated with Collebrook–White [3] relation, depending on the relative roughness, k/D, of pipe and flow regime, specified by the criterion Reynolds, $\Re e$; L_{CE} is the length of waste pipe.

Substituting the relation (25) in the expression (28), then, the obtained expression in the characteristic (27), finally, it results

(29) $$Z_R = Z_E + \frac{0.0826}{D^4}\left[\frac{\lambda L_{CE}}{D} + 36.7704\mathrm{e}^{-3.3951(\alpha(Q)-\alpha_0)}\right]Q^2 .$$

3. Results and Discussions

Numerical results were obtained with **Clapet_Batant.m** MATLAB program, for the following Inputs [2]:

a) *Constructive and functional parameters of the arrangement*
Z_I = 38.55 m, $Z_E^{\max}$ = 40.20 m, $Z_R^{\max}$ = 44.70 m, Z_F =37.33 m;
D = 1.20 m, L_{CD} = 262.15 m, k = 2.5 mm, ν = 1.31e^{-6} m^2/s;
Q_0 = 1.922 m^3/s, Q_{at} 0.3235 m^3/s, ρ =1,000 kg/m^3, γ =9,810 N/m^3.

b) *Constructive and functional parameters of gate flap*
χ = 5 mm, δ = 20 mm, γ_{OL} = 77,500 N/m^3,
d = 15 mm, e = 0.70 m, k_r = 1.15, ε = 0.02 m,
μ = 0.010, α_0 = 20° = 0.3491 rad, τ =1.5.

Running the **Clapet_Batant.m** program, the following Output resulted.

a) *Auxiliary operand*
b_i =0.60 m, b_e = 0.62 m, a_i = 0.6385 m, a_e = 0.6585 m;
A_i = 1.2036 m^2, A_e = 1.2826 m^2, G = 571.5724 N, d_G = 0.2252 m ;
Z_{Ie} = 38.531 m, Z_S = 39.75 m, Z_{Se} = 39.769 m, Z_G = 39.15 m.

The results of hydrodinamic calculations, made in the same worst case regarding the water level in emissary, Z_E = $Z_E^{\max}$ = 40.20 m, consisted in determination of the main functional characteristics of the gate flap (Fig. 2), and also the determination of waste pipe characteristics (Table 1).

In Fig. 2 have been used the following identifiers for the characteristic curves:

a) Alf – for the characteristic (21), $\alpha = \alpha(Q)$;
b) Zita – for the characteristic (25), $\zeta = \zeta(Q)$;
c) hr$_{\mathrm{B}}$ – for the characteristic (26), $h_r^b = h_r^b(Q)$.

The analysis of these characteristic curves aspects: can highlight the following a) the position angle of the gate flap increases with the increasing of the discharged water flow; b) the local resistance coefficient of the gate flap decreases when the water flow is increasing Q; c) seeing the indication b), the characteristic $h_r^b = h_r^b(Q)$ is flattened.

Since the local head loss of the gate flap is of the same order of magnitude with the distributed head losses, will be significantly flattened.

Using spline interpolation between the functional nodes in Fig. 2 and Table 1, have been determined functional parameters relevant to design water flows, Q_{at} and Q_0 (Table 2).

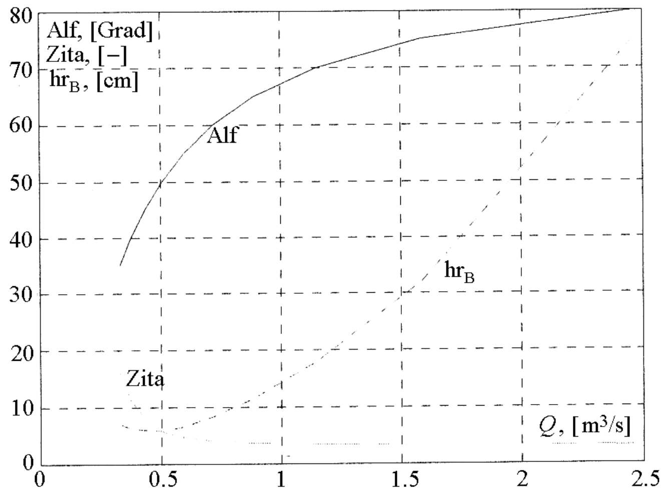

Fig. 2 – Functional representative of the gate flap.

Table 1

Waste Water Pipe Characteristic

Q, [m^3/s]	0.3325	0.3778	0.4337	0.5042	0.5954
Z_R, [m]	40.294	40.293	40.300	40.311	40.341
Q, [m^3/s]	0.7180	0.8905	1.1505	1.5856	2.4595
Z_R, [m]	40.392	40.482	40.654	41.040	42.197

Table 2

Functional Parameters of Gate Flap and Waste Pipe

Q, [m^3/s]	α, [grades]	ζ	h_r^b, [m]	Z_R, [m]
Q_{at} = 0.3 235	33.889	17.4316	0.073	40.295
Q_0 = 1.922	77.225	3.1542	0.459	41.423

From Table 2 it is noted that even in the worse case, $Z_E = Z_E^{\max} = 40.20$ m, gate flap will position at an angle for which the water flow, $Q = Q_0 = 1.922$ m^3/s, is discharged to a water level in the waste pipe below the field level where the lowest inspection chamber is placed.

4. Conclusions

The proposed mathematical model and the simulations have highlighted the following conclusions:

1. The opening angle of the gate flap depending on the discharged water flow, for an imposed water level in emissary, is determined using eq. (21).

2. Head loss characteristic of gate flap is given by eq. (26).

3. The water level in the waste pipe, providing discharge of designed water flow, is determined with eq. (29).

The proposed method may be applied in any situation of water discharge from pipe network in natural emissaries and, based on them, can be established the necessary data base to design oscillating gate flaps..

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CONTRIBUŢII LA CALCULUL CLAPEŢILOR BATANŢI POZIŢIONAŢI PE CANALELE DE EVACUARE ÎN PUNCTUL DE DESCĂRCARE ÎN EMISARI DESCHIŞI
I. Calcule hidrodinamice

(Rezumat)

Lucrarea reprezintă o continuare a uneia precedente [2] şi descrie funcţionarea în regim hidrodinamic a unui clapet batant aflat la capătul conductei de evacuare a unei reţele ce descarcă apa într-un emisar natural. Modelul matematic pentru funcţionarea hidrodinamică, dedus de autori, rezolvă trei probleme: determinarea unghiului de deschidere al clapetului; stabilirea caracteristicii pierderilor de sarcină pentru un nivel al apei în emisar impus şi, cel mai important, obţinerea cotei în canalul de evacuare care asigură descărcarea debitului de calcul la un nivel dat al apei în emisar. Este prezentat un exemplu de calcul pentru o situaţie de teren dată.

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SEASONAL FLUCTUATIONS OF LAKE'S WATER QUALITY AND RISKS ON FISH POPULATION (II)

BY

OLIMPIA BLĂGOI and *ADRIANA BURLACU

Abstract. The paper summarizes the influence of the hydrological and atmospheric factors, and of the chemical natural and human ones (sunlight, temperature, ice conditions, sedimentation processes, suspended-load, dilution discharges, wind, dissolved oxygen content fluctuation, carbon dioxide, nitrogenous substances, ammonia poisoning) over the lake water quality, during the seasons of the year, in co-relation with the freshwater lakes biocenosis, especially, the fish population. The case study was accomplished on some fishponds in Botoşani County, Romania, where a substantial fish kill has occurred during the warm as well as the cold season, because of the above factors.

Key words: fishpond; dissolved oxygen; ice-conditions; warm and cold season.

1. Lake Water Quality and Influence of Natural Chemical Factors

The hydro-chemical state of storage lakes represents the result of affluent chemism to which can be added the changes due to the deterioration of geological and pedological substratum of the lake bottom and through the biological processes from water's mass and at the water–sediment inter-phase.

The state of dissolved gases in water represents another defining element for the structure and evolution of an aquatic ecosystem.

A high importance have the gases that take part in the forming and maintaining of living matter from the natural waters (O_2, CO_2) and those which, in certain conditions, delays the vital process development (H_2S, NH_4OH, NH_3, CH_4).

1.1. Oxygen in Water

The dissolved oxygen content of water originates in two sources, namely the external source as atmospheric oxygen, that penetrates into water through diffusion and the internal source as the oxygen produced by the chlorophyll user plants, through photosynthesis. The oxygen diffusion from the atmosphere is performed very slowly. In a simplified way, the oxygen transfer in the depth may be explained as follows. The water top layer is enriched with oxygen, up to the saturation and the oxygen is partially given over to the lower neighbouring layer, until a balance between them is installed. In the same time, following the evaporation within the top layer, the salt concentration herby increases, therefore the density also increases in such a manner as the layer lowers. Thus, streams are generated in order to introduce the oxygen to the shallow area. The equilibrium concentration of dissolved oxygen *versus* the water temperature, at 760 mm Hg barometric pressure is shown in the Table 1.

Table 1

Equilibrium Concentration of Dissolved Oxygen versus *on Water Temperature, at 760 mmHg Barometric Pressure*

Water temperature ^oC	10	12	14	16	18	20	22	24	26	28	30
Dissolved oxygen mg O_2/L	11.27	10.57	10.26	9.82	9.40	9.02	8.67	8.33	8.02	7.72	7.44

Oxygen concentrations in the water column fluctuate under natural conditions: temperature, atmospheric pressure and other weather conditions, salinity of influents and lake water.

Part of dissolved oxygen is used by living aquatic organisms and by oxidizing processes of organic matter. Also, the dissolved oxygen in water influences the toxic substances dissolved, if they are oxidable. A small quantity of dissolved oxygen in water in which there are toxic substances shortens the fish life. During hard winter, due to the ice layer, the dissolved oxygen content significantly lowers because the oxygen consume is higher than his production. The lack of oxygen leads to the suffocation of the fish or to a decrease of its performances (growth delay, weak assimilation of food, sensibility at aggressions). The poor oxygenation of water is a stress factor for fish. The dissolved oxygen amount in freshwaters required for normal life varies with species, age, health, etc. For example, the optimal dissolved oxygen concentration for cyprinids is 6…8 mg/L and under 1.5…2 mg/L, signs of suffocation appear (Table 2).

Also, the required oxygen amount in water depends on water temperature, pH level, CO_2 content, the metabolism intensity, stress, and other factors.

But the major elements are temperature, size and density of fish.

So, in hot summer, the fish exposed to oxygen deficit stop feeding, swim at the surface, breath heavily, crowd together at the mouth of alimentation, have spasmodic movements which alternate with periods of calm, they are apathetic, lose the reflex of orientation and die.

In winter, in densely populated ponds, the fish may frequently die through suffocation.

Table 2

Dissolved Oxygen Requirements in Carp Fisheries

Mean requirement, [mg O_2/L]	Minimum requirement, [mg O_2/L]	
7.0…9.0	Winter 3.0…3.5	Summer 5.0…5.5

1.2. Carbon Dioxide in Water

The carbon dioxide is dissolved in water in molecular state, only 10% of it forms carbonic acid. This is free carbon dioxide. The ionic forms, represented by $(HCO_3)^-$ and $(CO_3)^{2-}$ ions, are very important for the capacity of neutralization of the water. The carbon dioxide influences the water pH.

1.3. Nitrogenous Substances in Water

Ammonia, nitrites and, in some cases, nitrates existing in water are the nitrogenous substances in water, pathogenic for fish. They came from the decomposition of dead organic matter, from reduction of nitrates and nitrites existing in water, from different sources of pollution determined by the use of mineral and organic fertilizers, or may be produced by metabolism, as in the case of ammoniac [6].

The nitrogenous compounds lead to about fish intoxication, as: changes in body position (lateral or dorsal decubitus); abnormal movements (anxiety, lack of reactivity, sudden movements, lose of balance, the increase or the decrease of breathing rhythm); reactions of the nervous system – body changes (dark colour of tegument, pale bronchia); mucus hypersecretion.

The action of noxious substances is highly influenced by the water pH and the amount of dissolved oxygen. Some effects of toxic substances superpose and interpose (synergism), others counteract (antagonism).The ammonia is a very dangerous poison for fish.

The ammonia there is into water both in undissociated molecular form and dissociated form of ammonium ions. These two states are in balance, and together form the total ammonium.

The reaction of dissociation is $NH_4+OH^- \leftrightarrow NH_3+H_2O$. The ammonium ions are not toxic for fish, but the toxicity of ammonium salts is given by the ammonium molecules. The dissociation degree grows with the pH, so the toxicity will rise in the same time with the pH.

The ammonium in undissociated state has toxic effects on fish over respiratory and nervous systems, because penetrates very easily the tegument. It gets through the bronchial tissue, in the blood stream, with noxious action over the nervous system [3], [6]. High concentrations of ammonium lead to destruction of the entire bronchial tissue. Also, the ammonium has haemolytic action.

The symptoms manifested by fish intoxicated with ammonium are: agitation followed by short periods of calm, the acceleration of cardiac and respiratory rhythm, swim at the surface of the water, sudden leaps, muscular spasms, lateral and dorsal decubitus, mouth and operculum opened, punctiform bleedings on bronchia, at the basis of pectoral wings, at the eyes, mucus excess on bronchi and body, necrosis and bronchia destruction, death by suffocation.

2. Case Study

2.1. Thick ice and High Concentration of Ammonium (Dracşani Pool)

In winter of 2002–2003, a suspect mortality of fish in Dracşani Pool Fishery occurs. This lake is created by a retaining dam on Sitna River, first order tributary of Jijia River and has functions of flood defence and fish-breeding use, having the surface area of 579 ha and mean water depth of 1.7 m.

The main influent is Sitna River which collects, in upstream of the accumulation, the wastewater originating from Bucecea and Cătămărăşti water treatment plants, and Botoşani wastewater treatment plant. In addition, upstream of Dracşani pool fishery, the Sitna River receives Teascu tributary. The latter take a significant discharge of wastewaters treated only mechanically at the moment of this study, and so increasing the organic and ammonium charge of Sitna River. To investigate the causes of fish kill, physical, chemical analysis and observations on weather and fish health condition were carried out.

In January 2003, water samples were collected from three particular locations from Sitna River in relation with the inflow water quality and were analysed (Table 3). The ammonium from wastewater treatment plant effluent has a large impact on water quality of Sitna River (Table 4). The raise of ammonium with 1 mg/L was felt upstream lake edge. The micro-organisms metabolizing the nitrogen are acid bacteria. The factors acting as conditioners for the nitrification reactions are: the phosphates as nutritional material, the oxygen and an alkali to neutralize the nitrous acid and nitric acid resulted from the oxidation reactions: $2HNO_2 + O_2 = 2HNO_3 + 89$ J; $2NH_3 + 3O_2 = 2HNO_2 +$ $+ H_2O + 327.6$ J.

Table 3
Physical-Chemical Parameters of Water Samples from Sitna River

Sampling location	Date	Water temperature ºC	Chemical oxygen demand ($KMnO_4$) mg O_2/L	pH	Dissolved oxygen mg O_2/L	NH_4 mg/L
Sitna River, 300 m downstream wastewater treatment plant	05.01	0.5	16.6	7.99	11.90	3.06
	06.01	0.5	15.8	7.93	11.03	3.10
Sitna River, Stăuceni bridge, 3 km downstream wastewater treatment plant	07.01	1.0	15.0	8.08	12.84	3.16
	09.01	1.0	11.8	8.03	13.28	2.83
Sitna River, 500 m upstream Dracşani Lake edge	05.01	1.0	15.8	7.83	8.12	4.34
	07.01	1.0	13.4	7.96	10.66	4.29

Table 4
Main Physical-Chemical Parameters of Wastewater Treatment Plant Effluent

Date	Water temperature, [ºC]	Chemical oxygen demand ($KMnO_4$), [mg O_2/L]	pH	NH_4 mg/L	Discharge L/s
05.01	5	14.2	7.82	10.94	365.0
06.01	7	19.75	7.74	14.10	481.5
08.01	9	52.1	7.94	17.40	232.0

The temperature is an important factor in the efficiency of nitrification and denitrification processes, both for the aerobe bacteria and for the anaerobe one. It has to have higher values than 10º…15ºC.

Nowadays, the wastewater treatment plant includes a denitrification stage, which eliminates the above inconveniences.

The quality indicatives of Dracşani Lake water were measured in reference sampling locations. The analysis of recorded data evinces that the forming of an ice layer thick of 25…40 cm leads to a decrease of the dissolved oxygen content for a long time that has deteriorated the fish physiological state (Table 5). Synergism effects of ammonium high concentration and oxygen lack have accelerated the fish intoxication, followed by death. To point out that the ice layer of high thickness restrained the vital space of fishes, leading to overpopulation.

Also, the analysis of ice samples shows that the ice, through melting has almost the same properties as those of distilled water (weak mineralization, lack of organic substances and ammonium). This means that, when forming the ice, the pond water ingested a concentration of salts and pollution factors of the same proportion as the ice quantity in the lake.

Table 5

Correlation between Weather, Chemical Characteristics, and Fish Health

Sampling location	Date/hour	Ice thickness cm	pH	Chemical oxygen demand ($KMnO_4$) mgO_2/L	Dissolved oxygen mg O_2/L	NH_4 mg/L	Weather. Fish health condition
Dam-pier	02.01/14		7.48	16.50	0.22	4.82	Sun, clear sky. Ice without snow. Fish dense crowd at ice-hole.
Dam-ice hole, 100 m upstream	02.01/14	28	7.57	18.80	0.23	4.70	
Dam-gate	02.01/14		7.59	13.40	0.33	4.43	
Dam-gate	02.01/17		7.52	18.90	1.60	4.76	
Edge of lake	03.01/10		7.79	16.50	11.65	2.26	Dead fish. Equilibrium loss of fish (lateral or dorsal decubitus).
Upstream 1 km middle of lake	03.01/11	25	7.80	12.60	9.16	2.71	
Middle of lake	03.01/11		7.64	11.80	5.01	3.94	
Dam-pier	03.01/12		7.68	15.80	2.59	4.19	
Dam-ice hole	03.01/12		7.73	12.60	2.49	3.72	
Dam-gate	03.01/13		7.78	15.00	2.75	3.20	
Dam-ice hole	04.01/11		7.66	15.01	1.58	4.61	Overcast sky. Closed gate. Substantial fish mortality.
Dam-gate	$04.01/11^{30}$	24	7.68	15.08	1.80	4.51	
Upstream 1 km middle of lake	$04.01/12^{30}$		7.65	19.75	1.93	4.48	
Middle of lake	04.01/13		7.95	11.60	4.50	2.34	
Dam-gate	05.01/10		7.59	18.17	2.50	3.84	Overcast sky, wind. Dead and agonizing fish.
Dam-pier	$05.01/10^{30}$	24	7.53	15.80	2.00	4.32	
Dam-ice hole	$05.01/10^{40}$		7.50	16.60	1.95	4.68	
Upstream 1 km middle of lake	$05.01/11^{20}$		7.41	17.20	2.48	4.44	
Middle of lake	05.01/12		7.33	17.60	1.76	4.52	

2.2. Hot Summer and Eutrophic Lake Water (MELIC II Pond)

In hot summer of 2005, fish mortality has occurred in the reproductive carp pond (MELIC II), Botoşani County.

In order to identify the causes, a complex study was accomplished. Water samples have been taken from the lake, in representative profiles and depth landings: at the inlet, in the middle and at the dam.

The water depth in the sampling points was as follows: at the lake inlet – 1 m, in the middle area – 3 m, at the dam – 1.5 m. Beside, water samples were collected from the influent and the effluent, but from these locations, the results have not been significant. The sampling has been performed during the daytime, when the weather conditions were as follows: clear sky, strong sunlight, the lack of the air streams that could produce waves, water natural circulation nearly inexistent. In the dam area, underwater abundant vegetation and yellow-greenish transparent water has been observed, which showed a pronounced eutrophication.

The physical-chemical analysis of the water samples excluded the fish poisoning due to any toxic substances. Two important water parameters attracted our attention by their significant values, namely pH > 8 due to algae flourishing, and the oxygen level up to 21.5 mg O_2/L during daylight hours due to chlorophyll assimilation. The oxygen content decreased during the night, and fell at their lowest value in the early morning hours, below the critical value for fish (i.e. at 20°C, 4 mg O_2/L for carp and 2.5 mg O_2/L for golden crucian).

The fish shows typical symptoms, indicating the intoxication degree [3], [6]: flurry (the fish makes agitate movements, with frequent jumps over the water), irritability increase or decrease (at different external stimulus, fish may respond by sudden movements, or, on the contrary, by remaining apathetic), balance disorders (the body makes light swings or torsion movements, the body position is sometimes horizontal, vertical or otherwise oblique, total ataxia (fish completely lose their stability and fall in lateral or dorsal decubitus), agony (fish falls to the bottom of the pond, being not able to move, respiratory movements being very weak), death followed by the body cadaverous hardening.

In these conditions, the mortality was due to several factors including: reduction of the dissolved oxygen content in water during the night, concurrently with the increase of the carbon dioxide concentration; the lack of oxygen, because a constant circuit of the supply – discharge flow wasn't equipped; existence of a rich underwater vegetation, a great oxygen consumer during the night and generating putrescent organic substance; low water depth, which allowed rapidly heating water, concurrently with the decrease of dissolved oxygen concentration.

2.3. Low Atmospheric Pressure and Hot Summer (Costeşti Fish-Pond)

During last extremely hot summers, a fatal danger for fish has been reported to Costeşti fish-pond, Botoşani County.

Weather conditions were the following: water temperature +25°C, quiet atmosphere, total lack of wind, cloudy sky with a very low ceiling of clouds, very low atmospheric pressure. This cloudy and calm day, without wave action, extended the fish critical period by reducing water re-oxygenation from photosynthesis and diffusion.

The aquatic organisms consume large amounts of oxygen at night, causing a temporary shortage of the oxygen just before dawn.

In the morning, apparently, fish do not sense the danger and swim to safety in time. Then, it becomes very agitated and rises to the surface of the lake. If the phenomenon is long, these symptoms are followed by a movements weakening, paralysis and tabescence. This is the consequence of the carbon dioxide accumulation in the blood, simultaneously with the lack of oxygen. By carbon dioxide accumulation is reached the respiratory center, which loses its excitability, causing progressive paralysis, especially of the cardiac activity. In the case of asphyxia due to lack of oxygen, the fish keeps the mouth wide open and the opercula very open. When asphyxia occurs through the accumulation of carbon dioxide in the blood, the fish has the mouth half-open and the opercula little opened. Intoxication occurs in time. If the lack of oxygen does not last a long time, the phenomenon is reversible, thus when the normal conditions (dissolved oxygen level) are restored, the fish comes back to life. The prolonged episodes of depressed dissolved oxygen level of 2 mg O_2/L can result in fish kill. In the investigated case, the phenomenon was not durable and fish mortality has not been registered.

2.4. Spring and Autumn Mornings and Weather Conditions (Dracşani Pool)

The study was accomplished in the Dracşani fish pond, Botoşani County, following an alert of a sudden mortality in fish, supposing an accidental pollution.

Area inspection and water samples analysis excluded pollution as the cause, and have shown a decreasing amount of dissolved oxygen under the influence of natural factors.

Especially, during spring and autumn mornings, daily fluctuations of the water quality occur at the same sampling point. Water samples were collected in October, from the edge and middle of the lake, from the right and left bank. The results, presented in Tables 6 and 7, show the evident dependence of oxygen concentration on meteorological conditions. The decrease of the oxygen content in the pond water may be caused by the occurrence of a curtain of fog over the water. The different values of pH and dissolved O_2 resulted in the cross section of the lake, show the non-uniformity.

Table 6
Time of Day and Weather Conditions Influence on Dissolved Oxygen Content

Date	Hour	Water temperature ^oC	Sampling location	Meteorological conditions	pH	Dissolved oxygen mg O_2/L
23.09	6.45	13	edge of lake	darkness, dense fog, calm water, gas bubbles, phytoplankton in decomposition	7.90	0.70
06.10	13.05	15	edge of lake	clear sky, small waves	7.23	6.70

Table 7
Sampling Location and Weather Conditions Influence on Dissolved Oxygen Content

Date	Hour	Water temperature ^oC	Sampling location	Meteorological conditions	pH	Dissolved oxygen mg O_2/L
23.09	6.15	13	middle of lake (left bank)	darkness, dense fog, calm water	8.08	5.80
07.10	14	18	middle of lake (right bank)	cloudy sky, moderate waves, turbid water	7.89	1.50
07.10	16	15	middle of lake	rain, cloudy sky, moderate waves, turbid water	8.19	8.40

4. Conclusions

During the cold season the oxygen lack may provoke the death of freshwater livings.

Some measures must be taken to avoid this risk, as: ice-holes made at the surface of the ice layer, a good quality water rush of alimentation will be provided, strong and permanent, optimal density of fish in the pond must be respected.

The movement of the mud from the lake’s edges will be observed and stopped, because that is a highly oxygen consumer to oxidize the organic substances and producer of anaerobic compounds, toxic for fish.

Meteorological conditions have a huge influence on the water quality in the hot season as well as during the late spring or early autumn mornings, with impact on the fish population in that ecosystem.

The impact over the ecosystem is even greater as the stored water volume and the depth are lower, and the sedimentation and eutrophication degree is more accentuated.

The risk of summer fish kill can be reduced by keeping as eutrophication and nutrients blot out of the water as possible. In this way, the production by aquatic plants is reduced, less decomposition is required, and dissolved oxygen will not become depressed to critical levels.

Other solutions to improve the environmental conditions of these stagnant waters and their suitability for fish life are dredging or sucking bottom sediments in order to increase the body water, to reduce the nutrient rich sediment, and to reduce the growth of nuisance vegetation.

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VARIAŢIILE CALITĂŢII APEI DIN LAC DUPĂ ANOTIMP ŞI RISCURILE ASUPRA POPULAŢIEI PISCICOLE (II)

(Rezumat)

Se studiază influenţa factorilor hidrologici, atmosferici şi chimici asupra calităţii apei din lac, în toate anotimpurile, în corelaţie cu populaţia piscicolă. Studiul de caz s-a realizat pe câteva lacuri piscicole din judeţul Botoşani, România, unde s-a observat o anumită mortalitate atât în anotimpul cald cât şi în cel rece, din cauza factorilor menţionaţi mai sus. S-au făcut observaţii şi analize asupra afluenţilor, asupra caracteristicilor meteorologice şi dezvoltării vegetaţiei în lacuri. Au fost recoltate probe de apă din respectivele lacuri şi din afluenţii lor, din secţiuni şi de la adâncimi reprezentative.

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THE FUTURE OF GLOBAL POSITIONING SYSTEM

BY

D. ILIOI, HORAŢIU HOGAŞ and *MĂDĂLINA ILICA

Abstract. This paper analyses the trends and developments in the Global Positioning System (GPS) field in the last decade, from both a technical but also a financial perspective and suggests how the performance at the user's end of the system can be improved.

Key words: GPS; satellite; geodesy; augmentation.

1. Introductions

The Global Positioning System (GPS) is a satellite-based radio system, providing precise three-dimensional position, navigation and accurate time information to suitable equipped users.

The GPS is owned and operated by the US Department of Defense and was designed originally, in the 1970s, as a navigation system for the United States military forces. It has been used for the solution of geodetic problems since about 1984 and has since gradually become available to millions of independent users around the world.

In its final configuration, available since 1995, the GPS consists of at least 24 satellites placed in orbits of about 20,200 km altitude above the Earth's surface. The arrangement of satellites has been laid out in such a manner that at least four satellites are simultaneously visible above the horizon, anywhere on Earth, 24 hours a day.

2. Trends and Development

Remarkably, the satellites unit cost has decreased with increasing capability, as shown in Table 1. As a result, on April 13th 2009, the constellation comprised 31 satellites, with the most recent Block IIR-M satellite launched on March 24, 2009. With the augmented constellation, most users have six to eight, or at times even more satellites in view instead of the minimum of four. New satellites broadcast additional signals. The last one, launched on March 24th, includes a new demonstration payload that will transmit a third civil signal located on the L5 frequency (1,176.45 MHz). Hence the demand for multi-frequency receivers will increase.

Table 1
Satellites Forming the Baseline Constellation

Characteristics	Block II/IIA	Block IIR	Block IIF
Number	28	21	12
First Launch	1,989	1,997	2,005
Weight, [kg]	1,665	2,030	1,545
Power, [W]	1,100	1,700	2,900
Design Life, [years]	10	10	15
Unit cost, [US dollars]	43 millions	30 millions	28 millions

Furthermore, especially in the last decade, the improvement in the performance of GPS has been phenomenal. The worldwide market for GPS applications and services was estimated to have reached nearly 60 billion US dollars by 2005 and is projected to grow to about 100 billion US dollars by 2012. Sales of GPS-enabled Portable Devices (GPS-PD) are expected to grow from 180 millions units in 2007 to 720 millions units in 2012. Geodesy and surveying, although the most challenging part and driving force of the development, is still covering a small section of the global market but nevertheless is forecast to rise from 3 billion US dollars in 2008 to 6…8 billion US dollars by 2012.

Table 2
Sales of GPS-Enabled Devices (units)

Sales of	Year		
	2007	2008	2012 (forecast)
High precision GPS devices	150,000	200,000	500,000
GPS-enabled portable device	180 millions	285 millions	720 millions

GPS has also changed from being solely the navigation technology of choice for sea, air and road travel, into a very serious tool for a variety of numerous professional fields that include cadastral surveying and GIS, GPS seismology, control surveys, geodynamics, altitude determination, monitoring and engineering, photogrammetry and remote sensing, synchronization of base stations in mobile cellular networks, marine and glacial geodesy, etc.

At the navigation end of the user's segment, with the miniaturization and fall in prices, every week the media publicizes new and novel uses for GPS: lone worker protection, locating farm animals, prisoner tracking, special needs patients tracking, pay-as-you-go motor insurance, and many others.

Most of the performance improvements achieved by GPS so far have come from better receivers and their ability to detect very weak signals from the background noise. The next-generation GPS is expected to embrace additional diversity techniques that will include more frequency bands and separation of data bearers from navigation signals, to allow for quicker and easier signal acquisition. The new receivers will also have to allow for assisted GPS or GPS augmentation techniques to provide external information in order to improve its performance. The information provided (*e.g.* through a cellular network) typically consists of the basic satellite data (identity and position in the sky), which helps the receiver narrow down faster, the signal search, provided it has *a priori*, a rough idea of its location.

Some manufacturers introduced also new receivers with GLONASS and GPS L2C satellite signal capabilities. Others have receivers that have successfully tracked GIOVE-A signals from the first GALILEO test satellite along with signals from GPS and GLONASS satellites.

Simulations show (Eisfeller, 2002) that a combined evaluation of GPS/GALILEO data for geodetic purposes has several advantages:

a) increased number of satellites in sight (> 15);

b) smaller Position Dilution of Precision (PDOP < 1.6);

c) increased success rate of the ambiguity fixing, and

d) increased positioning accuracy, by a factor of 2 for the horizontal and a factor of 3 for the vertical component.

3. Limitations of the GPS System

GPS was the first Global Navigation Satellite System (GNSS) and is the only system generally available for commercial use today. In order to calculate a position, the receiver needs to be able to capture and accurately measure at least four satellite signals. However, the satellite signals are extremely low power. To place this in context, the strongest signal from an GPS satellite is 1,000 times weaker than the weakest signal at which a mobile phone works; the weakest signal at which a digital TV can receive a picture is about 100,000 times stronger than the strongest GPS signal. And when an obstruction such as buildings, high cliff walls or dense trees obscures direct visibility of the satellite, the signals becomes even weaker and highly sensitive receivers with long integration times are needed in order to measure it.

In addition to coping with weak signals, the lack of frequency diversity in the current GPS satellites, contributes to interference in urban settings, just to add to blockage from buildings. Usually this is unintentional arising from the electronic systems all around us, of which many emit low-level spurious signals in the GPS band (around 1.5 GHz).

Interference may also be intentional, introduced in the system by a hostile interferer. Ownership is another issue that complicates GPS effectiveness. The US government owns the GPS satellites, and it can do with them what it pleases. President Clinton decreed an end to the degradation of the accuracy of civil GPS frequencies in 2000, but it is not a stretch to think that national security issues could bring back civilian restrictions.

4. Conclusions

Having more than one GNSS does provide additional diversity and robustness by having several complete sets of satellites using different frequency bands which can improve the overall performance, especially in tough urban environments.

Although it is very likely that GPS will remain the hub around which navigation applications are centered for some time to come, gradually this role will be taken on by a few different GNSS, including GALILEO and GLONASS, which will work alongside GPS.

However, the role of other techniques, such as map-matching as well as GNSS assistance and augmentation data, is likely to be critical in the future success of GNSS.

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TENDINȚE DE DEZVOLTARE ÎN SISTEMUL DE POZIȚIONARE GLOBALĂ

(Rezumat)

Se analizează tendința şi evoluția sistemului de poziționare globală (GPS), din ultimul deceniu, deopotrivă, dintr-o perspectivă tehnică dar şi financiară şi se sugerează ce anume ar trebui făcut din punct de vedere tehnic, în special la nivelul segmentului utilizatorilor, astfel încât sistemul să poată fi îmbunătățit şi dezvoltat în continuare.

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ASPECTS REGARDING THE EVOLUTION AND PERSPECTIVE OF SOME URBAN ENVIRONMENTAL SERVICES IN THE CITY OF IAŞI

BY

DORIN COTIUŞCĂ-ZAUCĂ, *FLORIAN STĂTESCU and *NICOLETA MAZILU

Abstract. The paper presents a new approach for improving the urban environmental services taking into account both the population's will and technical measures in order to secure a sustainable development of their neighborhood and the preservation of natural resources for further generations. The conclusions of a study regarding people's attitude *versus* the improvement of these services in the city of Iași, Romania, as well as further development of the matter are revealed. The contribution at improving the sustainability of these services of the staff and students from Faculty of Hydrotechnical Engineering, Geodesy and Environmental Engineering is also presented.

Key words: urban services; water metering; water service.

1. Introductions

The urban services are important for several reasons. First of all they are representing more than half of the total amount of local administrations expenditures in Central and East Europe. So the financial strength of these administrations is mainly function of the efficiency of these services, highly capital hungry. The second reason is that the health of the population is directly connected with the way these services are supplied. The third reason is the impact of these services on the towns aspect and thus their attractivity for foreign investments.

On the other hand the cost of these services is a significant part of local and citizens' budgets. So in the town of Iaşi, a representative town for the average city of Romania, the urban services immediately after 1989, were spending more than 60% of the mayoralty budget [1].

In respect to the citizens' budget, the expenditures for urban services in Romania represented about 10%, abroad they are varying between 0.0006% in the United States, 0.013% in Great Britain and 5.7% in Tanzania, therefore quite a high value.

At the same time the households got on even more the declined services than those before the revolution. Cold water services were reduced at 12…20 h/day and the hot water at 2…3 h/day. As respect to the whole country the water distribution is: 50 cities, with a total of 3.6 million inhabitants, had an 8 hours/day shortage, 36 towns having a population of 1.4 million inhabitants were affected by an 8…12 h/day shortage, and 17 towns with 0.5 million of people had a more than 12 h/day water shortage. The huge leakages from the distribution network lead to an important waste of capital and to the flooding of ground water sheet with negative influence on the slope stability and some important buildings in the city. Romania takes an unwanted place 10 in an EEA ranking statistic. The leakage in the water network requires the use of great quantities of water at the intakes with negative impact for the environment. The privatization of water services does not necessarily leads to a reduction of those inputs since the water companies does not earn benefits from this. As result, in some European countries (Great Britain) the amount of losses in the network are established by law.

The situation of hot water services in the town of Iaşi is similarly, with shortages, and about 50% losses. The household waste collection are qualified as being good by only 39% of the population, the main problem being the collecting delays and the garbage spread around the collecting places. As consequence the air and soil can be severely affected because the poor quality of these services [2].

The service strategy in this sector is made up of a set of policies designed to provide three types of services. These include: *water supply services* (which affect the frequency, pressure, and quality of water supply), *maintenance services* (which affect the performance of the network, common property piping, and private plumbing), and *financial services* (which affect the calculation, distribution, and collection of bills). The provision of these services in Iaşi involves a range of participants including the cold water utility, the hot water utility, the association administrator, the private sector, and households. In a survey carried on by the authors in 1995, the households were asked to evaluate the efficiency of these services.

2. Water Supply Services in Iaşi

At the time of the study, two companies were providing the water services in Iaşi: RAJAC – the cold water supplier and RAT – the hot water supplier. The households reported that cold water service was supplied far more often than was hot water service; the average daily frequencies of hot and cold water service are shown in Fig. 1.

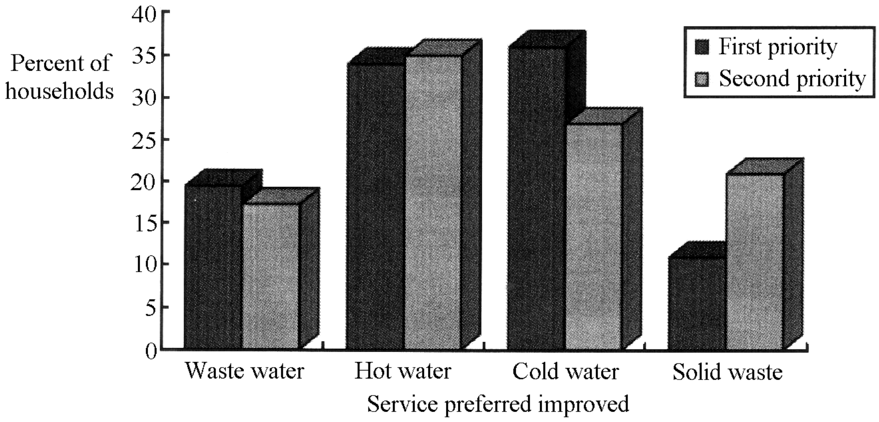

Fig. 1 – Households' first and second priorities for improvement in environmental services.

Households reported that cold water arrived an average of 16 h every day, which is consistent with RAJAC's estimates. Only 20% of households reported receiving cold water less than 2 h/day, while 60% of households received it more than 12 h/day. In contrast, households reported that they received hot water an average of 7.8 h every other day or about 3.5 h/day. This approximates the RAT claim that 60% of households received at least some hot water every day.

Not surprisingly, 60% of households rated the frequency of cold water supply "good", while only 37% of households rated the frequency of hot water supply as "good". These ratings suggest that the quantity of hot water supplied is in greater need of improvement. When asked which service should be improved if the government could improve only one, 41% chose hot water. Surprisingly, although a majority of households rated the frequency of cold water supply as "good", households ranked it as their second priority if only one service could be improved. This suggests that households viewed aspects of cold water provision, other than the quantity supplied, as highly inadequate.

In the urban area only 51% of the population are connected at the water supply systems and have access at drinking water. The situation is worst in the rural areas where this percentage is not greater than 11.2%. Although the national plan for environment states that there are necessary important investments to comply with the EU acquits, till 2030 approximately 4.5 billion Euro for urban areas and 4.5 billion Euro for rural areas. The national plan for environment ISPA (NPE-ISPA) states

a) investments to lead to water supply complying the EU directives (98/53/EC);

b) investments in waste water management for communities larger than 100,000 inhabitants according to 91/271/EEC directive;

c) investments in waste water management for 50% to the communities between 10,000 and 100,000 inhabitants according to 91/271/EEC directive;

d) protection of the most important water surfaces against eutrofication;

e) potable water treatment plant rehabilitation in compliance with EU quality standards;

f) Black Sea, Danube and its affluent protection against pollution by waste water treatment plants rehabilitation and avoiding waste discharges;

g) rehabilitation of water and waste water networks in order to reduce the leakages or unwanted discharges leading to ground water or surface water contamination.

As seen above, the problem of developing the urban services is complex, so it is approached by us under two aspects: socio-economical and technical. The socio-economical aspect of the research has to establish recommendations regarding the reorganization of the way the water distribution institutions are functioning and issuing of propositions of regulations according to those in EU. The technical aspect of the research is going to reveal solutions for water supply services, and household waste collection, focusing for their performing work in order to satisfy both the beneficiary water requirements and a friendly and non destructive impact over the environment as required by our country.

3. An Evaluation of Switching to Pricing Policies Based on Metering

Water delivery systems across Central and Eastern Europe were plagued by several problems that only an improved pricing policy could address. Historically, socialist governments did not meter the consumption of households because their philosophy of entitlements presumed that the state would always have adequate water and financial resources. The folly of this presumption was painfully obvious to households who suffered from falling service levels and rising service prices. However, reforming water pricing policies means incurring the costs of implementing more comprehensive metering programs. Local officials had to determine whether the benefits of adopting a more efficient pricing policy were greater than the costs of metering. We have considered these questions in the context of the municipality of Iaşi, Romania. Like many large cities in post-socialist Europe, Iaşi's transition to democracy has meant coping with the institutional remnants of socialism, becoming more fiscally autonomous, and learning to do more with fewer resources. The water utility in Iaşi currently used a flat-rate pricing policy and suffered from high levels of water loss and inadequate financing. There were two unusual circumstances in Iaşi that make it an interesting case study of pricing policy reform. Firstly, in other countries, utilities typically mandate metering programs because consumers will not voluntarily install meters, hoping instead that other consumers will meter first so that they can enjoy the benefits and avoid the costs. In Iaşi, however, households perceive large private benefits and actively demand metering. Secondly, although most metering programs were paid for by consumers, they are financed by the water utility. In Iaşi, however, because a loan from the European Bank for Reconstruction and Development (EBRD) prohibits the water utility from increasing its debt burden, we had to explore the possibility and practicality of a consumer-financed metering program. Our analysis suggested that the transition has created the potential for local officials to adopt and finance an innovative pricing policy where one would not have expected it. The benefits of a comprehensive metering program arise from efficiency gains which develop because metering induces consumers to reduce both water losses and unnecessary water use. However, metering and pricing reform have the features of a public good leading to free-rider problems. The free-rider problem arises when a household resists switching to metered consumption (and long-run marginal cost pricing) in the hope that other households will switch so that it can benefit from lower costs without altering its consumption behavior. Because of this free-riding problem, consumers tend to adopt metering only when utilities mandate it. Unfortunately, utilities typically only implement such demand management policies when they need to delay the development of a costly or politically-sensitive water source. However, in Iaşi we find that both the utility and households want to switch to consumption based pricing policy.

4. Financing to Meter Family Dwellings

Our analysis took the form of a contingent ranking and valuation of households' preferences for consumer financing packages under alternative hypothetical scenarios. Table 1 presents the characteristics of the four consumer credit packages we presented to the 71% of all surveyed households who reported dissatisfaction with the way their bill was calculated. Although every financing option is based on a real rate of interest of 10%, each varies in the size of its down payment and monthly payment and the duration of its repayment period. Table 1 also presents households' ranking of the three most preferred options.

Table 1
A Description of the Four Financing Options and Households' Ranking of Each Option

	Option I	Option II	Option III	Option IV
Characteristics				
Repayment period, [years]	0	3	5	10
Monthly payment, [lei]	0	13,300	9,700	6,800
Down payment, [lei]	430,000	60,000	40,000	20,000
Households' Ranking				
First choice, [%]	3	14	11	72
Second choice, [%]	2	8	84	7
Third choice, [%]	2	78	4	16

Less than 3% of households chose option I, in which households had to pay the full cost of metering up front. Option IV was the most preferred by the majority of households, followed by option III and then option II, revealing that households generally preferred smaller down payments and monthly payments and a longer repayment period. Not surprisingly, households with greater cash flow constraints (*i.e.* poorer, older households with relatively fewer household members employed and relatively more children) chose option IV (the option with the smallest down payment and monthly payments) from the other options.

We did not assume that because a household ranked an option first they would actually accept it. Once a household had ranked the options, we asked each household if they were willing to pay for meters given their preferred financing plan. We found that 74% were willing to pay for meters when offered their first choice of consumer credit options. Slightly less (62%) were willing to pay for meters when offered their second choice of consumer credit options. Our statistical analysis showed that younger, richer households, who were aware of both free-riding by neighbors and the cost of the service, were more willing to pay for their first and second financing options.

5. Conclusion

The present study was a milestone in future development of the two companies and the way they are now providing their service to the population of Iaşi. Any assumption at that time proved real, so today there is no any hot water or cold water service provided without metering. The results of the work of staff and students of the Faculty of Hydrotechnics at that time made possible a faster transition to a fair and high quality water service in Iaşi.

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ASPECTE PRIVIND EVOLUŢIA ŞI PERSPECTIVA UNOR SERVICII URBANE DE MEDIU ÎN ORAŞUL IAŞI

(Rezumat)

Se prezintă o nouă abordare pentru îmbunătăţirea serviciilor urbane de mediu, luând în considerare atât dorinţa populaţiei cât şi măsurile tehnice necesare pentru a asigura o dezvoltare durabilă a localităţii lor şi conservarea resurselor naturale pentru generaţiile viitoare. Sunt prezentate concluziile unui studiu cu privire la atitudinea oamenilor faţă de îmbunătăţirea acestor servicii în oraşul Iaşi, România, precum şi dezvoltarea ulterioară a lor. Este menţionată contribuţia personalului şi studenţilor de la Facultatea de Hidrotehnică, Geodezie şi Ingineria Mediului la îmbunătăţirea furnizării acestor servicii.

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ASPECTS OF SOIL LEAD CONTAMINATION FROM BAIA MARE COUNTY

BY

ANIŞOARA UNGUREANU

Abstract. This paper presents the results of experimental research conducted in the center of Baia Mare town, specifically in Market Vasile Lucaciu and adjacent streets. It was analysed the lead concentration in soil, compared with corresponding threshold values alert, that the threshold of intervention, provided in the Order of the Ministry of Waters and Environmental Protection no. *756*/1997.

Also was analysed and soil reaction, because it influences the mobility of lead content in soil. Research has mainly aimed to identify areas affected by the content of lead and finding the most appropriate solutions for sustainable management of soil.

Key words: soil; pollution; lead; concentration; area effect.

1. Introductions

Soil is an important resource in Romania. Soils damaged by pollution represents a critical problem. Pollution in Baia Mare town is this already for a long time due to mining and extraction and processing of ferrous materials. Baia Mare is an industrial depression developed in the production of lead and gold, this pollution is felt very much at ground level.

Measurements performed on soil samples taken from the city center, namely Dr. Vasile Lucaciu Market and adjacent streets, shows four times more lead than the limit of international standards. Thus, toxic compounds of lead is 85.2 mg per kilogram of soil, when the maximum allowed would be only 20 mg/kg. Copper is not harmful to soil concentrations below 20 ppm.

Depassing this concentration negative humus properties change; microbiological activity in the soil for plants is toxic even at very low concentrations of 0.1 ppm. Pollution is serious and is largely due to ROMPLUMB – Baia Mare. This factory is the only company in the country that process concentrates plumbo-copper.

Trace elements discharged into the air and gaseous chemical compounds accumulate in the lower atmosphere are washed by rain (very often acidic), reach the soil, are taken from the hydrographic and thus there is an extension of pollution by trace elements over large areas in the Baia Mare town and the surrounding areas.

2. Materials and Methods

For a description as complete monitoring points were chosen as follows:

a) two points (TA1 and TA3) under the direct impact of pollution sources in industrial areas, non-residential;

b) one point (TA2) in the residential area, not being regarded as the direct impact of sources pollution;

c) one point (TA4) on the adjacent area of ponds MEDA - SASAR.

Soil samples were collected from depths of 0…10 cm and 20…40 cm. Reviews were conducted on samples obtained by mixing several media samples from the surface of 25…250 m. The contents of lead in analysed soils are given in Fig. 1.

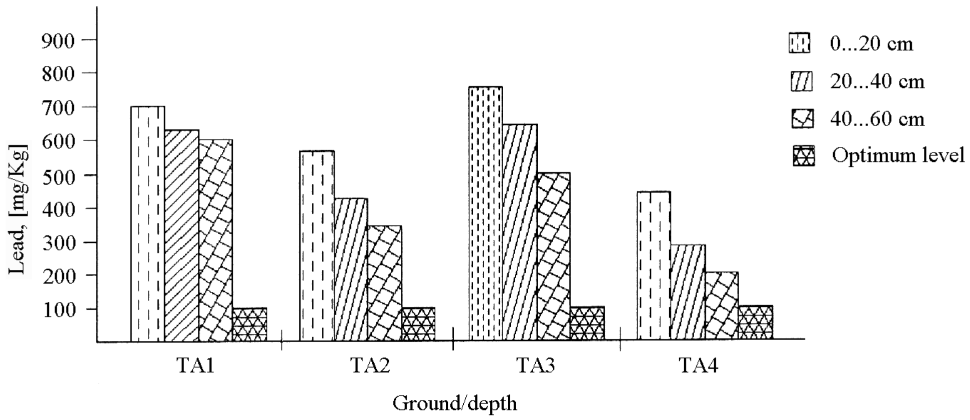

Fig. 1 – Concentration levels of Pb^{2+} in the fields studied.

Pb^{2+} content in the soil at the three levels of depth far beyond the concentration. Considering the influence of pollution sources, we see a slow evolution of soil lead pollution in the Baia Mare town.

3. Results and Discussions

Soil pollution by lead (Figs. 2 and 3) presents the annual average concentrations and annual frequency of exceeding daily maximum allowable concentration (MAC) during 1974 to 2003.

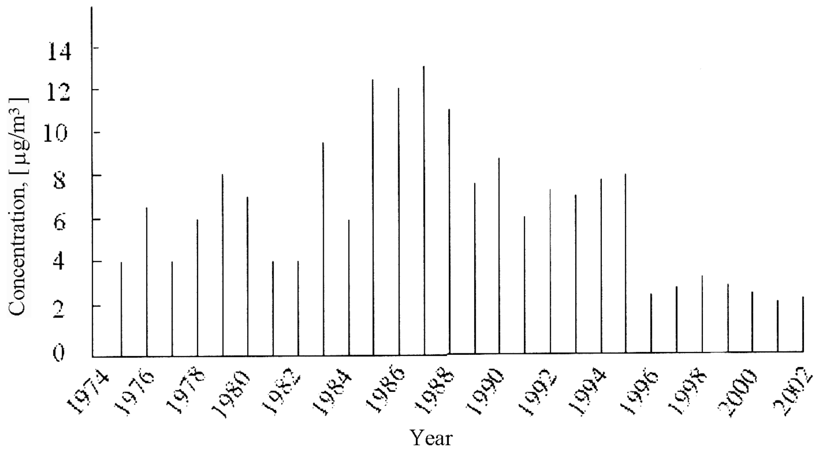

Fig. 2 – Annual average concentrations of lead.

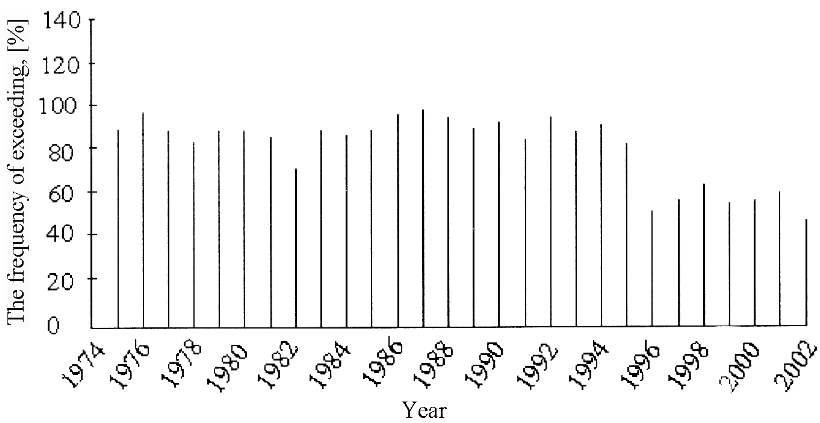

Fig. 3 – The frequency of exceeding daily MAC lead.

Analysing Figs. 2 and 3, there is a frequency exceeding the amounts allowed in 78% to 98% during 1974 to 1994 and a gradual decrease only after 1995. Annual average concentrations recorded is frequently than the maximum allowed in the years 1974…1994, registering the maximum values in the period 1984…1989, which corresponded to a maximum period of activity of the unit ROMPLUMB factory.

After 1990 there were decreases in these values, the most significant being the period from 1995 to 2003 as can be ceen in Table 1. As regards the analysis conducted at the sampling point, a definite difference between the level of Pb pollution in areas with direct impact of pollution sources and residential area, is observed.

Table 1

The Frequency of Exceeding of References Level

Year	Pb Normal values mg/kg	Alert threshold		Intervention threshold		Frequency of exceedance %			
		Type of use		Types of use		Alert		Intervention	
		*A**	*B***	*A**	*B***	*A**	*B***	*A**	*B***
1996	20	50	250	100	1,000	82	144	732	7,896
1997	20	50	250	100	1,000	128	102	975	6,785
1998	20	50	250	100	1,000	0	2,396	59.4	4,494
2000	20	50	250	100	1,000	100	100	87.2	70
2001	20	50	250	100	1,000	93.5		80.6	100
2003	20	50	250	100	1,000	90.2	77.8	80.5	22.2

*A** – zones with little sensibility; *B*** – zones with more sensibility.

Analysing the obtained results it is possible to observe that the values recorded in 1996, 1997 and 1998 do not differ significantly. According to a study conducted in 2003, in the Baia Mare compact outlines five areas, degraded (Table 2) are determined.

Table 2

The Sources of Pollution and Area Affected

Sample No.	Source of pollution	Area affected	Area, [km^2] affected soil above the permissible	Area, [km^2], soil degraded
1	Meda pond	Meda-Săsar Zone	34.50	12.28
2	Historical pollution	Valea Roşie Zone	7.22	2.4
3	SC RGB PHOENIX	Factory Zone	9.7	1.97
4	SC ROMPLUMB	Factory Zone	4.2	0.94
5	EM Herja	The area of confluence of the stream with brook Săsar Herja	2.9	1.06

Table 3 point out the sources of pollution based on the analysis presented in depth penetration of pollutants leading to land degradation through interference overrunning at depths of 100 cm.

Table 3
Source of Pollution and Area Affected

Sample No.	Source of pollution	Area affected	Area, [km^2], affected soil above the permissible value	Area, [km^2], soil degraded
1.	SC RGB PHOENIX	Factory Zone	5.18	2.38
2.	SC ROMPLUMB	Factory Zone	3.11	0.91
3.	EM Herja	The area of confluence of the stream with brook Săsar Herja	1.83	0.62

5. Conclusion

Processing all the presented data, it can be concluded that the sources of pollution have a definite influence on the degradation of soil quality, but an accurate assessment and closer to reality on its weight may be undertaken only by knowing the composition of natural background.

We can say that the degree of pollution with Pb maintains high values, the main source being SC ROMPLUMB Ltd., caused by a technological nature (defective machinery involved in circulation of gas, repeated stops of technological process, failure of mechanical nature) and weather nature (conditions of dispersion of the Baia Mare are all bad).

Arrangement of field sampling points of soil samples was such that to obtain information on soil quality of an area as large in the results of experimental research conducted. Accident prevention of soil contamination with copper is the best method to stop the pollution substance.

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ASPECTE PRIVIND CONTAMINAREA SOLULUI CU PLUMB ÎN JUDEŢUL BAIA MARE

(Rezumat)

Se prezintă rezultatele unor cercetări experimentale efectuate în centrul oraşului Baia Mare, mai precis in Piaţa dr. Vasile Lucaciu şi străzile adiacente.

A fost analizată concentraţia de plumb din sol, comparativ cu valorile corespunzătoare pragului de alertă, respectiv pragului de intervenţie, prevăzute în Ordinul Ministerului Apelor şi Protecţiei Mediului nr. *756*/1997.

De asemenea a fost analizată şi reacţia solului, deoarece acesta influenţează mobilitatea conţinutului de plumb în sol.

Cercetările au avut ca obiectiv principal identificarea zonelor afectate de conţinutul cu plumb şi găsirea celor mai potrivite soluţii pentru managementul durabil al solului.