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A METHOD TO FORECAST THE SEDIMENTATION-EROSION PHENOMENA IN SOME AREAS OF THE DAM LAKES ON RIVERS

BY

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Abstract. The paper presents the results of some researches on the riverbed morphology. These researches include the modeling of erosion-sedimentation processes, the measurements in situ over a long period of time and the verification of the model that was tested at the Chirita Reservoir of Iasi, for the mouth-river area of the two tributaries. A special conceived program was tested on the studied case.

Key words: sedimentation; erosion; lakes.

1. Introduction

The alluvial processes, which appear at the river mouth, have certain particular characteristics provided of the river waters interaction with the environment accepting them. These processes may be studied using the mathematical model of the liquid jet submerged into a liquid having the same

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density. Corrections concerning the density are necessary. The density varies with the length and height of the jet, because of the temperature and suspended load differences existing between the two liquids, which come into contact.

In our approach, we tried to study this complex process, by collecting data over a long period of time and processing them with the help of the Lagrange interpolation polynomial.

This investigation included three stages:

a) *in situ* data collecting;

b) mathematical modeling of the erosion/settling processes with Lagrange interpolation polynomial and conceiving the program;

c) running the program based on collected data and the validation of the mathematical model.

2. Data Collecting

The analysis of the morphological modifications which take place at the river mouth, (Mitroi, 1999), was realized on two tributaries of the Chiriţa Reservoir (Fig. 1). Observations and measurements on the river bad in this area exist since 1965. Some of the collected data were use to verify and run the program conceived by the team.

2. Mathematical Model

The Lagrange interpolation polynomial is a polynomial $L_m(x)$, designed as so to have the same values as the function $f(x_i)$ in the specified points x_i :

$$L_m(x_i) = f(x_i) = y_i \,, \; (i = 1,2,.., n). \tag{1}$$

First, we shall find a polynomial $p_i(x)$, so that it might be annulled in all points, excepting $j = i$:

$$p_i(x_j) = \partial_{ij} = \begin{cases} 1 \text{ for } j = i; \\ 0 \text{ for } j \neq i. \end{cases} \tag{2}$$

The expression of such a polynomial is:

$$p_i(x) = C_i(x - x_1)\ldots(x - x_{i-1})(x - x_{i+1})\ldots(x - x_n) = C_i\ \Pi_i(x) \tag{3}$$

in which: $\Pi_i(x) = \prod_{j\neq i}(x - x_j)$, C_i – constant coefficient, determined by accepting that $x = x_i$.

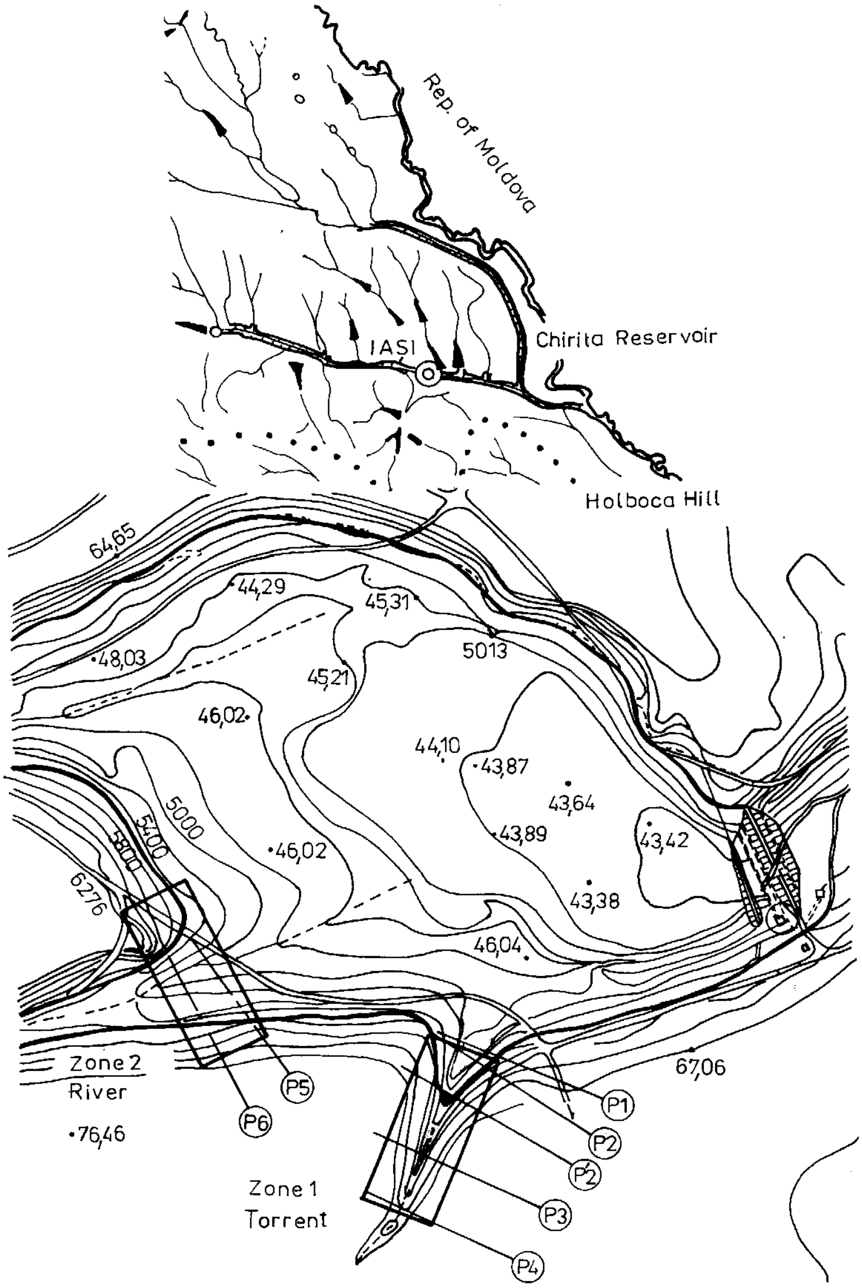

Fig. 1 – Investigated areas.

Consequently:

$$p_i(x_i) = 1 \text{ and } C_i = 1/\Pi_i(x_i)\,. \tag{4}$$

From eqs. (3) and (4), the polynomial we are looking for shall have the following form:

$$p_i(x) = \frac{\Pi_i(x)}{\Pi_i(x_i)}\,. \tag{5}$$

As for the polynomial $L_m(x)$ and the condition (1), the former shall have the following form:

$$L_m(x) = \sum_{i=1} y_i \cdot p_i(x)\,. \tag{6}$$

Really, since the polynomials $p_i(x)$ are of the $(n - 1)$ order, $L_m(x)$ is of the same order and it meets the condition (1):

$$L_{n-1}(x_j) = \sum_{i=1}^{n} y_i\, p_i(x_j) = \sum_{i=1}^{n} y_i \partial_{ij} = y_j\,,\ \ (j = 1, 2, .., n). \tag{7}$$

After the necessary substitutions, we get to a Lagrange interpolation polynomial whose form is (Mitroi, 1999; Popescu, 1999):

$$L_{n-1}(x) = \sum_{i=1}^{n} y_i \frac{\Pi_i(x)}{\Pi_i(x_i)} = \sum_{i=1}^{n} y_i \frac{\prod_{j\neq i}(x - x_j)}{\prod_{j\neq i}(x_i - x_j)}\,. \tag{8}$$

Particular cases:

a) When $n = 2$, there are just two tabular points so that the eq. (8) is reduced to the equation of the line $y = L_1(x)$, which passes through the above-mentioned points:

$$y = \frac{x - x_2}{x_1 - x_2} y_1 + \frac{x - x_1}{x_2 - x_1} y_2\,. \tag{9}$$

b) When $n = 3$, there are three tabular points. The eq. (8) represents the parabola $y = L_2(x)$, which passes through these three points and whose expression is:

$$y = \frac{(x - x_2)(x - x_3)}{(x_1 - x_2)(x_1 - x_3)} y_1 + \frac{(x - x_3)(x - x_1)}{(x_2 - x_3)(x_2 - x_1)} y_2 + \\ + \frac{(x - x_1)(x - x_2)}{(x_3 - x_1)(x_3 - x_2)} y_3. \tag{10}$$

2.1. The Conceived Program

The program can forecast the evolution of the river bad in the river/lake contact area for the $y = L_1(x)$ equation line particular case, which, for the purpose of this research, proved to be sufficient. The core lines of program below can be easily converted for any newer version of Visual Basic for a better graphical interface.

```
CLS
 INPUT "Cititi din fisier D/N"; D$
 IF D$ = "D" OR D$ = "d" THEN GOTO  1
 INPUT "Nr. masuratori ="; NC
 INPUT "Nr. verticale/masuratoare ="; NP
 NT = 1: 'INPUT "Nr. profile"; NT
 INPUT "Nume fisier "; F$
 CLS
 DIM T(NC), XI(NC), YI(NC), XO(NP, NI), YO(NP, NI)
 TT = -.1
 FOR I = 1 TO NC
2 PRINT "Introduceti timpul pentru masuratoarea "; I; "->"; : INPUT " ", T(I)
 IF T(I) <= TT THEN PRINT "Greseala, t(i)>t(i-1)": GOTO  2
 TT = T(I)
 NEXT I
 PRINT
 OPEN "o", #1, F$
 PRINT #1, NC; NP; NT
 FOR U = 1 TO NT
 FOR I = 1 TO NP
 PRINT "Profil "; U; ",  Verticala "; I
 PRINT "---------------------------"
 XX = -.01
 PRINT "distanta pana la verticala "; I; "="; : INPUT "", X
 IF X <= XX THEN PRINT "Greseala, x(i)>x(i-1)": 'GOTO  3
 XX = X
 FOR J = 1 TO NC
 PRINT "y_timp_"; J; "="; : INPUT "", Y
 PRINT #1, X; Y; T(J)
 NEXT J
 PRINT
 NEXT I
 NEXT U
 CLOSE
```

```
  'F$ = "profile"
1 IF D$ = "D" OR D$ = "d" THEN INPUT "Nume fisier "; F$
  INPUT "Calculul se face la timpul: "; X: PRINT
  OPEN "i", #1, F$
  INPUT #1, NI, NP, NT
  'NI numarul  de masuratori, NP numar verticale, NT numar de profile
  IF D$ = "d" OR D$ = "D" THEN DIM T(NI), XI(NI), YI(NI), XO(NP, NI), YO(NP, NI)
  OPEN "o", #2, LEFT$(F$, 6) + "PR"
  PRINT #2, NI; NP; NT
  XMAX = 0: YMAX = 0: XMIN = 1E+07: YMIN = 1E+07
  FOR U = 1 TO NT
  FOR V = 1 TO NP
  GOSUB  4
  NEXT V
  PRINT "--------------------------------------------"
  NEXT U
  IF XMAX < X THEN XMAX = X
  'PRINT xmin, xmax, ymin, ymax
  CLOSE
  INPUT "Desen D/N "; D$
  IF D$ = "d" OR D$ = "D" THEN GOSUB  5
  END
4 'Sub CALCUL
  FOR K = 1 TO NI
  INPUT #1, D, YI(K), XI(K)
  IF XMAX < D THEN XMAX = D
  IF YMAX < YI(K) THEN YMAX = YI(K)
  IF XMIN > D THEN XMIN = D
  IF YMIN > YI(K) THEN YMIN = YI(K)
  NEXT K
  Y = 0!
  FOR I = 1 TO NI
  P = 1!
  FOR J = 1 TO NI
  IF J <> I THEN P = P * (X - XI(J)) / (XI(I) - XI(J))
  NEXT J
  Y = Y + P * YI(I)
  NEXT I
  PRINT "Pentru profilul "; U; " si verticala "; V; " y="; Y
  PRINT #2, D; Y
  RETURN
5 'Sub DESEN
  DEF FNO (U) = (U - XMIN) * 620 / (XMAX - XMIN)
  DEF FNP (V) = 400 - ((V - YMIN) * 400 / (YMAX - YMIN))
  SCREEN 12
  LINE (0, 0)-(640, 640), 0, BF
  OPEN "i", #1, LEFT$(F$, 6) + "PR": 'curba prognozata
  INPUT #1, C, NP, D
  FOR I = 1 TO NP
  INPUT #1, A, B
  X = 10 + FNO(A)
```

```
Y = 10 + FNP(B)
IF I > 1 THEN LINE (XO, YO)-(X, Y), 4, , &HFF00
XO = X: YO = Y
NEXT I
CLOSE
OPEN "i", #1, F$: 'curbele masurate
INPUT #1, NI, NP, NT
FOR I = 1 TO NP
FOR J = 1 TO NI
INPUT #1, X(J), Y(J), C
X = 10 + FNO(X(J))
Y = 10 + FNP(Y(J))
IF I > 1 THEN LINE (XO(I - 1, J), YO(I - 1, J))-(X, Y), 15 - J
XO(I, J) = X: YO(I, J) = Y
NEXT J
NEXT I
RETURN
```

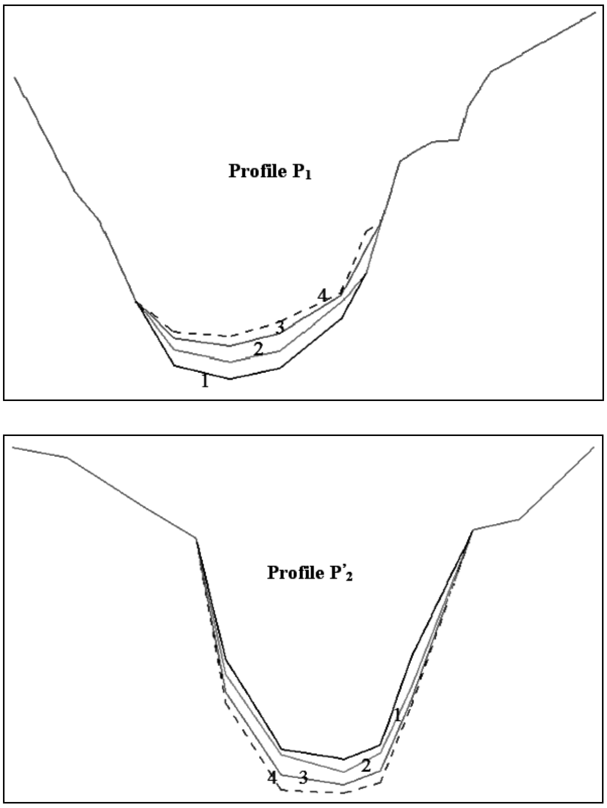

Fig. 2 – Prognosis of the alluvial phenomena evolution in the tributary – lake area: 1 – *in situ* measurements for 1965; 2 – *in situ* measurements for 1987; 3 – results of the program confirmed by measurements in 1998; 4 – program's forecast for 2015.

REFERENCES

Blăgoi O., Mitroi A., Cotiuşcă Zaucă D., *A Mathematical Model of the Sediment Prediction in the River- Lake Contact Area.* Proc. of the VII-th Internat. Symp. on Water Manag. a. Hydraulic Engng., Poland, 2001.

Jansen Ph., *Principles of Rivers Engineering.* Ed. Pitman, 1993.

Mitroi A., *Contribuţii la soluţionarea atenuării transportului de aluviuni pe cursurile de apă permanente şi nepermanente pentru protecţia lacurilor de acumulare*. Ph. D. Diss., "Gh. Asachi" Techn. Univ., Iaşi, 1999.

Popescu Ş., *Aplicaţii ale informaticii în hidraulica sistemelor hidrotehnice*. Edit. Cermi, Iaşi, 1999.

O METODĂ DE PROGNOZĂ A FENOMENELOR DE SEDIMENTARE-EROZIUNE ÎN UNELE ZONE ALE LACURILOR DE ACUMULARE

(Rezumat)

Se prezintă rezultatele unor cercetări asupra morfologiei albiei. Aceste cercetări cuprinde modelarea proceselor de eroziune-sedimentare, măsurătorile in situ pe o perioadă lungă de timp şi verificarea modelului, care a fost testat la acumularea Chiriţa din Iaşi, pentru zona gurii de râu a celor doi afluenţi. Un program conceput special a fost testat pe cazul studiat.