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FLOOD ROUTING SIMULATION IN ATERNO-PESCARA RIVER

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Synopsis

This paper deals with the lamination of the wave of the flood routing in Aterno-Pescara river along a reach embanked but not to be led again into a cylindrical bed, made interesting with the presence of three important confluences which, in three kilometres' distance, affect the extent of the flow (when the river is in flood) by 50%.
The study has been made with the De Saint Venant Equations and the results, concerning the flood occurred in November and December 1966, have been put in a graph.

1. The Aterno-Pescara river is composed, upstream from Popoli, Pescara, Italy, of two main branches: the Aterno and the Sagittario. The basin of the latter, in the confluence section, is nearly half the one of the former in the same section. From the confluence downstream for some three kilometres, the water-course is named Aterno-Sagittario as far as the waters, running from the 'Pescara Sources', flow into it. From here the river takes the name of Aterno-Pescara. As it flows downstream it receives the contributions from other two important sources: San Callisto and Giardino. The river, so formed, runs after a few kilometres, through the natural threshold constituted by the 'Gole di Popoli' (Popoli Gorges) and, after some 45 kilometres, flows into the Adriatic. This paper only concerns the reach of the above described river indicated in Fig.1. It comprises, besides the above said three confluences of source type, also the confluence between the rivers Aterno and Sagittario. In addition, a ground of particular interest in the prosecution of the research is that the river Aterno, shortly before its confluence with the Sagittario, flows through the 'Gole di S. Venanzio' where the stream is certainly swift but perhaps even rapid.

There exist numerous observations which allow the study of our river system; in particular four water-gauging stations of the Italian Hydrography Office are installed, which have been in operation for some fifty years or more. Moreover, the presence, besides the reach deep-set in rock, of a lot of sections embanked about a century ago, lets us know, excepting the position of the bottom moderately variable, the geometry of the section through the designs concerning the same settlement and for a survey carried out in 1977.(1)

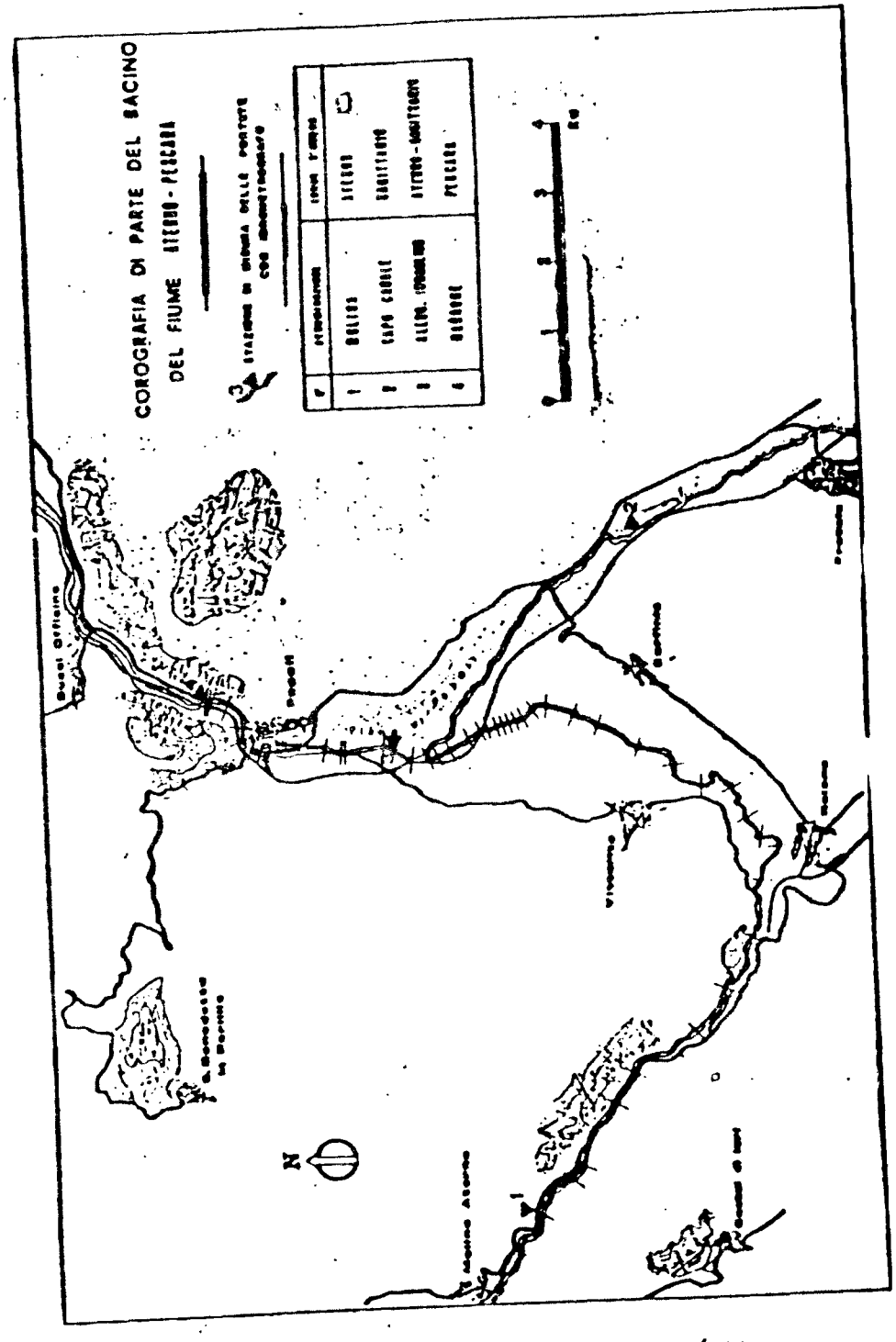

Fig.1

1. The survey was carried out with the contribution of CNR N° made out to Prof. Guido Calenda.

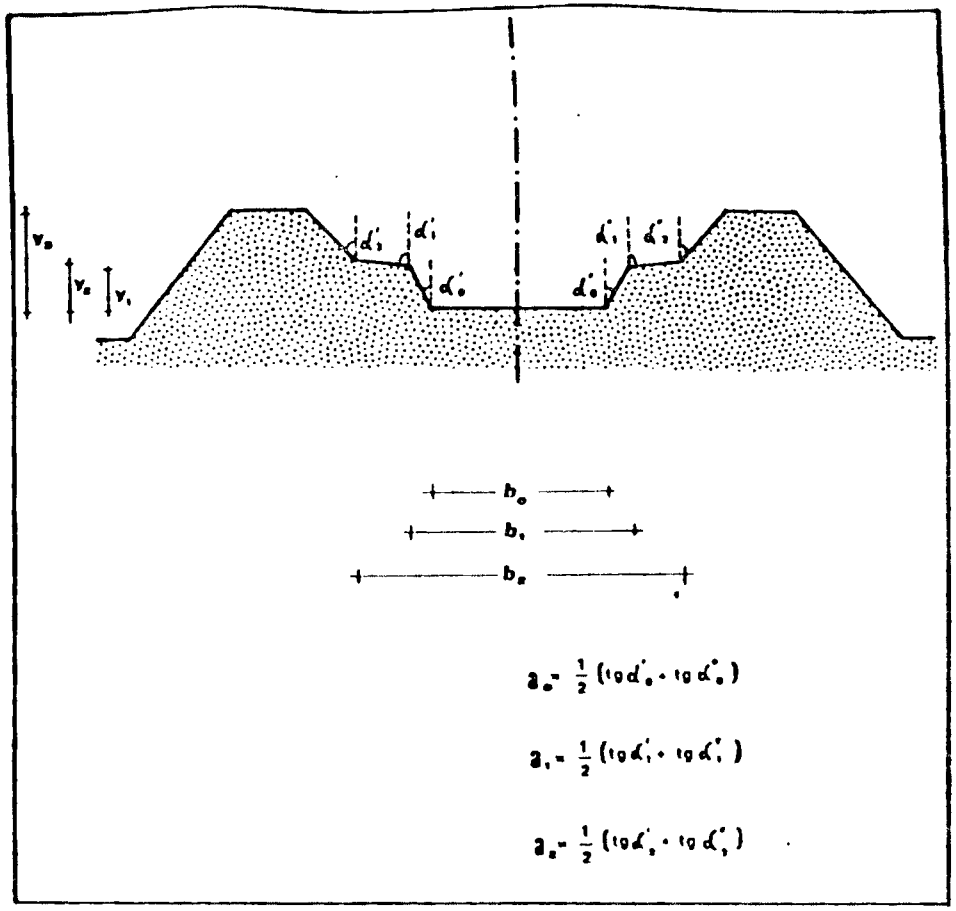

Fig.2

This paper sets forth a first stage of the study, the one concerning the river branch comprised between Section No.3 (water housing) and Section No.4 (Maraone) of the Aterno-Sagittario-Pescara river courses.
First of all attention has been attracted to this branch, since this is delimited by two of the four hydrometrographers above mentioned and there are also some of the characteristics which are later found in the complete study, on which the authors hope to relate in the near future.(2)

2. The Authors hope they can present their complete work at the Convegno di Idraulica e Costruzioni Idrauliche, Palermo, Oct. 1980 or at XIX IAHR

In particular, the bed of said reach, although embanked, cannot be in general led again into the classical cylindrical bed because of the extreme variability of dimensions among each section and the preceeding and successive. In addition, there are also three important source contributions which, even in the river flood period, helps considerably its flow. . The Pescara source gives, by itself, a contribution equal to the ones of the other two altogether.
The geometry of the system has been referred to trapezium type section with more orders of water lines. Fig.2 gives an example of such sections. The calculation of the characteristics of the sections has been effected on the ground of parameters a_i and b_i defined in the same figure.

2. For the study of the reach under examination the classical equations of varied motion, gradually varied, were used, known as De Saint Venant Equations, written in the following form:

$$\begin{cases} \frac{\partial Q}{\partial x} + \frac{\partial A}{\partial t} = q_l - q_u \\ \frac{\partial z}{\partial x} + \frac{1}{g}\left(\frac{1}{A}\frac{\partial Q}{\partial t} + \frac{Q^2}{a}\frac{\partial}{\partial x}\frac{1}{A}\right) + S_f = 0 \end{cases} \qquad (1)$$

with obvious significance of the symbols.
In the second of (1) the term of energetic dissipation was omitted because of the confluence since, in the reach under examination, it is to be considered as null or, in any case, negligible.
As it is known, the validity of these formulae depends on the following hypotheses:
- the bottom slope must be slight;
- the axis, adopted as the curvilinear ascissa, must not present sharp curves;
- the free surface slope must not be very marked;
- the coefficients for comparison of kinetic energy and momentum of flow must not greatly differ from 1.

These limitations are not very restrictive and therefore the equations (1) are adopted in general (various works by Pisa I.B.M. Scientific Centre and by Institute of Hydraulics of Pavia University are instanced); we have been how-

with correctives, to the reach of the river Aterno enclosed in the 'Gole di S. Venanzio' where, the first and third hypotheses do not occur.

The (1) equations, associated with the

$$z = z(t) \qquad (2)$$

law concerning upstream and downstream sectons, derived from the observations of the Italian Hydrography Office, and with the outflow scale defined, as usual, by the Manning formula

$$S_f = n^2 \; v^2 \; / \; R^{4/3} \qquad (3)$$

have been discreetized to the finite differences on the basis of Fig.3 grid in accordance with Crank-Nicolson implicit scheme with coefficient θ equal to .5. Each quantity has namely been referred to the central generic point M of each rectangle of Fig.3 grid.

The (1) equations with conditions at profile (2) are, as it is known, not linear and therefore a solution is only attained by means of an iteration process. We have on purpose chosen the Newton method.

As initial conditions the system has been provided with the flow and position values of the free water surface in each of the 13 sections of the river discreetized, calculated for the condition of permanent motion that, as can be seen in the graphs of Fig.4, was the one existing before the flood.

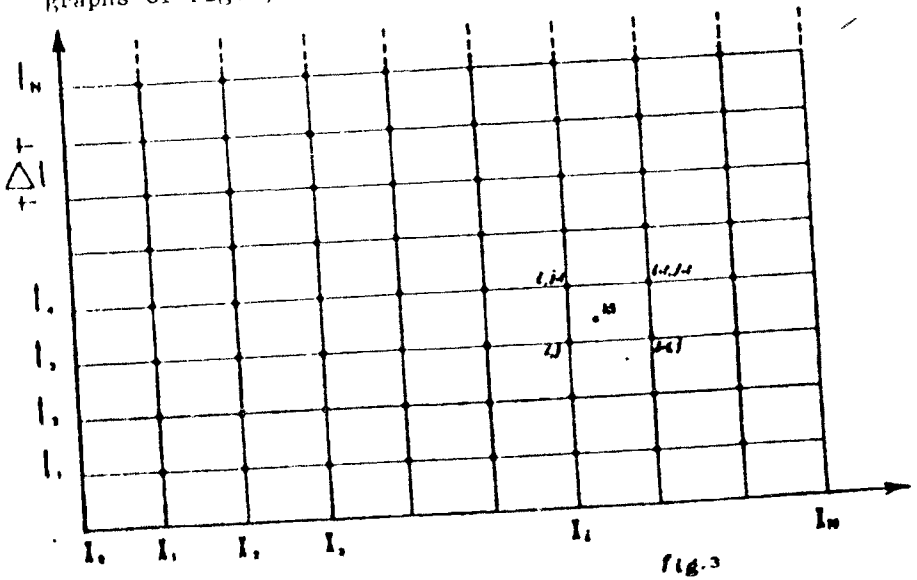

fig.3

The interval of time on the basis of discreetization process has been chosen, basing ourselves on the indications taken from the relevant literature, equal to an hour. The interval of space is instead variable due to the knowledge about the geometry of the river-bed and its variability. Such space intervals go from a minimum of 110 metres to a maximum of 700.

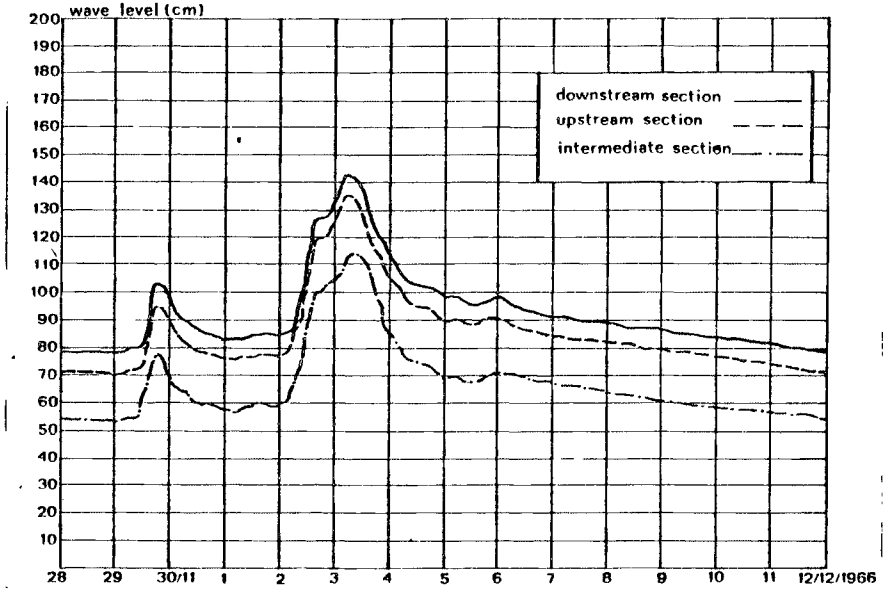

fig.4

3. The same graph of Fig.4 relates, besides the flood waves surveyed by the Italian Hydrography Office in the upstream and downstream sections of the reach under examination, also the wave calculated in an intermediate section concerning the event of flood occurred on 28-11 to 12-12-1966.

As it is obvious, the latter has the same course as the first two. Analogous results are obtained from the examination of curves z=z(t) relating to the other sections and the one concerning flows. We maintain, therefore, that our mathematical model reproduces the hydrodynamics of the river section pretty faithfully examined, despite the disturbing presence of source contributions.

Before, however, bringing the model to the reaining river sections, we are going to proceed to the simulation, on the present one, of other flood events, always drawn from the Italian Hydrography Office recording. We are going to verbally relate on the results of these simulations at the Symposium.

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