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A POINT OF VIEW ON THE DIGITAL TERRAIN MODEL WITH REFERENCE TO ZONES ON WHICH LAND RECLAMATION WORKS ARE PLANNED

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A b s t r a c t

The numerous specialized works which have been published so far emphasize and, we might say , solve the mathematical treatment of the digital terrain model (DTM) by using an infinity of solutions , but they do not tell much from the topographical point of view.

Starting from the main forms of relief which we found in nature, the present report examines the selection of the characteristic points and the modalities to define them through their digital model , taking into account the way in which the data are obtained (topographic and photogrammetric methods). The author gives data referring to the number of points considered necessary for an accurate description of each of the forms of relief , which are examined in accordance with the purpose we pursue and with the plotting scale.

The paper outlines the types of digital models which should be adopted as well as the rules to define them (selection, recording , coding) in the stereoplotter or in the terrain.

I n t r o d u c t i o n

The massive growth of investments in our country requires more and more topographical studies and consequently an ever increasing quantity of designing calculations.

As a result - and also taking into account the equipping with the existing and ever developing calculation technics - we have passed on to the automatic performance of an important quantity of calculations with the help of computers.

But then the activity of supplying topographical data (obtained either through classical or photogrammetric methods) should be organized in a special way to allow the direct and automated processing of data. Hence it is necessary that different terrain models should be drawn up in accordance with each situation occuring in the common practical activity. In the last 10-15 years, the digital model (including that of the terrain) has aroused a special interest from the mathematical point of view, and many specialists tackled this problem, so that numerous types of such digital models (which can be placed among the types indicated in fig. 1) as well as the corresponding computing programs have been created. Unlike other digital models, the digital terrain model is in most cases very complex. Most of the digital models (of building, of the ground water level inferred from measurements at discrete points etc.) can be defined either by using conventional geometric elements or by the adoption of more or less complicated mathematical models as well as of the close mathematical methods of interpolation (linear, of surface etc.) of the necessary elements. At the same time, as regards the digital model of a surface of terrain, we can find a general mathematical rule of definition only in particular cases or for limited areas on account of the numerous " accidents " of the ground.

Consequently, the digital models of the ground which have been adopted and made known in the specialized literature cannot be considered generally valid, as they are only incomplete solutions of the problem.

But such partial solutions render more and more difficult the planning as they bring about either the interruptuion of the automated technological process or erroneous interpretations of the actual situation. Therefore it is necessary to discover a new way of approaching the problem of drawing up digital terrain models. We should return to the way of definition and differentiation in the stereoplotting of the various forms of relief (beginning with the simplest and ending with the most complicated) and revert to the basic knowledge as we have learnt it from classical treatises of topography and geomorphology.

Starting from what has been stated above, we have tried to outline the sequence of the necessary operations for the definition of a terrain general digital model, as well as the modalities of generalizing by points with established elevation some forms of relief which frequently meet in the areas where land reclamation works are planned or carried on.

The way of drawing up a terrain general digital work model

If we consider a stretch of land from the most complex earthly surface , with all that has been made on it, we see that it consists of : a) horizontal zones ; b) sloping flat areas ; c) gently rolled areas ; d) powerfully rolled areas ; e) natural "accidents" of the ground (peaks, ridges, breaks, steep banks, ravines, debouchments, mamelons, depressions, holes etc.) ; artificial "accidents" (batters, embankments, other constructions a.s.o.)

The forms of terrain specified at "a", "b", and "c" lend themselves easily (while those indicated under "d" lend them - selves less easily) to their being converted into a model.But the definition of the forms of terrain or of their alterations as a consequence of the "accidents" mentioned under "e" and "f" is always difficult and leads to the particularization of each digital model.

Therefore when we draw upbegin to draw up a digital model of the terrain we have to proceed as in the scheme shown in fig. 2, that is to say we must start with the delimitation of the forms and "accidents" (as in the example shown in fig.3) and with the selection of the types of digital model (defined as in fig.1) for each delimited area (table 1).

Therefore the terrain digital model should be built up with the help of a smaller or greater number of various types of digital models , depending on the existence or absence of the natural or artificial "accidents" of the ground.

The various simplifications which could be considered when we draw up the general model of the terrain starting from the peculiarities of the planned land recalamtion works (levelling water delivery, main canal, drains, modelling, filling up of ravines, drainage on sloping lands, consolidation of a land sliding etc.) should be performed only if they are in accordance with the accurate definition of the terrain and do not lead to an unpermitted generalization during the further stages of designing.

The selection of characteristic points of the natural aor artificial "accidents" of the ground.
Figure 4 has been formed starting from the several types of relief enumerated at "1", where we have mentioned the characteristic points which should be selected for the accurate plotting of the respective form of ground. Table 2 has been drawn up on the basis of these points . It shows the density of height points necessary to accurately define the situations with which we met.
The way to select (in the terrain, on the orthophotoplan or in the stereo plotting devices) the points defining the forms of relief or the "accidents" met with are of utter importance at this stage.
For instance, let us take the situation shown in fig.5, which has been defined with the help of a stereo plotting instrument. In similar cases it is necessary to proceed as follows :
a) first we should select and record compulsory points for the definition of the "accidents" of the ground ; b) then we shoul should select and record the points defining the connection of the "accidents" with these forms of relief which cannot be easily classified ; c) finally,we should select and record the points which are linked with the completion of the relief. Of course, we have to record distinctly (separately, if possible the necessary points for the further plotting to a certain scale of the field situation which is digitted (depending on the plotting possibilities).
Naturally, if we were to plot the same situation by means of conventional measuements (including the equipment for distance measurements through waves) it would be very difficult to follow the scheme given above, because then the operator selecting the points should be not only a simple doer, but he should be also well acquainted with the terrain and the ways of its generalization.

Ways of working with various types of digital terrain models.
Two situations can be distinguished : a) the first is linked with the utilization of these models for the designing calcu-

lation performed directly on the computer and in this case the order of the automated processing of the various forms of the terrain is indifferent ? b) the second is connected with the plotting of the terrain and in this case it is necessary to begin the processing with the most complex forms (those having elements of the type indicated under "e" and "f") and to end with the simplest ones (see those indicated at "a"). We have to take this course because the complex forms require a very great number of records or of planimetric drawing , which can be organized only with difficulty on the respective map or at any rate conditions the scale of plotting.
At the same time we want to mention the fact that we can talk about the digitizing of the terrain by using only one known mathematical method, when we take the land in large, hence when we need either a general image or a very detailed one (but covering a small surface) and this depending on the scale of the modelled image , on the peculiarities of the terrain and on what we expect from the digital model. Here are two illustrative examples ; a) "1" is a digital model for the elevations of the railway stations or of the health resorts ; "2" is a digital model for a pumping station situated on a flat ground which is to be levelled.

C o n c l u s i o n s

The analysis regarding the use of the same type of digital model for a stretch of terrain including the natural and artificial "accidents" of the ground shows that the results we obtain (especially regarding the volumes of earthworks) are not in keeping with the reality. Therefore it is necessary to divide the area under consideration into homogeneous parts and to adopt for each of them a digital sub-model of the most adequate terrain.
The digital model of an area where land reclamation works are planned, should be worked out of a number of specific digital sub-models.
The quality of a general digital model of the terrain is sequred only if we correctly select the characteristic height points when we draw up the various digital sub-models, which

depends on the quality of the operator working in the field or of the stereo plotting instrument and on their capacity to generalize the various usual field situations.

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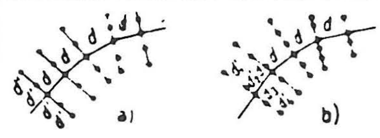
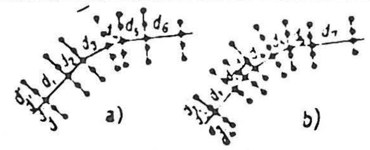
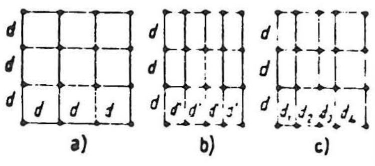
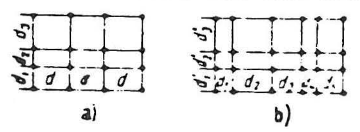
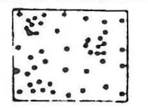
TYPE	SUB - TYPE		Simbolic notation for a digital model: any d.m.	Simbolic notation for a digital model: terrain d.m.	EXEPLIFICATION
1 The points are placed at constant or variable intervals on straight lines perpendicular to a straight-zine or curve axis	A The distances between the straight lines perpendicular to the axis are constant	a) The distances between the points placed on the straight lines are constant	DXM^{1}_{cc}	DTM^{1}_{cc}	
		b) The distances between the points placed on the straight lines are variable	DXM^{1}_{cv}	DTM^{1}_{cv}	
	B The distances between the straight lines perpendicular to the axis are variable	a) The distances between the points placed on the straight lines are constant	DXM^{1}_{vc}	DTM^{1}_{vc}	
		b) The distances between the points placed on the straight lines are variable	DXM^{1}_{vv}	DTM^{1}_{vv}	
2 The points are placed at the intersection of some horizontal and vertical straight lines which create a particule of points	A The distances between the horizontal straight lines are constant	a) The distances between the vertical straight lines are constant and equal to those between the horizontal straight lines	$DXM^{2}_{c=c}$	$DTM^{2}_{c=c}$	
		b) The distances between the vertical straight lines are constant and different from those between the horizontal straight lines	$DXM^{2}_{c\neq c}$	$DTM^{2}_{c\neq c}$	
		c) The distances between the vertical straight lines are variable	DXM^{2}_{cv}	DTM^{2}_{cv}	
	B The distances between the horizontal straight lines are variable	a) The distances between the vertical straight lines are variable	DXM^{2}_{vc}	DTM^{2}_{vc}	
		b) The distances between the vertical straight lines are variable	DXM^{2}_{vv}	DTM^{2}_{vv}	
3 The points are placed in an arbitrarily given space	—	—	DXM^{3}	DTM^{3}	

„x" It is replaced by the letter defining the nature of the digital model (i e. - T - terrain , P- project s.o.)

Fig. 1. Types and sub-types of digital models

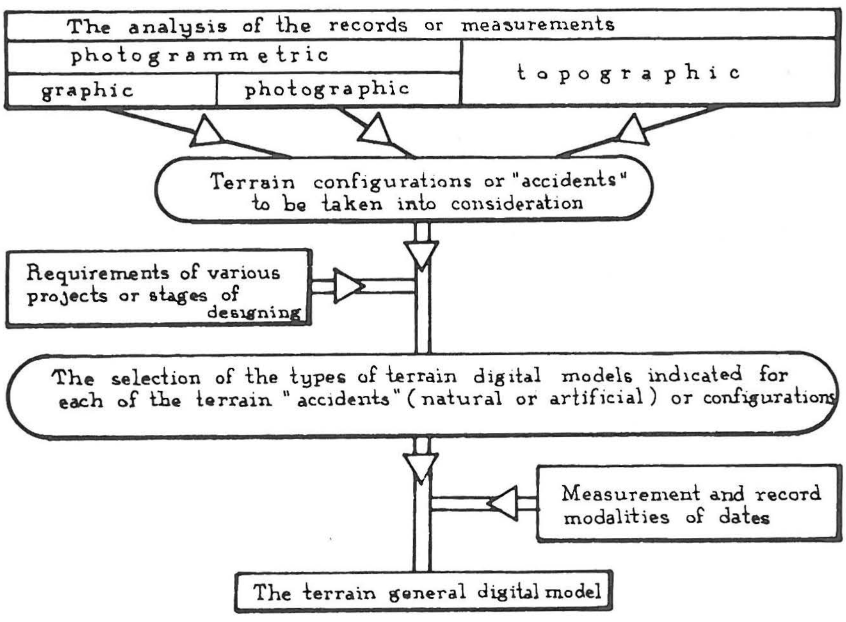


Fig. 2 The drawing up diagram of a terrain general digital model .

Fig. 3. Delimitation of the terrain configurations or accidents (area in the south-west of Dobrudja, on the right bank of the Danube River)
A - horizontal zones ; B - sloping flat areas ; C - gently rolled areas ; D - powerfully rolled areas ; E - natural terrain "accidents" ; F - artificial terrain "accidents"

TERRAIN FORM OR ACCIDENT	THE TYPE OF THE DIGITAL MODEL (corresponding to the notations in fig. 1)
A_1 , A_2	DTM^2_{cc}
B_1 — B_{25}	$DTM^2_{c=c}$, $DTM^2_{c\neq c}$, DTM^2_{cv} , DTM^2_{vc} , DTM^2_{vv}
C_1 — C_8	DTM^3 , DTM^2_{vv}
D_1 — D_5	DTM^3
E_1 — E_{13}	DTM^3
F_1	DTM^1_{vv}
F_2	DTM^1_{cc} , DTM^1_{cv} , DTM^1_{vc} , DTM^1_{vv}
F_3	DTM^1_{cc}

TABLE 1. The selection of the types of digital model for the delimitated terrain forms or " accidents ".

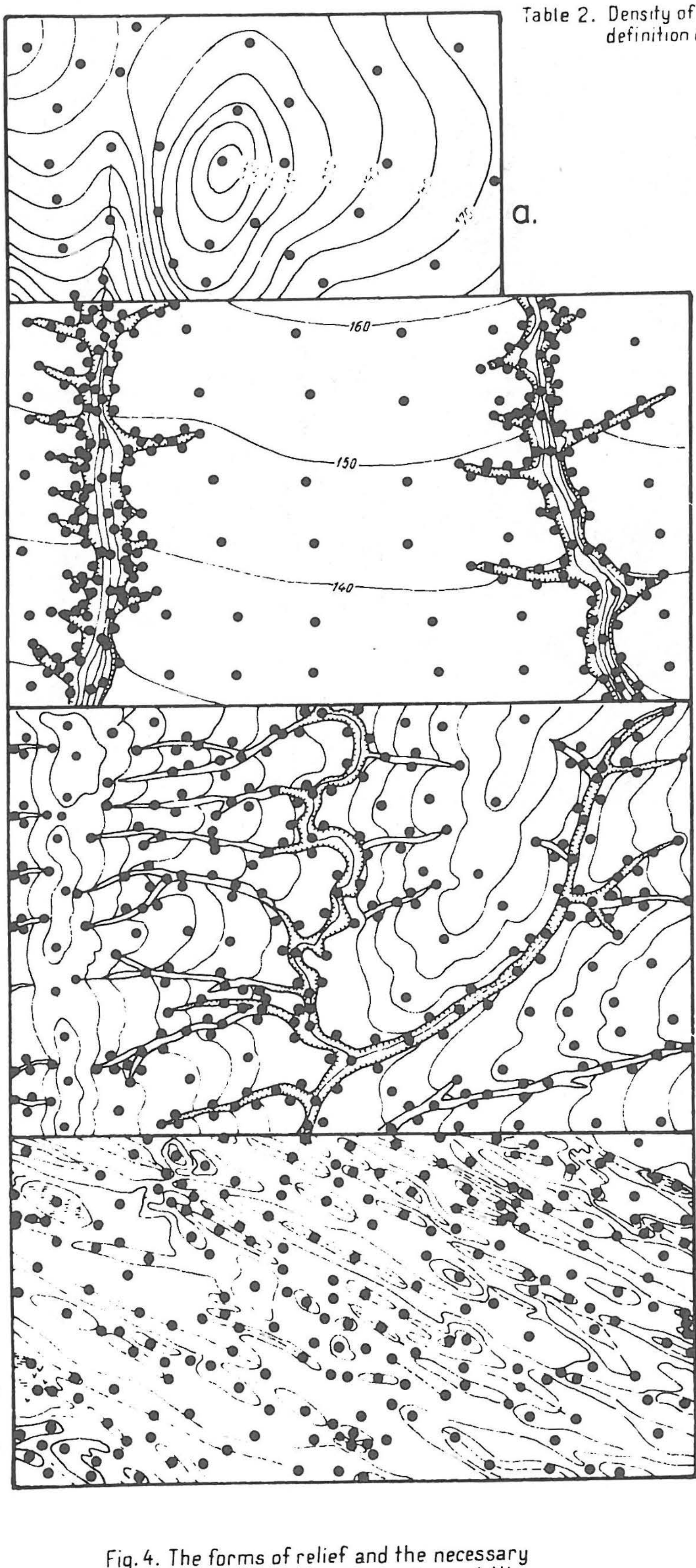


Fig. 4. The forms of relief and the necessary characteristic points for thein plotting in a digital model.

Table 2. Density of the height points which are necessary to the definition of some terrain configurations or „accidents“*)

Number of necessary height points
32
274
280
231

*) The performed analysis is based on the results obtained by Prof. Dr. Enginner N. Oprescu (2) referring to the density of the height points which are necessary in plotting the relief by means of the facet method.

Fig.5 The selection of characteristic points defining the forms of relief and the natural or artificial „accidents"

a.ravine within the hydrographic basin of the Buzău River (terrestrial photogram); b.-area with hollows situated north of Bucharest (aerial photogram); c.-portion of the zone of the Siriu dam during the excavations (terrestrial photogram); d.-portion of the headwater channel for the „Carasu" irrigation system.

• compulsory points; + supplementary points.