

The integration of a topographical and cadastral database of a river basin into a GIS application and the 3D forming operation of the basin in case

Constantin BOFU, Assoc. Prof. PhD. eng., Technical University "Gh. Asachi" Iasi, Roumania, constantinbofu@yahoo.com

Maximilian Diac, Lect PhD. stud. eng., Technical University "Gh. Asachi" Iasi, Roumania, neocadis@gmail.com

Silvia Bofu, PhD. stud. eng., IT Regional Department, Iasi, Roumania, silvia.bofu@ias.cfr.ro

Abstract: *The weather-hydrological phenomenons occured in the last period of time have influenced in a major way the environment and the communities. In order to take the best decisions and to limit, as possible, the human and material losses, it is necessary that systems which allow a full analysis of the special situations to be created, facilitating, in this way, a real time intervention. GIS is one of these types of systems required above and the 3D Model of the field along with an alfa-numerical database represent the optimum solution.*

Keywords: *GIS, 3D Model, Database, Alfa-numerical, Hydrographic basin*

1. Introduction

This work has as purpose to create a certain part of the informative support on a GIS platform in order to realize a real-time analysis base for some hydro-meteorological phenomena.

The chosen study area is the Bahlui hydrographic basin which is a settled basin with many storage lakes and important hydrotechnical works.

The Bahlui hydrographic basin is a 3rd order basin, according to the cadastral classification, having a surface of 1967 sq. km. It is the most important habitation in Moldova that is located on it, the city of Iași.

The basin's surface is framed on 13 map sheets on the scale of 1:50000 (Fig. 1). The maps are edited by the Ministry of National Defense in 1979, in the Gauss-Kruger projection, with the Baltic Sea as the reference system of the quotas.

GIS application was made by using Autodesk Civil 3D platform.

2. Working method

2.1 Graphical data

The process of acquiring the graphical data was made by using the digitizing method inside the screen space. The digitizing process was preceded by the process of scanning the analogical maps and by the cartographic analysis of the trapezes, by means of which the graphical information existing on them was analyzed and the corners' rectangular coordinates were determined, by their transcalculation from the geographical coordinates.

The four corners of each trapeze were used for georeferencing the scanned trapezes.

The graphic data were organized on information layers for their easier manipulation in the integration and editing steps. These layers are as follows:

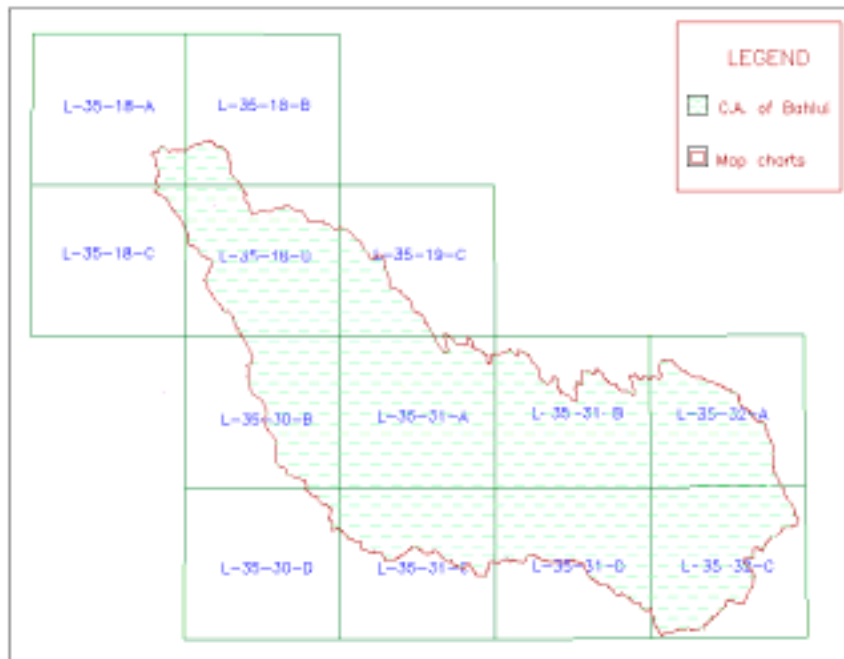


Fig.1. Framing of the Bahlui hydrographic basin on the trapezes 1:50000

- Trapeze – contains the vector limit of the geographical frame ;
- Scanned_trapeze – is the layer to insert the scanned images of the scanned maps;
- Level_curves – are placed the vectorized level curves with the equidistance of 10 m (Fig.2)

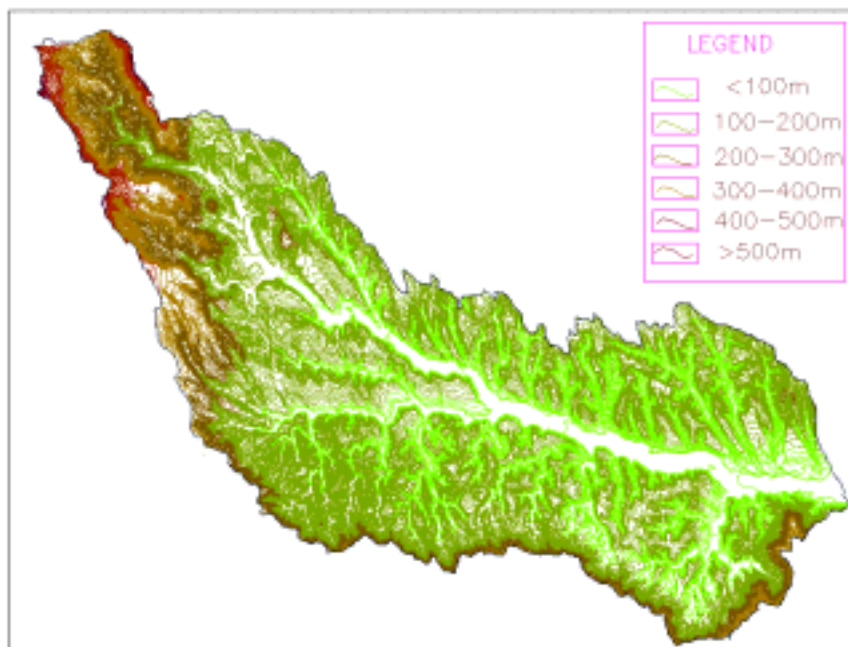


Fig. 2. Bahlui hydrographic basin – level_curve layer

- Hydrographic_basins – is the layer with the vectorial limits of the subbasins up to the 6th order(Fig.3);

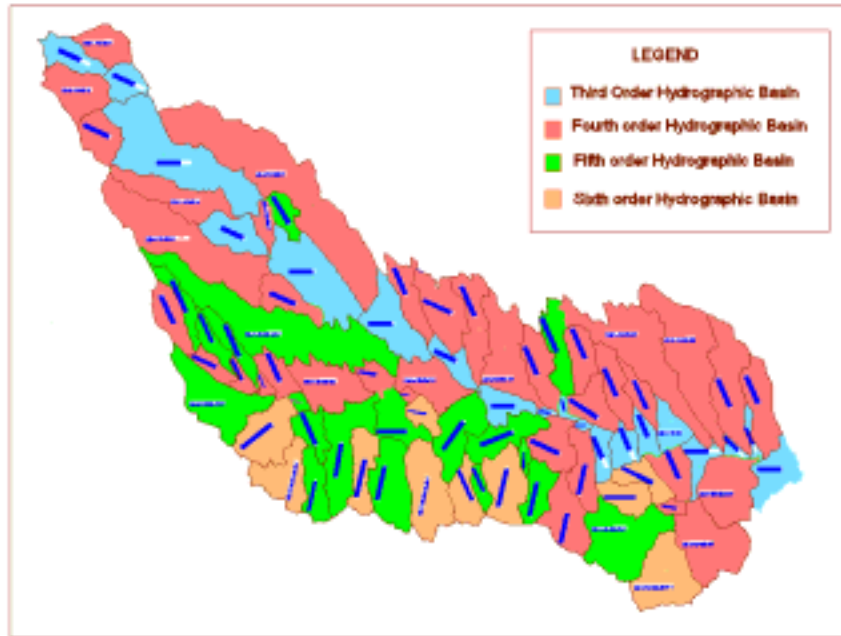


Fig. 3. Bahlui hydrographic basin – Hydrographic_basins layer

- Hydrographics – contains the hydrographic network of the basin (Fig.4);

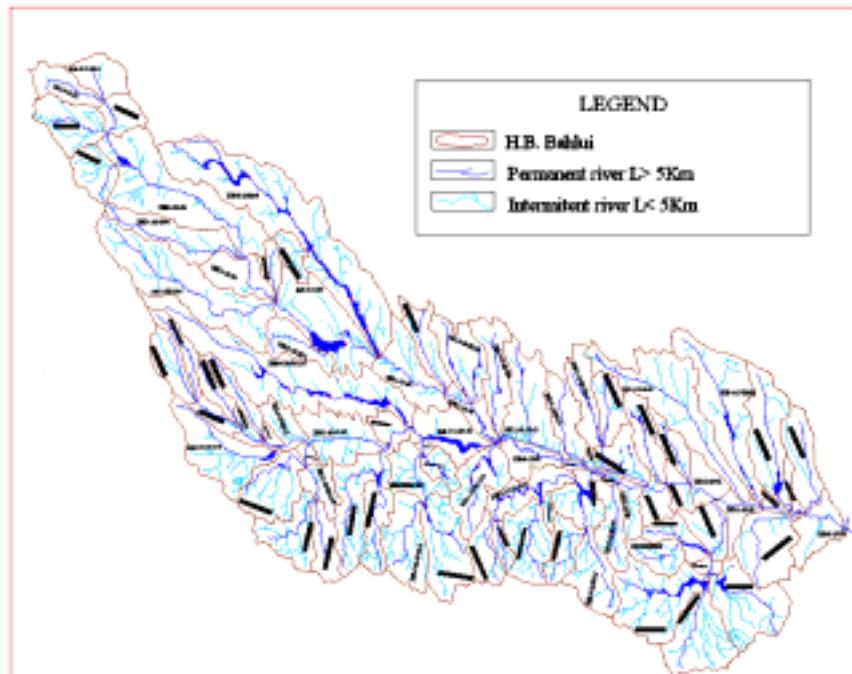


Fig. 4. Bahlui hydrographic basin – Hydrographics and lakes layers

- Measurement_stations – the locations of the meteo and hydrometric stations are placed(Fig.5);

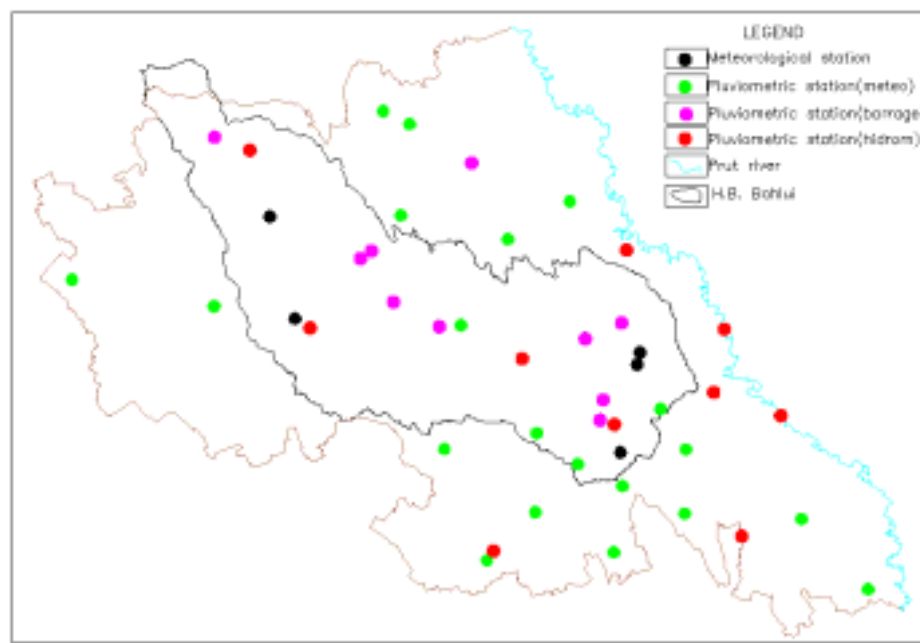


Fig. 5. Bahlui hydrographic basin – Measurement_stations layer

- Cadastral_marks – are represented the cadastral_marks of the cadastral axis are represented;
 - Lakes – all the storage lakes belonging to the basin are placed(fig.3).
- After having the graphical information vectorized, the process of editing information followed; it consisted of applying the procedures of cleaning the information in order that the errors may be eliminated and the topologies on information layers may be realized. There were realized two polygonal topologies(Basins and Lakes), a network topology(Hydrography) and three knot topologies(Meteo_stations, Hydrometric_stations and Marks). Surfaces of the hydrographic subbasins included into the topological database of Basins are presented in table 1.

2.2 Alphanumeric data

Attribute data were acquired into a structure of external database by means of Access. The projected database is called Hydrographic basin and consists of seven relational tables (Fig. 6).

Tables of the database have in their structure the following types of information:

- The table *Hydrographic basin* consists of: cadastral number of the basin, name, surface, average altitude, wooded surface
- The table *Watercourse* consists of: cadastral number of the watercourse (which is the same with the basin's one), name, confluence position regarding the main emissary, length, elevation at riverhead, elevation at rivermouth, average slope, sinuosity ratio;

Table 1 Surfaces of the hydrographic subbasins belonging to the Bahlui hydrographic basin

Identification cod	Nr. crt.	Denomination of the basin	The topological surfaces (km ²)	The surface from the "Water Cadastre" (km ²)
0	1	2	4	5
XIII-1-15-32	1	Bahlui 1	16,419	17,00
XIII-1-15-32	2	Bahlui 2	12,961	12,00
XIII-1-15-32	3	Bahlui 3	79,354	79,00
XIII-1-15-32	3	Bahlui 4	20,577	20,00
XIII-1-15-32	5	Bahlui 5	0,211	0,00
XIII-1-15-32	6	Bahlui 6	48,751	45,00
XIII-1-15-32	7	Bahlui 7	30,430	31,00
XIII-1-15-32	8	Bahlui 8	3,827	3,00
XIII-1-15-32	9	Bahlui 9	7,887	8,00
XIII-1-15-32	10	Bahlui 23	0,197	9,00(1)
XIII-1-15-32	11	Bahlui 10	14,246	15,00
XIII-1-15-32	12	Bahlui 11	1,701	1,00
XIII-1-15-32	13	Bahlui 12	2,496	3,00
XIII-1-15-32	14	Bahlui 13	1,768	1,00
XIII-1-15-32	15	Bahlui 14	10,151	9,00
XIII-1-15-32	16	Bahlui 15	10,898	11,00
XIII-1-15-32	17	Bahlui 16	8,647	9,00
XIII-1-15-32	18	Bahlui 17	12,900	13,00
XIII-1-15-32	19	Bahlui 18	9,227	7,00
XIII-1-15-32	20	Bahlui 19	3,440	3,00
XIII-1-15-32	21	Bahlui 20	1,045	2,00
XIII-1-15-32	22	Bahlui 21	4,326	4,00
XIII-1-15-32	23	Bahlui 22	20,319	21,00
XIII-1-15-32-1	24	Bahlui. Mic	16,743	17,00
XIII-1-15-32-2	25	Valea Mare	25,633	27,00
XIII-1-15-32-3	26	V. Cetățuiei	17,098	17,00
XIII-1-15-32-4	27	Buhalnița	30,591	33,00
XIII-1-15-32-5	28	Vulpoiu	7,766	8,00
XIII-1-15-32-6	29	Măgura	75,705	78,00
XIII-1-15-32-7	30	Putna	16,958	16,00
XIII-1-15-32-8	31	Gurguiata	120,969	117,00
XIII-1-15-32-8-1	32	Valea Nuc.	9,788	10,00
XIII-1-15-32-9	33	Lungu	17,967	20,00
XIII-1-15-32-10	34	Durușca	27,713	30,00
XIII-1-15-32-12	35	Bahluiet 1	17,014	17,00
XIII-1-15-32-12	36	Bahluiet 2	8,086	8,00
XIII-1-15-32-12	37	Bahluiet 3	5,240	5,00
XIII-1-15-32-12	38	Bahluiet 4	3,023	3,00
XIII-1-15-32-12	39	Bahluiet 5	12,625	11,00
XIII-1-15-32-12	40	Bahluiet 6	30,390	30,00
XIII-1-15-32-12	41	Bahluiet 7	9,494	10,00
XIII-1-15-32-12	42	Bahluiet 8	25,859	26,00
XIII-1-15-32-12-1	43	Pășcănia	11,235	12,00
XIII-1-15-32-12-2	44	Probotă	9,710	10,00
XIII-1-15-32-12-3	45	Cucuteni	12,678	13,00

XIII-1-15-32-12-4	46	Rediu	41,250	42,00
XIII-1-15-32-12-5	47	Ciuncă 1	15,981	16,00
XIII-1-15-32-12-5	48	Ciuncă 2	12,659	12,00
XIII-1-15-32-12-5	49	Ciuncă 3	3,188	3,00
XIII-1-15-32-12-7	50	Valea Oii	95,795	97,00
XIII-1-15-32-12-5-1	51	Lunca	24,948	27,00
XIII-1-15-32-12-5-2	52	Bahna	29,910	30,00
XIII-1-15-32-12-6-2	53	Albești	36,448	36,00
XIII-1-15-32-12-6-1	54	Goești	18,685	18,00
XIII-1-15-32-12-8	55	Sinești 1	32,031	34,00
XIII-1-15-32-12-8	56	Sinești 2	18,833	18,00
XIII-1-15-32-12-8	57	Sinești 3	2,044	2,00
XIII-1-15-32-12-8-1	58	Gâmboasa	35,729	35,00
XIII-1-15-32-12-8-2	59	Iaz. din Văi	9,208	8,00
XIII-1-15-32-12-9	60	Hărpășești	28,722	28,00
XIII-1-15-32-12a	61	Tatoești	24,900	25,00
XIII-1-15-32-13	62	Hoisești	38,103	38,00
XIII-1-15-32-14	63	Ileana	20,283	21,00
XIII-1-15-32-15	64	Voinești 1	25,551	26,00
XIII-1-15-32-15	65	Voinești 2	20,09	21,00
XIII-1-15-32-15-2	66	Săuzeni 1	6,120	6,00
XIII-1-15-32-15-2	67	Săuzeni 2	22,08	22,00
XIII-1-15-32-15-2	68	Săuzeni 3	3,466	3,00
XIII-1-15-32-15-1	69	Horlești	15,858	16,00
XIII-1-15-32-15-2-1	70	Durduc	15,651	16,00
XIII-1-15-32-15-2-2	71	Căsuța Mare	27,701	28,00
XIII-1-15-32-17a-1	73	Roșior	19,444	20,00
XIII-1-15-32-17a	74	Bogonas 1	16,111	16,00
XIII-1-15-32-17a	75	Bogonas 2	17,083	16,00
XIII-1-15-32-18	76	Lupu	18,665	19,00
XIII-1-15-32-19	77	Rediu	11,908	11,00
XIII-1-15-32-17	78	Pârâul Mare	19,033	19,00
XIII-1-15-32-20	79	Nicolina 1	41,828	42,00
XIII-1-15-32-20	80	Nicolina 2	3,767	3,00
XIII-1-15-32-20	81	Nicolina 3	16,163	14,00
XIII-1-15-32-20-1	82	Valea Locei	48,042	49,00
XIII-1-15-32-20-1-1	83	Frumoasa	36,698	36,00
XIII-1-15-32-20-2-1	84	Cornet	14,843	15,00
XIII-1-15-32-20-	85	Ezăreni	13,975	19,00
XIII-1-15-32-21	86	Cacaina	62,486	63,00
XIII-1-15-32-22	87	Chirița	38,313	39,00
XIII-1-15-32-23	88	Ciric	57,923	58,00
XIII-1-15-32-24	89	Vămășoaia	34,835	35,00
XIII-1-15-32-25	90	Orzeni	25,077	25,00
TOTAL:			1955,491	1967,00

- Table *Storage_lakes* has values of the following attributes: storage name, lake surface, surface of the laying-up basin, average flow, average stock, dead storage, available storage, storage retained in case of breaking up some pools, protection storage, volume between the top of the waste weir and the cornice, total volume, value of the drain axis, value of the waste weir's top, value of the cornice, drain's dimensions, waste weir's width, value of the normal retention level, value of the maximum level with assuring 1%, value of maximum level with assuring 0,1%, value of maximum level with

assuring 0,01%, value of maximum level with assuring 0,01% plus breaking up the dam, type of use for the storage lake.

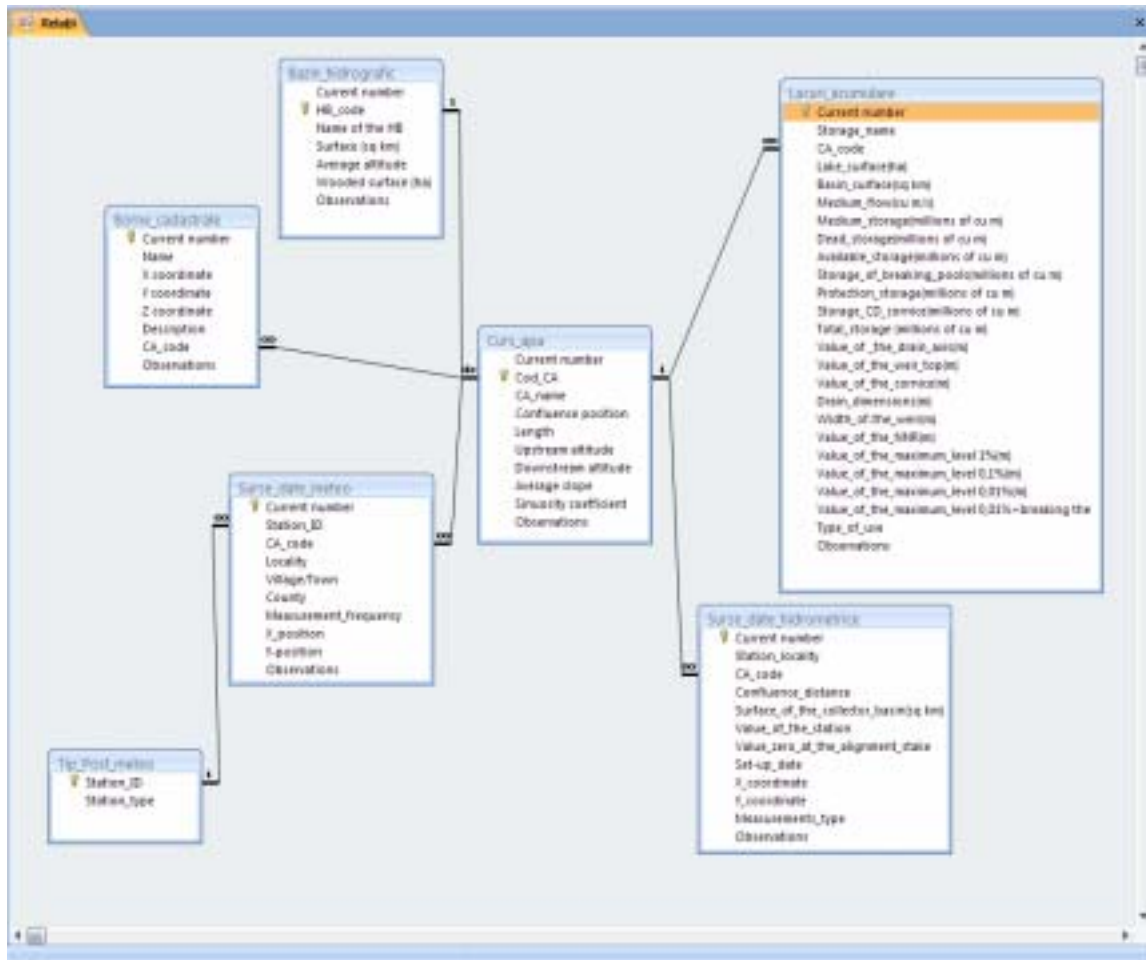


Fig. 6. The projected database Hydrographic basin

- Table *Cadastral_marks* has the following attributes: mark's name, coordinates of the spatial position(X,Y,Z), marks' description.
- Table *Sources_of_meteo_data* contains data about the following attributes: identification code of the station, locality where it is placed, village or town to which it belongs administratively, county, measurement technique (permanent or periodic), spatial position
- Table *Sources_of_hydrometric_data* contains information about: locality where the station is located, distance from the confluence, surface of the measured receiving basin, station height, height zero on the alignment stake, set-up date, coordinates of the spatial position, type of the executed measurements(levels, flows, etc)
- Table *Type_of_the_Meteo_Stations* contains the four types of posts for taking over the data from precipitations: rainfall stations belonging to the pluviometric network, rainfall stations belonging to the meteorological network, rainfall stations belonging to the hydrometric network, rainfall stations at the barrages, meteorological stations.

Loading the database was realized by means of some forms defined inside the database according to figure 7.

Current number:	1	Value of the drain top(m):	160,80
Storage name:	Fărcovaci	Value of the weir top(m):	170,00
CA code:	XIII-3-15-32	Value of the cornice(m):	178,60
Lake surface(ha):	58	Drain dimensions(m):	7 buc 165x225
Basin surface(sq km):	95	Width of the weir(m):	45,00
Medium flow(cu m/s):	0,424	Value of the NPM(m):	170,00
Medium storage(millions of cu m):	13,45	Value of the maximum level 1%(m):	177,30
Dead storage(millions of cu m):	0,50	Value of the maximum level 0,1%(m):	178,30
Available storage(millions of cu m):	5,00	Value of the maximum level 0,01%(m):	182,00
Storage of breaking pool(milions of cu m):	-	Value of the maximum level 0,01%+break:	-
Protection storage(millions of cu m):	-	Type of use:	Irigați - 200ha; AP-200 Ps; Abonare vitari
Storage CD cornice(millions of cu m):	2,50	Observations:	Abonarea vitari se face numai prin descirculări de suprafață
Total storage (millions of cu m):	9,00		

Fig 7. The forms defined inside the database

2.3. Connecting the attribute-typed data to the graphical elements

Connecting the attribute-typed data to the graphical elements was made automatically by bringing the data base in the GIS environment and by using the functions of realization the connections. These connections were realized as follows:

- Recordings of the table Water_mark were connected to the topological graphical elements having the type Hydrography network
- Recordings of the table Hydrographic_Basin were connected to the polygon-typed topological graphical elements of Basins
- Recordings of the table Storage_lakes were connected to the graphical topological polygon-typed elements of Lakes
- Recordings of the table Cadastral_marks were connected to the topological graphical knot-typed elements of Marks
- Recordings of the table Sources_meteo_data were connected to the knot-typed topological graphical elements of Meteo_stations
- Recordings of the table Sources_of_the_hydrometrical_data were connected to the knot-typed topological graphical elements of Hydrometrical_stations

2.4. Realizing the numerical model of the land

Civil 3D has functions of creating 3D models of the lands and spatial analyzing on these models. Since the basin's surface is big, realizing the 3D model of the land requires a great capacity hardware platform, i.e. a performance graphical station.

In the figure 8 we present the 3D model of the land for a hydrographic subbasin.

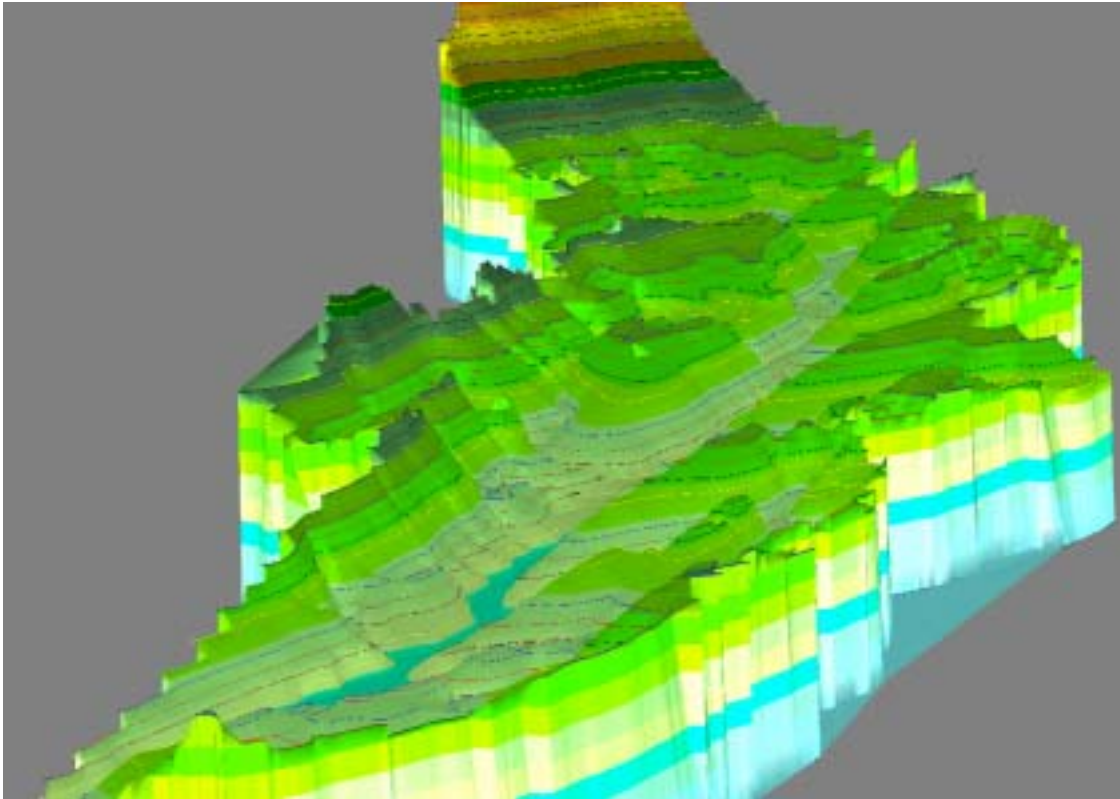


Fig 7. 3D model of the Gurguiata hydrographic subbasin

3. Conclusions and proposals

- The two types of data, graphical and alphanumeric, integrated on the GIS platform allow getting some useful information about: characteristics of the Bahlui hydrographic basin and of its subbasins; their riggings and spatial localization.
- The 3D model completed with other data too (soils, types of use,..) permits creation of spatial analysis of the drain, determinations of the drain directions, level of the sunlit condition, slopes, erosions, etc.
- The model can be updated very easily when there appear some changes in the relief and other details in that piece of land.
- The database can be easily completed and connected.

4. References

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