

UPDATING OF THE CARTOGRAPHIC DATABASE OF THE ADMINISTRATIVE TERRITORIAL - UNITS FROM THE SURFACE DRAINAGE AND UNDERGROUND PIPE DRAINAGE SYSTEMS

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Abstract

The natural conditions from the extra Carpathian region of Suceava County have favored the humidity excess at the surface of the agricultural fields and in the superficial layers of the soil profile. In order to eliminate the water excess from the natural field-soil units the following systems have been created: surface drainage, underground drainage, ridged rows, deep harrowing. In the Suceava Plateau, with the following sub-units: Baia Depression, Falticeni Plateau, Dragomirnei Plateau and Radauti. Depression have been created more than 20 large hydroameliorative systems and a series of local systems for regulating the water regime in the soil and for effectively using the land resources. The case study included the framing of Suceava County in cadastral maps, scale 1: 50,000. Based on these geospatial data the land boundaries of the Baia - Sasca surface draining and underground draining system have been drawn up on 28 trapeziums, scale 1:5,000. The hydrotechnical scheme of the Baia - Sasca hydroameliorative system has been created between 1978 and 1980 on a total surface of 5,500 ha. The territorial distribution of the hydroameliorative system included the following five territorial - administrative units of the communes: Horodniceni, Cornu Luncii, Radaseni, Baia and Vadu Moldovei. The updating of the cartographic database was made using the coordinates system of the 1970 Stereographic projection for the 28 geodetic trapeziums at scale 1:5,000 that rigorously framed the hydroameliorative system studied, which represents the graphic support of the cadastral records of the land surfaces officially registered in the land register..

Key words: underground pipe drainage, cartographic database, geodetic trapeziums

After performing the measurements at the level of the basic administrative territorial units are obtained the primary technical data of the unitary cadastral system and land register on cadastral sectors and real estate/parcels (Cadastru and Real Estate Publicity Law no.7/1996, amended, 2013).

From the content of the unitary data base of the integrated cadastre and land register system, all the necessary elements for creating the specialty information cadastre system are extracted by the users. From the information systems organized nowadays for various fields of activity, the ones pointed out are those referring to the fields with the following use categories: *agricultural, forestry, water, incorporated, communication paths, natural protected areas and others* (Moca V., 2013 et al.). For the fields with agricultural destination and use there are created at national, regional and local level a wide range of information systems on the following categories of land improvement works: irrigations, damming and water flow regularization, surface drainage and underground pipe drainage systems, combating soil erosion, preventing and combating landslides.

In Suceava County, surface drainage systems were set up on 55, 100 ha, tile drainage networks on 26, 300 ha and systems of embanking and protection against floods on 7, 400 ha between 1960 - 1990 to remove this excess moisture (Bucur D., Moca V., 2012).

Surface drainage and pipe drainage works have contributed on the one hand, to reduce excess soil moisture and secondly to increase production capacity of these soils.

A drainage system reduces the volume of drainage water leaving a field by 20 – 30% on average; however, the outflow varies widely, depending on the soil type, rainfall, type of drainage system and management intensity (Ramoska E., et al, 2011).

In the last period of time there have been expanded the topographic and geodetic measurements based on high technologies, with the help of which there have been drawn up and created maps for the flood risk fields. (Coșarcă C. et al. 2013).

Among the methods frequently used in cadastral measurements are pointed out the ones

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performed with the help of the total stations, the digital photogrammetry technique and the GNSS satellite technology and others (Bos N., Iacobescu O., 2007).

MATERIAL AND METHOD

Patrimoniul Suceava's county land patrimony has the total surface of 855,350 ha, of which: 349,502 ha agricultural land (41%) and 505,848 ha, non-agricultural land (59%). Among the use categories of the agricultural field, it stands out the arable field with 177,801 ha, being followed by pastures and natural hayfields. The territorial placement of Suceava County has determined, according to the natural conditions, the distribution of the agricultural field in three distinct areas:

The plain area, including almost 1/3 of the agricultural surface is placed in the river meadow and the terraces of the hydrographic basins of Suceava and Siret rivers, in the south-eastern part of the county.

The hilly and the plateau areas include the sub-Carpathian hills from the central and the north-eastern part of the county (*Dragomirnei Plateau and Falticeni Plateau*).

The mountain area is characterized by cold and moist climate in which there are numerous natural pastures and poorly fertile soils (*Oriental Carpathians*).

In the natural conditions of the agricultural fields from Suceava County, over the years, it was recorded the permanent humidity excess that caused the soil gleization process and the temporary humidity excess which contributed to the production of the stagnogleization process.

From the agricultural surfaces with permanent humidity excess there have been pointed out, first of all, the ones from Radauti Depression. The areas with temporary humidity excess have been identified both in the Dragomirnei Plateau and the Falticeni Plateau. In these areas there have been performed a series of works meant to collect and eliminate the water excess. The first works for eliminating the water excess consisting of a systematic network of draining canals that was afterwards completed by underground pipe draining system are the ones made toward the end of the 19th century and the beginning of the 20th century in Radauti Depression, by the Agricultural Society from Viena (Moca V., et al, 2010).

The surface draining works and the underground pipe draining system from Suceava County were made in several stages. Thus, between 1950 and 1975 there have been created a series of surface draining systems and water regularization systems - damming waterways. In another period that lasted between 1976 and 1990 new works intended to eliminate the humidity excess have been performed on hydrographic basins. Here there have been included the surfaces from various administrative territorial units. The stage between 1990 and 2000 included, according to the local requests made, works meant to complete and clean the old systems.

At the same time, there have been set a series of local systems meant to capture and evacuate the water excess, being mentioned various works of damming the water courses to prevent flooding and freshet.

According to the data of the Direction for Agriculture and Sustainable Development from Suceava, the total surface where surface draining works and underground pipe draining works have been performed is of 55,100 ha, and according to the execution contracts, on 26,300 ha of the total it has been performed a systematic underground draining network, consisting in collecting drains and absorbing drains. These works include 20 large systems and a series of local systems that have been made in all territorial administrative units. They are positioned in the extra Carpathian area of Suceava County.

The case study consisted in updating the geospatial database, the works being performed first for the territory of Suceava County. On the graphic support of the geodetic trapeziums, scale 1:50,000, it was performed the cartographic framing of the Baia - Sasca hydroameliorative system that included the surface draining and underground pipe draining system. This hydroameliorative system included the water side and the terraces from the left side of the water course, from the hydrographic basin of Moldova river, respectively.

The technical and specialty data of the agricultural field from the Baia – Sasca system must be registered in the cadastral records of the following administrative territorial units: Horodniceni, Cornu Luncii, Radaseni, Baia and Vadu Moldovei.

For updating the data base from the information system of the cadastre for agricultural fields foreseen with surface and underground draining it was framed the hydrotechnical scheme of the Baia – Sasca system on cadastral maps, scale 1: 50,000 with the nomenclature: L-35-17-C (Baia) and L-35-17-D (Fălticeni).

Depending of the positioning of the hydrotechnical scheme on the five territorial administrative units, the cartographic framing has been detailed on map sheets, scale 1:25,000 on the plan sheets, scale 1: 10,000 and scale 1:5,000. The geospatial database calculation and assignment was established in the official system of plane rectangular coordinates of the 1970 Stereographic projection, which included the corners, the dimensions and the areas of the 28 geodetic trapeziums, scale 1:5,000.

On the graphically georeferentiated fund of the trapeziums, scale 1:5,000 there have been placed the themed layers of the parcel system from the five administrative territorial units and the hydrotechnical scheme, respectively.

The graphic fund of the geospatial distribution of the hydrotechnical scheme included, according to the technical data from the execution contract, a total surface of 5,527 ha, and on 1,806 ha of them there has been created a systematic underground pipe draining network.

RESULTS AND DISCUSSIONS

The application of cadastral works at the level of the administrative territorial units ensures the fulfillment of the economic and legal requirements of the local community. The cadastral information system from an administrative area includes the two distinct areas, the incorporated and the unincorporated ones with the specific use categories, agricultural and non – agricultural.

a. Suceava County's geographic position

The administrative territory of Suceava county is positioned in the North-East of Romania. Considering the cadastral delimitations, there are the following border lines: in the North – the state border with Ukraine, in the East - Botosani and Iasi counties, in the South – Neamt and Harghita Counties, in the West – Mures, Bistrita-Nasaud and Maramures County.

The territory expands between the volcanic mountains of the Oriental Carpathians (*Calimani Mountains*) and Suceava Plateau represented by the following sub units: *Dragomirnei Plateau, Falticeni Plateau and Siret Valley*.

The geographical position of the county's territory is given by the geographic coordinates parallel 47°05' south and 47°58' north, and meridian: 24°53' west and 26°40' east (*figure 1*).

b. Cartographic framing of Suceava's administrative territory

For the projection of the underground drainage works it has been used the following cartographic documentation: cadastral maps scale 1:50,000 and basic topographic plans, scales 1:5,000 and 1:2,000. For the surface and underground draining works performed in Suceava County, and the general technical projects it was used the cadastral map, scale 1:50,000 edited in 1982, in the 1970 Stereographic projection system. At the same time, there have been used basic the topographic plans scale 1:5,000, to establish the technical solutions of the execution projects for the surface drainage and underground pipe drainage hydroameliorative systems.

For updating the cartographic database of the hydroameliorative systems, there were considered, first of all, the nine map sheets scale 1: 100,000 (geodetic trapeziums) that frame the borders of Suceava's territory. The geodetic trapeziums scale 1:100,000 have been divided in four equal parts that correspond to the map sheets scale 1:50,000. The cartographic framing scale 1:50,000 included 38 geodetic trapeziums.

For solving the case study the following trapeziums were used L-35-17-C (Baia) and L-35-17-D (Falticeni), which framed the spatial position of the hydroameliorative system (*figure 1*).

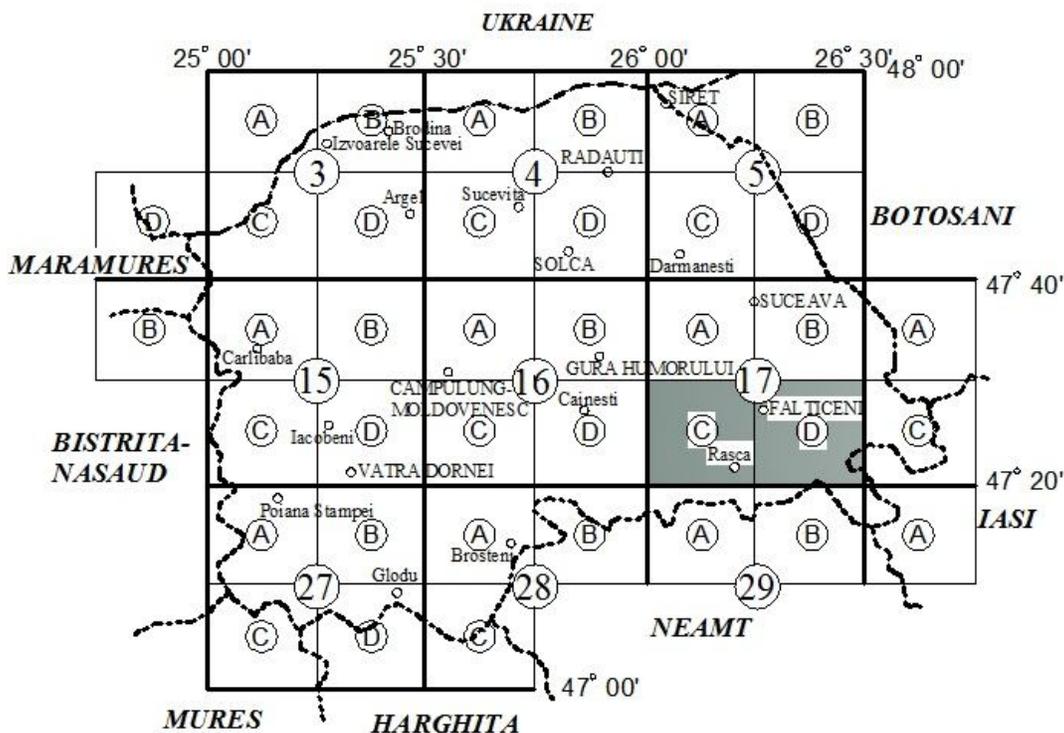


Figure 1 Cartographic framing of the cadastral territory of Suceava County

c. Calculation of the cartographic database of the geodetic trapeziums scale 1:5,000

For the hydrotechnical scheme of the **Baia – Sasca** surface and underground draining system it has been calculated the cartographic base of the **28 geodetic trapeziums**, scale 1:5,000, which frame the total surface of **5,527 ha** of the territory works have been performed on.

Depending of the geographical coordinates (φ , λ) of the corners of the geodetic trapeziums from the surface of the **Krasovski-1940** reference ellipsoid there have been determined the plane 1970 - stereographic rectangular coordinates (**X<70>**, **Y<70>**). The algorithm used (Moca V., Oniga Ersilia, 2011) included the calculations in the following order:

- **Based on the scheme with the spatial distribution and the nomenclature of the geodetic trapeziums** it has been made the transformation of geographical coordinates into plan stereographic rectangular coordinates using the method of noticed coefficients (figure 2).

- **Coordinates calculation (x_{tg} , y_{tg})** from the **“tangent plan”**, parallel with **“the secant unic-1970 plan”** with the formula:

$$x_{tg} = (a_{00} + a_{10}f + a_{20}f^2 + a_{30}f^3 + a_{40}f^4 + a_{50}f^5 + a_{60}f^6) l, 00 + (a_{02} + a_{12}f + a_{22}f^2 + a_{32}f^3 + a_{42}f^4 + \dots) l^2 + (a_{04} + a_{14}f + a_{24}f^2 + \dots) l^4 + (a_{06} + \dots) l^6 \quad [m]$$

$$y_{tg} = (b_{01} + b_{11}f + b_{21}f^2 + b_{31}f^3 + b_{41}f^4 + b_{51}f^5) l + (b_{03} + b_{13}f + b_{23}f^2 + b_{33}f^3 + \dots) l^3 + (b_{05} + b_{15}f + \dots) l^5 \quad [m]$$

Where:

f = $10^{-4}\Delta\varphi$ - the latitude difference between teh point given (φ_i) and the projection pole ($\varphi_0 = 46^\circ$);
l = $10^{-4}\Delta\lambda$ – the longitude difference between the given point (λ_i) and the projection point ($\lambda_0 = 25^\circ$);

constant coefficients a_{00} , a_{10} , ... b_{01} , b_{11} for the coordinates of hte projection pole and the geometric parameters of the **Krasovski-1940** reference ellipsoid.

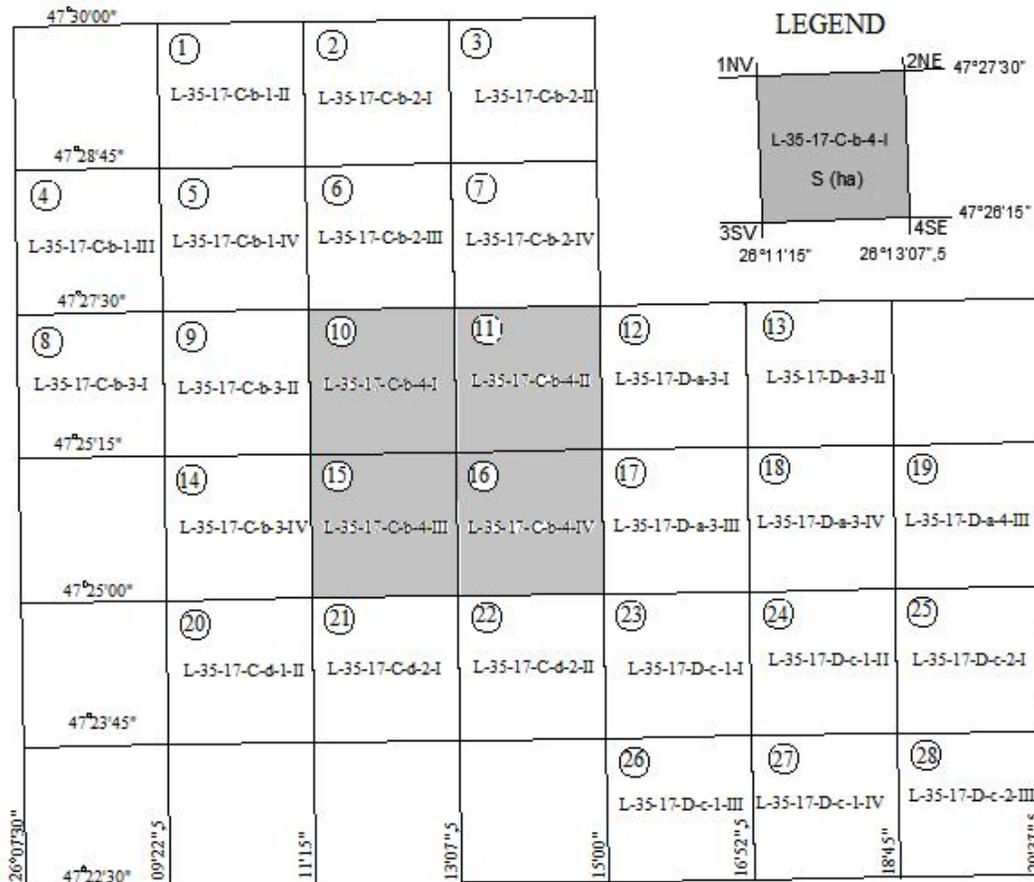


Figure 2 Scheme and nomenclature of geodetic trapeziums, scale 1:5,000, from the Baia-Sasca hydromeliorative system

Calculation of plane rectangular coordinates from the secant plan of the 1970 Stereographic projection (x_{sec} , y_{sec}), was made by modifying the scale of the tangent plane, in the secant plane using the coefficient or the constant module: $C = 0.999\ 750\ 000$.

$$x_{sec} = x_{tg} \cdot 0.999\ 750\ 000 \quad [m]$$

$$y_{sec} = y_{tg} \cdot 0.999\ 750\ 000 \quad [m]$$

-Calculation of plane rectangular coordinates depending of the conventional origin that resulted after translating the origin of real axes system (XOY) by 500,000 m to the South and 500,000 m to the west.

$$X<70> = x_{sec} + 500,000\ m$$

$$Y<70> = y_{sec} + 500,000\ m$$

The values obtained in the case study conducted on the points representing the corners of the geodetic trapeziums scale 1 : 5,000 (1NV, 2NE, 3SV, 4SE) are presented for the **four trapeziums** situated in the central area of the hydroameliorative system, as follows:

- L-35-17-C-b-4-I (table 1)
- L-35-17-C-b-4-II (table 2)
- L-35-17-C-b-4-III (table 3)
- L-35-17-C-b-4-IV (table 4)

Depending of the stereographic coordinates ($X<70>$, $Y<70>$) of the trapeziums corners, scale 1:5,000 there have been calculated the areas of the **28 trapeziums** that cartographically frame the hydrotechnical scheme of surface and underground draining with the general formulas:

$$+2S = \sum_{i=1}^n x_i (y_{i+1} - y_{i-1}) \quad [m^2]$$

$$-2S = \sum_{i=1}^n y_i (x_{i+1} - x_{i-1}) \quad [m^2]$$

The values obtained for the areas of the **four trapeziums** situated in the central part of the hydroameliorative system are presented in *tables, 1, 2, 3 and 4*, based on the program used.

After making the new cadastral measurements at the level of each administrative territorial unit and for the basic entities, it results necessary to compensate and restrict the surfaces measured on the **trapezium's control area**.

The reporting of the cadastral basic entities is going to be performed on the graphic support of the geodetic trapezium, scale 1:5,000 for both the agricultural fields on which surface draining and underground pipe draining works have been performed, and the agricultural fields not included in these works.

Table 1

Coordinates and area of geodetic trapeziums

Trapezium L-35-17-C-b-4-I		
Point no.	1970 stereographic coordinates	
	X<70> (m)	Y <70> (m)
1NV	662 763.049	589 532.925
2NE	662 799.077	591 888.951
3SV	660 447.125	589 567.877
4SE	660 483.161	591 924.823
Trapezium surface		545.8709 ha

Table 2

Coordinates and area of geodetic trapeziums

Trapezium L-35-17-C-b-4-II		
Point no.	1970 stereographic coordinates	
	X<70> (m)	Y <70> (m)
1NV	662 799.077	591 888.951
2NE	662 836.042	594 244.969
3SV	660 483.161	591 924.823
4SE	660 520.134	594 281.761
Trapezium surface		545.8739 ha

Table 3

Coordinates and area of geodetic trapeziums

Trapezium L-35-17-C-b-4-III		
Point no.	1970 stereographic coordinates	
	X<70> (m)	Y <70> (m)
1NV	660 447.125	589 567.877
2NE	660 483.161	591 924.823
3SV	658 131.22	589 602.823
4SE	658 167.264	591 960.689
Trapezium surface		546.0795 ha

Table 4

Coordinates and area of geodetic trapeziums

Trapezium L-35-17-C-b-4-IV		
Point no.	1970 stereographic coordinates	
	X<70> (m)	Y <70> (m)
1NV	660 483.161	591 924.823
2NE	660 520.134	594 281.761
3SV	658 167.264	591 960.689
4SE	658 204.245	594 318.547
Trapezium surface		546.0825 ha

d. Cartographic framing of the hydroameliorative system on geodetic trapeziums

In the “*Baia Depression*” which includes the water side and the terraces from the left watercourse of Moldova River, the first regularization and draining works have been performed in 1959 – 1960. These works have been redimensioned and expanded based on a new execution project that was made in 1978 – 1980.

The dimensional elements of the technical execution project included the following categories of hydrotechnical arrangements and constructions:

Surface draining of 5,527 ha that included a systematic network of draining canals of different orders, the distance between them ranging from 300 to 400m. The total length of the draining canals was of 168.10 km.

Surface draining of 1,806 ha which consisted in underground ceramic pipe draining network and different orders of plastic materials. The distance between the absorbing draining lines ranged between 15 and 20 m, with the depth of 0.80 - 1.10 m (figure 3).

Hydrotechnical constructions performed on the surface draining and evacuating network and, the agricultural roads, respectively have been made through **7 consolidated bridges with reinforced concrete slabs and 76 tubular footbridges.**

Hydrotechnical constructions performed along the collecting drains network included: 48

visiting holes and the consolidation of evacuation holes of the collecting drains in opened canals.

The hydrotechnical surface draining and underground pipe draining scheme created in the Baia - Sasca system was rigorously framed on 28 geodetic trapeziums, reported on the basis of the 1970 - stereographic trapeziums, scale 1:5,000.

For the presentation of the plane rectangular coordinates of the corners of the geodetic trapeziums it was used the **AutoCADMap 2011.**

The updating of the cadastral plan implies the use of the graphic entities of the hydrotechnical scheme and their reference based on the points that define the details of the field measured.

With this purpose, it was georeferenced the situation plan of the surface draining and underground pipe draining hydroameliorative system that was created in 1978 - 1980.

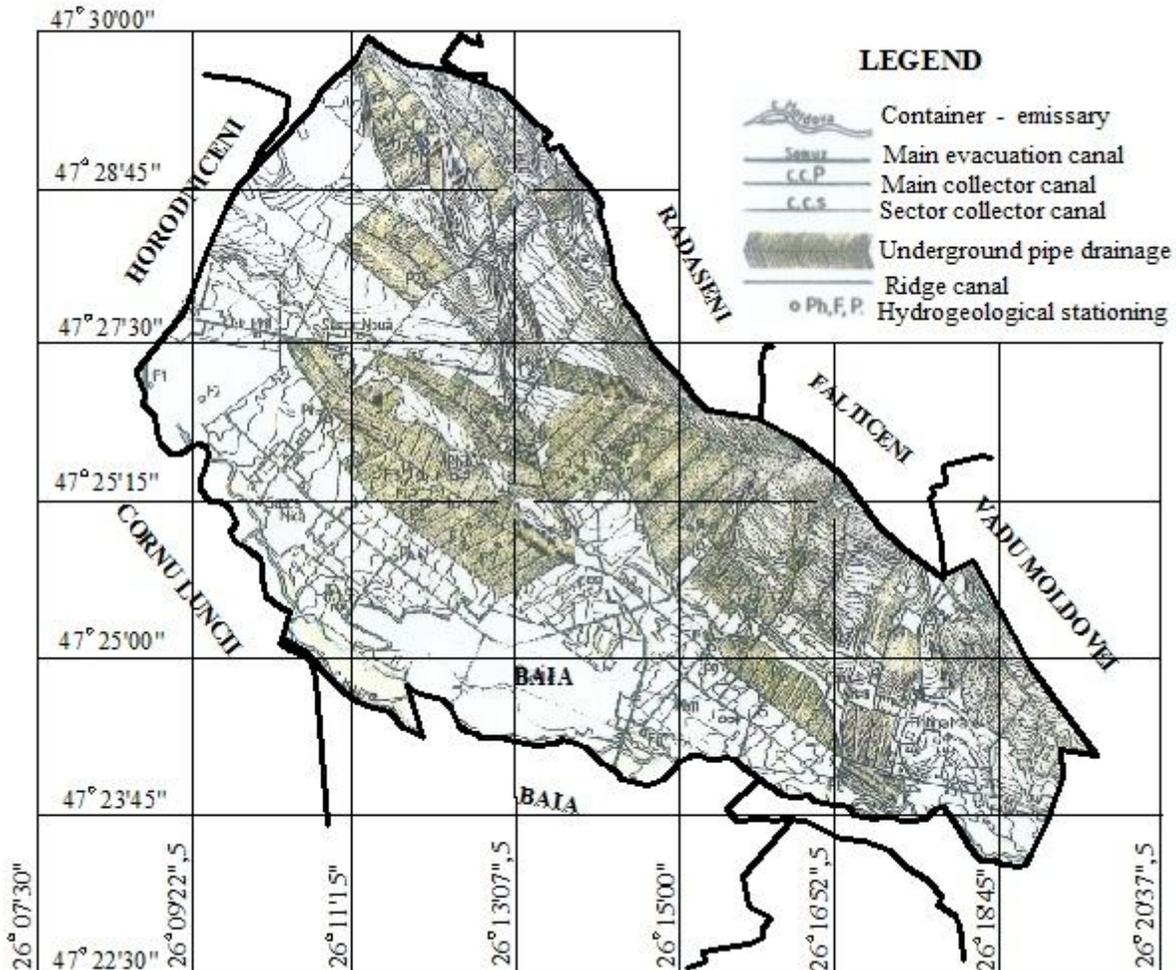


Figure 3 Framing of hydroameliorative system on geodetic trapeziums scale 1:5,000

e. Cartographic framing of the hydrotechnical scheme on administrative units

With the cadastral works nowadays there are

identified, measured, described and registered in the official cadastral documents all the real estates; they are also graphically represented on planes and

cadastral maps. In the case of administrative - territorial units where land improvement works and/or other territorial systematization works have been made, it is necessary the existence of on field measurements and their correlation with the graphic and textual data from the execution projects. The updated cadastral plan must include the graphical representation of the border limits of an administrative territorial unit as well as all the limits of the real estates/parcels that are registered in the land register.

Based on the technical norms for the introduction of cadastre, cadastral plans are made and they are analogically presented as trapeziums with the official nomenclature of the 1970-Stereographic projection (figure 4).

The Baia - Sasca hydroameliorative system was positioned, according to the execution plan, on the territory of the following five administrative units: Horodniceni, Cornu Luncii, Radașeni, Baia and Vadu Moldovei.

and Vadu Moldovei.

For the inventory of these fields that have been organized for surface and underground draining works, the boundaries of the total surface of the hydroameliorative system is established. Within the hydroameliorative system, there are going to be updated the boundaries of the administrative - territorial units and topographic and cadastral measurements are going to be made.

From the planimetric details specific to the surface draining and underground pipe draining hydroameliorative systems, there are also mentioned the arrangements and the surface and underground hydrotechnical constructions.

As an example, the following are quoted: network of draining canals, ridge canals, evacuation holes of collecting drains, visiting holes, consolidated bridges. The surface of the measured real estates must be framed on the trapezium control area, scale 1:5,000 (figure 4).

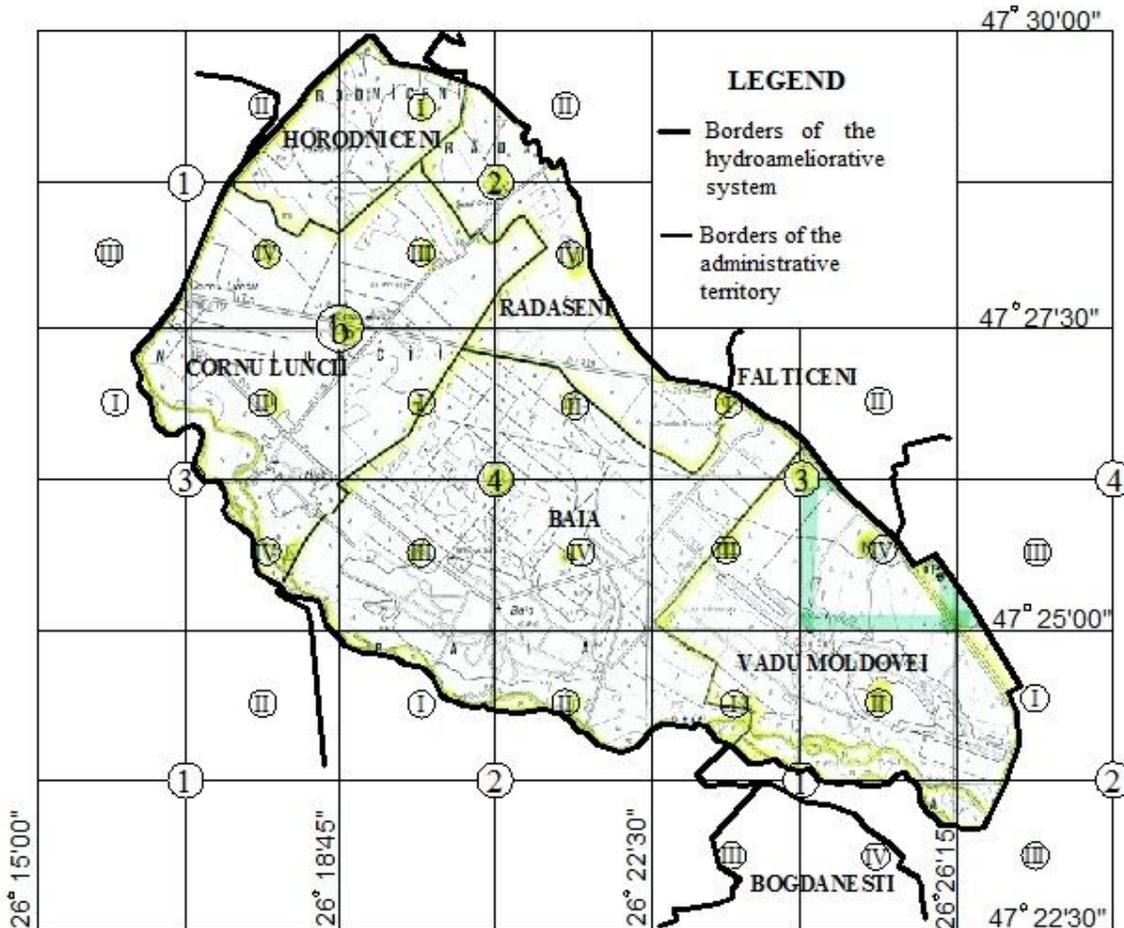


Figure 4 Framing of the hydroameliorative system on geodetic trapeziums scale 1:5.000

Depending of the framing of the border limits of the Baia – Sasca hydroameliorative system, on the georeferentiated support of the

geodetic trapeziums, scale 1:5.000 it resulted the following spatial distribution:

Horodniceni: **4 geodetic trapeziums;**

Cornu Luncii: **8 geodetic trapeziums**;
 Rădășeni: **7 geodetic trapeziums**;
 Baia: **10 geodetic trapeziums**;
 Vadu Moldovei: **10 geodetic trapeziums**.

In order to analyze the size of the surfaces foreseen with surface and underground draining systems on administrative territorial units, there have been considered the **control areas** of four trapeziums, scale 1:5,000 (*table 5*).

Table 5

Dimension of arranged surfaces on administrative territorial units		
Trapezium L-35-17-C-b-4-I		
Surface of the geodetic trapezium		Administrative territorial unit
ha	%	-
545.8709	35	Cornu Luncii
	10	Rădășeni
	55	Baia
Trapezium L-35-17-C-b-4-II		
545.8739	40	Rădășeni
	60	Baia
Trapezium L-35-17-C-b-4-III		
546.0795	100	Baia
Trapezium L-35-17-C-b-4-IV		
546.0825	100	Baia

From the analysis of the data included in the table above, resulted the following framing on cadastral sectors arranged on trapeziums and administrative territories, respectively.

L -35-17-C- b- 4- I: Cornu Luncii (35%), Rădășeni (10%) și Baia (55%);

L -35-17-C- b- 4- II: Rădășeni (40%) și Baia (60%);

L -35-17-C- b- 4- III: Baia (100%);

L -35-17-C- b- 4- IV Baia (100%);

The agricultural fields belonging to the private and public domain on which land improvement works have been performed must be registered in the cadastral register based on the technical documentations of execution of these hydroameliorative systems.

From these execution projects are going to be extracted and verified on the field all land improvement works.

CONCLUSIONS

The graphic and alphanumeric data base used for the information cadastral system of the agricultural fields arranged for surface draining and underground pipe draining has been calculated for 28 trapeziums, scale 1:5.000 in the 1970 – stereographic projection.

The Baia – Sasca hydroameliorative system that was set on the total surface of 5,527 ha, from which 1,806 ha also include a systematic underground pipe draining network, was cartographically framed on the following five administrative territorial units: Horodniceni, Cornu Luncii, Radaseni, Baia and Vadu Moldovei.

The cartographic framing of the surface draining and the underground pipe draining hydroameliorative system rigorously provides the calculation and the borders of the real estates/parcels on the control area of the geodetic trapezium, at the scale of the graphic representation.

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