THE USE OF DIGITAL ORTHOPHOTOMAPS AT THE REALIZATION OF SPATIAL DATABASE FOR THE LAND-SOIL CARTOGRAPHIC UNITS

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*By using photogrammetric technologies that provide digital photographic image processing, one has moved to the realization of the spatial database in digital format. In this context, for the 2003-2007 period, it is highlighted the drawing and editing of the orthophotomaps at the scale 1:10000 for all the basic administrative units of territory from Romania, with the main user, the Agency for Payments and Intervention in Agriculture. To integrate the existing spatial database for Bilca cadastral territory from Suceava County there were used the orthophotomaps in digital and analog format at scale 1:10000, and respectively, the maps of the land-soil cartographic units elaborated based on the pedological mapping studies at the same scale. On the digital orthophotomap that comprises geospatial information from the 189 agricultural physical blocks, occupying an area of **1** 853.31 hectares, the three spatial layers / entities of the map of the soils were overlapped. For this purpose were used graphic information of the 24 land-soil cartographic units, ecologically homogeneous, identified for an agricultural area of 1358.14ha. By achieving the spatial database were ensured the validation, and the access to information for each cadastral plot, as a component of a physical block, with regard to the size of areas occupied by the land-soil cartographic units, the field grade, the favorability and the suitability of agricultural land.*

***Key words**: cadastre general, orthophotomap, spatial database, agricultural physical block, cadastral plot*

Based on the pedological studies performed on soil resources in Romania over a period of 100 years (1906-2006), a series of soil maps were developed at small, medium and large scale. Thus, as a result of the mapping work carried out during 1963 and 1994 at small and medium scale, a soil map of Romania was developed, at the scale of 1: 200 000. The map was surveyed on 50 sheets, which were later updated with a new legend, and digitized [Florea N., 2002].

At present, due to the new requirements for recovery and conservation of soil resources, land-soil maps started to be modernized. Pedological study must be prepared in digital format for both the graphics, descriptive and analytical part [Munteanu I., 2002].

In order to achieve the spatial database of land-soil maps, there were used photogrammetric products such as pictures and digital photogrammetric data [David Viorica, 2007]. Among the specific products used, the following ones can be mentioned: aerial photographs, maps, orthophotomaps, mosaics, satellite images, altimetry digital models, linear digital data, cross sections and profiles, parameters which can provide the possibility of spatial description of land-soil cartographic units. Widespread use of aerophotogrammetric surveys, GPS technology and terrestrial automated measurements allowed the achievement of digital graphical support for large-scale land-soil maps [Moca, V., 2008]. The cartographic base in digital format for soil resources may be associated with a number of correlative maps emphasizing the close relation between soil and physical-geographical factors.

MATERIAL AND METHOD

The implementation of sustainable development measures for the rural area of Romania implies the achievement of technical and economic functions of the general cadastre. Using the technical function of the general cadastre, a thorough land inventory is performed at the level of agricultural physical blocks. With the economical and/or qualitative functions of the agricultural cadastre information system, specialized data acquaintance is ensured in order to promote some monitoring and the management systems for soil resources.

In this context, it is emphasized the achievement of orthophotomaps, during 2003-2007, in digital and analog format, with a resolution corresponding to the scale 1: 10 000, at the level of territorial administrative units of Romania. Based on land-soil mapping works, achieved in the unitary system by using the genetic-geographic methods, large-scale land-soil maps (1: 10 000) and very large-scale land-soil maps (1: 2 000 - 1: 5 000) were developed. Large and very large-scale land-soil maps were developed mostly at the level of the cadastral territory and partly for other regional areas and / or river basins, in close correlation with studies of environmental factors.

In order to achieve the general structure of the experimental model, there were used the spatial scanned / digitized maps and the non-spatial data files available at the level of the administrative territory of Bilca village from Suceava county. With this goal, the following specific operations were performed step by step: collecting, processing, interpreting and storing of topographical, cadastral and pedological data.

- **Collection of spatial data**: main cadastral map at the scale 1: 50 000, with the nomenclature of L-35-4-A (Vicovu de Sus), L-35-4-B (Bilca); main cadastral and topographical plan at the scale 1: 5 000, with the nomenclature of L-35-4-B-to-3-III (Bilca); orthophotomap of Bilca territory in digital and analog format at scale 1: 10 000; the map of land-soil cartographic units, at scale 1: 10 000; correlative maps, at scale 1: 10 000, with the depth of ground water, landforms and soil texture.
- **Collection of non-spatial data**: land registry books; files for agricultural physical blocks in rural area of Bilca territory (area, category of use, average slope); analytical and descriptive data of the land-soil units.
- **Data processing and interpretation**: technical standards in introducing the general cadastre and the agricultural cadastre information system; development methodology for pedological studies; software programs.
- **Computer storage of spatial cadastral database**: digital plans; thematic layers of geographical information systems; synthetic reports.

RESULTS AND DISCUSSIONS

The cadastral administrative territory of Bilca village is located in the extreme north of Suceava County, near the Romanian-Ukraine state border. The administrative area of Bilca territory unit is located mostly in the Dragomirnei Plateau (geomorphologic sub-unit of Suceava Plateau) and a small part in Radauti Depression.

a. Boundary demarcation and mapping classification

By implementing the general cadastre works, Bilca territory was delimited by the following border limits: at **North**, the Romanian border with Ukraine, at **East**, the territory of the Fratautii Noi village, at **South**, the territories of Galanesti and Vicovu de Jos village, at **West**, the territory of Vicovu de Jos village.

The cartographic localization on the geodesic trapeziums for the maps and topographic plans was performed on the basis of the official nomenclature for the Stereo-70 Projection System, used to represent the Romanian territory. From the general scheme of the connection of geodesic trapeziums, resulted the following cartographic framing of the Bilca territory: 2 map sheets at scale 1:50000, 4 map sheets at scale 1: 25 000, 5 map sheets at scale 1: 10 000 and 13 plan sheets for the scale 1: 5 000.

b. Calculation of the cartographic base for the plan sheets

In order to report the internal frames from the field originals of the cadastral plan sheets, at scale 1: 5 000, so that they overlap the digital orthophoto image, was calculated the cartographic base. In the case of Bilca territory, the cartographic framing included: 12 sheets of full / empty maps with adjacent territories and a sheet of full / full map (100% Bilca).

The case study was analyzed for the trapezium L-35-4-B-a-3-III (Bilca) which includes both the residential and the unincorporated area. The rectangular coordinates in STEREO-70 Projection System were calculated as a function of the ellipsoidal geographic coordinates and trapezium corners, based on formulas with constant coefficients and a determination accuracy of ± 0.001 m. At the same time were determined the trapezium dimensions and area on the surface of Krasovski - 1940 reference ellipsoid and on the STEREO-70 Projection, respectively (Table 1).

Non-spatial database (areas occupied by the cadastral parcels, agricultural physical blocks, land-soil map units) was calculated and compensated by the control area of 541.0387 ha of the considered trapezium at scale 1: 5 000.

Table 1

Coordinates of L-35-4-B-3-III trapezium corners and the area on the Krasovski-1940 reference ellipsoid and in STEREO 1970 projection plane

No.	Point position	Geographic coordinates		Stereo-70 Coordinates		Trapezium area (ha)
		φ (° ´ ´´)	Λ (° ´ ´´)	X (m)	Y (m)	Ka-40/ Stereo-70
1	NV	47 56 15	25 45 00.0	715630.758	556038.999	**540.9816/ 541.0387**
2	NE	47 56 15	25 46 52.5	715653.569	558373.914	
3	SV	47 55 00	25 45 00.0	713314.268	556061.166	
4	SE	47 55 00	25 46 52.5	713337.085	558397.005	

c. **Cadastral delimitation of territorial units on the plan sheets (trapeziums) at scale 1: 5 000, and area calculations**

In accordance with the *technical norms for introducing the general cadastre*, the elaboration of the main cadastral plan in analog form has to be made on map sheets (trapeziums) in the Stereo-70 Projection System.

In order to verify the calculation method for the areas of the territorial cadastral units from the plan sheets, the known area of the trapezium is used. In the case of the digital orthophotomap, with nomenclature L-35-4-B-3-III, corresponding to the cadastral territory of Bilca village, two separate cadastral units, namely, the residential and the unincorporated rural area, respectively, were bounded according with the current legislation. Areas calculated and compensated on the control surface of the trapezium of 541.04 ha were 394.28 ha for the unincorporated rural area and 146.76 ha for the residential area (*Figure 1*).

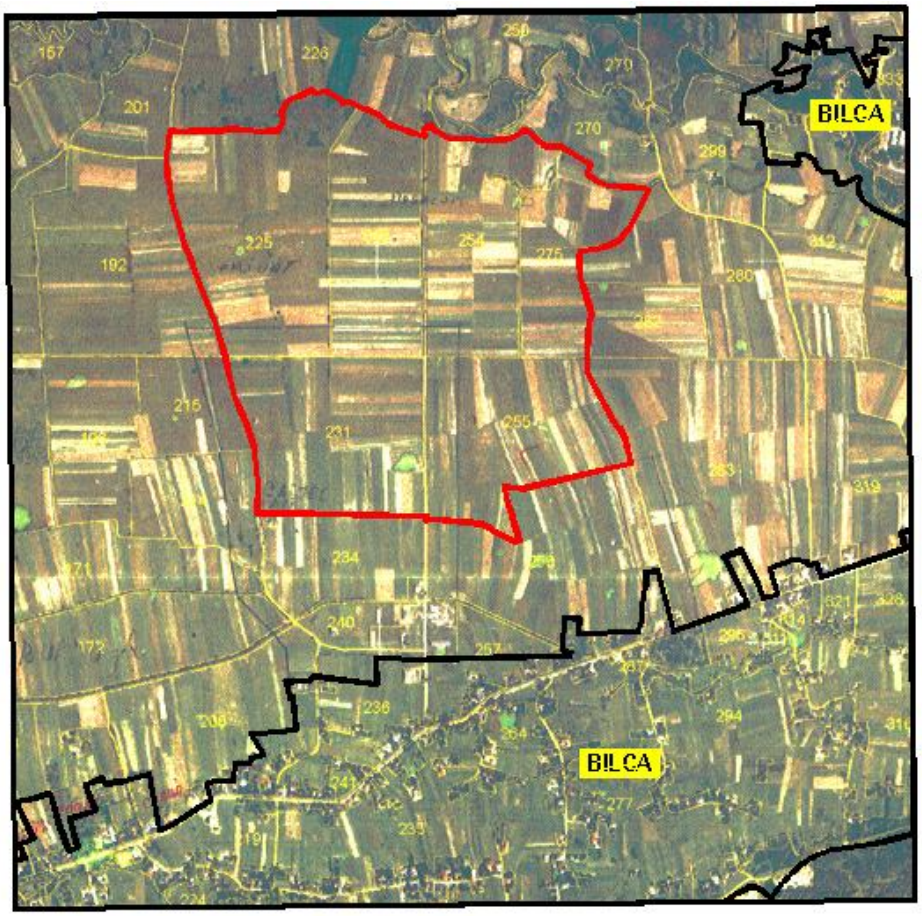

Figure 1 **Orthophotomap (trapezium L-35-4-B-3-III) showing the layers of cadastral parcels and agricultural crops, scale 1: 5 000**

Areas determined for the rural and residential areas were considered as control values for the calculation of the areas of physical blocks. In the inner frame of the plan sheet were bounded a number of **48 physical blocks**. The distribution of agricultural land in rural area covered **32 physical blocks** with limits of the areas between 0.10 and 10.0 ha and **16 physical blocks**, with limits from 10.01 ha up to 30.0 ha. The main use of the land for agriculture, emphasizes the predominance of agricultural land with an area of **389.52 ha**.

For spatial database integration of the digital orthophotomap with land-soil cartographic units, there was considered the experimental model of a cadastral sector, with a total area of **100.44 ha**, which includes the spatial configuration of the following 6 physical block: **225**, **243**, **254**, **275**, **231** and **255** (*Figure 2*).

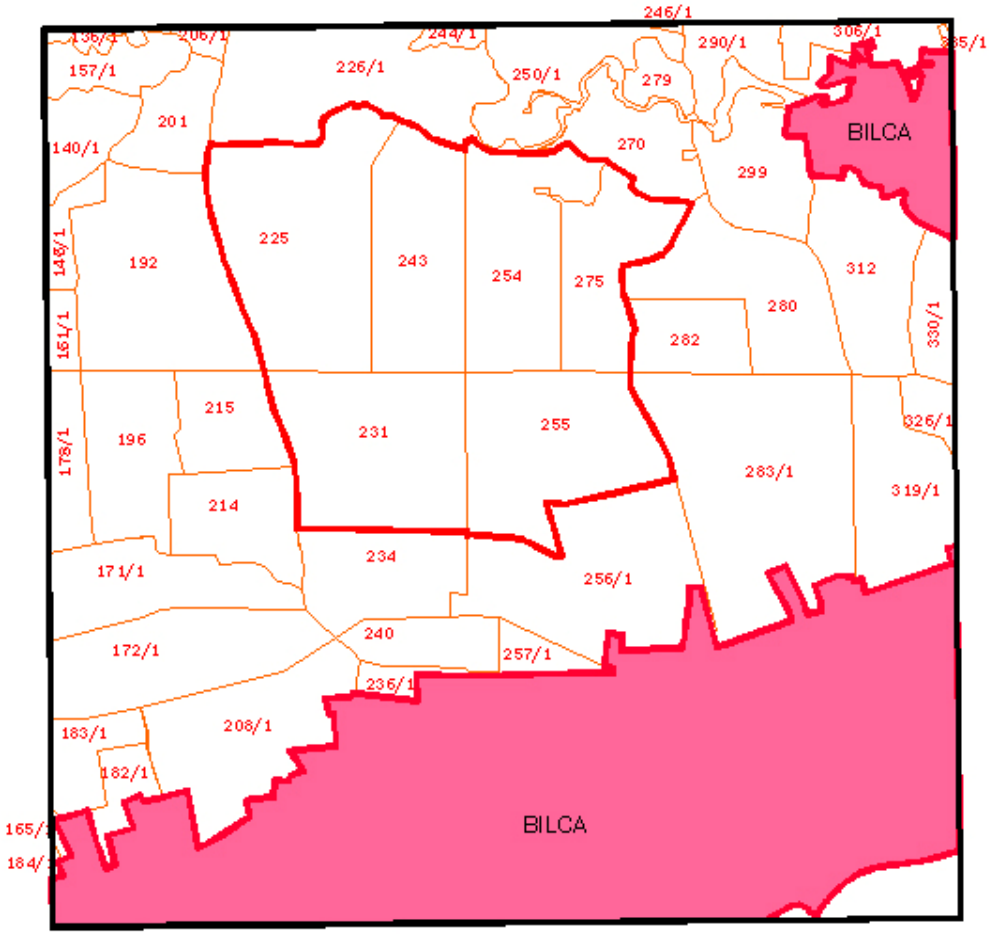

Figure 2 **- Orthophotomap (trapezium L-35-4-B-3-III) showing the layer of agricultural physical blocks in unincorporated rural area, scale 1: 5 000**

d. Delimitation of soil cartographic units on plan sheets (trapeziums), scale 1: 5000, and calculation of areas

Pedological mapping carried out in the area corresponding to the agricultural land, under the physical and geographical conditions of the two distinct geographical landscape units, Dragomirnei Plateau and Rădăuţi Depression, outlined the classification of soils in 24 land-soil cartographic units (U.S.). On the plan sheet considered in the case study were identified a number of **18 land-soil cartographic units** with an area of **394.28 ha** and **27 component areas**.

In the case study, undertaken for the agricultural cadastral sector, with an area of **100.44 ha**, were identified by overlapping the two distinct information layers, a number of 12 land-soil cartographic units, with a distribution of planimetered areas from **0.06** up to **10.66 ha** (*Figure 3*).

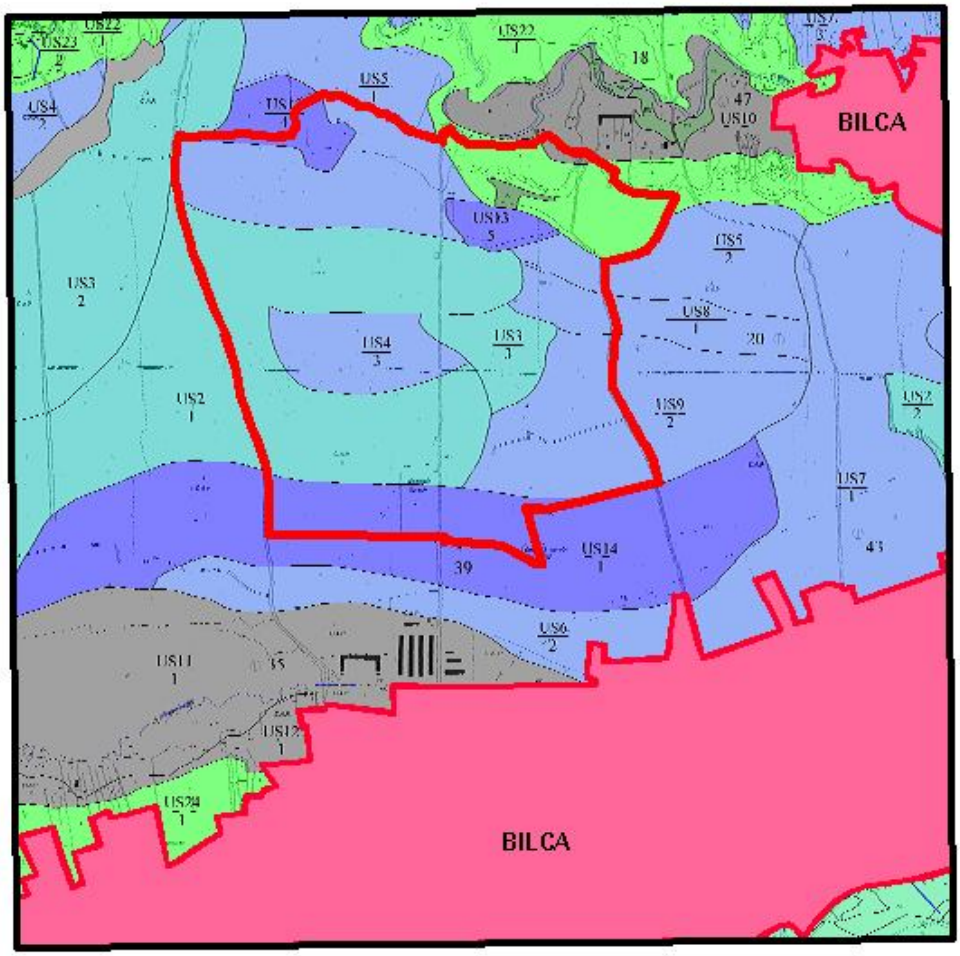

Figure 3 **– Land-soil Map (trapezium L-35-4-B-3-III) showing the layer of the land-soil cartographic units, scale 1: 5000**

e. Storage of spatial data for the land-soil cartographic units on the orthophotomap digital medium

Large-scale land-soil maps (≥ 1 : 10 000) represent the basic information for quantitative and qualitative assessment of soil resources. By integrating the spatial database of the land-soil maps with specific data for agricultural physical blocks from the ortophotomaps content, has resulted the database information medium.

The experimental model achieved for the plan sheet L-35-4-B-3-III ensures the access to the database at the level of all 48 physical blocks. For instance, by accessing the physical block with the **cadastral number 254,** results the following types of spatial and non-spatial data: physical block area = **15.34 ha;** use: **agricultural land**; average slope = **1.12%;** land-soil units and types: **(U.S.);** topographic elements of land; parcel owners; agricultural crops (*Figure 4*).

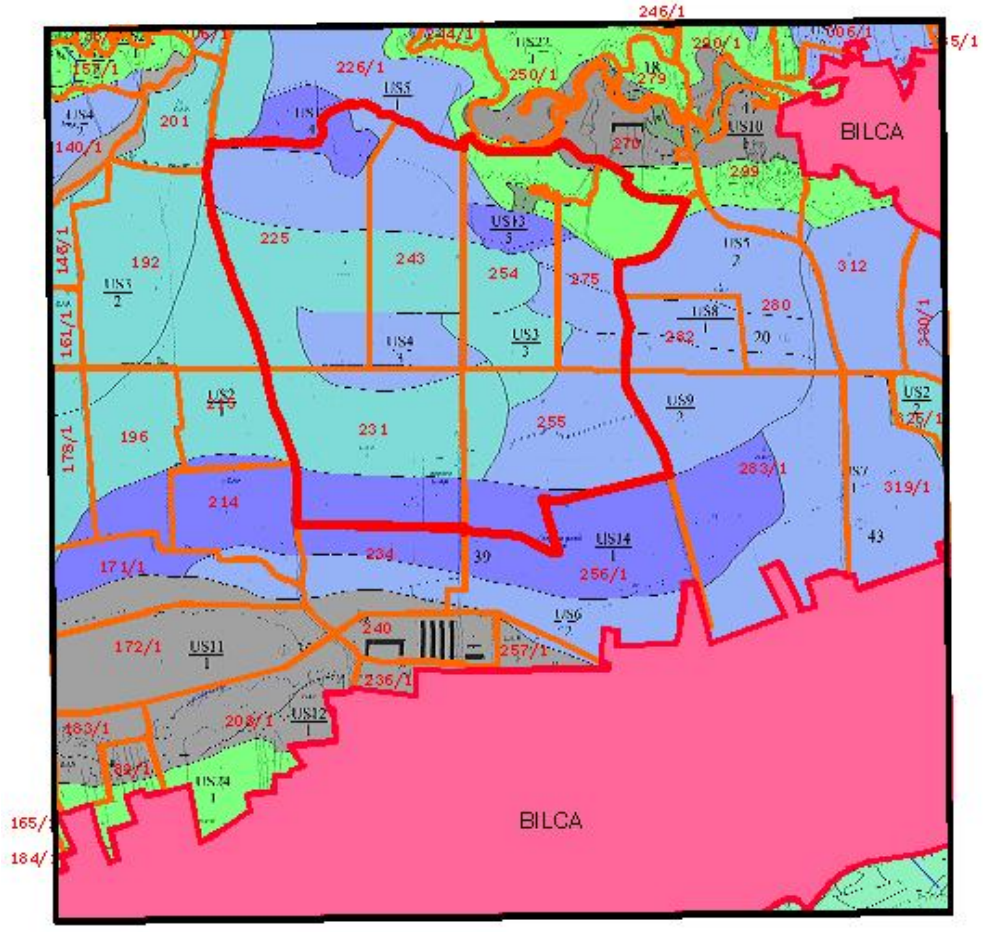

Figure 4 - **Overlapping the soil maps (trapezium L-35-4-B-3-III) over the layer of agricultural physical blocks in rural area, scale 1: 5 000**

From the data set content shown in Table 2, results the distribution of land-soil cartographic units (U.S.) on the total area of **100.44 ha** of the six physical blocks considered, with cadastral numbers 225, 231, 243, 254, 255 and 275.

Table 2

The distribution of the land-soil cartographic units on the agricultural physical blocks from Bilca plan sheet L-35-4-B-to-3-III

Soil unity (US)	Soil units areas by cadastral numbers of agricultural physical blocks (ha)						
	225	231	243	254	255	275	TOTAL
US 2/1	9.96	11.54	4.98	3.15	2.85	-	32.48
US 3/3	-	-	0.28	3.25	1.07	0.27	4.87
US 4/3	2.56	1.67	3.20	0.30	0.01	-	7.74
US 5/1	8.32	-	6.21	0.83	-	-	15.36
US 5/2	-	-	-	0.31	-	1.50	1.81
US 8/1	-	-	-	0.75	-	2.06	2.81
US 9/2	-	-	-	-	10.66	1.54	12.20
US 10/1	-	-	-	0.42	-	0.06	0.48
US 13/4	2.39	-	-	-	-	-	2.39
US 13/5	-	-	-	2.20	-	0.14	2,34
US 14/1	-	5.74	-	-	3.28	-	9,02
US 22/1	-	-	-	3.67	-	4.77	8.44
PD_1	-	-	-	0.46	-	0.04	0.50
TOTAL	**23.23**	**18.95**	**14.67**	**15.34**	**17.87**	**10.38**	**100.44**

CONCLUSIONS

The integration of the two types of spatial data (land-soil maps and orthophotomaps) was performed firstly at the scale 1: 10000 and then on the geodesic trapeziums at scale 1:5000.

The soils map having an area of 1358.14 ha, spatially distributed on the 24 land-soil units, was integrated with the layer of the 189 agricultural physical blocks.

The experimental model achieved on the trapezium with the nomenclature L-35-4-B-a-3-III, with the control area used to calculate the surfaces of the 541.0387 ha, includes all information required to manage the soil resources in relation with the usage of agricultural land.

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