

## CAD AND GIS TECHNIQUES IN GEOREFERENCING MAPS FOR THE IDENTIFICATION AND MAPPING OF MEADOWS IN ARAD COUNTY

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**Abstract.** *The agricultural territory, delimited and represented by the farthest "cartographic series", is considered to be a "real challenge" in terms of identification and "spatialization" given its spatio-temporal dynamics. Changing the destination of agricultural land and resizing parcels implies the instability of topo-cadastral boundaries, making old mapping materials used in the land use analysis non-permanent. If in the first complex cartographic representations, 100-150 years ago were delimited agricultural fields with different surfaces and destinations, the current situation is very different. Based on this rationale, the present study aims at updating the topo-cadastral databases and materials referring explicitly to the surfaces used as meadows and grassland at the level of Arad county through methods and techniques specific to CAD and GIS environment. It follows the degree of scientific "safety" provided by the old cartographic representations, as well as the possibility of using other current cartographic materials to complement and validate the extracted information so as to create a more accurate picture of the reality on the ground. Following the analysis of the old topographical and cadastral maps and the current mapping materials, significant differences were found regarding the area and the position of the meadows, which alters their share in the total agricultural area. Old cadastral and topographic maps can provide general information about existing grassland at county level, but can no longer be a "safe source" of information. Following the identification of grasslands, their representation and analysis together with other geospatial data sets can be made.*

**Keywords:** *georeferencing, mapping, representation, pasture, updating*

### INTRODUCTION

The agricultural lands, symbolized starting with the first cartographic representations, because of their importance, impose difficulties in terms of identifying and "spatializing" on cadastral maps in view of their spatio-temporal dynamics. Old cadastral maps in the process of georeferencing have difficulties in terms of the coordinate system after which they have been drawn up, and the change in the land use category, the reduction or the extension of the land, make the agricultural land, and especially the meadows, to be difficult to analyze in terms of space-time evolution.

Georeferențierea hărților cadastrale vechi, procedura cercetată și perfecționată prin contribuția mai multor autori, din cercetare sau instituții de specialitate ([1], [2], [3], [6], [7]), constituie o etapă deosebit de importantă în obținerea informațiilor referitoare la modul de utilizare a terenurilor, în cazul de față a suprafețelor utilizate ca pajiști. În unele cazuri, hărțile cadastrale vechi sunt disponibile în forma georeferențiată [10], însă există numeroase cazuri în care aplicarea georeferențierii este iminentă, astfel, calitatea datelor și acuratețea lor depinde de corectitudinea procesului respectiv.

In the extraction of cadastral information, in the present case the delimitation of pastures, in addition to the old cadastral maps, current cadastral maps and topographical maps, which can be georeferenced in the coordinate system and the Stereographic projection 1970, according to the specific methodology [4] [11], [12]). Therefore, the main purpose of this study

is to "quantify" the existing cartographic material for the territory of Arad County and to exemplify the possibilities of georeferencing of the different types of maps that can be used for the extraction of spatial information on the grassland areas. For example, the study was done for the territory of Cermei administrative unit, the situation at Arad County being similarly drafted.

#### **MATERIAL AND METHODS**

The research presented in this paper was carried out in the western part of Romania, on the administrative territory of the Cermei commune, located in Teuzului Plain, in the basin of Satis River, at a distance of 67 km from Arad [16].

In the realization of the study, in order to achieve the proposed goal, we used:

- data from the literature (georeferenced historical maps) [10]
- scanned analogous cartographic materials (cadastral plans and maps) and digital (orthophotomaps) taken from the profile institutions ([8], [9])
- data in vector format (limit of administrative-territorial unit of Cermei) [15].

The identification and spatial location of grassland can be done on the basis of several sources: cadastral maps and plans, parcel plans, orthophotomaps, topographical maps, etc. When cartographic materials are in analogue format (on paper), they must be scanned, so "converted" in digital format. After analog-to-digital conversion, to be integrated and processed with specialized software (GIS, CAD, etc.), they need to be georeferenced - assigning a coordinate system [5]. In many cases, however, georeferencing can be difficult because there is insufficient information about the map (projection, scale, topographic elements, etc.) or the transformation parameters in the different projection and coordinate systems currently used.

The fact that the materials to be used in grassland analysis come from different sources and different time periods are executed through different processes at different scales is sometimes a real impediment to their unitary use within the same project, it is necessary to apply the specific techniques by which they are "equated". These issues require special attention from the analyst, otherwise the inconsistencies between the different materials used translate as errors in the final results. Based on these considerations, the present study aims to inventory the existing mapping materials in the county of Arad and to describe the methods by which they can be "homogenized" and used as a support for the identification and delimitation of the grassland areas. Taking into consideration the territorial dimensions of the analyzed area, case study will be the administrative-territorial unit of Cermei.

#### **RESULTS AND DISCUSSIONS**

The first sources of information on the pastures of Arad County can be considered "historical maps" elaborated since the 18th century - the three surveying campaigns. Georeferencing of these maps, a complex and difficult process, has been applied by field specialists, which are available on the geo-spatial community platform [10]. Considering the age of these cartographic materials, it is necessary to use recent maps as close as possible to the current territorial situation to analyze the current situation of grassland areas.

Thus, the cadastral maps drawn up around 1980 at the scale of 1: 10000 were taken into account. These mapping materials, in analogue format, have been scanned and, for CAD or GIS, they have been georeferenced

Since the cadastral map does not mark the grid, the coordinates or the parameters of the projection system, georeference will be made according to the contour of the respective area, in vector format [15], in the Stereographic 1970 projection, officially used in Romania.

In the CAD system, the georeferencing process of the cadastral map is done as follows:

- in the first phase the contour of Cermei territorial-administrative unit in the national stereographic projection system 1970, in vector format, is used to serve as the basis for geo-referencing the 1: 10000 scale cadastral plan that has been scanned in two layers, west, respectively the eastern part (figure 1), using the correspondence between the vector elements represented in the program and their position on the raster images

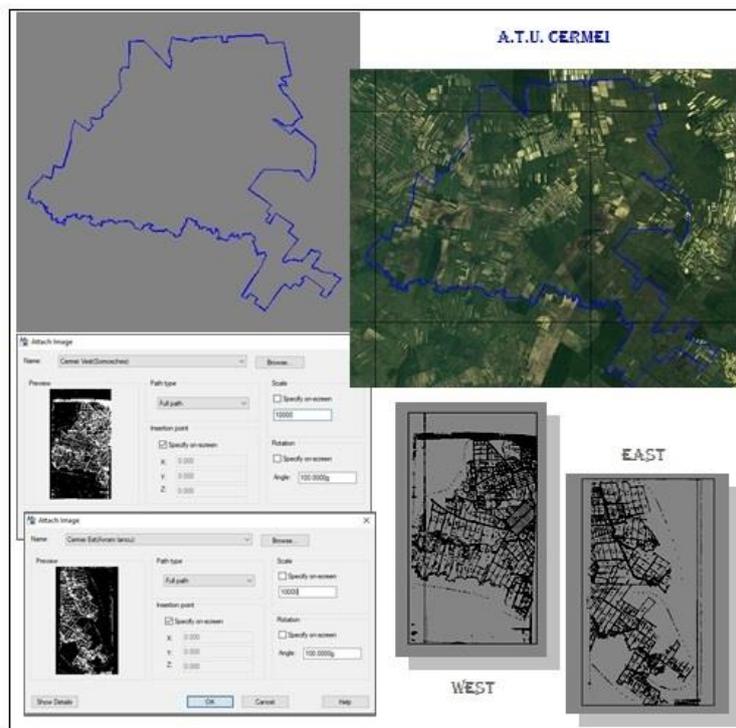


Figure 1. Georeferencing of cadastral maps in CAD system (processing after [8], [9])

- in the second phase the proper georeferencing process begins, which involves aligning the two planes to a defined coordinate system; mathematically, is a translation and / or rotation operation of the image coordinate system over the coordinate system in which georeferencing is performed; in fact, three identical checkpoints were identified on both maps, and with the **ALIGN** command the point of point (raster) and then destination were pointed; following this operation the plans were aligned according to the boundary of the administrative-territorial unit (figure 2).

Most modern maps have a clear grid that can be used for control points. Old maps may not have this information and this causes many technical difficulties. In georeferencing, in addition to ATU limits, point elements such as churches are ideal, but they must be selected with care, because they can be repositioned over time. They are used as georeferencing control points, using their location on the source map.

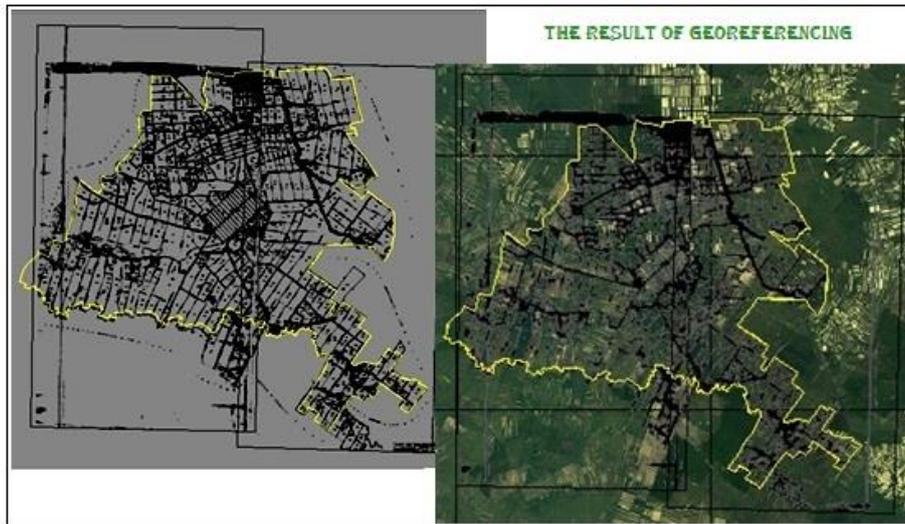


Figure 2. The result of the georeferencing procedure (processing after [8], [9])

Georeferencing is an important source of potential errors. If the map sheet is distorted in some way or is not perfectly flat on the scanner, all will cause errors in the georeferencing process. These errors will remain as a fundamental part of the resultant layer. Many software allows georeferencing to provide a measure of error, expressed as RMS mean square error in both georeferencing units and actual units. This is an error estimate based on the comparison between the coordinates of control points in scanner units and actual coordinates. Using multiple control points increases the accuracy of the RMS estimate.

Because not all edges of the old planes are straight, geometric corrections will be applied, using georeferencing methods where identical details can be identified on old and orthophotomaps. This will prevent serious distortions of planar elements, uncovered surfaces, or overlapping planes.

The mosaic (assembling the planes into a single image) is useful after georeferencing to obtain a single raster image with all the cadastral planes (figure 2), in the case of the present work we have two planes, the east and the western part (figure 1).

After applying georeferencing, the vector mapping procedure can be initiated on the resulting map. The higher the zoom, the higher the vectoring accuracy. In this way, you can "navigate" over the image at different "zoomed", controlled by the zoom factor. Using this method pasture 703 was identified and its vectoring was performed, as can be seen in figure 3.



Figure 3. Identification and vectoring of grassland areas

In the GIS system, the georeferencing of the cadastral map was made according to the following algorithm ([13], [4]): the contour of Cermei administrative-territorial unit [14] was selected and exported compared to the Stereo 70 [15] coordinate system in vector format and the Cermei A.T.U. map in raster format; identical checkpoints were marked on both maps and thus the raster was "aligned" according to the already georeferenced map (figure 4).

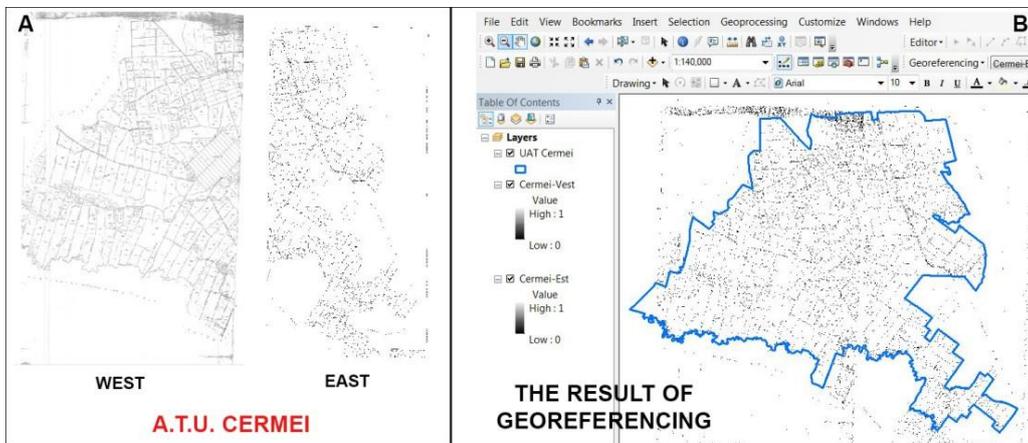


Figure 4. Georeferencing of cadastral maps in GIS (processing after [15], [8])

After the georeferencing of the Cermei A.T.U. raster, the vectoring process [4] can be applied (figure 5).



Figure 5. Representation of grassland areas in the study area (processing after [15], [8])

Unlike the CAD system, in the GIS software, in addition to the graphic component, the database is created, the descriptive part, in the form of a table, which can then be supplemented according to the needs of spatial analysis (figure 5). For each graphical entity, n features that are particularly useful in all spatial analyzes can be introduced into the database.

Google Earth also lets you view your own spatial data on that land surface model. This function is used to verify the accuracy of the georeferencing: if the image was properly georeferenced, it will overlay on the virtual land surface of the application when it is loaded in Google Earth.

For this, the **.dxf** file needs to be converted to **.kmz** format, which is the format supported by Google Earth, for example through Global Mapper software. The file has been loaded into the application and the fact that it is georeferenced is confirmed by the fact that for any position of the mouse on the screen the coordinates are specified. Further on, the image will be exported in **.kmz** format for Google Earth.

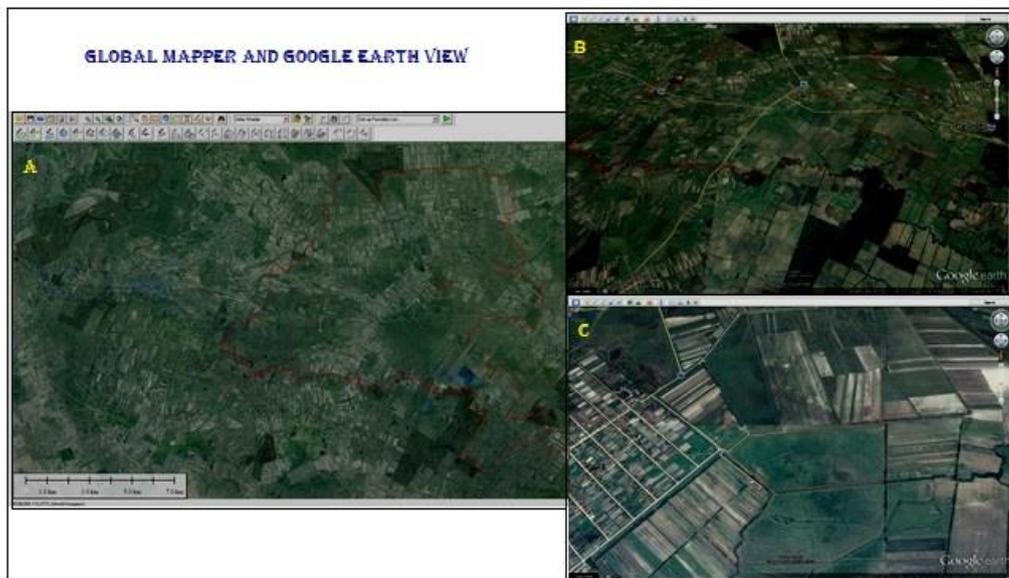


Figure 6. Representing grassland areas in the study area in Google Earth

The effect is spectacular because the program simulates a flight downhill from high altitude and above North America to the loaded data set in the case of the present work in western Romania, in Cermei (figure 6).

### CONCLUSIONS

The present study presents consistent procedures for the conversion of cadastral plans and maps performed in different timeframes from analogue to digital format into the 1970 Stereographic System to be used in CAD and GIS.

Georeferencing can be performed in a variety of specialized software (AutoCAD, ArcGIS, MapSys, Global Mapper, etc.) or software that incorporates georeferencing modules, the accuracy of which is dependent on the quality of the maps, the available information, the analyst's experience and attention.

At Arad County level, the "coverage" of cartographic materials from which spatial information on pasture units can be extracted is satisfactory, maps of different time periods, different scales of representation, varying degrees of detail can be used. Through processing, these cartographic materials can be integrated into GIS projects along with other spatial data types.

Modern methods and means of analysis of the geographic environment make it easy and accurate to obtain all the information related to grassland ecosystems in terms of graphic representation. An advantage is that we can identify almost any category of use in the area of interest and we can locate it. Besides that, we can calculate quite accurately the surface or perimeter of a surface.

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