A GIS FOR THE PEDOLOGICAL SOIL MAPPING OF POPRICANI AREA IN IASI COUNTY

George Calin BALTARIU, Prof. M.s. Eng., "Gheorghe Asachi" Technical University of Iasi, Romania, george.calin.baltariu@gmail.com
Constantin BOFU, Prof. Ph.D. Eng., "Gheorghe Asachi" Technical University of Iasi, Romania, constantin.bofu@academic.tuiasi.ro

Abstract: *The main purpose of the article aims in creating a GIS application for the pedological soil mapping of Popricani area in Iasi County with an eye to a further efficient utilisation of it by the end user, using web technologies, VBA and AutoLisp. Also the application includes an inventory of all the pedological data of the region. Other undertaken and proposed objectives are represented by creating an attribute database, relationing that database with graphic entities, making analysis, queries, thematic maps and creating a complex system that eases the end user experience and productivity.*

Keywords: *Soil Mapping, Pedology, GIS, VBA, AutoLisp, WEB, end user expericence, AutoCAD Map3D 2021, Microsoft Office Access, thematic maps, queries, SQL, Popricani*

1. Introduction

The alphanumeric and graphic information existing on old pedological surveys and their afferent soil maps, constitute an important asset that can be integrated in GIS applications for further efficient use and development.

By integrating a soil map that is part of the „**OJSPA IAȘI** – Studiu pedologic scara 1:10.000 Teritoriul comunei Popricani, Jud Iași, 1998" in the GIS application and relationing it with all the alphanumeric data found in the study we obtained a series of thematic maps and statistic data using AUTODESK AUTOCAD MAP 3D 2021. Furthermore by using web technologies, VBA and AutoLisp we automatized the process for a better end user experience of running the application, enabling even non-qualified office clerks to use it, and by so it can reduce the producing time of other scientific, educational or administrative materials.

2. Materials, Methods and Results

2.1.Existing information analysis and georeference

The pedological study provided three maps, from which one was chosen to provide data about the soil types in that administrative area.

Most common elements figured on the maps are:

a. Administrative boundaries (villages limits, administrative teritorial unit limit, forests)
b. Soil units

The map was spatially positioned through georeference by using a the official contour of the administrative unit provided from the ANCPI database.

The map is shown in Figure 1 and the georeference stages in Figure 2.

Fig.1. Soil map of UAT Popricani, scale 1:10 000.

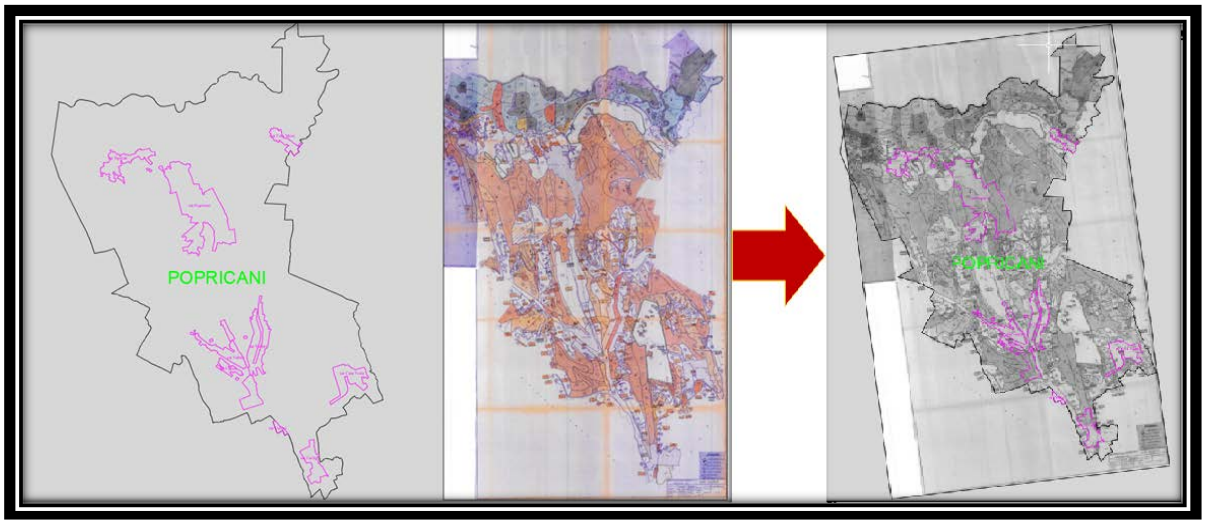


Fig.2 The georeference stages of soil map.

2.2.Vectorization, editing and creating topologies

The vectorization was done using a semi-automatic feature of AutoCad Raster Design called „Countour Fallower” that analysis the paths of white pixels/ black pixels in

bitonal images. Therefore the image was converted from Full Color to Monochromatic to Bitonal and then Vectorized.

The semi-automatic feature doesnt work very tidy and needs human supervision and intervention to eliminate errors occured. Further elimination of erros was achieved automatically by means of specialized functions, for each layer.

Vectorization stages are shown in Figure 3.

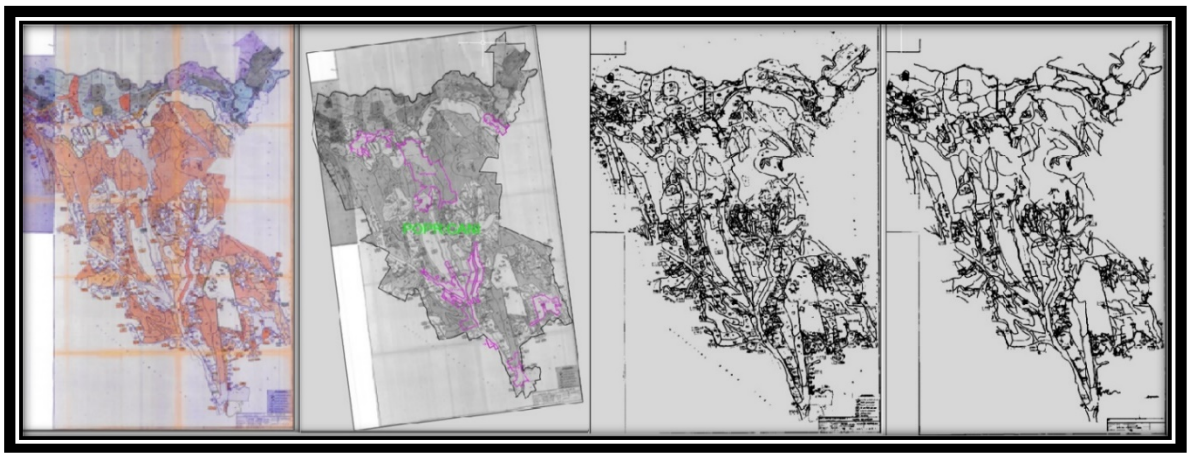


Fig.3. Preparing stages of semiautomated vectorization.

The soil units were numbered using a standard pattern based on soil unit type and their succesive repetitions on the map and to establish a spatial relationship between graphic objects and to obtain statistical information about the geometry of objects creating a polygonal topology called „Unitati_sol" that represents the resulting information about soil units location and area was needed.

2.3. Designing, creating and attaching an external database

By identifying existing alphanumeric information on the maps, we designed an external database using Microsoft Acces which consists of 14 tables which were loaded with specific information via 14 forms that are detailed in table 1. (Figure 4)

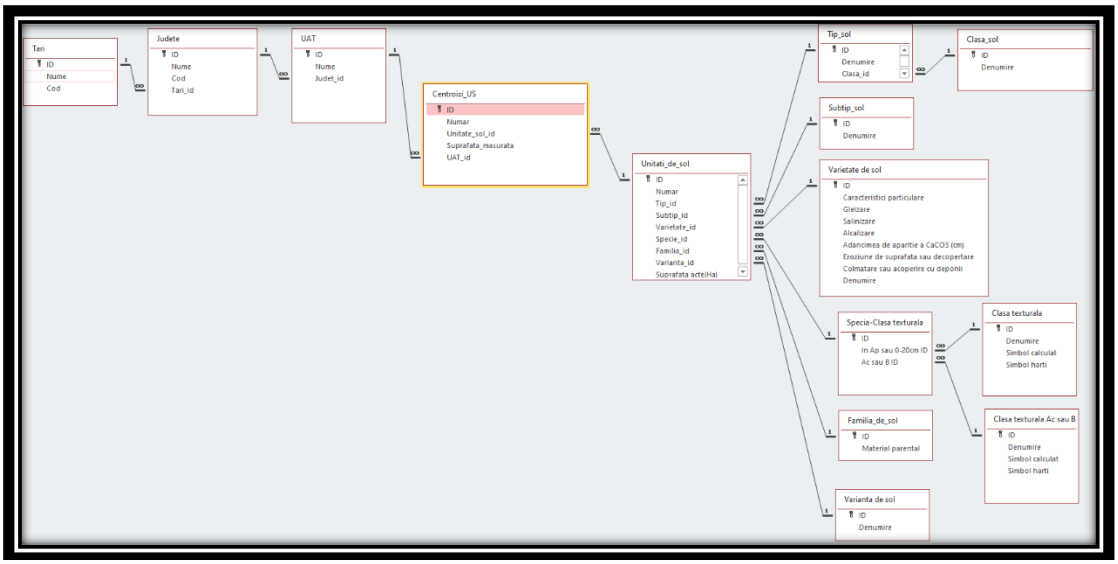


Fig.4. The tables of the external database and their relations.

Tab.1 The database tables individual decription.

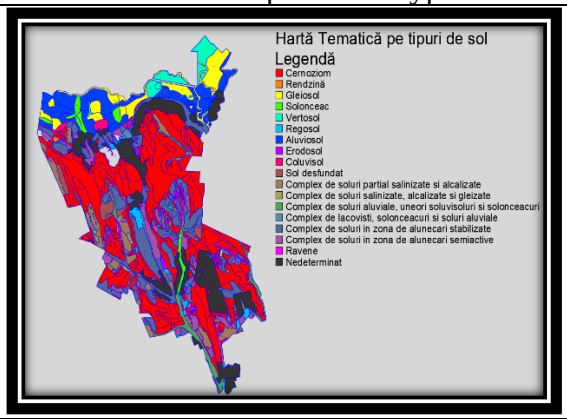
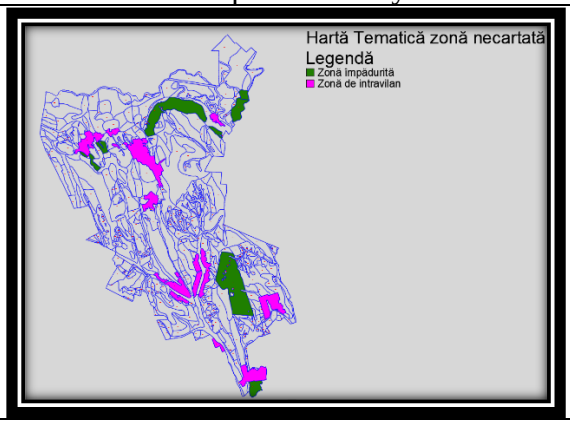
Nr.Crt.	Table Name	Description
1	Centroizi_US	Contains Current Soil Units.
2	Clasa texturala	Contains Textural classes.
3	Clasa texturala Ac sau B	Contains Ac or B textural classes.
4	Clasa_sol	Contains Soil Classes.
5	Familia_de_sol	Contains Soil Families.
6	Judete	Contains counties.
7	Specia-Clasa texturala	Contains the species textural classes.
8	Subtip_sol	Contains Soil Subtypes.
9	Tari	Contains countries.
10	Tip_sol	Contains Soil Types.
11	UAT	Contains Teritorial Administrative Units.
12	Unitati_de_sol	Contains Soil units.
13	Varianta de sol	Contains Soil Variants.
14	Varietate de sol	Contains descriptive data about Soil variety.

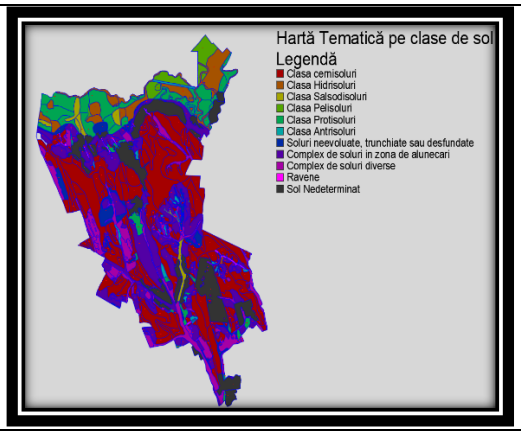
All the data loaded in these tables was later attached to the graphic information using Autocad Map 3D specialized functions.

2.4. Thematic Maps and Statistical Data.

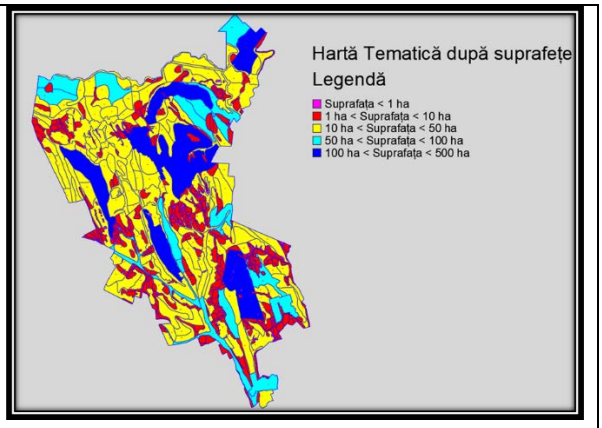
By using the topological information and the created database in thematic query procedures were created twelve maps that describe from a pedological view the study area (Table 2.), eleven report that present detailed descriptive data from the maps.(of which is shown only one large table)(Fig.5). and one table that presents polygonal data.(Table 3)

Tab.2 The thematic maps resulted by exploiting the GIS application.

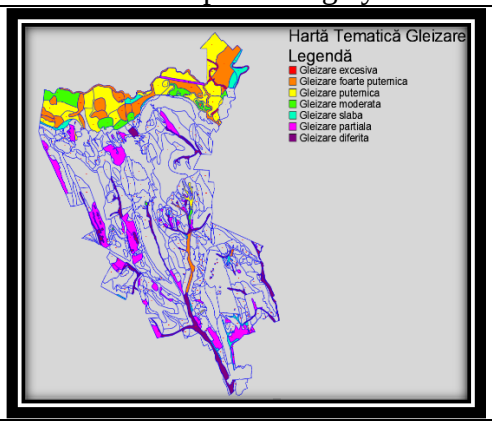
Thematic map on Soil Types	Thematic map of unsurveyed zone
	
Thematic map on Soil Classes	Thematic map on surfaces



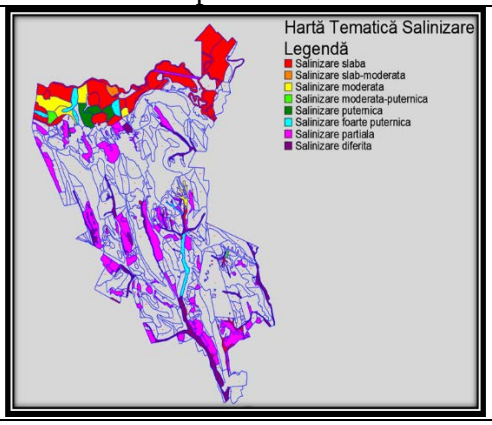
Thematic map on soil gleyzation



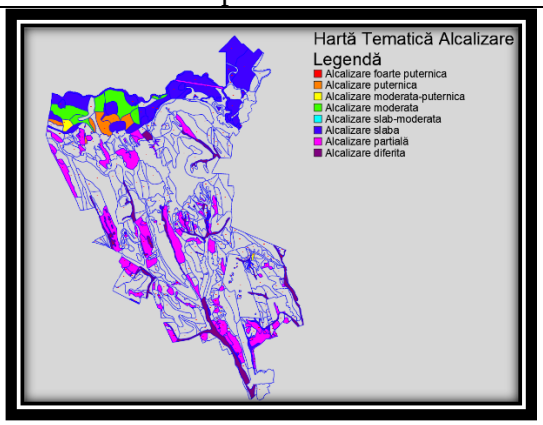
Thematic map on soil salinization



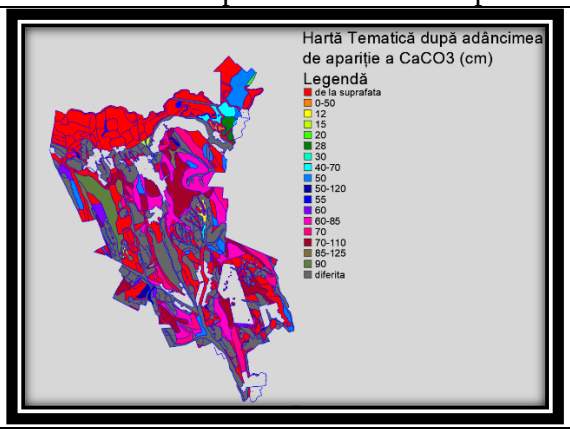
Thematic map on soil alcalization



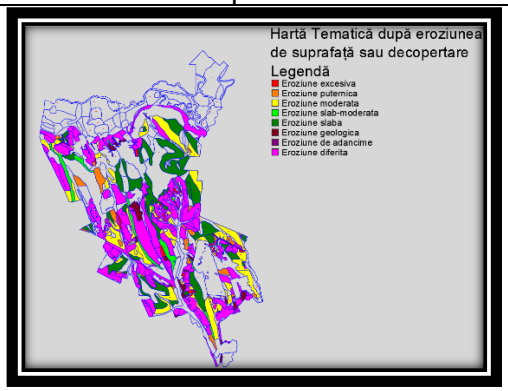
Thematic map on soil CaCO3 depth



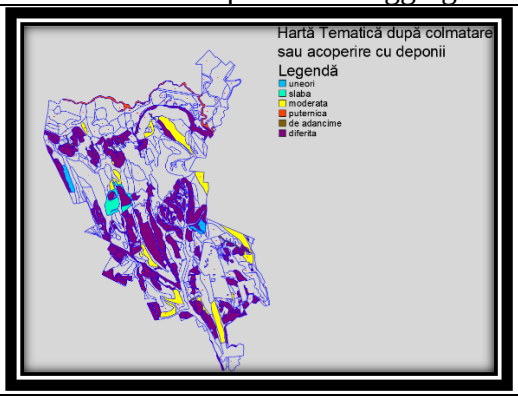
Thematic map on soil erosion



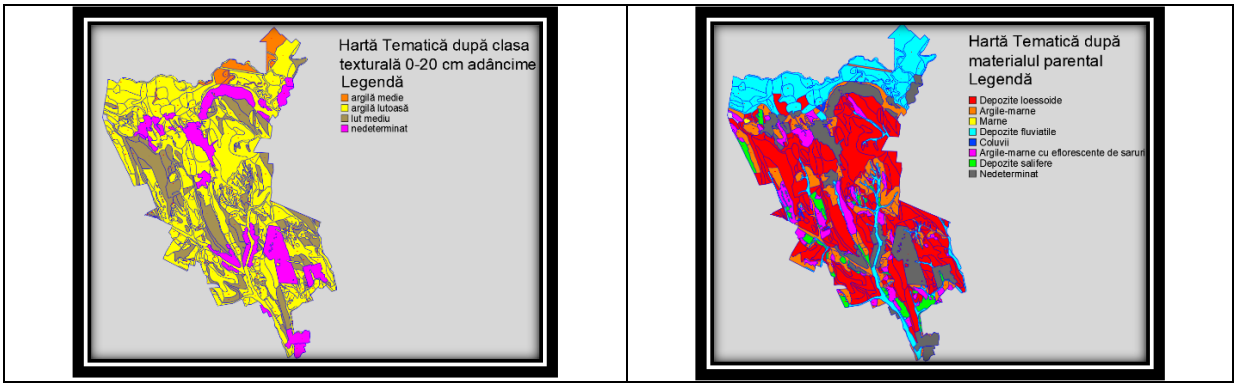
Thematic map on soil clogging



Thematic map of soil texture depth=0-20 cm



Thematic map on soil parental material



Unități de sol comuna Popricani, Jud. Iași

Numar US	Suprafata (Ha)	Clasa	Tip	Subtip	Varietate de sol	Caracteristici particulare	Gleizare	Salinizare	Alcalizare	Adancimea de aparitie a CaCO3 (cm)	Eroziune de suprafata sau decopertare	Colmatare sau acoperire cu depuneri	Clasa texturala Ac sau B	Clasa texturala in Ap sau 0-20cm	Material parental	Varianta
US1	91.5	CERNISOLURI	Cernoziom	tipic	1.Cernoziom tipic					50			argilă lutoasă	argilă lutoasă	dep loess	1
US2	33.5	CERNISOLURI	Cernoziom	tipic	2.Cernoziom tipic	Cumulic				50-120			argilă lutoasă	argilă lutoasă	dep loess	1
US3	222.3	CERNISOLURI	Cernoziom	tipic	3.Cernoziom tipic					de la suprafata	slaba		argilă lutoasă	lut mediu	dep loess	1
US4	167.4	CERNISOLURI	Cernoziom	tipic	4.Cernoziom tipic					de la suprafata	slab-moderata		lut mediu	lut mediu	dep loess	1
US5	315.1	CERNISOLURI	Cernoziom	tipic	5.Cernoziom tipic					de la suprafata	moderata		argilă lutoasă	argilă lutoasă	dep loess	1
US6	139.8	CERNISOLURI	Cernoziom	tipic	6.Cernoziom tipic					de la suprafata	puternica		lut mediu	lut mediu	dep loess	1
US7	184	CERNISOLURI	Cernoziom	cambic	7.Cernoziom cambic tipic					90			lut mediu	lut mediu	dep loess	1
US8	463.1	CERNISOLURI	Cernoziom	cambic	8.Cernoziom cambic tipic					70-110			argilă lutoasă	argilă lutoasă	dep loess	1
US9	103.3	CERNISOLURI	Cernoziom	cambic	9.Cernoziom cambic tipic	Cumulic				85-125			argilă lutoasă	lut mediu	dep loess	1
US10	466.6	CERNISOLURI	Cernoziom	cambic	10.Cernoziom cambic tipic					60-85	slaba		argilă lutoasă	argilă lutoasă	dep loess	1
US11	292.4	CERNISOLURI	Cernoziom	cambic	11.Cernoziom cambic tipic					70	moderata	moderata	argilă lutoasă	lut mediu	dep loess	1
US12	65.6	CERNISOLURI	Cernoziom	cambic	12.Cernoziom cambic tipic					60			argilă lutoasă	argilă lutoasă	argile-marne	1
US13	3.5	CERNISOLURI	Rendzină	-	13.Pseudorendzina					de la suprafata	moderata		argilă lutoasă	argilă lutoasă	marne	1
US14	28	HIDRISOLURI	Gleiosol	aluvic	14.Lacoviste mlastinoasa salinizata		excesiva	slaba		de la suprafata			argilă lutoasă	argilă lutoasă	dep fluviatile	1
US15	15	HIDRISOLURI	Gleiosol	aluvic	15.Lacoviste salinizata-alcalizata		foarte puternica	slaba	slaba	50			argilă lutoasă	argilă lutoasă	dep fluviatile	1
US16	55.7	HIDRISOLURI	Gleiosol	aluvic	16.Lacoviste salinizata-alcalizata, inundabila		foarte puternica	slaba	slaba	de la suprafata			argilă lutoasă	argilă lutoasă	dep fluviatile	1

Fig.5. The Soil Units Report that presents all pedelogical data available.

Tab.3. Polygonal data resulted by exploiting the GIS application.

Class	Polygons	Minimum area(m^2)	Maximum area(m^2)	Total Area(m^2)
1	2	3	4	5
Cernisol	207	1005	1767831	26654067
Hidrisol	18	16308	1072694	3738901
Salsodisol	7	40868	312012	1056332
Pelisol	13	3129	662316	1790963
Protisol	46	10551	714099	6290417
Antrisol	18	8505	130412	607551
Unevolved Soils	35	3349	462375	2282755
Soil complex in landslides	118	3178	1043156	11965294
Soil complex	75	1589	869057	6047779
Ravines	30	647	77848	295047
Undetermined	23	28023	1954652	8937691
Total(m^2)	590	117152	9066452	69666797

2.5. Creating an informatic solution for an efficient further use of the application

Traditionally by using the topological information and the created database in thematic query procedures are resulting thematic maps and statistical data manually. But this methods are inneficient and time consuming. By introducting an automatized working system with maps and queries and creating a web application for distribution and further management of the GIS lots of time can be saved.(Figure 5.)

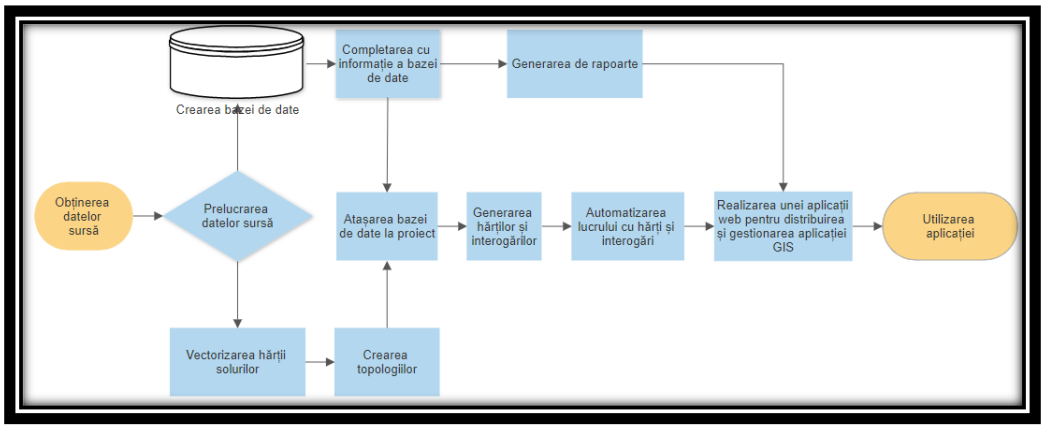


Fig.6. Logic Scheme of the application.

This informatic solution is made of a Graphic User Interface for the semi-automatized generation of Thematic Maps, a VBA application and a set of .LSPs for Thematic Maps Generation and a WEB application for distribution and further management.

The GUI consists of a series of macros defined and customized inside AUTOCAD MAP 3D by using the specialized functions ACTRECORD, ACTUSERMESSAGE, ACTSTOP and the CUI interface of the CAD program.(Figure 7.)

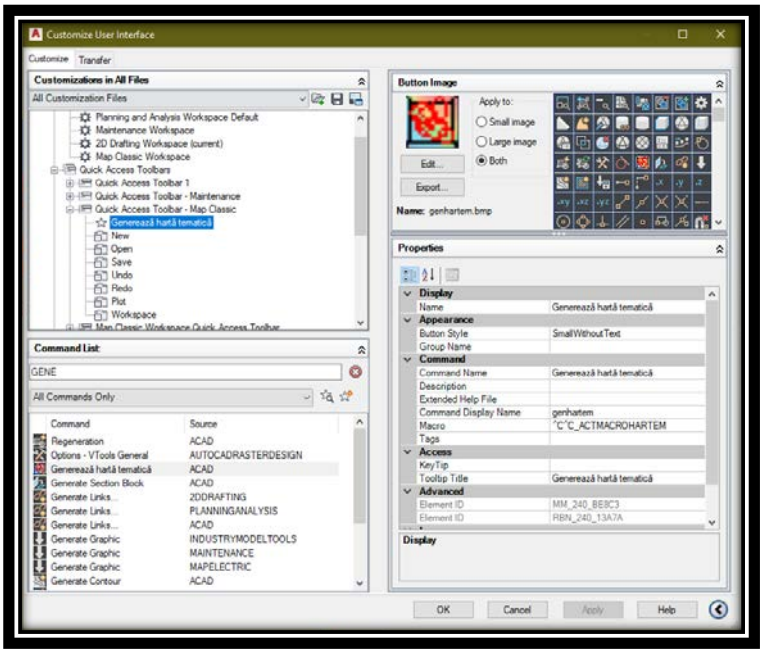


Fig.7. Window Customize User Interface

The button created was saved in .cuix format so it can be shared on any other device and by providing a series of templates for thematic maps it can reduce minutes of work to seconds of work while generating thematic maps.(Fig. 8)

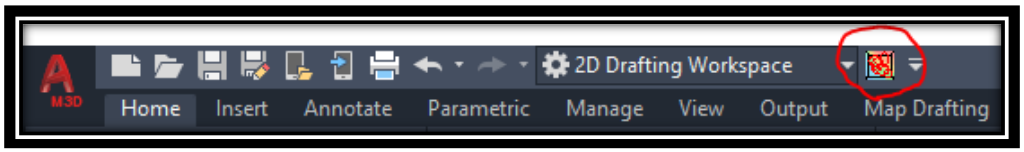


Fig.8. The thematic map generating button.

The VBA application was realized using the Visual Basic Editor function in Autocad and coded in Visual Basic for Applications and it allows the user to generate thematic maps and queries on-demand just by pressing a button instead of the tradional time-consuming method.(Figure 9.)

Fig.9. Part of the source code (left) that powers the Graphic Interface(right).

The 25 .LSPs were created using the AUTOLISP programming language inside the Visual Lisp Editor function of Autocad Map 2021 and reduce the time consuming routines of making queries. They are saved in a predefined location and can be loaded using the APPLOAD command in Autocad. Once loaded they can be called using the command bar.(Fig. 10)

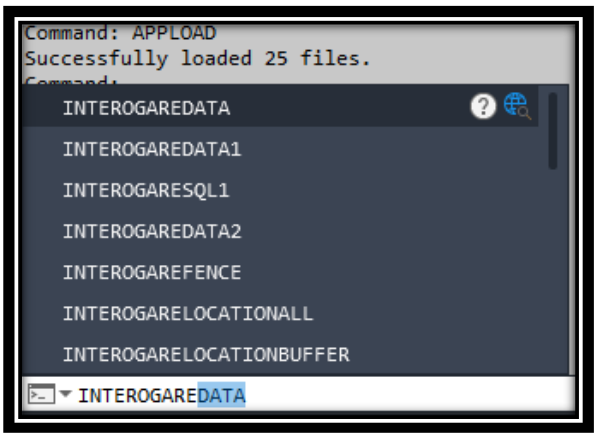


Fig.10. The command bar loaded with the AutoLisp routines created.

The WEB application for distribution and further management of this GIS aims at creating a complex system that eases the end user experience and productivity. By providing everything needed via internet the end-user needs just to acces the secured web application and download the data, watch the intructions or ask for support in minutes.

The WEB application was realized using HTML, CSS and Javascript.(Figure 11)

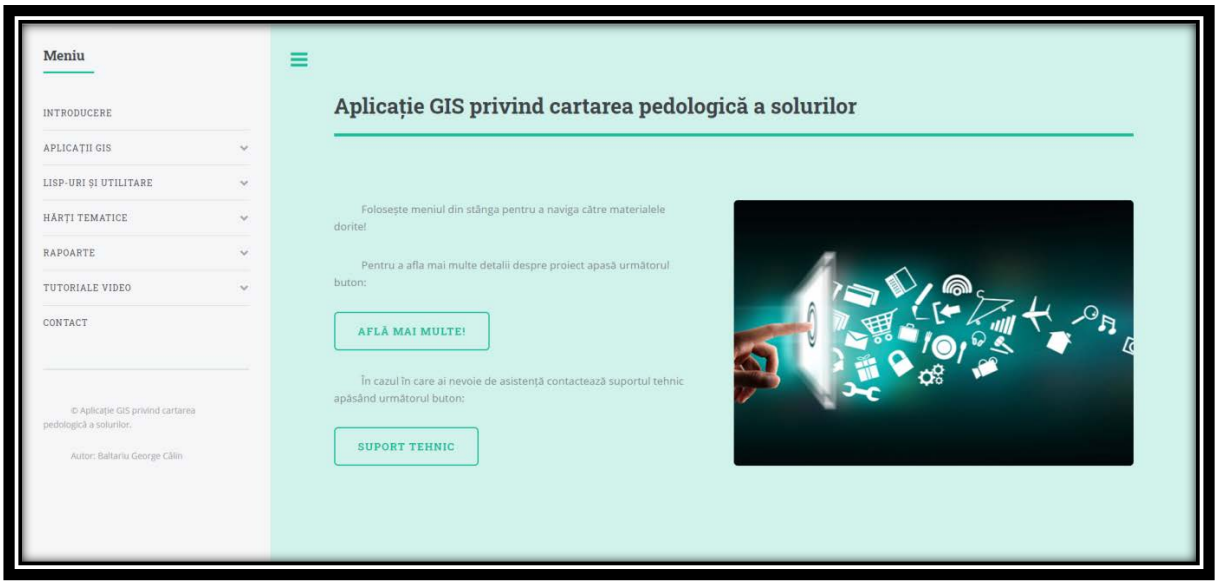


Fig.11. First page of the WEB application.

3. Conclusions

The alphanumeric and graphic information existing on old pedological surveys and their afferent soil maps, constitute an important asset and must be integrated in GIS applications both because they are valuable and must be protected and for further use because they can serve as a base layer further studies and research.

The GIS application has an enormous potential and can be upgraded to serve a much larger area thus providing pedological data from the whole country to researchers and professionals, and by this preserving the existing data that stays under the dust in archives and renewing it with more recent data.

Furthermore the informatic system created facilitates the end user to increase productivity of using the data available and can result in a further faster development of science.

4. References

1. *Baltariu M., „Eficiența economică a tehnologiilor de mecanizare totală la culturi”, UAIC, Iași, 1980.*
2. *Blaga Gh., Rusu I., Udrescu S., Vasile D. - Pedologie, Editura Didactică şi Pedagogică RA, Bucureşti, 1996;*
3. *Bofu C., Chirila C., Sisteme Informaționale Geografice, Ed.Performantica, Iaşi, 2005.*
4. *Stătescu F., Pavel V.L. , Tehnici moderne de cercetare a solurilor, Editura Politehnium Iași,2016*
5. *Florea N., Munteanu I., – Sistemul Român de Taxonomie a Solurilor. UAIC, Iaşi, 2000*
6. *Mihalache M.– Pedologie – geneza, proprietăţile şi taxonomia solurilor. Editura Ceres, Bucureşti, 2006;*

7. *Mihalache M., Ilie L.– Bonitarea terenurilor agricole, Editura Dominor, Bucureşti, 2009*
8. *Moca V., Radu O., Huţanu Cr., – Evaluarea calitativă şi valorică a terenurilor agricole pe baza bonitării cadastrale a solurilor. Lucrări ştiinţifice. Seria Agronomie, vol. 47, USAMV Iaşi. 2004*
9. *Stătescu F., Pavel V.L. , Tehnici moderne de cercetare a solurilor, Editura Politehnium Iaşi,2016*
10. *OJSPA IAŞI – Studiu pedologic scara 1:10.000 Teritoriul comunei Popricani,Jud Iaşi, 1998.*
11. ****, 2001 – ICPA/OSPA/IEA – Norme de conţint pentru elaboarea studiilor pedologice şi bonitarea terenurilor în vederea întocmirii cadastrului agricol (proiect).*
12. ****, 2002 – MAAP – ordin 223 privind aprobarea metodologiei întocmirii studiilor pedologice şi agrochimice şi a finanţării sistemului naţional şi judeţean de monitorizare sol-teren în agricultură.*
13. *Manual AutoLISP, LISPR.DOc R.2.1*