

A Beziers example to demonstrate a GIS based methodology on selecting possible Roman cadastre grids.

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Abstract:

Taking into consideration the traditional method on the research for Roman cadastre grids, and using a new GIS-based software, we made an application situated at Beziers area. The main idea is to import all the relevant data into separate GIS layers and process them, using tools provided by modern technology.

In our example, we digitized the pedological units, the primary road network, the main towns and the archeological sites of the studied area. Finally we digitized all the possible lines that could form a Roman cadastre grid. The data process also requires the formation of a theoretical digital Roman cadastre grid. The GIS-based software, apart from creating the theoretical grid, enables the user to select all the lines and sites that match the given grid. In case the results are acceptable, the user can save the grid for later use. After that, other possible grids can be created, so the user can experiment on different grids to choose the best possible one.

The results from the application of this modern GIS-based methodology, at the southEastern part of Beziers area, show the benefits of this approach.

In this study, we are going to present an example of the GIS-based Cadastre GRID method (Vassilopoulos, A., 1998). This method helps in various ways in the selection of lines that theoretically form a Roman cadastre grid, out of a big set of possible lines. We applied it in a small (84,14 Km²) SouthEastern part of Beziers area.

The traditional method, consisted in three main procedures: a) the copy of all the parallel lines on a transparent paper, b) the formation of a given dimension grid on a transparent paper, c) the manual matching of the lines to the grid, by moving the grid layer over the line's layer.

This new method can handle all the possible lines, regardless of their declination from the North, their length, or origin. The lines can be digitized directly from maps, aerial photos, satellite images, or any other source. These lines are digitized on a separate GIS layer. In our example we digitized 1530 lines and selected 1009 within the boundary of the

studied area. Other valuable information, such as archeological sites, pedological or geological units, contour lines, drainage system, etc. may also be digitized, in separate layers.

By this step, the user may update the database of the GIS, with information concerning each line or pedological unit. Figure 1 shows all the data used for this study, except for the grids. The possible archeological lines are demonstrated by red color, while the sites by black asterisks, over the pedological map. Moreover we can see the primary road network and the main towns of the area. All the layers have different databases, depending of course, on their nature. These data, can be used later, when setting criteria on the selection of the lines and sites, e.g. “Find all the lines AND sites that match a certain grid AND have length over X meters AND are not situated on XXX pedological unit”.

Figure 2, demonstrates the lines that have been transformed to Vector layer, over the primary raster image. Moreover it shows a thematic map of the area’s pedological unit, plus an information window with the description of the selected pedological unit and the area it covers in square Kilometers. After inputting all the necessary data, the user has to load the Cadastre GRID software, that will be used to form the theoretical grid and apply the selection of all the matching lines and sites. The software has to be initialized, by entering two parameters: the dimension of the grid’s cells, and the tolerance to be estimated during the selections. The user also has to ‘draw’ the initial direction of the grid, before the program will automatically generate the theoretical grid. Four examples have been made. Table 1 shows the parameters used each time, and the corresponding selected lines. All four grids use the same direction and position.

	Grid’s Cell Dimensions (m)	Tolerance (m)	Declination from North (°)	Number of selected lines
1 st	850	±15	357	26
2 nd	707	±15	357	74
3 rd	707	±20	357	94
4 th	707	±25	357	106

The grid is generated on a new fixed layer over the raster image and below the layers of the lines and sites. The user has the ability to shift it over the other layers, making the final corrections on the grid’s exact position. All the grid’s parameters and its final positioning can be saved

to a GIS file, so that the user can retrieve them and easily reconstruct the grid later.

The final step on the use of the software is the automatic selection of all the digitized lines and/or sites that match the generated grid. The software, displays the selected lines in a different color or pattern on the map window, a browser including only the selected lines, and their total count number. Figure 3 demonstrates the grid with dimension 850m and tolerance ± 15 m. The selected lines are colored red. The total number of the selected lines is only 26, as expected since the dimension 850m is not appropriate for the studied area. The user can then isolate the selected lines and save them to a new GIS file, or repeat the process giving different initial grid values and direction. Figure 4, shows in two windows the results of the 2nd and 3rd attempt with ± 15 m tolerance for the first one and ± 20 m for the second one. In the 2nd attempt the total number of the selected is the minimum compared to the 3rd and 4th one, but this was also expected as we increased the tolerance. Figure 4 also shows a part of the browser with info on the selected lines. The field of tolerance has two kinds of numbers (15 and 20). Lines with tolerance ± 15 are those that have been selected from the grid with ± 15 tolerance, while lines with tolerance ± 20 are those that have been selected only from the grid with ± 20 tolerance and not from the ± 15 one. The final example shown in figure 5 was made with an even bigger tolerance and the selected lines were even more numerous. This easy, precise and fast loop of the whole process, enables the user to create different theoretical models, examining not only the common dimensions Romans were using but many others, choosing the best possible solution, which will be the one that includes the largest number of selected lines.

Finally at the lower half of figure 5 we can observe the 3 grids (with different tolerance) and with different color for each one. At the window of this map we may see a detail of the grids. The 3 grid layers are visible. The upper layer is the one with the smaller tolerance (± 15) and it is represented by the yellow color, the middle layer is the one with the middle tolerance (± 20 m) and is represented by green color and the lower layer is the grid with the biggest tolerance (± 25 m) in blue color. The two lines shown in this part have not been chosen from the upper grid layer (with the ± 15 tolerance), but they have been selected from the middle and lower one.

In case the attempts are numerous, it is easy to create a histogram within the GIS environment, to emphasize the results and isolate the best initial values.

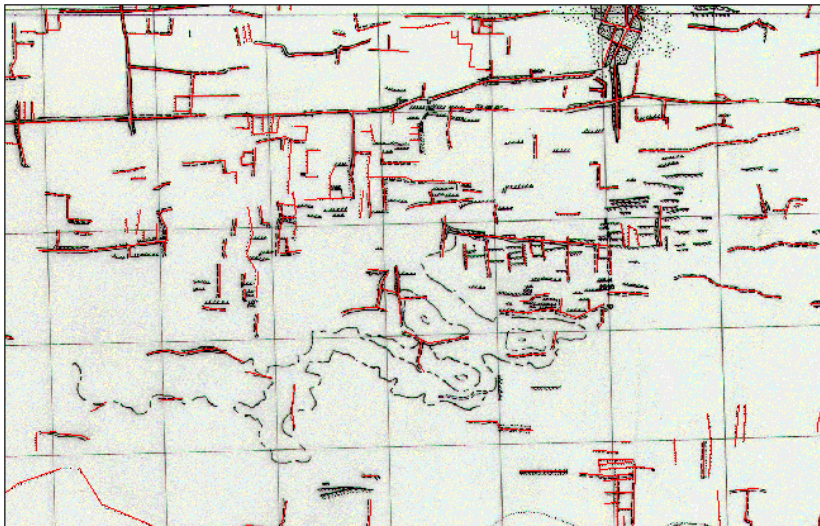
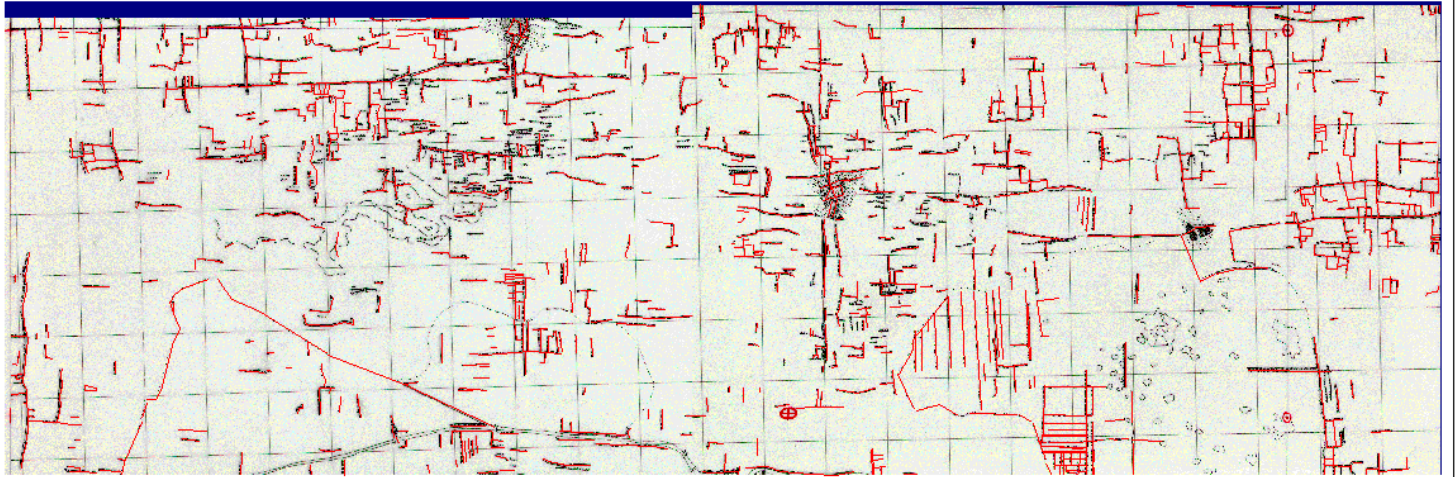
The benefits of this methodology are quite a lot. First of all, we speed up the calculations and reduce human errors. Moreover, we eliminate the

subjectivity on the decision of which line is within the grid and which is not. Another advantage is the easy and fast repeat of the whole process, making possible the examination of many theoretical grid models. Finally, all the data that were used on the selection process, plus the results, are on a GIS format, making it easier to update the database, reprocess the output data, exchange data with other scientists, print browsers, or plot thematic maps.

References:

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2. Evelpidou, N., Geological and Geomorphological observations on Paros island, using GIS and Remote sensing methods, University of Geology, Athens, 1997, p.181.
3. Evelpidou, N., Vassilopoulos, A. Vaiopoulos, D.,1997, Development of GIS Methodology, for the study of landuse at Paxi island, Proceedings of 1st International Congress "Space Applications and Environment" of Hellenic Astronautical Association.
4. Gournellos, Th., Vassilopoulos, A., Evelpidou, N., 1997, Development of a GIS-based methodology to analyze geological, geomorphological and environmental data of the island of Zakynthos, Engineering Geology and the Environment, Proceedings of the International Environmental Congress, organized by the Greek National Group of IAEG, Athens-Greece.
5. Vassilopoulos, A., Evelpidou, N., The Geographical Information Systems and their applications in Earth Sciences, University of Geology, Athens, 1994, p.87.
6. Vassilopoulos, A., Evelpidou, N., Vaiopoulos, D.,1997, Evaluating average % relief slopes at Sifnos island, using GIS, Proceedings of 1st International Congress "Space Applications and Environment" of Hellenic Astronautical Association.

Digitized Cadastre Map of Beziers Area



Zoom window of the upper Map window

Main Towns

☒ (5)

Primary Road Network



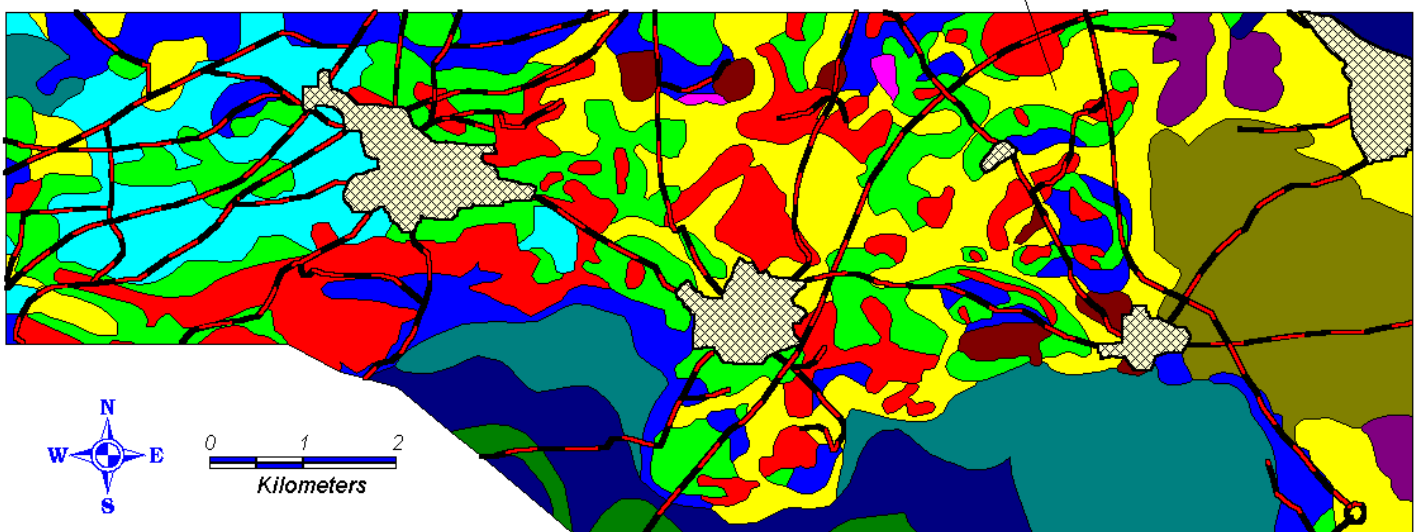
Pedological Formations

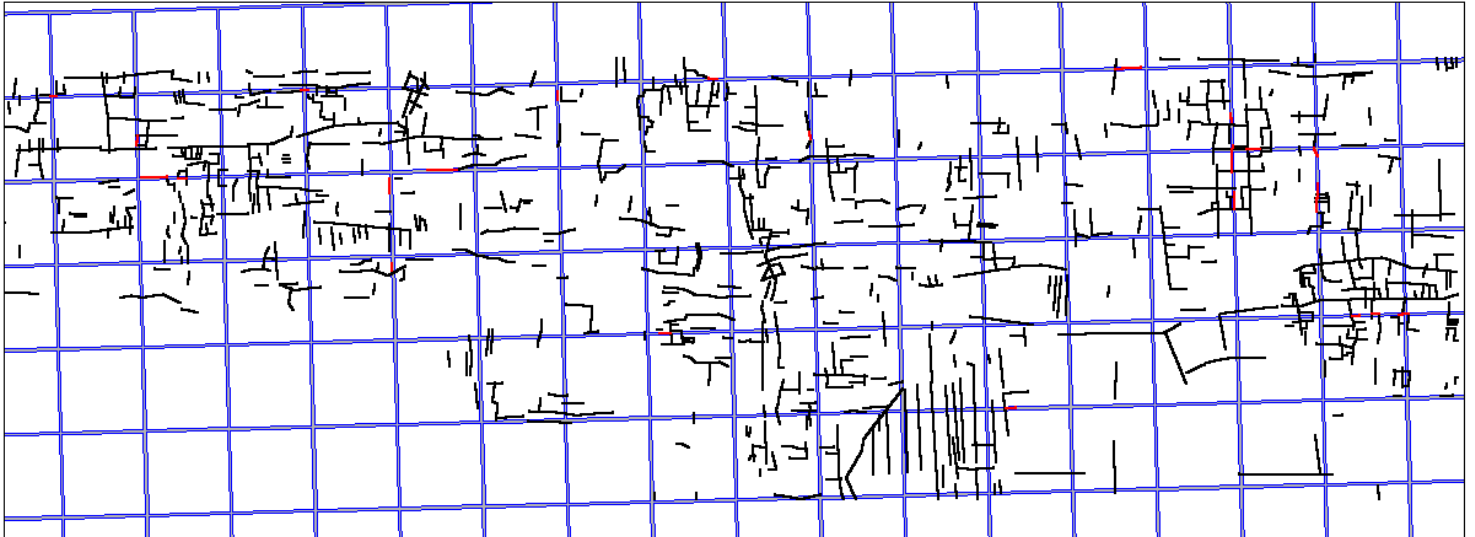
- A (35)
- B (31)
- C (20)
- D (2)
- E (13)
- F (5)
- G (7)
- I (3)
- K (4)
- L (3)
- M (1)

Pedological Unit Info

name: E

area: 8,857



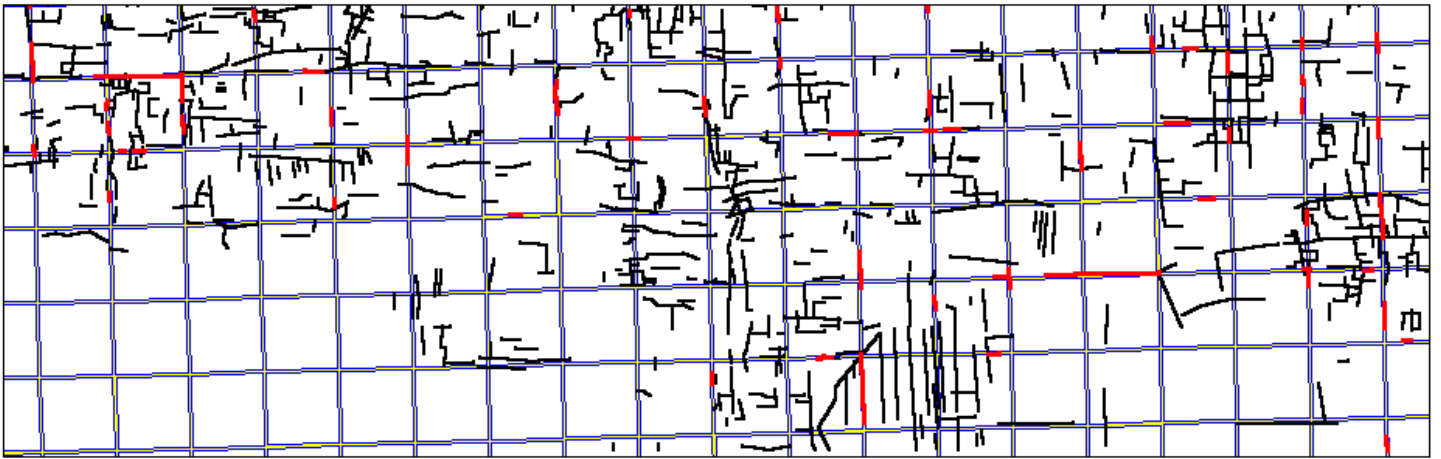


Grid Values :

Dimensions 850m
Tolerance +-15m
Direction N 88.5 E

ID	Description	Pedology	Tolerance
		E	0,00
		F	0,00
		F	0,00
		F	0,00
		F	15,00
		F	0,00
		B	0,00
		A	15,00
		A	0,00
		E	0,00
		E	15,00
		N	0,00
		N	15,00

Browser of Selected Lines
(Count of Selected Lines : 26)
(Selected lines are colored RED)



Description	Pedology	Tolerance
	F	15,00
	F	15,00
	B	15,00
	E	15,00
	E	15,00
	A	15,00
	F	15,00
	A	15,00
	F	15,00
	B	15,00
	F	15,00
	F	15,00
	F	15,00
	B	15,00
	B	15,00
	F	15,00

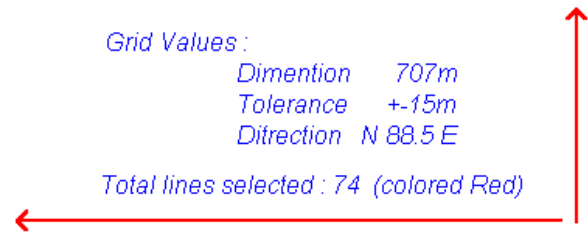
Grid Values:

Dimension 707m

Tolerance +15m

Direction N 88.5 E

Total lines selected : 74 (colored Red)



Description	Pedology	Tolerance
	F	20,00
	F	15,00
	F	15,00
	B	15,00
	E	15,00
	E	15,00
	A	15,00
	A	20,00
	F	15,00
	A	20,00
	A	15,00
	F	15,00
	B	15,00
	F	15,00
	F	15,00
	F	15,00
	F	15,00

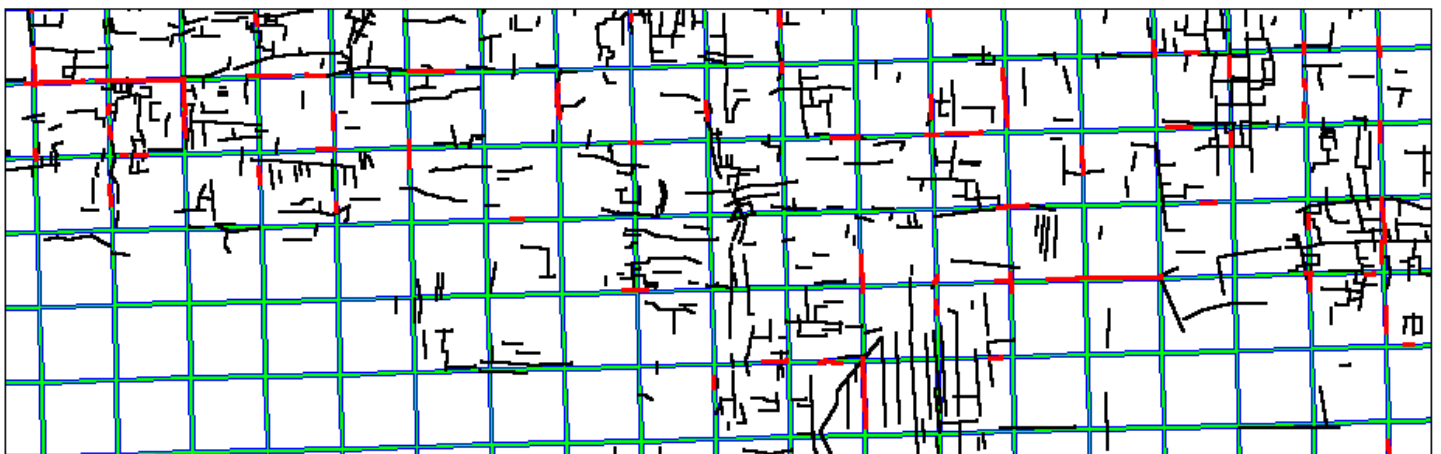
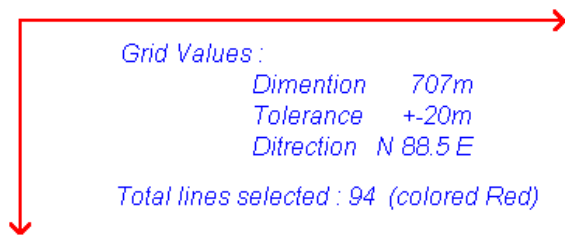
Grid Values:

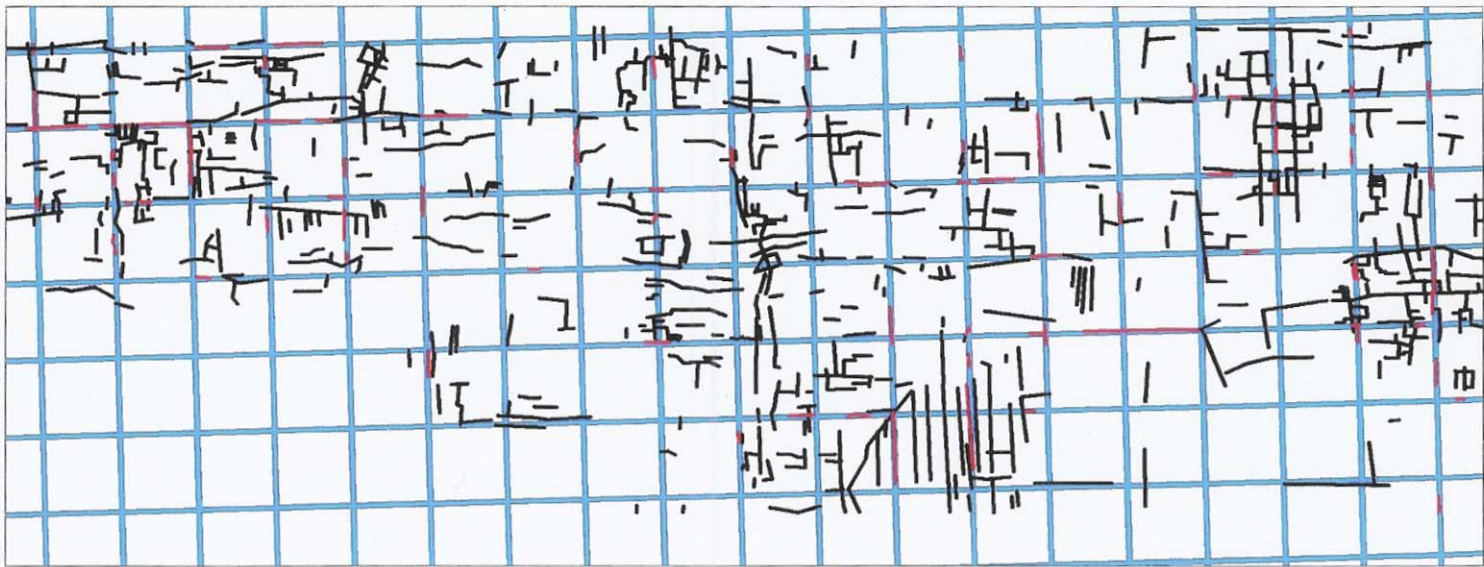
Dimension 707m

Tolerance +20m

Direction N 88.5 E

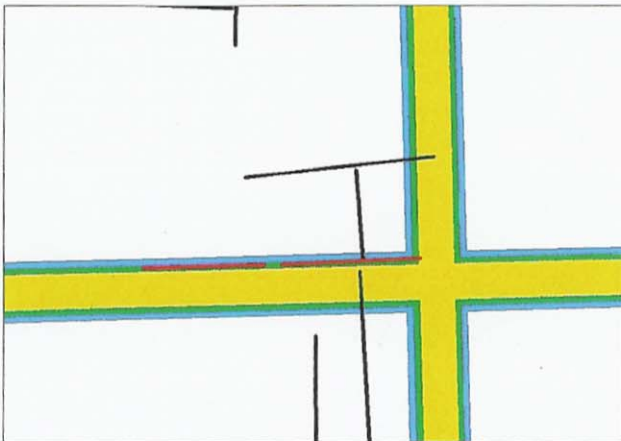
Total lines selected : 94 (colored Red)





Grid Values :
 Dimention 707m
 Tolerance +/-25m
 Direction N 88.5 E
 Total lines selected : 106 (colored Red)

Descriprion	Pedology	Tolerance	Length
	A	15,00	63,896
	F	15,00	102,308
	B	15,00	49,398
	F	15,00	29,022
	F	15,00	14,718
	F	15,00	43,477
	B	15,00	89,292
	B	15,00	801,461
	F	15,00	255,703
	F	0,00	134,623
	F	15,00	142,708
	F	0,00	389,032
	F	15,00	151,003



The upper layer is the grid with the smaller tolerance (15m=yellow). The middle layer has a 20m tolerance (green), while the last one 25m (cyan)

Zoom in of Lower Map Window. The three different grids are printed with different colors depending on the tolerance.





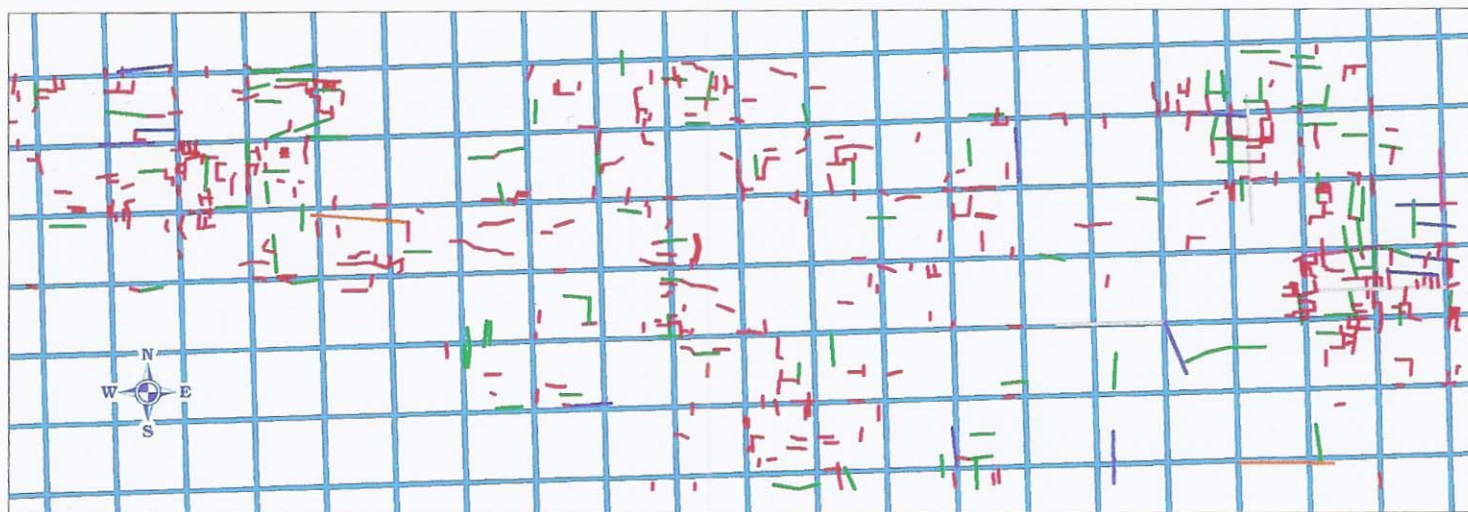
Lines categorized by Pedology

—	A	(90)
—	B	(94)
—	C	(41)
—	E	(88)
—	F	(104)
—	I	(5)
—	K	(28)
—	L	(4)
—	M	(186)
—	N	(27)

Grid (N 88.5 E, 707m, +-25)

Grid

This thematic map shows all the selected lines (within grid 707+-25m) with different colors, depending on the pedological unit they are situated.



Lines categorized by length (m)

—	1,000 to 1,400	(3)
—	800 to 1,000	(2)
—	600 to 800	(2)
—	400 to 600	(13)
—	200 to 400	(105)
—	0 to 200	(542)

This thematic map shows all the selected lines (within grid 707+-25m) with different colors, depending on their length (m).

SOUTHEAST BEZIERS AREA

Archeological Sites/Lines on pedological units

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Main Towns
☒ (5)

Primary Road Network
—

Archeological Sites
* Site symbol (115)

**Possible Archeological
Lines/Directions**
— Line symbol (987)

Pedological Formations

■	A	(35)
■	B	(31)
■	C	(20)
■	D	(2)
■	E	(13)
■	F	(5)
■	G	(7)
■	I	(3)
■	K	(4)
■	L	(3)
■	M	(1)

X: 672.020
Y: 3.107.480
Z: 2
Site_Name: Villa temple de Venus
Community: Vendres
Info:
Pedology: N

