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## **Gregoriano Cadastre: transformation of old maps into Geographical Information System and their contribution in terms of acquisition, processing and communication of historical data**

*Keywords:* Gregoriano Cadastre; main maps; reduced size maps; property registers; historical landscape; prospective views simulation

### *Summary*

The indispensable cartographical working-out for our historical analysis has been conduct drawing up maps originating from the nineteenth century *Gregoriano* Cadastre (*Catasto Gregoriano*) maps preserved in the State Archive of Rome, which have been reproduced in digital format, georeferenced and vectorized. With the creation of a database, it has been possible to add to the maps the information gathered from the property registers concerning crop production and socioeconomic variables, in order to set up a Geographical Information System (GIS). The analysis covered an area located along the “internal Marche ridge” of the Apennines, in the Province of Ancona (Marche Region, Italy). The combination of the database with the digitized maps has allowed the creation of a univocal relation between each parcel and the related historical data, obtaining an information system which integrally and completely evidences the original cadastre data as a final result. This project has allowed to make interesting qualitative and quantitative evaluations covering the so called *thematisms* as well as to create a three-dimensional model of the historical landscapes which permits to visualize the cultural diversification of that historical period. This model is accessible and immediately understandable by the general public.

### **Gregoriano Cadastre**

The starting point of our study is the historical analysis on the *Gregoriano* Cadastre<sup>1</sup> maps in reduced size. This cartography offers a complete and detailed representation of the territorial and urban settlement of the “internal Marche ridge” of the Apennines, in the Province of Ancona (Marche Region, Italy) in the first decades of 19<sup>th</sup> century. In order to practically use the great deal of information derived from the reduced size maps and from

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<sup>1</sup> “This is the first geometric cadastre in the Papal State: it was commissioned in 1816 by pope Pio VII, and carried out by pope Gregorio XVI only in 1835. The cadastre was continued by the *Presidenza generale del Censo*, in the same way as used by the Italian Kingdom for the Napoleonic cadastre in the *Legazioni* (Bologna and Romagna) and in the Marche region. A copy of the documentation was in the local land registry offices (*Cancellerie del Censo*). It is composed of three related series of documents: main maps (1:2000), reduced size maps (1:4000 or 1:8000), property registers (*brogliardi* or *sommarioni*). The copy in the State Archive of Rome is usually the more complete, original and well preserved, compared with the ones used in local land registry offices that have often been corrected over time. This cartography shows the most complete vision of the land and urban shape of Pontifical State” (see, [www.asrm.archivi.beniculturali.it](http://www.asrm.archivi.beniculturali.it))

the relative property registers, it has been necessary to determine an appropriate methodology for the acquisition and the working-out of such material (Mangani and Mariano 1998; Buonora 2004). The images of the *Gregoriano* Cadastre reduced size maps have been acquired in digital raster format from the State Archive of Rome and then georeferenced with respect to a 1:10.000 scale cartography (Fig. 1, Fig. 2).



Figure 1. Macerata's reduced size map n. 49 (*Gregoriano* Cadastre, State Archive of Rome – Italy):  
Before georeferencing.



Figure 2. Macerata's reduced size map n. 49 (*Gregoriano Cadastre*, State Archive of Rome – Italy):  
After georeferencing.

It was possible to georeference these maps, using the regional technical map (on scale of 1:10.000), in virtue of the known scale of representation of the old maps and of the quantity of the toponymy-elements. For each map it has been drawn a border in order to create a mosaic. These reduced size maps in raster format cover the 92% of the provincial territory, the georeferenced ones the 41% or so, while the currently vektorialized area (as we see in the following paragraphs) has an extent of about 167 Km<sup>2</sup>, i.e. 8% of the provincial territory (Fig. 3).

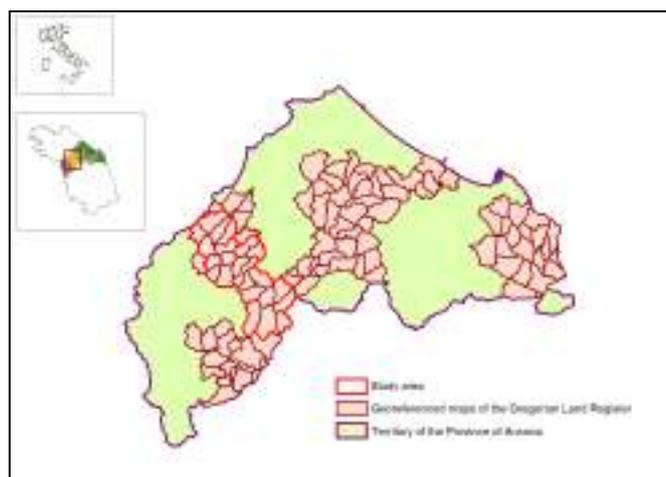


Figure 3. Summary from the provincial coverage of georeferenced *Gregoriano* Cadastre's reduced size maps.

The digitization campaign was realized in two different phases. First it was worked out the computerization of the hydrographical and road reticulum and the residential settlement, consisting in the main urban centres and scattered houses. The digitization was carried out according to the following topological criteria: the linear elements as streets, rivers and signs that have bearing on territorial morphology were put in along the middle line. The main rivers were put in as polygonal entities in order to show a better representation of the fluvial river basin. Main streets were digitalized following the middle line and minor ones as borderline between the properties. Bridges were reported as punctual entity with the associated toponym. It was decided to reproduce with punctual and linear entities the more important reliefs that in reduced size maps are underlined by toponymy and by a graphic stumping treatment. All the settlements (main urban centres and scattered houses) were digitalized aside as polygonal entities; in the associated database has been reported, where present, the relative toponym. Afterwards it was realized the plot of agrarian parcels, as represented in Fig. 4 (this is a parcellar geometric land register, therefore in each parcel is present a number which connects it to the information showed in the property registers).

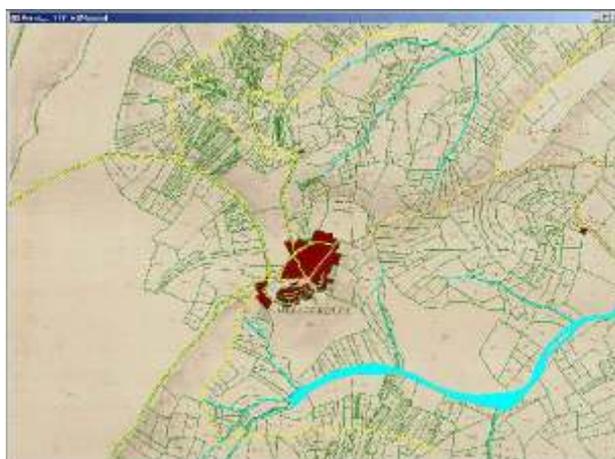


Figure 4. Example of digitalisation of Macerata's reduced size map n. 49 (*Gregoriano* Cadastre, State Archive of Rome – Italy). In the working-out are readable elements like road (yellow) and hydrographical networks (blue), settlement (brown) and the plot of parcels (green).

### Compilation of property registers

At the same time it was created a database that refers as accurately as possible all the information we founded in property registers; this has allowed to combine each parcel with the relative notions through the parcel number (e.g. owner's name, kind of culture, land position, plot of ground extent, etc). It was realized an input mask in order to facilitate the compilation of database (Fig. 5, Fig. 6). The combination of database with the digitalized maps was done with the creation of a key, which could restore one-to-one relation between the parcel and the relative data, which cannot be guaranteed with the parcel only (Fig. 6). The result is a quite complete transposition on informatics ground of the primary land register information system. This has allowed the following valuation of the use of a plot and of the properties distribution or typology. These synthesis thematic maps rendered explicit and considerably completed the information found on the primary cartography. From this informative base it was possible to work out a quantity of historical/territorial analysis, i.e. a precious support for the planning of the provincial administration (Orciani et al. 2005).

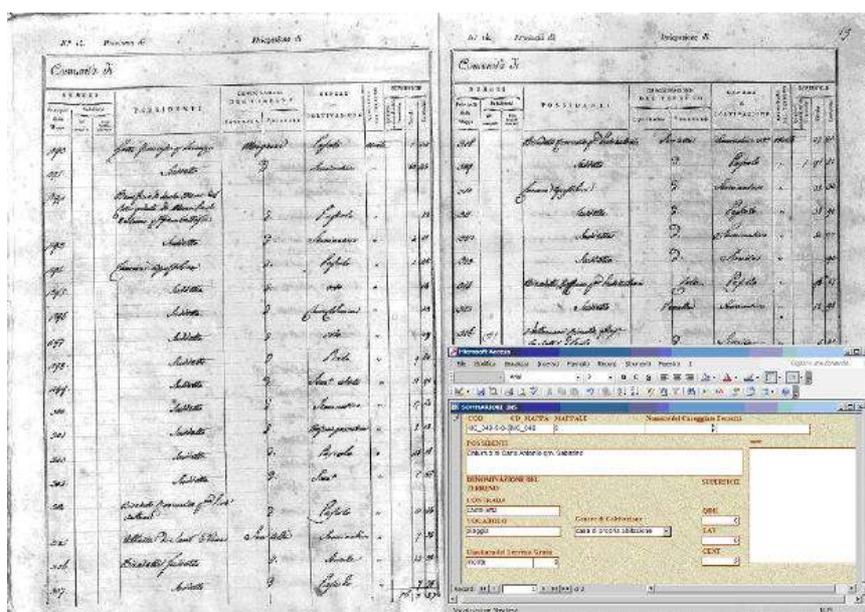


Figure 5. Property register relative to Macerata's reduced size map n. 100 (Gregoriano Cadastre, State Archive of Rome – Italy) and relative input mask.



Figure 6. Detail of property registers input mask.

The property registers file shows the following compilation tables:

1. The ADMINISTRATION table reports data studied in the title of each reduced size map (Fig. 7).

CD_MAPPA	PROVINCIA	DELEGAZIONE	GOVERNO	COMUNE	MAPPA	SEZIONE
MC_049	Marca	Macerata	Fabriano	Fabriano	Castelletta	Albacina

Figure 7. Administration table relative to data in the title of each reduced size map.

2. The PROPERTY REGISTERS table reports data founded in the property registers (Fig. 8). The CD\_MAP field always shows the reference to reduced size map which a particular parcel takes place in. The SUB field refers to many-storied buildings:

1=ground floor of a building,

2=first floor of a building,

3=building on the upper floor than the first floor.

MAPINFO_ID	COD	CD_MAPPA	MAPPALE	SUB	FERACITA	POSS	CONTR	VDCB	USO	GIAC	GR	QOR	TAV	C
1	MC_049-9-0-0	MC_049	9	0	0	Chirrubini Carlo Antonio qm	castelletta	piaggia	casa di proprio abitazione	monte	0	0	0	
2	MC_049-10-0-0	MC_049	10	0	0	Chirrubini Casini Margherita	castelletta	piaggia	casa di proprio uso	monte	0	0	0	
3	MC_049-11-2-0	MC_049	11	2	0	Chirrubini Casini Margherita	castelletta	piaggia	casa di proprio uso	monte	0	0	0	

Figure 8. Property registers table relative to data present in register itself.

The NOTE field specifies this information (Fig. 6). The FERTILITY (FERACITÀ) field (Fig. 8) refers to parcels with the same number which is fractionized into two parts (e.g. parcel number 382 with fertility 1 and parcel number 382 with fertility 2).

3. The USE table refers data in property registers that are relative to kind of cultivation (Fig. 9). This is important for the compilation through key code of the field: “types of cultivation” that is present in the PROPERTY REGISTERS \_INS mask (Fig. 6). In this way it is possible to have a list of use-typologies and then to select the one that interests.

The realization of a GIS through the input of information we found in reduced size maps and in property registers, has allowed specific studies about the following *thematism*s, by investigating the understanding basis and by defining the main variations happened between the 19<sup>th</sup> century and the current period:

- Structure of settlements and relative dynamic analysis;
- Toponymy of the period;
- Historical routes and their hierarchy;
- Hydrographical network and relations with the morphology;
- Land-uses and configuration of historical landscape.

This analysis covered a specific area located along the “internal Marche ridge” of the Apennines, in the Province of Ancona (Marche Region). The physical-morphological, geological, botanical-vegetation aspects show how the area has the characteristics of an ecotonal context, that links the hilly strip and the mountainous relief of the ridge. Considering the vegetation landscape, the link corresponds to the passage from the area of the

crops (with less presence of meadows) to the area of the woods and pastures. This aspect confirms the role of the area as *frontier territory*.

USO	NOTE
▶ aja	
aja ad uso promiscuo	
andito promiscuo	
atrio con sagrestia	
boschina forte	
boschina mista	
bosco ad uso di caccia	
bosco ceduo forte	
bosco ceduo forte con pascolo	
bosco ceduo forte con pascolo in parte	
bosco ceduo forte con querce d'alto fusto	
bosco ceduo forte da frutto	
bosco ceduo forte e d'alto fusto	
bosco ceduo forte e querce	
bosco cespugliato	
bosco con ginepri	
bosco con querce	
bosco da frutto	

Figure 9. Use-table relative to the kind of cultivation present in every parcel.

### Structure of settlements and relative dynamic analysis

The residential tissue, dense in case of the main urban centres<sup>2</sup> and rarefied in case of scattered houses, was accurately reproduced so as to have a detailed description of the building property in the middle of the 19<sup>th</sup> century (Fig. 10). The residential system is one of the more important themes in the planning; between the various distinctive characteristics we focused our attention on the settlements throughout the extra-urban territory, because they were fast bound to the use of the same agricultural territory and to its transformation in relation to the economic events of the region.

In this order data relative to the analyzed area were completed as further threshold of time in comparison with those that were picked out in the currently present residential settlement classification (before 1898, 1898-1954, 1954-1984, 1984-1994), this is a *thematism* that is already worked out for analyses inherent to PTCP<sup>3</sup> and already spread over the whole provincial territory.

There were underlined the elements of extra-urban building patrimony that are present in the first decades of 19<sup>th</sup> century and there were located the lost ones. The analyses of dis-

<sup>2</sup> It was decided to represent the main urban centres as separate polygonal entities, using the same principle found in the *Gregoriano* Cadastre reduced size maps: this land register uses for extra-urban territories reduced scales (1:4.000 or 1:1.8.000), while it represents, often in a map aside, the bigger urban centres with a larger scale (1:2.000). We intend to complete in future the digitalization campaign with the vectorialization of urban centres.

<sup>3</sup> Provincial Plan for Territorial Coordination.

appeared houses' localisation is a proof that just a little part of such decrease is to attribute to the increase of centres and urban groups, which absorbed the nearest buildings; in reality, the disappearance phenomenon just sporadically interested the ridge localizations, while it was a frequent event in some slopes and in valley flats of minor streams. Probably physical elements played a not secondary rule in the selection of the abandoning rural building, for instance: more stability and salubrity of ridge positions than versant and valley flats ones.



Figure 10. Settlements.

The results of the analysis, as regard the evolution of residential settlement from 19th century until today, could be completed in prospect of an implementation of the research with analogous study of historical and current road routes, underlying the main transformations.

### **Toponymy of the period**

Main and reduced size maps report the toponyms of the principal hydrographical (rivers, torrents, streams, etc.), morphological (relief, hills, ridges, etc.) and anthropized ele-

ments (roads, bridges, urban centers, etc.). This kind of analysis shows an interesting perspective of research about the study of the origin of toponymy of the period and about the connection with geological and floristic-vegetation characters of that time (Fig. 11a).

### Historical routes and their hierarchy

The main streets were digitalized following the middle line; the bordering parcels didn't touch the line. Once digitalized the parcels you can see the thickness of road tracks. For such road network it was possible to classify routes in according to the importance, analysing some graphical choose of the mapmaker as a different type of sign and a different thickness of the tracks. The presence of toponyms in the more important road tracks made possible to assume a route hierarchy (e.g.. departmental road, municipal road, local road, etc.). The minor streets were digitalized as borderline between the properties. The presence of bridges was reported as punctual entity with the associated toponym (Fig. 11b).

### Hydrographical network and relations with the morphology

The digitalization of ditches, rivers, torrents present in *Gregoriano* Cadastre has allowed a comparison with the current hydrographical network, noticing all the variations and analysing the main phenomena that led to such variations. In this contest the morphology and the territorial management have gained a particular importance: they have conditioned in the time the landscape, having deep repercussions on the configuration of hydrographical network.

It should be noted that the cultivation model in 19<sup>th</sup> century was in close connection with the local hydrographical management. In particular an assiduous and regular presence in fields allowed a continuous monitoring and in the same time all the lands were cultivated, those of moderate slope, as well. In the last years many of cultivated fields had been abandoning; the hydrographical network development has been conditioned mainly by the territorial morphology (Fig. 11c).

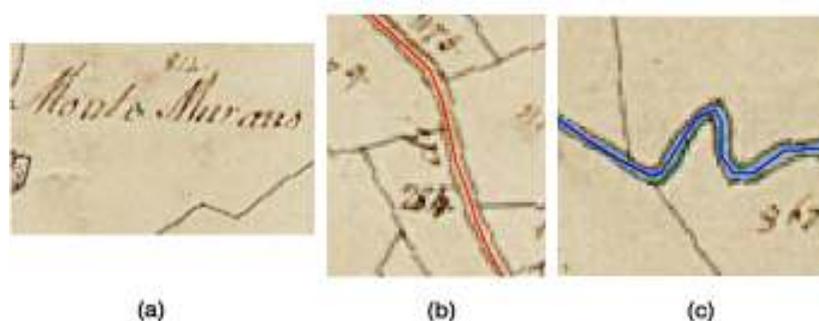


Figure 11. (a) Toponymy; (b) Historical routes; (c) Hydrographical network.

### Land-uses and configuration of historical landscape

The *Gregoriano* Cadastre took a detailed census of the various utilizations of the territory in 19<sup>th</sup> century, specifying the cultural destination and carefully noticing the physiog-

onomic-structural variations bound to territorial morphology (e.g. oaks between stones, slopes with dense woody olive-trees, etc.) and bound to a specific kind of management (thick forest trees, coppice, sowable land with thick forest trees, sowable land with mulberry-trees, etc.). Fig. 12 shows furthermore the thematic map according to property.



Figure 12. Thematic representation of parcels according to property.

From a methodological point of view all the existent parcels were digitalized and then defined according to the following macro-categories: woods, shrubs, grasslands, annual crops with permanent crops, sowable lands, vineyards, olive-groves. Inside every macro-category it was kept information relative to each parcel and concerning the primary use, which it was present in 19<sup>th</sup> century. Fig. 13 shows a thematization of cadastral parcels on the basis of the annual crops (sowable lands) with permanent crops macro-category.

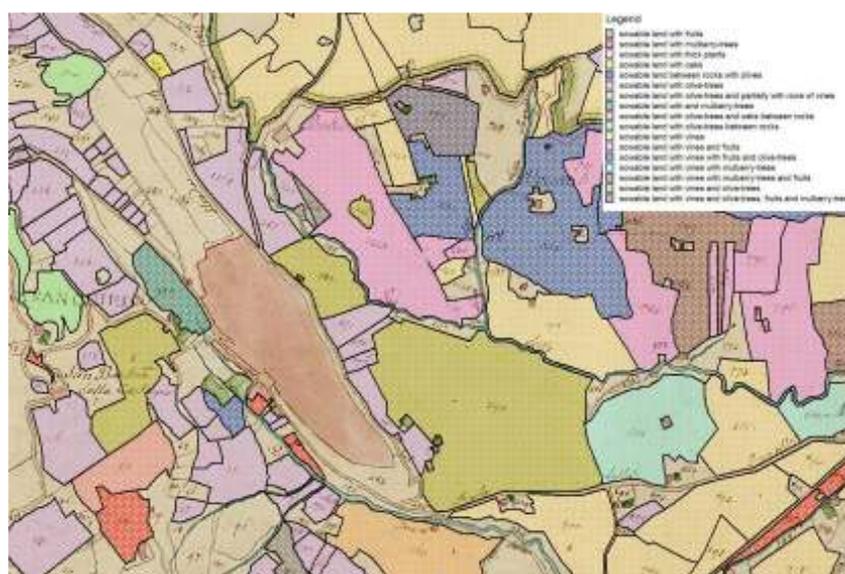


Figure 13. An example of the abundance of information in *Gregoriano* Cadastre. Annual crops with permanent crops.

The availability of such historical information and its transformation in a GIS has represented a very important source for the future and currently management of the agricultural landscape and the natural resources. The workings out have allowed determining quantitative-qualitative variations of the use of the land, noticing what is increased, what is remained persistent and what is decreased from 19<sup>th</sup> century till now.

The above-said analyses were propaedeutical to the creation of a rendering of the historical landscapes (Fig. 14) which makes possible a visualization of the cultural diversification of that historical period which is accessible and immediately understandable by the general public.

In order to realize such rendering we had to retrieve bibliographic material (studies, images, etc.) relative to the configuration of the 19<sup>th</sup> century landscape. This study revealed that the sowable lands with trees represented a very common landscape element in the 19<sup>th</sup> century that characterized the agricultural landscape of the hills of the Marche region. These sowable lands are crops associated with different types of trees (i.e. oaks, mulberys, olives, etc.) or with rows of vines (associated with maples, etc.). The bibliographic research provided specific information that was necessary to define the planting model inside every culture in 19<sup>th</sup> century, by defining the distances between the rows (A.A. 1982; Anselmi 2001; Mormorio 2001; Sereni 1989).

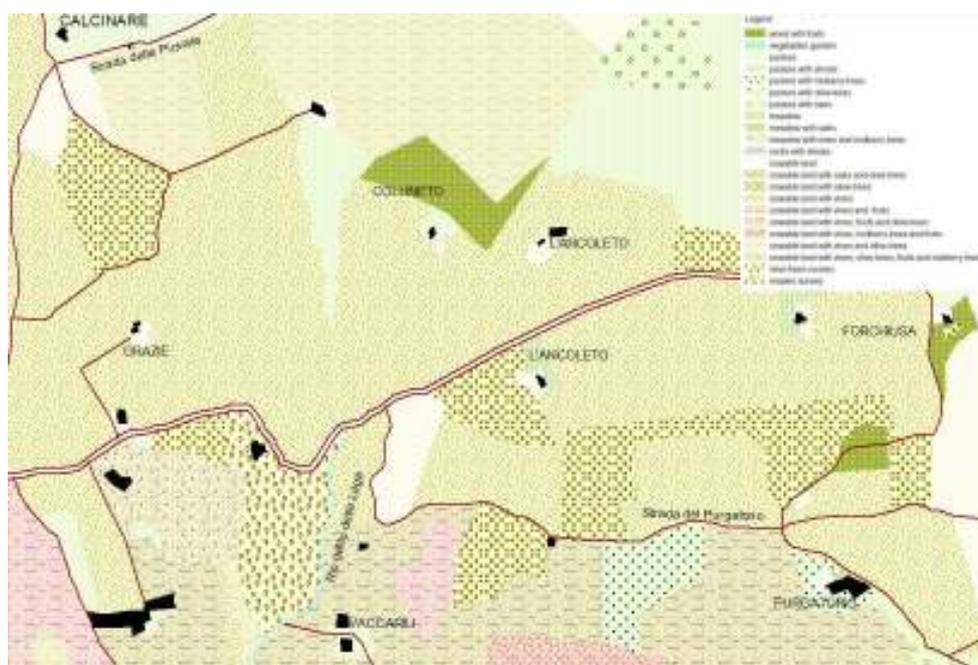


Figure 14. The landscape in *Gregoriano* Cadastre.

In 19<sup>th</sup> century, vineyards (cultivated *a folignata*) were raised high among fruit trees in quincunx setting. In the sowable lands with rows of vines, the distance between rows permitted the transit of the plough (10-20 metres). All this information, completed with the thematisms concerning the settlement and the hydrographical network of that period, has allowed the realization of the rendering of landscape showed in Fig. 15.

The Fig. 14 shows the typical characteristics of the historical agricultural landscape: vegetation near water stream was practically absent, specialized sowable land were not ranged very much, but there were many rows of vines alternated with fruit-trees, olive-

very much, but there were many rows of vines alternated with fruit-trees, olive-trees, mulberry-trees, etc. The human presence on the lands was practically continuing and constant all the year, which allowed keeping such cultivating system and its relative landscape's framework and which allowed defending territory from problems of instability and from erosion.



Figure 15. Three-dimensional model (rendering) of the landscape in *Gregoriano* Cadastre.

## Conclusions

The integration in Territorial Information System (SIT) of historical information from *Gregoriano* Cadastre, of socio-economic analyses concerning business changes and in parallel the study of the transformations of territorial framework, showed to be a very important instrument for the area planning, allowing to identify specific planning approaches not only for urban settlement but also for restoration of variety and complexity of agricultural landscape.

This study has been conducted on the landscape of the area in a multitemporal and multisectorial perspective (social-demographic, urban, landscape, economical). The study has led to the comprehension of the system dynamics in an evolutionary sense, aimed at identifying negative tendencies and programs useful to bring such tendencies back towards greater eco-compatible perspectives. The work opens further research in various directions, identifying some pilot areas which test new managerial models, foreseeing simulation of management impacts both on business profitability and landscape configuration.

The future development of the project is the upgrade and evolution of the database, followed by the acquisition of data related to the following historical periods. This acquisition is a fundamental opportunity to investigate the research carried out till now and to achieve the above-said purposes. From this point of view it is very important to complete the covering of *Gregoriano* Cadastre on provincial territory both with the acquisition of lacking raster (about 8% of territory) and with the georeferencing and digitizing of reduced size maps, developing the associated database and improving the codified methodology.

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