

Setting Up the Infrastructure for Improving the Development of Cadastre in Greece

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SUMMARY

Since the early 19th century Greece has adopted the French originated system of Registrations and Mortgages as a public register of real property owners and the deeds that they have been involved in. The development of the Greek Cadastre has started in the mid 1990s. The project advances through a demanding procedure which requires input by many different data sources and the involvement of different entities (beneficiaries, state agencies that manage state land or issue acts that modify the cadastral situation in an area, registrars, notaries, lawyers and surveyors). So far, with the cadastral programs initiated in the 1990's, only a small part of the Country has been included in the cadastral project.

In order to advance the project of developing Cadastre at a faster pace, Ktimatologio S.A., the company responsible to develop and maintain Cadastre in Greece, undertook a large project, with the co-financing of the European Union which aimed to develop a data and technology infrastructure that will improve the efficiency and effectiveness of developing Cadastre in Greece taking advantage of economies of scale that can be achieved by country – wide interventions.

The project was initiated in 2005. Currently most of the actions included in it have been completed and its products have already started being used in the new cadastral survey program that is currently underway, which will include in the cadastre all the major urban centers of the Country. The benefits of using this infrastructure are already evident to all the parties involved in the new cadastral program by providing high quality data and services to all. Furthermore, the results of the large project will greatly contribute to the improvement of the effectiveness of all the state agencies that must use cadastral or spatial data during their daily operation.

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1. Background

The project of developing Cadastre in Greece was initiated by the Ministry of Environment, Physical Planning and Public Works back in 1994. The Cadastral System aims to replace the existing system of Registrations and Mortgages, which maintains in paper-form a register of all the deeds on real properties that a particular person has been involved in, in a particular area (person-based organization of the information). This register is not complete (e.g. the rights of the State are not registered), does not ensure legal security of the transactions and does not allow the identification of the existing owners or the location of a real property.

Furthermore, there are even more problems plaguing the real property market in Greece that make the situation even more complex, such as:

- The Greek State does not know the extent of the land it owns (i.e. forested areas and coastal zones)
- State agencies that issue acts that modify real properties and their ownership status maintain paper records that are not well-organized and information is very hard to retrieve from them.
- Topographic plans whenever they are issued for land parcels not only are seldom agreed among neighbours but in many cases they are drafted in local reference systems, making their reliability low.
- The records of the Registrations' and Mortgage Offices contain all the information since their establishment without being able to assess the current owner of a real property unless a lawyer runs a full legal evaluation of all the registered information concerning this real property for a period of at least 30 to 50 years.

In this context, the Greek Cadastre comes as a uniform and always up-to-date system of registrations, which consist of the geometric description and the ownership status of all the real properties of the Country, overseen and guaranteed by the State. Thus, the term Cadastre in Greece is used to describe a system that combines Cadastre and Land Register.

The first cadastral programmes started back in 1996-1998 and covered about 340 regions of the country. With the completion of these programmes, 8.500 square kilometers and 6.1 million property rights had been registered in the Cadastre. For the operation of the Cadastre in these areas, 97 interim Cadastral Offices have been established.

However, these programmes came across serious problems that resulted in considerable delays and budget overruns showing that a new approach was needed in order to carry out successfully the development of the Greek Cadastre.

2. DATA AND IT INFRASTRUCTURE FOR A MODERN CADASTRE

In order to deal with all this uncertainty and to better prepare the continuation of the Cadastral project for the rest of the country, Ktimatologio S.A. the company responsible for the development and the operation of Cadastre in Greece, with the assistance and the co -

financing of the European Commission, drafted the terms of reference for a major infrastructure project that would drastically alter the real property information landscape in Greece.

The large project was titled “Data and IT Infrastructure for a Modern Cadastre” with an overall budget of about 80 million euros (without V.A.T.) and it was included in the 3rd Community Support Framework (CSFIII), under the Operational Programme “Information Society” with 50% co financing by the Greek State and the European Commission.

The project aimed at the establishment of a functional, high quality database at a national level which would contain preliminary cadastral data and the necessary IT infrastructure in order to support optimized cadastral survey projects until the completion of the development of the Cadastre in Greece.

The large project included a series of subprojects, which, apart from the commencement of the new cadastral survey studies for the large urban centers of the Country, which is not dealt with in the context of this paper, involved the following:

- Setting up a complete national GPS reference network and similar positioning service (HEPOS) for the entire Greek State, in order to become the basic geodetic and surveying infrastructure for all cadastral projects from now on.
- Preliminary delineation of forests and forested areas for the whole country.
- Development of basemaps for delineating the coastal zone for the whole country.
- Digitization of existing cadastral data on rural areas of the country (land consolidation and land distribution acts) and development of a database compatible with the database of the Greek Cadastre.
- Development for the whole country very large-scale fully orthorectified imagery as a basemap for the cadastral surveys of urban areas and orthoimagery on a scale of 1:5 000 as a basemap for the cadastral surveys of agricultural, forested and mountainous areas.
- Establishment of IT infrastructure and services to support the management of these activities, as well as, provide state-of-the-art services in the context of the new cadastral projects.
- Digitization of the Cadastral Books and Maps in the existing Cadastral Offices for the islands Kos, Leros and Rhodes (Dodecanese Cadastre).

2.1 The Hellenic Positioning System

The Hellenic POsitioning System (HEPOS) was established by KTIMATOLOGIO S.A. in order to improve, homogenize and facilitate the cadastral survey activities in Greece. The system allows for the determination of high precision and homogeneous coordinates throughout the whole country, setting up an infrastructure that, at the same time, reduces the cost and the effectiveness of GPS-surveying.

The HEPOS system, which was fully operational within 13 months after the contract signing, consists of 98 permanent GPS reference stations (Figure 1), a control center and communication lines (main and backup) that supports data transfer between the reference stations and the control center.

HEPOS supports all common GPS techniques for post-processing and real-time surveying. In particular, for network-based positioning the techniques of VRS, FKP and MAC are

supported. For post-processing applications, RINEX and Compact RINEX files are provided for RS and VRS at observation intervals of 1, 2, 5, 10, 15, 20, 30 or 60 sec.

At the same time, HEPOS modernizes the geodetic infrastructure of the country. Since 1987, the official reference system of Greece is the Hellenic Geodetic Reference System of 1987 (HGRS87). This system is implemented by trigonometric points throughout the Country. Taking into consideration that a) these trigonometric points are poorly maintained and b) there are considerable tectonic movements that move parts of the Country towards different directions, this reference framework for ground surveys has become quite problematic causing major incompatibilities among measurements in the context of different projects by different agencies, thus reducing the possibility of data re-usability among state agencies. HEPOS, however, introduces a new geodetic reference frame as a realization of ETRS89. The new system is named HTRS07 (Hellenic Terrestrial Reference System 2007) and aspires to become the new national reference system. Towards this direction, a two-way transformation model between HTRS07 and HGRS87 has been established. To accomplish this, approximately 2470 trigonometric points, evenly distributed all over Greece, have been measured in a national GPS measuring campaign in a period of 8 months. The measured points are shown in Figure 4.

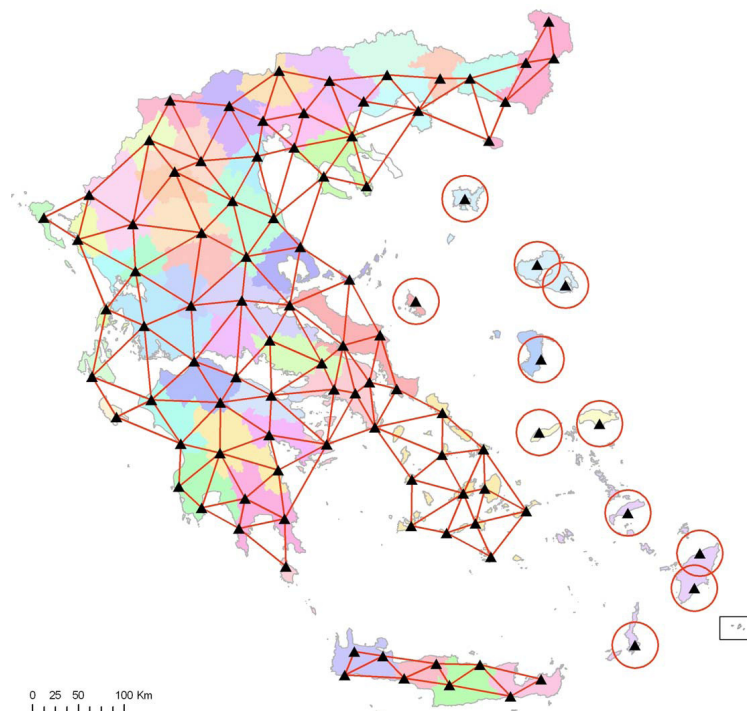


Figure 1. Graphic representation of the HEPOS reference network.



Figure 2: The 2470 trigonometric points measured for the computation of transformation parameters.

2.2 Forest delineation

In Greece, forested areas belong by default to the Greek State, unless a private person can prove that he/she has titles that date back to the late 19th century or an official deed of concession by the State. In order to determine the forested areas, forest maps must be developed through a complex and demanding procedure (stereoscopic photointerpretation and field verification), taking into consideration the current land cover of an area, the land cover back in 1945 (using 1945 aerial photography) and any administrative deeds issued by the local forest services. The completion of forest maps for the entire country is a project with a timetable of more than 10 years. For this reason, a project that would produce a preliminary delineation of the forested areas by simple monoscopic photointerpretation of current and 1945 orthoimagery (Figure X) gives a good first approximation of the extents of forests in the Country for planning reasons and as input data in the process of developing forest maps. The project was carried out in 14 months running 6 contracts in parallel to cover the entire Country. The results of the project gave for the first time a reliable measure of the extents of forest land in the Country providing a very useful tool for physical planning and environmental protection.

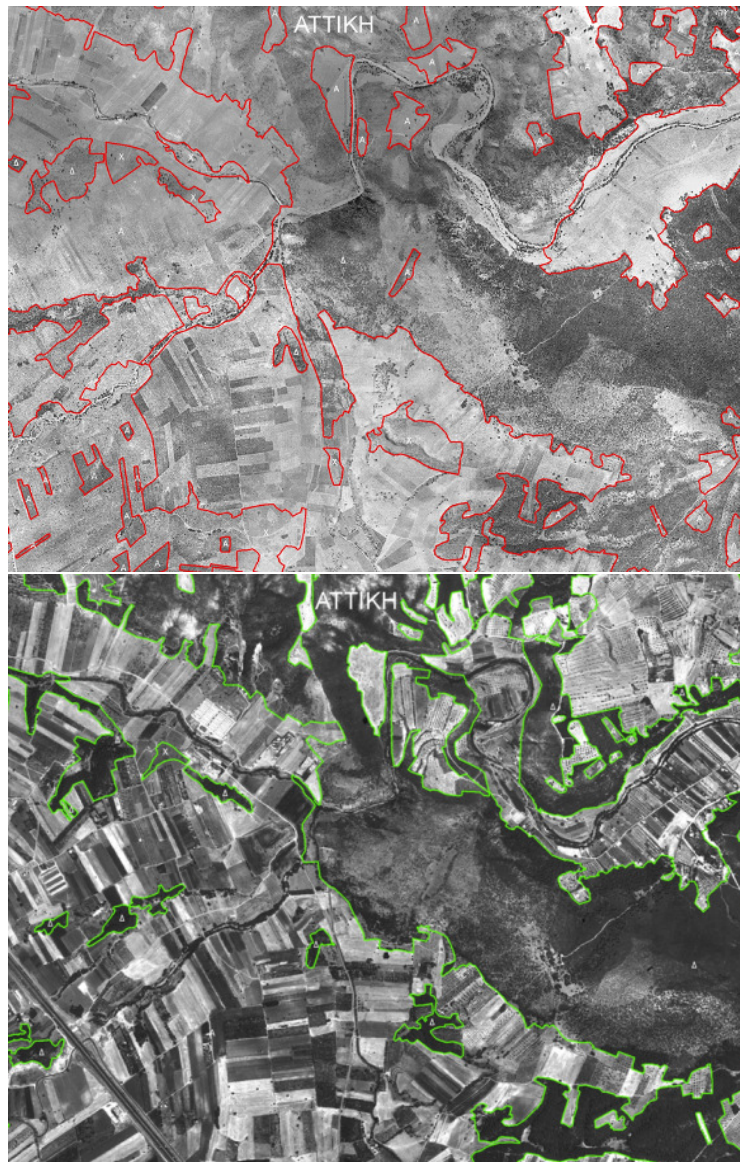


Figure 3. Delineation of forested areas in 1945 imagery (in red) and recent imagery (in green)

2.3 National coverage of orthoimagery

The development of the Cadastre in Greece is based on aerial photography which is used to identify land parcel boundaries. In this context, for the purpose of extending Cadastre to cover the whole country, 3 contracts were carried out in parallel to produce a national coverage of orthoimagery with a pixel size of 50cm and the corresponding digital elevation model. The projects were completed in 2,5 years.

Especially for the large urban centers of the Country covering about 3.500 square kilometers, a separate contract was carried out that produced fully rectified orthoimagery with a pixel size of 20cm and the corresponding digital surface model (DSM) (Figure X).

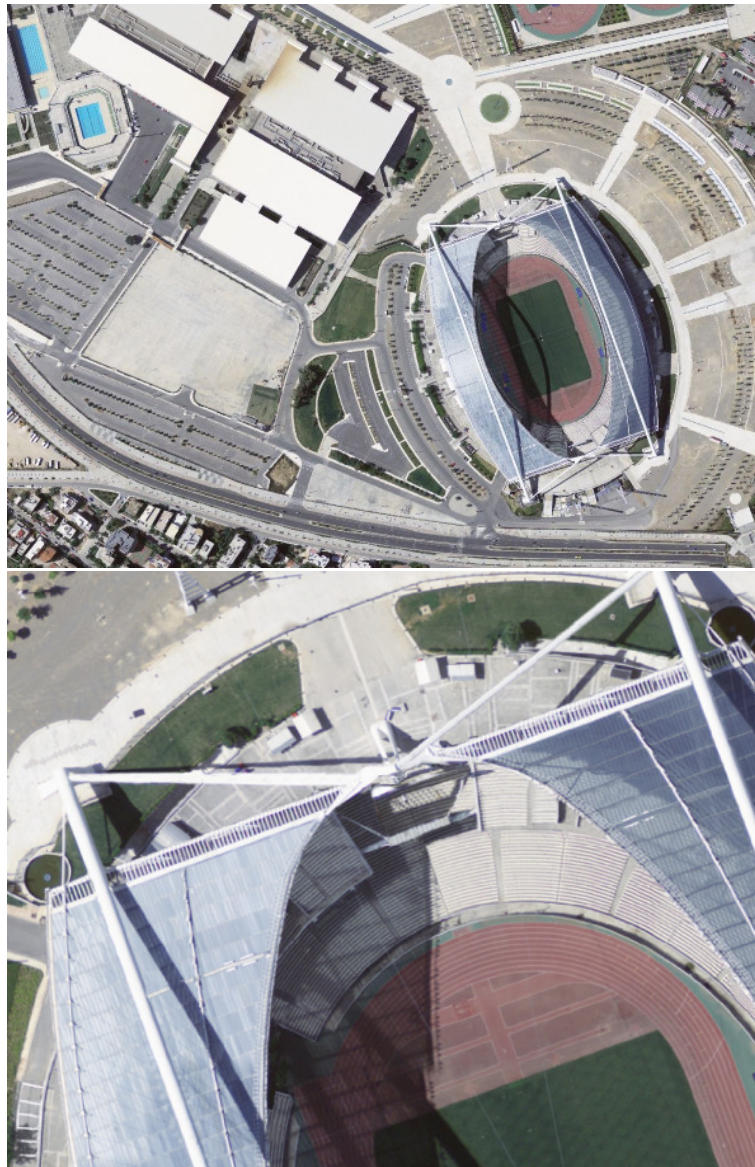


Figure 4. Samples from the fully-rectified orthoimagery produced for the urban areas (Athens' Olympic Complex).

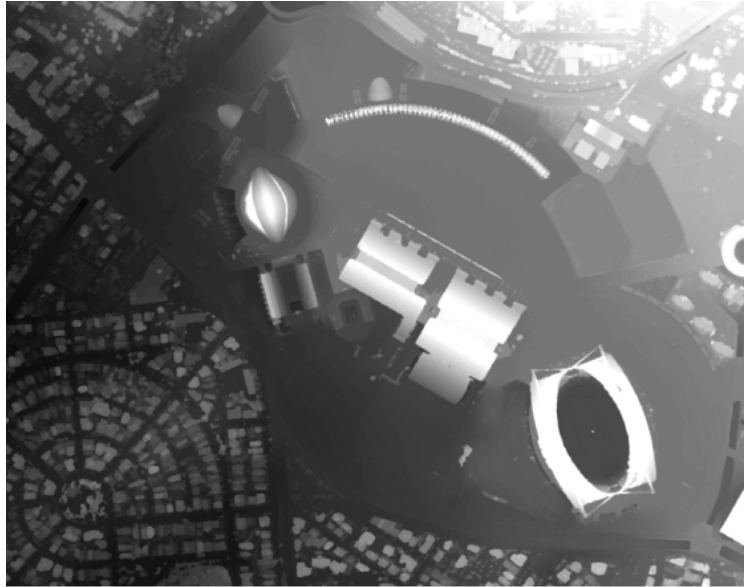


Figure 5. Sample of the digital surface model produced (Athens Olympic Complex).

These projects produced the first full national coverage of large scale imagery which is already used not only for the on-going cadastral survey project, but also for a number of other projects by State agencies (i.e. Statistical Service) and utility companies.

2.4 Coastal zone delineation

In Greece, the coastal zone belongs to the State. The delineation of the coastal zone is prescribed by law as a very expensive procedure of ground survey that is initiated by citizens or companies that wish to develop a real property which lies close to the sea shore. For this reason, less than 10% of the Country has a delineated coastal zone and this delineation may be in many cases problematic to adjudicate on the field, since the special reference points established for this work may have been destroyed. Realizing the benefits that modern technology can offer in this field, a project was carried out that covered with corridor mapping the entire coastal zone of Greece (a zone of 300 m from the coast), as well as all the navigable rivers and the large lakes of the Country. The imagery included also an infrared channel, the pixel size was 25 cm. A detailed digital elevation model was also produced. The total length of the area covered was about 16.000 km. Also in the context of the same project, a preliminary delineation of the coastal zone was carried out using objective criteria such as the edge of vegetation or the relief. The project was completed within 2 years, offering to our company significant experience in running such high-end technological projects and to the Greek public administration, an extremely useful tool to protect and better manage the coastal zone of the Country.



Figure 6. The areas included in the coastal zone basemap project (coasts in red, large lakes and navigable rivers in blue).



Figure 7. Samples of the coastal zone imagery and delineation.

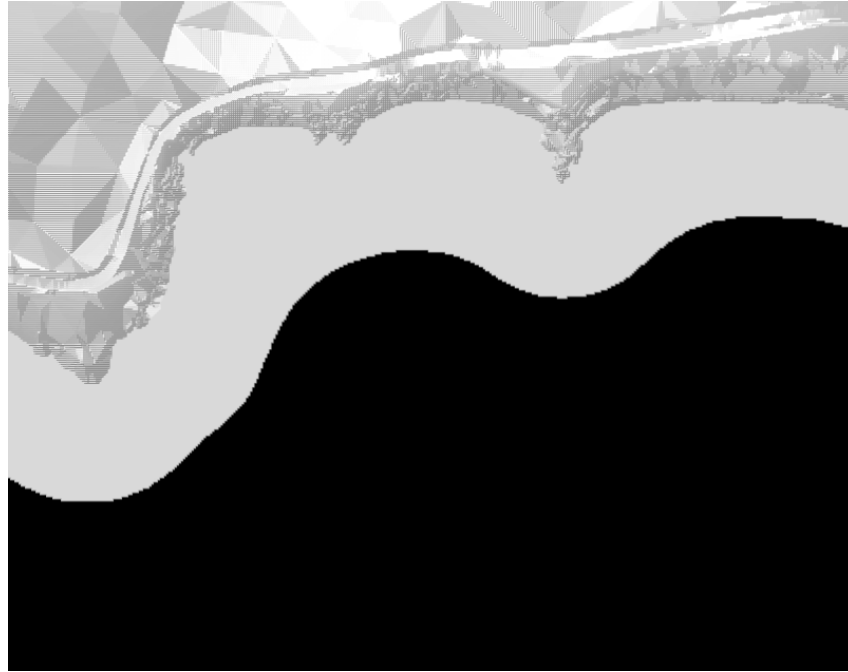


Figure 8. Sample of the detailed digital elevation model produced in the context of the coastal zone basemap project.

2.5 Digitization of land consolidation and land redistribution acts

Land consolidation and land redistribution acts are the basis for developing cadastre in agricultural areas. The official archives are dispersed in prefectural level in paper form kept by the local competent agencies. Because of this, management of this information has been problematic, reaching to the point that even basic statistics such as the extent of the country covered by land consolidation/land redistribution acts could not be derived. Ktimatologio S.A. with the co-operation of AGROGI S.A. a company of the Ministry of Agriculture responsible to manage State rural lands carried out a project that involved the collection of all the acts from the local agencies, scanning of the maps and tables, georeference of the maps and production of a digital geo-database with all the information of these acts. The project was carried out in-house by the two agencies employing over 60 persons fulltime for a period of 2,5 years.

As a result, the valuable archive of all these administrative acts has been preserved and for the first time useful information on a national scale can be deducted on the extent and the characteristics of ownership in agricultural land in Greece.

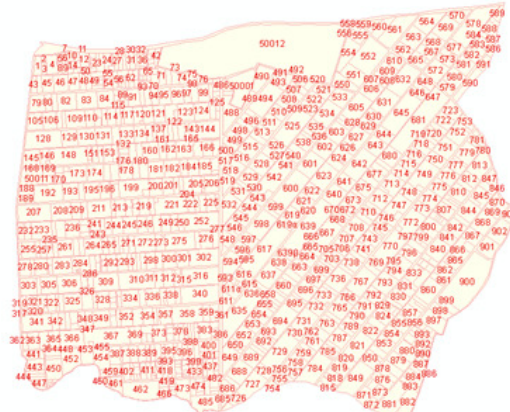


Figure 9. Samples of scanned and vectorized maps of a land consolidation act.

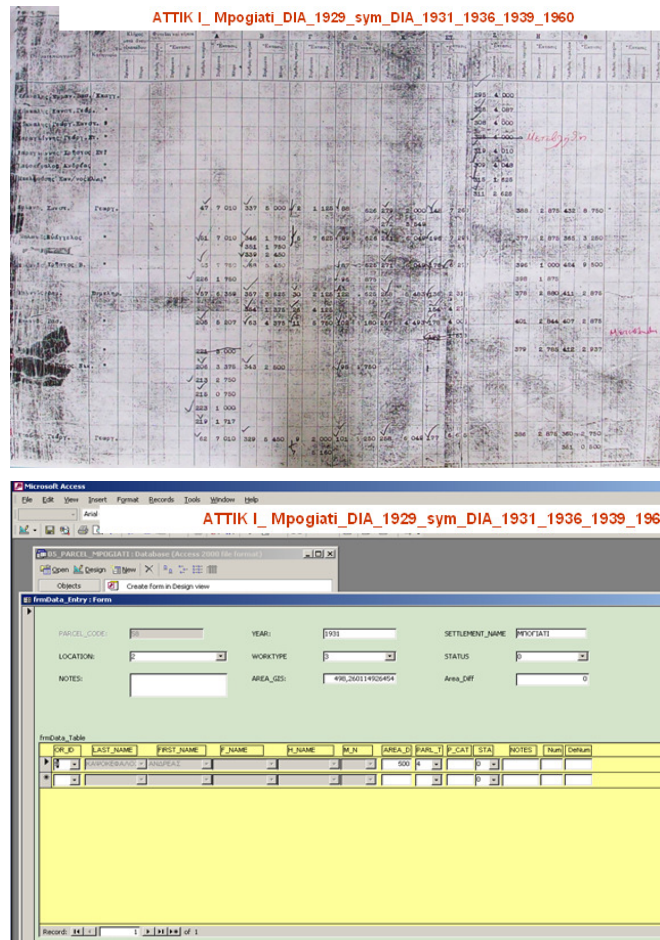


Figure 10. A sample of a land consolidation table and a digital record produced from it.

2.6 IT infrastructure and web services for cadastral surveys

KTIMATOLOGIO S.A. has taken major steps into setting up a technological infrastructure that:

- supports effectively the development and operation of the Cadastre, by providing advanced technological solutions that ensure security, high availability and performance, standardization and quality control of all the procedures,
- provides modern services to the citizens especially during the cadastral development stage,
- builds up a high performance data infrastructure that can effectively support the operation of state administration in multiple levels, as well as become a major player in the context of INSPIRE.

KTIMATOLOGIO S.A. has set up state-of-the-art data centers (primary and disaster recovery) with high availability (99,99%), modern networking, security and backup mechanisms and high storage capacity (120 TB in each), where all its data and applications reside (central storage).

To improve the efficiency of new cadastral survey studies and to provide better services to all interested parties, a series of applications have been developed inhouse.

2.6.1 Services to citizens

Online internet applications have been developed for all the persons (natural or legal) who want to declare their real property to the Cadastre during a cadastral survey study. Through this application a user can online:

- declare all the information necessary to register his/her property to the Cadastre,
- identify the location of the declared real property on orthophotomaps,
- pay the cadastral fee using his/her credit card,
- send scanned copies of the deeds that support his/her declaration,
- print a receipt

2.6.2 Services to legal persons

For the legal persons that have a great number of rights to declare, KTIMATOLOGIO S.A. developed a special application to allow them to produce a database with all the information about their real property rights, and submit it electronically to the Cadastre. This application has been used in the cadastral survey projects that were initiated in 2008 by most of the banks operating in Greece.

2.6.3 Services to KT contractors of cadastral surveys

For the contractors carrying out the cadastral survey projects, KTIMATOLOGIO S.A. has developed a special application used to receive, register and geo-locate on orthophotomaps all the declarations that were presented in the cadastral survey offices. All the declarations' information registered by this application was in real-time stored in KTIMATOLOGIO S.A.'s data center. The application allows, among other things, uniform codification of all the information registered, online checks that prohibit a number of mistakes during data entry, computation of the corresponding cadastral fee for each declaration, real time monitoring of the progress of the work and real time access to all the declaration data from KT's headquarters.

These applications have already been successfully employed during the current cadastral survey programme that involved in its first phase, the declaration of about 7.000.000 property rights in over 100 municipalities.

2.6.4 Ktimatologio S.A.'s ERP

Also in the context of the Large Project, an Enterprise Resource Planning System was introduced in Ktimatologio S.A. in order to manage the daily operations of the company. The system includes as basic modules Human Resources Management, Accounting, Document Management, Customer Relationship Management, Sales, Workflows and Project Management. The project lasted two and a half years and now the system is operational in all the departments of the company.

2.7 Digitization of the Dodecanese Cadastre

Since 1929, a cadastral system implemented by the Italians was set up for the islands of Rhodes, Kos and part of the island of Leros. Since then the system is operating in paper form maintaining a register consisting of cadastral index maps, individual real property plans, cadastral books and deeds that generate, alter or annul the registered rights. The project involved the scanning of the existing archive of these cadastral offices, georeference and vectorizing of the cadastral maps and finally the development of a GIS database compatible

with the data model used for the Greek Cadastre. The project was completed in 30 months and it involved the digitization of over 6,3 million pages of documents and the development of a digital database of over 800.000 real property rights.

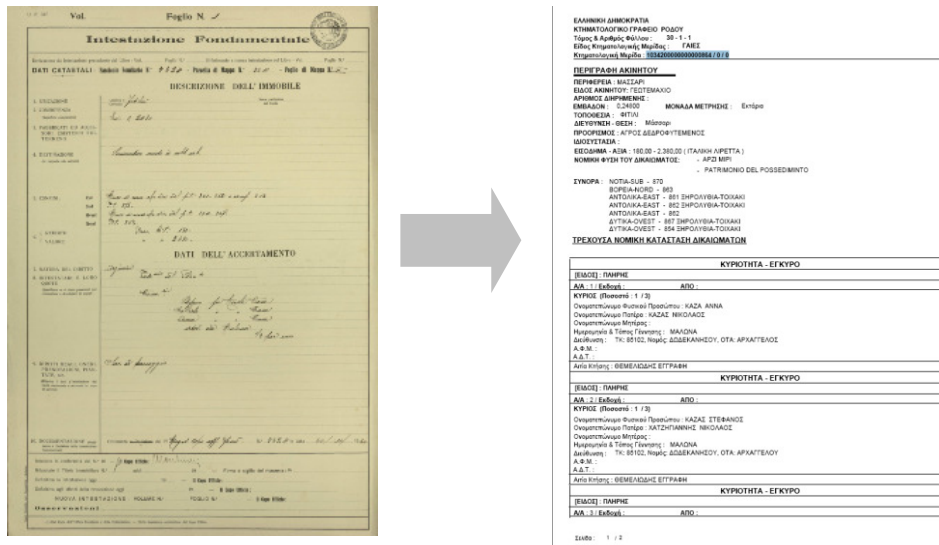


Figure 11. Converting cadastral sheets in digital records.

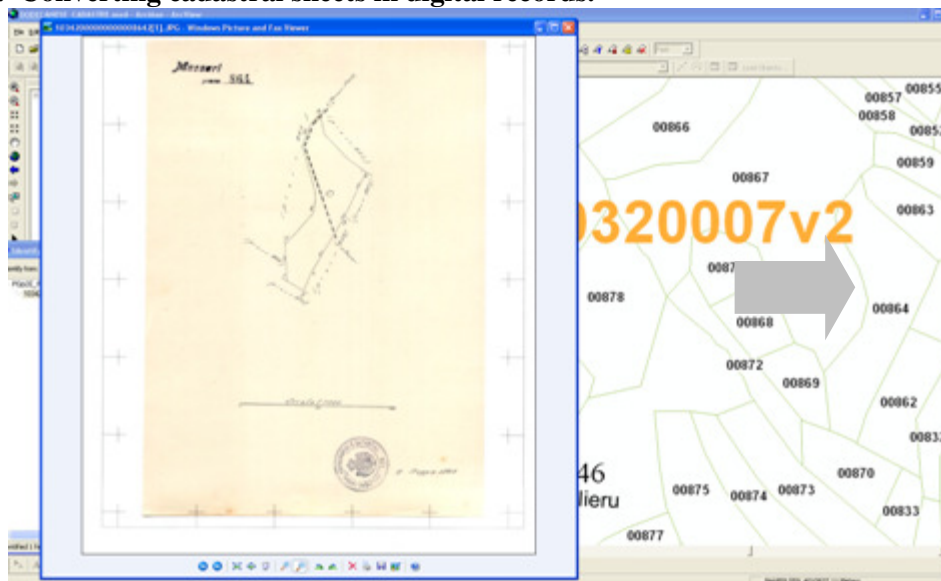


Figure 12. A GIS system based on the original paper maps was developed

3. CONCLUSIONS

All actions included in the Ktimatologio's CSFIII large project were organised on the basis of experience acquired from the first three cadastral survey programmes. In particular, an effort was made to avoid the barriers and risks encountered during implementation of those three

programmes which led to delays in the completion of the projects and increased costs. The actions included in the Large Project were designed and organised in such a way as to:

- Achieve the maximum possible economies of scale. This was done by discriminating the cadastral survey activities (such as basemap production) which could be carried out effectively at national level achieving considerable economies of scale, from those which require detailed examination at a local level.
- Ensure optimum contract management. The Large Project was organised into a relatively small number of large contracts which allowed Ktimatologio S.A. to more closely monitor them and better manage them, a fact which has a positive impact on the cost and quality of the said projects.
- Ensure maximum cost savings due to the use of advanced technology. The economies of scale achieved by national scale projects allowed the use of state-of-the-art technology, which, although considered more expensive, realized greater benefits and in the long run reduced the cost of cadastre.
- Ensure optimum use of existing data in cadastral surveys. This is achieved by digitising and distributing data in the archives of various agencies. Contractors having direct access to this material can achieve considerable cost savings.

This new management approach translates into more cost effective and more efficient implementation of the work required to develop the Greek Cadastre. They also contribute to its timely implementation and to the quality assurance of its deliverables.

Moreover, the deliverables of the Large Project offer unique opportunities and advantages to Greek society above and beyond the development of the Greek Cadastre. These opportunities and advantages include:

- Giving Greek businesses the opportunity to invest in state-of-the-art data collection and processing technologies due to implementation of nationwide projects and to create economies of scale.
- Many of the databases produced in the context of the Large Project are powerful tools, readily available in the hands of the Greek authorities to effectively protect environmentally vulnerable areas which are under pressure.
- Improving the position of individual beneficiaries and clarifying any restrictions or claims which exist in relation to properties since the data will be public.
- Creating a joint, uniform database from the deliverables of the large project, will form a functional framework for many public and private sector organisations so they can organise their own data, and thus avoid repeated and overlapping surveying and mapping activities while at the same time offering a common, stable basis for intergovernmental and cross-sectoral cooperation.
- Finally, with the deliverables of these projects, Greece takes a significant step towards implementing the aims of the INSPIRE directive

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