

REAL ESTATE-URBAN GEOGRAPHICAL INFORMATION SYSTEM OF A MUNICIPALITY

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Abstract: *The Geographical Information System (GIS) is a modern software tool which allow the collection of referenced data, the storage, organisation, viewing, integration and interpretation of information with a spatial component, so that it the relations between them are understood and that the patterns and tendencies may be established. The Land Information System of a municipality is a very important and complex system, achieving a strong scientific and information basis accessible for the assistance of activities which support the decision-making process in local government, a major factor in making the qualitative level of geo-spatial information domains more efficient. The main purpose of the GIS project is to organise a coherent database that would contain information regarding the installations and equipment in the distribution network and to correlate the information with their position, represented through maps and digital plans.*

Keyword: *cadastre, information system geographic, implementing GIS technology, real estate urban, integration, software.*

1. Introduction

The municipality represents a highly complex social, economic, historical and cultural spatial structure, whose management and administration raised several concerns and implies the continuous taking of decisions with various areas of influence in space and time.

The high quantity of information contained in the maps and documentations existing at the level of local government, the outage of the analogue support of the information, their difficult handling, the high staff expenses incurred for the purpose of obtaining the cadastral survey plans, the land parcel plans, the reports and statistical data, the difficulties in their interpretation and analysis, if they are not sufficiently clear, the lead to the mobilization of important financial resources at the national and local level, for the purpose of obtaining decision documents.

For the work, it started from the premise that the mechanisms necessary in the decision-making process in urban policies, are elements essential for any managerial system. In urban communities at the local and national level, which dead with incomplete spatial data and information, these mechanisms can be fragmented and influenced by a series of factors, generating great shortages in the decision-making process. Under these circumstances, one of

the best solutions at the local level is the creation, development and implementation of a functional Geographic Information System for the management of the real estate-urban fund. The Geographic Information System specific to the real estate-urban and banking area of urban data, as a too implemented for the purpose of supporting the institutional capacity, the one for planning and urban development, contributes to decision-making in everyone's interest.

The main purpose of the information system of the real estate-urban fund consists in the technical-real estate inventorying of the real estate property belonging to natural and legal persons, as well as of the urban dowry of the locality. For the purpose of achieving this major desideratum, the real estate-urban information system must support the data and documents of the technical part of the general cadastre including the database of the Real Estate Register.

2. Performance of the Unitary General Cadastre Project

The performance of the Unitary General Cadastre Project, in line with Law 7/1996 on the Cadastre and Real-Estate Publicity, including subsequent amendments and additions, and of the implementing regulations, for a municipality, is based on, among other things, on the compliance with the following compulsory requirements:

- design and materialization of municipal GPS geo-spatial networks endorsed and received by the Cadastre and Real-Estate Publicity National Agency, network integrated into the national system, based at least on four class A GPS points, internationally recognised;
- the aerophotography of the Territorial and Administrative Division of Local Government based on a photogrammetrical flight project which would take into account the urban conditions and the specific local landforms, with the help of low-height digital technologies, for the purpose of obtaining the digital cadastral survey plan on a scale of 1:500.
- the topographic surveys shall be executed based on a restored plan, the entities obtained through vectorisation on the ortophoto map, being combined with classical surveys, using the modern total stations;
- the collection of attribute cadastral data shall be carried out in compliance with the updated Regulations on the introduction of the general cadastre to the level of a locality.

2.1. The stages that are taken for the purpose of introducing and maintaining the General Cadastre

The succession of the stages, for the purpose of the performance of the General Cadastre Information System for a municipality is shown:

2.2. Organisation and collection of cadastral data

In order for the highly complex and important activity of data collection having as result the 3D and final digital cadastral survey plan to be organised and efficient, through all the stages and procedures imposed by the existing methodologies. The stages have the following succession:

a) Designing, materialization and determination of the municipal geodetic network:

- *Planimetric network. GPS support geodetic network* (B, C and D class) of Iași Municipality is constituted of a series of points, resulted from the thickening of the class A GPS National Geodetic Network, sufficient points to hereinafter serve the topographic surveys carried out on the administrative-cadastral territory. The tridimensional placement, in 3D system, was ensured with centimetrical precision and the project is integrated into the national reference system.

- **Surveying network the structure of the Geodetic Network for the Surveying of Heights.** From a structural point of view, the altitudinal geodetic network of a municipality is constituted of several types of points, in line with the technical legislation.

- **Demarcation and marking with boundary stones of the borders of the administrative territory, of the unincorporated premises and premises within city limits:**

a) **Unincorporated demarcation.** Cadastral administrative demarcation of a municipality in relation to the neighbouring localities.

b) **Demarcation within city limits.** Establishing a built perimeter of the municipality.

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2.3. Uploading the data covering the real estate fund

In municipalities, the real estate-urban cadastral fund is carried out in two forms:

2.3.1. Uploading the data covering the real estate fund

The information system of the real estate cadastre has the purpose of a technical, economic and legal inventory, as well as of registering all the land parcels and constructions in the populated centres. It uses as mandatory elements the data provided by the general cadastre, regarding the areas of the land parcels, the owners of the real estate properties, their purpose and uses.

Performing the technical aspect of the cadastre of the real estate-urban fund, concomitantly with the execution of the works of general cadastre. Refers to the measuring of the limits of land parcels and of the other details inside each property (real estate property).

Performing the qualitative aspect of the cadastre of the real estate fund, concomitantly with the execution of the works of general cadastre. Refers to the measuring of the limits of land parcels and of the other details inside each property (real estate property).

The elements for the assessment of the qualitative aspect of the real estate cadastre are collected on the field, within the interviews, carried out by surveyors with the owners or other holders of the real estate properties. The data obtained in interviews are centralized in the *Real Estate Property Sheet*.

a) Cadastral numbering

Cadastral numbering is the operation through which each cadastral territorial division on an administrative territory receives an identification cadastral survey number. This number links the land parcel plan, the cadastral registers and the Real Estate Register.

Moreover, the cadastral survey number also serves as a logical connection identifier, between the graphic database and the textual database, within the cadastral information system.

Each territorial administrative division has a unique registration code, the SIRSUP (Information System of the Region of the Territorial and Administrative Divisions) code, which is extracted from the Permanent Register of Territorial Administrative Divisions, published in the National Statistical Committee. Cadastral numbering is done separately for premises within city limits and unincorporated premises.

- **Numbering of properties (real estate property).** In the stage of the collection of cadastral data, maintaining the connection of the property was considered to be necessary, therefore, it was attached in front, together with a separator, the number of the cadastral sector

- **Cadastral numbering of linear details**, which represent rivers, channels, dams, railways, listed roads, streets, etc. were numbered separately, as land parcels, within a sector considered as having the number 0.

- **Cadastral numbering of land parcels** in each property unit (real estate property), the component land parcels were numbered in digits, from 1 to n, the digits being followed by the symbol of the user class.

b) Calculation of surfaces

In the general cadastre, the calculation of surfaces is done analytically; they are expressed in square meters and constitute one of the elements that the general cadastre provides to information systems and that must be compulsorily complied by them.

The calculation of surfaces was done in line with the calculation of the area of the administrative territory, upon the completion of demarcation works. The succession of operations to the calculation of surfaces, is the following: the calculation of surfaces per land parcels, the calculation of the surfaces of constructions, the calculations of the surfaces per properties, the calculation of the surfaces per cadastral sectors (quarters), the calculation of surfaces within city limits and unincorporated surfaces.

- **The calculation of the surfaces of cadastral sectors** in the case of drafted cadastral plans, the calculation of the area of cadastral sectors was done analytically, by using the coordinates of the points located on the respective limits, coordinates determined in the national projection system.

The control of the areas determined for cadastral sectors was also done on trapezes or on section of plan.

- **The calculation of the surfaces of the properties** was done within each cadastral sector (quarter), whose surface was previously determined and which serves for the control of the calculations in this stage.

In the case of plans numerically drafted, the calculation of the areas of the properties.

- **The calculation of the surfaces of land parcels.** The determination of the area of land parcel is carried out within each property unit, whose area, determined in the previous stage, serves for control.

c) The collection of attributes for the properties within city limits for their owners/holders

The attributes regarding each property and their respective owner, were obtained from the following documents:

- real estate property layout plan, with indication of borders to adjoining properties, drafted for the property units for the purpose of registering into the Real Estate Register;

- documentations executed in line with Government Decision 834/91 and endorsed by the Land Registry Office;

- title deeds issued in line with Law 18/1991.

The owner's identification data and the ones regarding the ownership documents shall be collected in the field, through "interviews" carried out by the contractor of the work.

The collection of cadastral data can be carried out as a separate work, organised for this purpose, or concomitantly with the execution of field works, within the performance of the digital land parcel plan.

- Acquisition of textual data

After the performance of the topology for each layer, a table of attributes was created, which is practically a tabular file, in which the standard attributes of the spatial characteristics of point, line and polygon are stored.

But a GIS also needs a series of attributes which are acquired directly from the field, either for the update of existing data, or for their completion and which must be introduced into the database. For the purpose of adding new attributes, the following steps were taken:

- *Creating a new data file for new attributes.* For this reason, these attributes were defined, mentioning a series of specific parameters, respectively: the name of the attribute, the type of the attribute (letters or numbers), as well as the memory quantity necessary for each.

- *Adding the values of attributed in the data file.* After creating the data file, values of new attributes were added on the form. If the values of the new attributes already exist in a file on the computer, they can be transferred directly into the newly created file.

- *Including the attributes into the table of attributes of spatial characteristics.* Together with the creation of the topology for a layer, a table of attributes was created, which automatically connects each spatial characteristic with the appropriate data in the table of attributes.

- **Identifying user classes.** For each property unit the identification of user classes was carried out concomitantly with the execution of cadastre works, respectively with the carrying out of field measurements for the purpose of updating the land parcel plans or of collecting the owners' identification data and the ones regarding the ownership documents.

For each land parcel, the Sheet of the real estate property, the user classes were identified and recorded, through their codes.

Textual information regarding the owners shall be collected on the field, for all the properties within city limits and unincorporated properties. With the information collected on the field, the main cadastral data sheet.

- **Identifying the owners and the legal status of the real estate properties.** The operation for the identification of the owners consists in the identification of the natural or legal persons who own a title deed on the real estate property.

The data regarding all the owners in the territorial administrative division were extracted from the Permanent Population Register, existing in the GIS Service of the Mayor's Office, as well as from the Police inventories.

As a result of the identifications, in the main cadastral data sheet the following have been recorded:

- the name, forename of the owner natural/legal person, personal identification number/the SIRSUP (Information System of the Region of the Territorial and Administrative Divisions) code and the postal address.

- the legal status of real estate properties: the name of the ownership document with the number and date of issuance, the share of the co-property if applicable, the surface recorded in documents for each land parcel, property unit and construction, where applicable .

- Validation of data

For the validation of data, after their collection at the level of the cadastral sector, the following types of checks are carried out:

a) *Formal check:* After performing the digital version of the land parcel plan, it was checked whether the spatial data (digital plan) contains formal errors.

b) *Checking the topology.* The connections between the spatial data of the digital plan are explained through topological relations. The creation of the topology of each layer also generates the table of attributes containing the data describing the layer. Once these relations

have been explained, in order to go to the execution of queries, analyses or data displays, the following checks must be carried out: construction of the topology, identification of errors and their correction and reconstruction of topology.

2.3.2. Uploading the data relating to the urban fund

The cadastre of the urban fund deals with the inventorying and systemic accountancy of the underground and overground urban equipment in the premises within city limits, both from a technical (quantitative) point of view and from a qualitative (economic) point of view.

The urban equipment refers to technical networks which serve the housing, the socio-cultural units, institutions, economic operators, etc., as well as the industrial technical networks in the urban space.

The objective of the cadastre of the urban fund is the urban equipment, consisting in:

- the supply of drinking water and the water for green spaces;
- the sewage system for waste water and rainwater: external public network and collectors, spillways, etc.;
- natural gas network: transport pipelines, handover stations, distribution network, connection pipelines, gas adjustment stations;
- heating network: main pipelines, distribution network, taps, valves, airing or discharge valves, etc.;
- electrical power system: distribution network for consumers, manhole chimneys, lighting system, etc.;
- telecommunications network: layouts of the main and secondary underground call lines, overground layouts, cable TV, etc.;
- traffic signals networks for vehicles and pedestrians: layouts of the underground or overground cables for flying traffic lights or traffic lights on pillars, robot traffic lights for traffic patterns, etc.;
- industrial networks for industrial water, oils, brines, compressed air, oxygen, gaseous or liquid fuels, special voltage cables, control cables, warning cables, etc.;
- technical constructions and facilities which *directly* serve the urban networks:
- normal and specialised manholes (for valves, airing taps, meters, etc.)
- water abstractions, tanks, aqueducts, constructions and plants for water quality improvement, mouths of the rivers, pumping plants, sewage treatment plants, gas adjustment and measuring stations for important consumers, handover stations, thermal substations for connection or preparation of hot domestic water, supply stations and substations, underground transformer substations, on ground or on pillars, distribution chambers and the ones for cable layout, main, magistral, secondary or connection technical galleries.

2.4. Drafting of final documentation

a. Digital complex technical-urban plan. Apart from the digital plan, for the handover/reception of the works, the analogue plan was also drafted on a scale of 1:500, on the plan's sheets or on standardised sections and contains all the urban networks drawn through conventional symbols, on a minimum planimetric basis.

The specific elements from the complex land parcel plan are:

- hatches for the manholes, masts for the electrical or telephone systems, layouts of the urban networks with its entire equipment, connections and joints for subscribers, auxiliary urban constructions and facilities, inscriptions associated to the urban networks: diameters of the pipelines, number of cables photographed together, building materials, pressures, voltages,

altitudes, etc. all in the form of digits or symbols, inscriptions associated to urban constructions and facilities.

b. Theme plans. The detailed content of digital theme plans is identical to the one of the complex land parcel plan, regarding only the urban networks that it shows or may contain certain selected elements.

Theme plans are drafted on the same scales as the complex land parcel plan or higher, for instance, 1:200, presented on sections of plan or on sections of artery, containing only a certain type of network or two three types of networks functionally connected or with compatible functions.

c. Surveys of shafts. The surveys of shafts, of manholes or manhole chimneys and of other urban constructions, were drawn to a convenient scale in order to fall within the place laid down in the Auxiliary Urban Constructions-Plants Sheet.

d. Auxiliary Urban Constructions-Plants Sheet. This sheet contains: the type of urban element (name) to which it refers (sewage shaft, heating shaft, water shaft, manhole chimney, etc.), location elements (street or crossroads), topographical description in the form of a drawing, placed in the place mentioned on the sheet.

e. Section sheet This sheet is drafted per types off networks and contains: the name of the section, the type of pipeline, the length of the section (the distances between the channels on the section are recorded); the manner of photograph; the drawing of the section with the topographical numbers of the shafts on it.

f. Various documents which were used for the drafting of the project are, among other things, the digital cadastral survey plan, the old cadastral survey plans or the land parcel plans, outline drafted on the field, measurements, etc.

The completion of the activity of introducing the cadastre of urban networks is carried out after checking the field, office works and the reception of the documents.

2.5. Management and exploitation of the Database at the level of municipality. Analysis and presentation of the results

The management of the database is carried out by the Database Management System (SGBD), consisting of a package of programs which must ensure: the organisation of the database, the introduction of the data and information into the database, as well as the development of applications connected to the content of the database. It is conceived so that it ensures, both the elements necessary for the appropriate organisation of the spatial component of the database, and the carrying out of specific general functions, by means of a textual component of the same database.

So that the performed database is functional, through the carrying out of the stages above-mentioned, it must have the layers with the updated topology, the necessary control substations, the precision of all the spatial data checked, the drafted table of attributes and the precision of their values checked.

If these elements are carried out, it shall continue with the storage of all spatial characteristics by using the field coordinates, with the storage of all the layers connected into a system of common coordinates and to the spatial referencing of the characteristics of each layer, with the characteristics in associated layers.

The theme layers have contributed to the organisation of related characteristics, minimising the number of attributes associated with each characteristic, facilitating the update of the plan and simplifying the display of the plan as the related characteristics are easier to draw, label and represent.

Theme layers refer to its vertical structure and the plan's sheets used as spatial partitions refer to its horizontal structure.

The plan's sheet (spatial partitions) are most of the times in the form in which the theme layer is obtained. These can be connected for analysis and display. The spatial partitioning of the data simplifies the update, thus, it is carried out on the plan's sheets.

Hereinafter, also through the SGBD, the plan's sheet can be connected in order to allow the analysis, query and display of the entire database.

As the spatial data with which the database is supplied, can come from various sources, SGBD must ensure that many of them are transformed, so that all spatial characteristics are maintained, by using a unique system of coordinates-field.

As in this stage, the main source that supplies the spatial data for the database of a GIS, is made of the restored cadastral survey plan, existing cadastral survey or land parcel plans and the legal cadastral documents, which shall be computerised through the digitisation process, or through scanning-vectorisation, these spatial data, organised on layers, result in digitiser units, only sub-directors which contain the layers in their final form. Moreover, SGBD ensures that the other sub-directors constituted during the acquisition of data.

Exploitation and query of the database

The data and information are structured and maintained into the two components, spatial and textual, of the GIS database, so that in the exploitation and query stage, the main reports for the general cadastre and the ones off the information systems per areas shall be obtained.

a) Classification of reports. The types of reports, by manner of presentation, are:

- *in graphic form*, type of land parcel plans;
- *in textual form*, respectively cadastral registers (on screen or printed);

having the content and structure required by the regulations:

- *in mixed form*, respectively the graphic part may be integrated into reports, three-dimensional views, etc.;
- *other types of reports*, specific to the area for which it was performed (EXCEL reports, combined reports, operative queries, etc.).

b) Obtaining land parcel plans. Depending on the type of data contained in the spatial component of the database, the data obtained in the process of drafting the *numerical land parcel plan* or the data obtained in the process of drafting the *index land parcel plan* shall be quickly edited:

- *basic land parcel plan*;
- *theme planes on various scales*;
- *graphic support of the index land parcel plan*.

These graphic products are necessary, as the information transmitted by means of plans are much more suggestive than the ones transmitted by means of other methods.

c) Obtaining standard reports. After certain queries regarding the data and information in the textual component of the data bank are carried out, cadastral registers belonging to the General Cadastre can be automatically generated, respectively: the cadastral register of land parcels, the alphabetic index of owners, the cadastral register of owners, the cadastral register of property units, the summary register with the status of the lands per user classes and per groups of owners, the real estate property sheet (property units).

d) Obtaining specific reports. Depending on the scope established, its database can be interrogated in order to obtain various information in the form of specific reports, respectively: queries regarding the properties, queries regarding the land parcels, queries regarding the constructions, queries regarding the networks, queries regarding historical monuments and sites, classified per architectural types, etc.;

The supply of information on the values of taxes on certain real estate properties, respectively: inventorying of the transactions of real estate properties, identifying the areas subjected to pollution, close to residential areas, establishing sanitary, education, voting boundaries, etc., depending on the density of the population, information on the real estate property and the surrounding area, for the issuance of the Urban Planning Certificate and of the Building permit, - issuance of permits for connection to various types of networks.

2.6. Interlinking of systems by using the Internet/Intranet network

By using a heterogeneous GIS platform, it is required that the existing information systems (produced by various organisations), which use programs and structures of various data (alphanumeric and/or spatial), would be much improved through the implementation of a *interoperability factor*, which would allow the increase of the capacity of information exchange, as well as the performance of new types of applications. This is possible nowadays, by the maximum use of modern technologies for the increase of the mobility of communications by the intense use of the Internet/Intranet, achieving at the same time a continuous update of the information owned by each of these systems, as well as the removal of the overlapping of data and information.

2.7. Automation of the works for the maintenance of the cadastre

The automatic maintenance of the cadastre entails, on the one hand, the automatic maintenance of the land parcel plan and on the other hand, the automatic maintenance of cadastral networks.

The functional model presented in this chapter, based on the actual stages and activities of performing the Integrated Information System of the Modern General Cadastre at the level of Iași Municipality, contains a series of procedures and methods grouped within an information flow, regarding the action of going from the data of the declaratory cadastre to the real one, starting with the carrying out of the works of cadastral data collection, data sources, data processing and storage, publication of the results for the purpose of consultation by owners, calculation and compensation of surfaces, settling the complaints, ex officio final registering into the Real Estate Register and the publication of the cadastral data on the INTERNET.

2.8. Publication of the cadastral data on the administrative territory of the municipality

In line with Law no. 7/1996 on the Cadastre and Real Estate Publicity, re-published, after the completion of the field works for an administrative and territorial division, the data obtained are processed, received and introduced into the Cadastral Databank, the Mayor's Office being under the obligation to notify the owners by written notification and by posting it at its headquarters.

In Figure 1, the scheme for the information flow for the stage of cadastre data publication is presented.

2.9. On-line publication of cadastral data

In recent years, due to technological progress and activity information in most areas of national economy, an "explosion" of *On-line Geographic Information System* took place. In this context, the **SCADIF (Information Cadastral System)** application is also part of, with the purpose of creating a modern service regarding the on-line publication of cadastral data of the users, at the level of Iași Municipality.

SCHEME OF THE INFORMATION FLOW FOR THE PUBLICATION OF THE GENERAL CADASTRE DATA STAGE

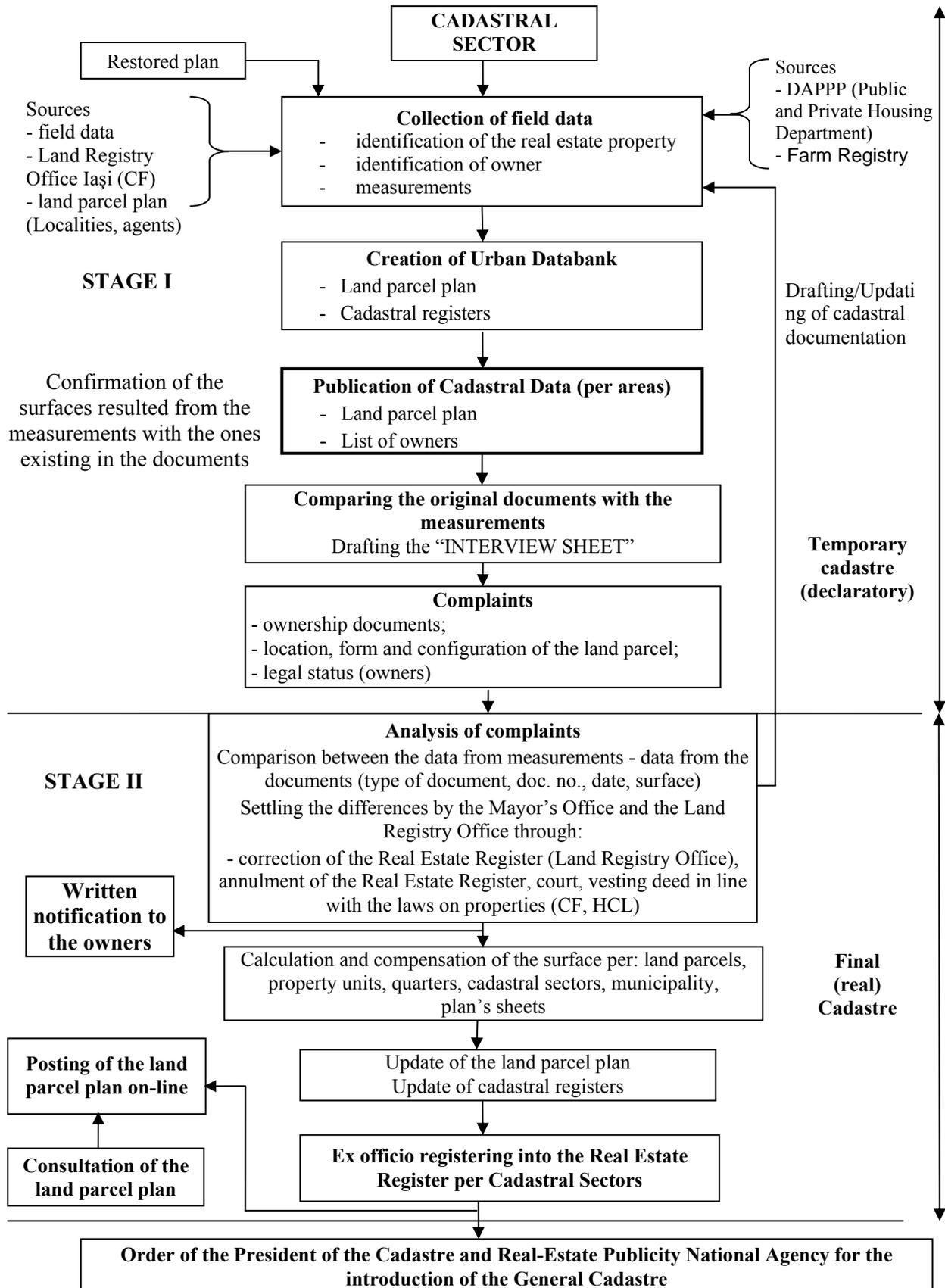


Fig. 1. The scheme for the information flow for the purpose of changing from not final to final

2.10. SCADIF (Information Cadastral System) application

An illuminating example to that end is the SCADIF application which strives to create a database with the elements (data and information) both of the general cadastre and of the Information system specific to the real estate-urban scope within a concept of *Internet Mapping* for the viewing and consultation of cadastral data and information by the holders, firstly, but also by other interested users.

The database, created and used for the purpose of using it in the application, was designed so that it allows the continuous communication with the database of the *General Cadastre* and of the *Information System Specific* to the real estate-urban areas, existing on the GIS server and the taking over of public information regarding the real estate properties provided by these, respectively:

- the *General Cadastre* (land parcel number, property units, land parcels, surfaces, use, legal status, etc.);
- *Information System specific to the real estate fund* (land parcels, constructions/apartments, surfaces, qualitative characteristics of the construction, type of property, etc.);
- *Information System specific to the urban fund*;

The applicative functions of GIS shall be used firstly for the purpose of drafting the standard reports: *land parcel plans and specific urban reports*.

3. Conclusions

In this stage, the interoperability at a national level is lacking, as well as the compatibility with European Union countries, regarding:

- digital plans/maps (the standard used in all ground and cadastre measurement, ordered per layers, names, coding, graphic representations);
- the alphanumeric database (attributes, functions, sheets, statistical and EUROSTAT indicators);
- the Statistical Office of the European Communities compatible indicators);
- applications for management, analysis and forecasting (indicators, reports), general and specialised ones.

Thus, it is necessary that the Local and Central Government Authorities, of the ones with responsibilities in the area of ground measurements and cadastre, potential users of information, to cooperate for the purpose of implementing specific regulatory documents and to promote the development of a unitary framework for the implementation of Geographic Information Systems - GIS. To that end, in line with the Rules governing the functioning and organization of the Cadastre and Real-Estate Publicity National Agency, the following main functions and responsibilities result:

- drafting of the structure of the Information System and of the Database for the Unitary Cadastre and Real Estate Publicity System;
- drafting, revision and improvement of the rules, norms, methodologies, working instructions and their harmonisation with the ones of the European Union.

Within the Local Government, the main role granted to the GIS, is represented by the creation of a tool for an automatic integration and management of cadastral data, from a technical, economic and legal point of view, which would generate the information support necessary to the bodies, services and persons that require, carry out activities or carry out tasks, responsibilities in the field of urbanism and land use, as well as for the technical and economic responsibilities of public institutions.

By means of the GIS, inventorying, organisation and distribution of specific information, data archiving, establishment of the urban history and networking of potential users, is ensured by establishing certain unique common references.

The design of a GIS within the local government is required, especially, due to the lack of a tool for objective, wide, interdisciplinary and rapid analysis, as a support for any type of decision. Based on the analyses of geographic data, new documentation can be obtained, which shall be the basis for future projects, in addition to the attracting new financing sources. The database is a source of information for the purpose of designing and exploiting information sub-systems that can also be integrated in other scopes of the local government, which in turn, form the institution's integrated information system.

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