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HABILITATION THESIS

GEOMATICS - IMPACT ON URBAN PLANNING, ENVIRONMENT AND SOCIETY

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HABILITATION THESIS

Geomatics - impact on Urban Planning, Environment and Society

Geomatica - impact asupra dezvoltării urbane, mediului şi societăţii

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Domain: Geodetic Engineering

Specialization: Land Measurements and Cadastre

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Foreword

GEOMATICS - technology of our times

Geomatics represent a natural consequence of the accelerated development of information technology. Until recently, for positioning and description of the locations of the land, have been used conventional means, fairly safe, but often complicated and expensive.
Information technology and spectacular achievements in recent decades have found fast uses through modern techniques for positioning and description of the Earth's components, respectively, land, water and air.
In time appeared the need for these modern and quality accomplishments in the field of research and knowledge of the land surface, to be integrated into a new science "geomatics", with objectives and domains of applicability well-defined.
A similar term in English and French, formulated for the first time in Canada by Duboisson in 1969 and owned by the International Organization for Standardization, resulted from the combination of the basic concepts of *Geodesy* and *Geoinformation*, considered more comprehensive and preferred to the "geospatial technology".
"Geomatics is the art, science and technology related to geographic information management about a piece of land, placed in a reference system".

Domains that use geomatics tools

Geomatics encompasses a wide range of fields, including tools and techniques used in surveying, mapping, remote sensing, Geographic information systems (GIS), global navigation systems by satellite (GPS), photogrammetric, geography and other forms related to the mapping of the Earth.
Geographic Information systems (GIS) are among the most popular and powerful geomatics tools for decision-making in the world.
The main characteristic of *GIS* is the use of information management tools in order to create *smart maps*.
Today, Geographical Informational Systems are used routinely for everything you can imagine, from the terrestrial surface mapping to natural and antropic resource management, from simulation and forecasting of events and phenomena to planning and decision making in almost all areas: infrastructure, environment, demography, urbanism, health, sociology, economics, tourism, administration, transportation, and many others.

HABILITATION THESIS

GEOMATICS - IMPACT ON URBAN PLANNING, ENVIRONMENT AND SOCIETY

A. ABSTRACT

Present thesis summarises the main domains for research activity of the candidate after defending the PhD Thesis at Technical University of Civil Engineering in Bucharest, Faculty of Geodesy, confirmed by the Ministry of National Education, on the basis of Order no. 3772, dated 05.05.1999.

On the basis of this diploma I was awarded the scientific title: *Doctor of Technical Science*, branch Science and Technology, for **the doctorate field: Geodesy, Photogrammetry, Cartography and Remote Sensing.**

The research activity and achievements presented here are developed in two main thematic directions. The first one is referring to the:

- **Implementation of new technologies and techniques for Cadastral applications with geo-information support in relationship with environmental protection**, which continues and diversify with new subjects, the topic of the PhD Thesis.

It should be noted that the activity of the candidate in this field (15 years of research), is in line with the fields of research of the National Geodetic School correlated with the national policies in the domain, and lately, connected also to European trends.

The results of my scientific research are materialized mainly in specialty scientific articles and books. Therefore, I have always focused on this aspect, considering that not only the quantitative aspect of the work is important, but also the quality and the value of the material published. It can be seen in the list of the scientific papers attached that I have also collaborated with colleagues from other Romanian universities at writing articles in my specialty.

A main priority in the last years was the publication of scientific articles in magazines and journals of different scientific events, indexed in Web of Knowledge (ISI), or magazines and volumes of different scientific events also indexed in other relevant International Data Bases BDI. The evaluation of my own research-development activity can be made by comparing it with similar activities, national and international. An important component of the management of my own research activity was the dissemination of the results obtained in the scientific community and the feedback obtained. Thus, I have taken part to various conferences, symposiums where I had the chance of getting a direct feedback on my research activity.

Another challenge was the decision of choosing the correct research directions in correlation with the existent financial, materials and mainly human resources. At present time, my research activity tends to be multidisciplinary, involving specialists in civil engineering, environment, architects, experts in information technology, researchers in the field of geosciences, etc.

This multidisciplinary cooperation, the contact with specialists from different research fields within the research teams I was a member of, have represented for me an important qualitative improvement. The collaboration has contributed to my training and my development from the professional and scientific point of view.

Another important component of my personal research activity consisted in the research documentation work on the subject of the international scientific activity in the geodetic engineering field.
Lately, I have become more involved in taking part in different scientific committees of various events or international publications, as well as in the activity of scientific referent of these publications. This is an intense activity from the scientific point of view, a voluntary one, but with the satisfaction of being useful in my professional field, on the national and international level.

The second direction for the research activity reffers to:

- **Implementation of geo-information bases for Urban Planning purposes, society needs and sustainable geodesy**, being rather a new field of research.

It should be underlined that in Romania, in general, and in geodetic engineering sector in particular, not too much work has been done in the field of sustainability research. The studies and applications performed by the candidate together with the colleagues from Land Measurements and Cadastre Department of the Civil Engineering Faculty from Timişoara represent a team work developed at local level, but also a partnership with main educational institutions in Romania (Faculty of Geodesy from Bucharest, Technical University from Iaşi, Faculty of Science from Alba Iulia) and economic partners authorized as national developers in the domain.
In what concerns the future research and development plans of the candidate, related to the fields of research presented above, the following research topics will continue or will be developed:

- **E**laboration of a data base for the use of geospatial information in managing Municipality projects; data collecting and data introduction
- **N**ational/local Program for infrastructure modernization
- **E**xperimental research for improving geodetic technologies performances
- **A**pplication of the terrestrial laser scanning for environmental processes and changes
- Photogrammetric applications for Open Cultural Landscape & Heritage

A short description of each topic has been done in Chapter C: *Future development plan.*

The new subjects of research in the post-thesis period are related to the following aspects:

Theoretical contributions:
- evaluation of the national geodetic framework as a support for cadastre implementation
- evolution of technical equipments and proper use for dedicated research
- evolution of techniques and methods related to new challenges in the Cadastral System
- ultimate design capacity of thematic portal frames made by habilitated organizations
- behavior of national geodetic infrastructure for engineering projects

Applicative maintenance for research:
- Development of Geographic Information Systems as efficient support for urban planning
- Using geographic information system analysis in the management of flood risk areas
- Real time positioning – solution for automation processes and monitoring land management
- Noise management and noise monitoring with geographical information systems
- Challenges in implementing the systematic land registration in Romania

For these applicative research maintenance problems, both technical and environmental performances have been studied.
The main achievements and results are presented in detail in Chapter B: *Scientific, professional and academic achievements.*

The development plan for the scientific side consists of two phases, namely: short and medium term development plan and long term research plan, respectively.

In order to improve and develop the research activity, on a short and medium term I plan to do the following:

- closer collaboration with accredited institutions and other profile faculties in Romania on subjects specific to our field
- set up a multidisciplinary research team, with various specialists (construction, hydrology, geology, geography, IT, etc), from numerous institutions, able to respond more efficiently to the call for scientific competition
- identify and promote several common research themes with other institutes and faculties, stating from the similar or complementary activities developed

From the professional point of view, I will continue my activity of designing projects, along with activities of execution and verification in the field of geodetic engineering; monitoring several objectives still in the execution or exploitation stage. I will monitor the impact of the topo-geodetic works on the environment and society as well.

Finally, it have to be underlined that the active role of the candidate will continuously increase by participation with new research topics to international conferences and papers published in specialized journals. Also, as member in different associations and comities, the candidate will continue the collaborative work with other researchers in the field.

B. Scientific, professional and academic achievements

1. Introduction

The main research field in which I was involved consists mainly in theoretical studies and practical support regarding Geodetic Engineering and Cadastral problems with impact on Environment, Urban Development and Society.

Continuing the subject of my PhD thesis entitled”**TOPOGRAPHIC TECHNOLOGIES USING GLOBAL POSITIONING SYSTEM FOR CONTROL CADASTRAL NETWORKS**” further studies were made on similar themes. They were made within the frame of different projects, such as:

- Real Estate Mapping in Romanian Counties, contract no. 674/2007, 6.000EUR
- Topographic studies and cadastral evaluation for Urban Planning in Deva city, Romania, contract no. 577/10.12.2006, 5000EUR
- Designing Database for using Geospatial Information for Registration and Monitoring cemeteries in Timisoara, Romania, contract no. 182/2008, 14.000EUR
- Application of the terrestrial laser scanning for environmental processes and changes - ATLAS, project no.10/0242-E/4005/2011, 31.802EUR
- Studies and experimental research concerning the improvement of technological performances of Francis FVM DE 57.5-128.5 turbines, hydro-electrical plant Bradisor, Romania, Topographic evaluation, contract no. 174/2010, 57.571EUR
- National Project for Infrastructure Modernisation-Interdisciplinary Laboratories, Surveying and Cadastre department, contract no. 2575/2007, 100.181EUR
- Online network for university collaboration to develop the capacity of providing superior competences in Geodesy, contract POSDRU/86/1.2/S/63140, 2010-2012, 1.225.685RON (300.000EUR)
- Internațional project - Modernization and Harmonization of Curricula in Cadastral measurements and Geodesy according to EU policies - Tempus Life Long Learning Programme – 2012

other projects

- INSTRUCT – Laboratory development for large scale tests, **PN II** Modul I, Capacităţi, 90 CP/ I/ 14.09.2007 (2007-2008-2009) – **team member**
- POSDRU/2/1.2/S/2 – “Development of an operational program of qualifications in Romanian Higher Education”; **member for *Geodetic Engineering* section**
- POSDRU/21/1.5/G/13798 - “Doctoral School - support for research in European context” - Contract nr. 16709/20 din 18.11.2010 – **long term expert**
- POSDRU/89/1.5/S/52603 ”Support and Development for multidisciplinary postdoctoral programs in technical domains of national strategy 4D - POSTDOC” – TUTOR, **long term expert** (2010/2013)
- POSDRU87/1.3/S/60891: Academic School for trainers in the domain of Engineering Technical Specializations - DidaTec, **long term expert** (2010/2013)
- POSDRU 2/1.2/S/2 “Development of Quality System in Romanian Higher Education” – **vocational training course** (**DOCIS**)
- Target Group, project POSDRU 97/6.3/S/60759: National School of Manager Women
- Target Group project POSDRU 2/1.2/S/6: Correct Information – key for studies recognition
- ***Inter-Institutional Agreement****: Scholarships and Inter-Institutional Cooperation in Higher Education; Financed by the EEA and Norvegian Financial Mechanism, 2013*
- ***EEA Financial Mechanism 2009-2014*** *Multi-criteria optimal decision support systems in fragmented forested landscapes: EEA 2013*
- **POSCCE-A2-O2.2.1-2013-1:** The integrated platform of research-development for building extreme actions behaviour **(**Platformă integrată de cercetare – dezvoltare pentru comportarea construcţiilor la acţiuni extreme - ACTEX), Programul Operaţional Sectorial Creşterea Compepitivităţii Economice, Axa Prioritară 2 – CDI: Operaţiunea 2.1.1, 2013-2015, valoarea totală a proiectului *21.000.000,00 lei*, **team member**.
- Grant Application Erasmus+ KA2 SP.3 *Low-cost Cultural Heritage Digital Documentation (Smartphone 3D Scanning), 2014*
- Grant PN II Partnership ***Romanian Bilateral Cooperation - China UEFISCDI -*** *Monitoring Technologies Development for urban green areas using Remote Sensing. Comparative Study, Timişoara – România , Beijing – China, 2014*

The results of my scientific research are materialized mainly in specialty scientific articles and books. Therefore, I have always focused on this aspect, considering that not only the quantitative aspect of the work is important, but also the quality and the value of the material published. It can be seen in the list of the scientific papers attached that I collaborated with colleagues from other Romanian universities at writing articles in my specialty.

A main priority in the last years was the publication of scientific articles in magazines and journals of different scientific events, indexed in Web of Knowledge (ISI), or magazines and volumes of different scientific events also indexed in other relevant international database (BDI).

The evaluation of my own research-development activity can be made by comparing it with similar activities, national and international. An important component of the management of my own research activity was the dissemination of the results obtained in the scientific community and the feedback obtained. Thus, I have taken part at various conferences, symposiums where I had the chance of getting a direct feedback on my research activity.

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Another important component of my personal research activity consisted in the research documentation work on the subject of the international scientific activity in the geodetic engineering field. Lately I have become more involved in taking part at different scientific committees of various manifestations or international publications, as well as in the activity of scientific referent of these publications. This is an intense activity from the scientific point of view, a voluntary one, but with the satisfaction of being useful in my professional field, on the national and international level.

During 2010-2011 and 2012-2013 I was a member of various management and implementation teams for projects financed by structural funds, national scientific competitions organized by UEFISCDI, SEE; I played an active part in submitting projects, in the activities of elaboration and logistics and in getting the projects ready to take part at the competitions, respectively.

As far as the collaboration with other institutions with the same profile from abroad, I initiated bilateral agreement and partnerships for educational and research projects (Agreement for scientific partnership Leica Geosystems AG Switzerland; Collaboration program - West University of Hungary, Faculty of Geoinformatics Szekesfehervar; Intergraph Corporation Education Program; Inter-Institutional Agreement UPT–Norwegian University of Life Sciences (UMB) Aas Norway; Bilateral protocol UPT-Military Economics Academy of Wuhan, China; ERASMUS Intensive Programmes as coordinator on behalf of my university, etc.).

The recognition of my activity is also marked by being a member of various professional organisations, such as: Uniunea Geodezilor din România (the Union of Romanian Geodesists), Ordinul Geodezilor din România, (The Order of Romanian Geodesists) Asociația Generală a Inginerilor din România (The General Association of Romanian Engineers), Agenția Națională de Cadastru și Publicitate Imobiliară (The National Agency for Cadastre and Land Registration), Ministerul Dezvoltării și Administrației Publice (Ministry of Development and Public Administration), EUROLIS, Balkan Environmental Association (BENA), FIG (Federation International des Geometres).

As a leader or as a research team member, involved in national and international projects, I can mention the following contributions related to the mentioned domains:

- presenting a state-of-the-art programme on the geodetic network analysis and evolution in the Banat county;
- designing experimental programs to investigate the seismic impact in Banat area;
- coordinating field and office work for completing the database for geodetic and cadastral infrastructure of Timisoara municipality;
- assessing and processing of the recorded data and offer technical solutions for present and future behaviour of the networks;
- achieving new techniques and technologies during international partnership stages
- implementation of modern technologies and methods for measurements and 3D modelling in engineering
- co-coordinating assistant for several interdisciplinary PhD thesis concerning the domain of Civil Engineering with geodetic component, presented by eng. Sorin Herban, Cosmin Musat, Alina Bala, Maria Brebu, Roberta Gridan, Beatrice Vilceanu, Adrian Alionescu, Anca Moscovici, Georgiana Rusu from Politehnica University of Timisoara, and also associate professors as economic partners, eng. Constantin Bora and eng.Nicolae Babuca.

As scientific referents of the theses were well known professors and researchers from Romanian universities and also international recognized experts in the field Geodetic engineering, such as Prof. PhD. Eng. Athanasios Styliadis from Greece. The fact that important names of our domain in Romania and international experts accepted to take part to these evaluation comities as scientific referents and the fact that they truly appreciated the performed work in all cases, underline the importance and the quality of the research and they serve as a significant acknowledgement (confirmation) of both, the thesis itself and of the researchers.
As author or coauthor, I published more than 25 research papers between 2009 and 2014 in the field of Geodesy, Cadastre, GIS indexed in international database (ISI Journals, ISI Proceeding; other International Database).
The most important papers were published in international/national recognized journals or conference Proceedings, such as: Journal of Environmental Protection and Ecology - JEPE, Journal of Geodesy and Cadastre - RevCAD, Research Journal of Agricultural Sciences -RJAS, SGEM Proceedings, WSEAS Proceedings, ICNAAM Proceedings, Österreichische zeitschrift für Vermesung & Geoinformation, FIG Conferences .
In terms of applicability of the previous research conducted, it is important to mention that the completion of the studies performed, enabled extensive measurements and performance evaluation of the actual stage of the geodetic frame in the region of Timişoara city. The research was materialized by its dissemination at several professional Conferences and Journals.
It has to be mentioned that for fifteen years I was member in the management team of the Surveying and Cadastre Laboratory which is part of the CCTFC Department, within Faculty of Civil Engineering at Politehnica University of Timisoara and also for the Intergraph Research Registered Laboratory (RRL). During this period the first laboratory was accredited by the National Authority in Cadastre and Land Registration (ANCPI).
In the last years, two other laboratories were also established, connected to the Surveying one. While holding an administrative position, I was a key person in the constant development of these laboratories, encouraging their expansion through important research contracts both with the industrial and the academic environment. The results of my management activity were quantifiable by constant development of laboratory facilities (equipment, data acquisition systems, IT infrastructure, software support, etc.), i.e.: acquisition of equipment in amount of over 150.000 EUR. In view of all of the above mentioned, it is considered that all the requirements for a proper research activity have been met by the existing infrastructure, with minor adjustments in the future.

In the second research area focused on the implementation of geo-information bases for sustainable geodesy, I have been participating since 2007 at the processes of elaboration and update the geo-database for Timisoara Municipality. Together with the team I presented periodically research reports regarding the state of art of the projects evolution and I performed personally measurements and data processing together with the dedicated GIS implementation; also the tests regarding the quality of the processed data extracted from the field elements.
The general research work comprises more than 80 projects/contracts that were performed mostly in the nearest area of Timisoara city, Romania.
I received professional recognition by important professional associations:

- Laboratory Chief for research and contractual activities - attested by ANCPI (National Agency for Cadastre and Real Estate)
- Laboratory Chief for educational activities, attested by Intergraph Company
- Expert ANCPI attested by National Agency for Cadastre and Real Estate
- Expert ACPART (National Qualifications Framework for Higher Education)
- Expert ARACIS (Romanian Agency for Quality Assurance in Higher Education)
- Trainer for development of study programs

-member of the Romanian Geodetic Union (UGR)
-president of the Local Geodetic Association (AGT)
-member of the Romanian General Association of Engineers (AGIR)
-member of BENA, Balkan Environmental Association
-member of MDRAP (Ministry of Regional Development and Public Administration), Technical committee
-member of ANCPI (National Agency for Cadastre and Real Estate), litigation commission

The scientific activity in the mentioned period increased constantly attending the following level:

- ISI journals – 11
- ISI proceedings – 4
- BDI journals - 20
- BDI proceedings - 12
- Papers for International conferences – 30
- Citations - 27
- Books – 9 as author, 2 as editor
- E-books - 5
- Research Grants – 32
- Grants over 10.000EUR - 4
- Grants less than 10.000EUR – 28

It has to be mentioned that during 2000 - 2013, I elaborated a ***total number of 121 papers*** and ***50 projects/research grants as coordinator or member in research teams.***

1.1 Articles constituting the habilitation thesis

This is a survey of the results constituting my habilitation thesis. It is based on the following articles:

1. **Grecea Carmen** - *Geodetic engineering - important tool for Romanian seismicity study*- SSE '09: PROCEEDINGS OF THE CONFERENCE ON SUSTAINABILITY IN SCIENCE ENGINEERING, Timișoara, Romania 2009, pag. 102-107, **(ISI Proceedings);**
2. **Grecea Carmen** - *Geoinformation support - impact on urban planning, environment and society* - LATEST TRENDS ON URBAN PLANNING AND TRANSPORTATION UPT 09- Rodos Greece 2009, pag 136-141 **(ISI Proceedings);**
3. **Grecea Carmen,** Bala AC - *Geospatial Information – Modern Tool for an efficient administration of cemeteries in Timisoara* - REVCAD - JOURNAL OF GEODESY AND CADASTRE – Alba Iulia 2009, Romania, **(BDI);**
4. **Grecea Carmen**, Ienciu I, Dimen L, Bălă A, Oprea L - *Impact of Surveying Engineering on the Environmental protection problems* - JOURNAL OF ENVIRONMENTAL PROTECTION AND ECOLOGY – JEPE 2009 pag. 352-361 **(ISI Journal);**
5. **Grecea Carmen,** Bala AC, Herban S, - *Cadastral Requirements for Urban Administration, key component for an efficient Town Planning*- JOURNAL OF ENVIRONMENTAL PROTECTION AND ECOLOGY – JEPE 2010 pag. 363-371 **(ISI Journal);**
6. **Grecea Carmen**, Vilceanu CB, - *Using Geographic Information System Analysis in the Management of Flood Risk Areas* - 13TH INTERNATIONAL MULTIDISCIPLINARITY SCIENTIFIC GEOCONFERENCE - SGEM 2013 – Albena, Bulgaria **(SCOPUS, Engineering Village) ;**
7. **Grecea Carmen**, Rusu G, Muşat CC, Moscovici AM, - *Challenges in implementing the systematic land registration in Romania* - EUROPEAN CONFERENCE OF GEODESY AND GEOMATICS ENGINEERING GENG'13, Antalya, Turkey 2013 **(SCOPUS, ISI);**

8. **Grecea Carmen**, Vilceanu CB, **-** *Geomatics – Possible Sollution for an efficient management of Environmental Problems* – Research Journal of Agricultural Science, RJAS vol.44 (3), 2012 pag. 199-207, **(BDI Copernicus);**
9. **Grecea Carmen,** Herban S, Vilceanu CB, - *Creating 3D Models of Heritage Objects using Photogrammetric Image Processing* - ICNAAM 2013: 11TH INTERNATIONAL CONFERENCE ON NUMERICAL ANALYSIS AND APPLIED MATHEMATICS, Rhodes Island Greece, **(ISI Proceedings);**
10. **Grecea Carmen,** Herban S, Bala AC, Babuca IN, - *Application of Laser Scan Technology to Landslide Monitoring, Volumetric Calculus and DEM* - 13TH INTERNATIONAL MULTIDISCIPLINARY SCIENTIFIC GEOCONFERENCE SGEM 2013 - Geodesy and Mine Surveying, Albena, Bulgaria, **(SCOPUS, Engineering Village);**

In the following figure, the development of the research and also the planned future activities are presented. It is worthwhile to mention the research activity has been continuously increasing within the last decade. There were continuous developments in the field of Geoinformation Sciences, with benefic support for Geodetic Engineering applications and also for modern cadastre implementation due to theoretical, numerical and graphical contributions.

Main PhD activity

-advantages and disadvantages of using satellite technologies
-evolution of geodetic control networks in Romania
-present stage for positioning and maintenance of the integrity of marking and signalling topographic points
-aspects regarding coordinates transformation
-integration of GPS networks in national frame
-theoretical design of the proposed spatial network; development of an experimental program for planning, field measurements and processing; analysis of the experimental results; description of the behaviour of the local network under different models of processing; proposal of a proper transformation algorithm; comparative studies

Activities post PhD

-models and methods for the control, design and evaluation for real estate mapping in Romanian counties
-designing databases for using geospatial information for registration and monitoring geodetic information
- topographic support development for construction behaviour at extreme actions

Future activities post Habilitation

-application of the terrestrial laser scanning for environmental processes and changes
-geodetic facilities to investigate the Earth's crust movements in western side of Romania
-creating 3D models of heritage objects using image processing
-using geographic information system and spatial database technology in analysis and management of risk areas
-challenges in implementing the systematic land registration in Romania in relation with European standards

2. GEOMATICS, IMPACT ON URBAN PLANNING

CADASTRAL SUPPORT FOR IMPLEMENTATION OF NEW TECHNOLOGIES AND TECHNIQUES

2.1 Introduction

During last century, the relationship between the human world and the planet that sustains it has undergone a profound change.
When the last century began, neither the people nor technology had the power to determine radically, modifications in the planetary systems. As the century closed, not only the huge increasing of population and it's activity, but other unbelievable changes are occurring in the atmosphere, in soils, in waters, among plants and animals in the human species and in the relationships among all of these.
We all are more or less aware that, at present and in the near future, especially the threats of explosive population growth and poverty (in some cases to the living environment threaten human well-being are strongly interrelated).
It is evident that all the identified phenomena or threats to the human race are very much connected with land.
As a consequence of increases in population and industrialization, society has become more complex for both government and other institutions, with the result that more complex and complicated tasks have to be performed. In order to solve these tasks properly, more and more information is required. Having passed through the stages of agricultural and industrial societies, we now live in an information society.
We all need land to live on, to build our homes on and to secure food from;
land includes also water, which becomes more and more important with respect to underground resources. All land management activities from various disciplines are strongly interrelated and need to be developed or improved.

2.2 General concepts of actual cadastre

Cadastre can be defined as a methodically arranged public inventory of data of all properties (parcels) within a certain country or district, based on a survey of their boundaries. A large definition of cadastre implies also the component of land registration; both of them have the task to complement each other inside the cadastral land information system, answering the questions: "who, how, where and how much?"
During its evolution in Romania, the cadastre activities deled with many economical and political changes and obstacles.
That's why, nowadays, the most important task of the new cadastral policy is to assure the informatization of this activity, related to general and multipurpose cadastre, to provide a complete evidence of lands and buildings in order to design the territory in a convenient way with environmental protection.
In time, it's role remained just the same, but the methods, technical tools and principles in organization changed a lot due to the progress in informatics and technology specific to cadastral work and also due to the inner conditions of the Romanian society.
Through cadastre work one can collect and store a big amount of technical, juridical or economical information and all this job can be efficient if the access to these documents is quick, convenient and reflects the reality.

The main quality of a modern cadastre is represented by the use of digital data at any level of the process.

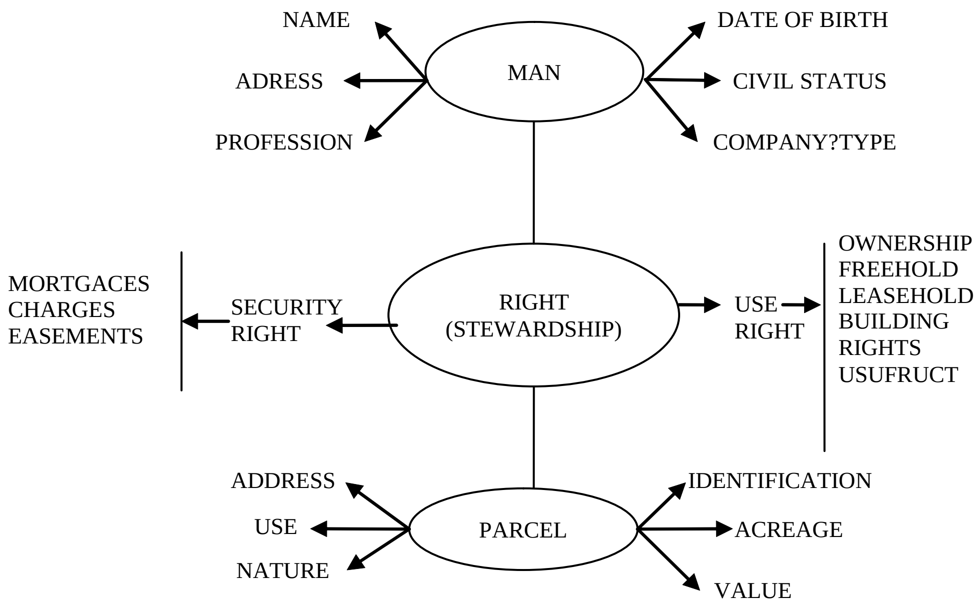


Fig. 2.1. The basic cadastre

Transformation of the present informational system into database system supposes the organization of all information into separate files, which are closely, related one to another.
Another important aspect of process is the acquisition and use of the modern, electronic total stations together with proper software models, which are used in accordance with our national standards.
The cadastral digital data can be collected and processed in an unitary automatic system as follows:

-GPS information
-Total stations data
-Aerial Photography, Orthophotography, and Photogrammetric Based Systems
-Digital data

The primary data processing for computation of the land surfaces for a property are quite simple at this first level but it becomes very difficult due to the huge number of parcels and owners and also to the existence of a great amount of corrections in the adjustment of the territory (around 6 million owners and a total surface of about 9 million hectares, and if we take into consideration a medium number of 6 parcels/owner, it’s necessary to create and determine by cadastral survey a number of about 30 million parcels).
This situation makes possible the elaboration of special, modern methods for data processing inside the local agencies for cadastre. These offer the following possibilities:

-to collect the primary information using the electronic equipment which provides a convenient processing in addition;

-to collect by graphical tools the data which can be obtained by digitizing the parcels directly on the cadastral plans (this aspect implies the use of the existing data);

-to compute and evaluate specific elements useful for the preparation of the final cadastral registers in the form of individual files;

-to draw up the new cadastral plans or to update the old ones;

-to create the database of the general cadastre;

In the previous period, all topographic and cadastral maps and plans were restored completely in a graphical form at different scales and accuracy depending on the methods.
The new tendencies of automation in this research area, imposed the necessity of restoration the topographic and cadastral plans in the digital form.
This profound transformation supposed the use of the computer systems as the main element of this new conception of data base creation and provides some advantages;

- the storage of spatial data in a very detailed way and with high accuracy; each of these can be later on expressed by optional selection, at a general level, to different scales and for different preferential area chosen by the user
- the necessity of using a non-deformation support disappears due to the storage of data in a digital form
- using the computers for processing spatial data, very accurate possibilities come in addition expressed by specific software for a deep analysis of the process itself.

2.3 The use of automatic processing data methods

Processing primary measured data in order to compute and evaluate property surfaces implies simple, common operations at this initial level, but very complicated because of the big amount of parcels and owners for an administrative territory.
This happens also due to the general rules in cadastral works regarding adjustment of closing errors found after the comparison of these surfaces with the corresponding ones from geodetic coordinates.
Such adjustments regards:

- corrections for parcels
- corrections for cadastral plans sheets
- corrections for the entire surfaces of all categories of land

Going further on, the computation should become more complex due to the necessity of expressing the evaluation in a selective and interactive way, graphical or numerical of all data referring to:

- owners and land destination
- land categories
- quality of lands for agriculture and others

Operations of data processing are performed in connection with normal evolution of cadastral works, such as:

- processing primary, initial data
- processing intermediate data
- processing final data, obtaining the cadastral registers

The necessity of using automatic processing tools is justified by the advantage of storage the big amount of collected information. Also, these technical advanced methods of processing data must satisfy the requirements of the general and multipurpose cadastre, as well as periodically updating of data and final information.
Today, the Cadastral GIS offers specialized functionality for each stage of processing including the digital map creation, plotting cadastral and topographical plans, generating and combining geo-referenced data in order to obtain a validated relational geo-database.
GIS as modern technology of analysis and graphical-textual database processing method is very important element in environment resources management. This is a particular crucial purpose in case of multifunctional spatial system.
One of the most convenient methods (in efficiency, accuracy, costs) for data acquisition implies the GPS technology. Going further on, the GPS reference station frame is more and more useful.

Cadastral and other detailed surveys require positioning methods that supply accurate, reliable positioning solutions in short time. GPS is such a highly flexible tool, able to provide *cm* accuracy in less than one minute over distance of few tens of kilometres, if an active reference network is employed.
According to the development tendencies of the services at European and global level of the GPS technology, after 1990 in Romania was also implemented the technology of global positioning (GNSS). At present, the most used GNSS (Global Navigation Satellite System) system in our country is the NAVSTAR-GPS system.
For long-term requirements of Geodesy it was projected and accomplished in our country a National Network of Permanent GPS Stations (RN_SGP).
The main objectives aimed for the accomplishment of this network are:

- Realization of an active space-temporal reference system;
- Use of the satellite observations for determining the position of the points from the National Geodetic Network;
- Use of the satellite observations for determining the position of the points from other networks of planimetric and altimetric support;
- Use of the satellite observations for determining the position of some points of interest in different fields: Topography, Cadastre, GIS, Cartography;
- Use of the satellite observations in the scientifically research.

2.4 Modern concepts of urban cadastre and automation

Town planning cadastre defines itself as a particular cadastre, part of the general one, which involves inventory and systematic evidence of the buildings, fields, networks and utilities inside towns. All these problems regard both technical and economical aspects. In order to automate cadastral activity, the first important procedure is to collect all physical information from a certain territory, which will supply later on the database for town cadastre.
Geodetic activity for civil engineering projects will be able to provide accurate solutions for positioning, setting out, control, mapping in order to cover basic needs of land administrative information and decision making for the Local Authorities.
The realization of different engineering projects in different living areas, in order to establish an accurate organization of the lands and of the existing building fond, as well as the design of various prospective plans in the urban and rural development, require a series of works, in order to obtain the best possible accurate record of all the existing buildings and of the lands which they occupy.
The systematic and thorough knowledge of the territory of the localities, with all the afferent topographic-geodetic works in the superstructure and the infrastructure of the localities, can be ensured by the establishing and the introduction of the cadastre. Thus it will ultimately lead to the creation of certain urban data banks accessible to any beneficiary category. It will solve specific problems such as:

- Exact information on the extent, configuration and position of different categories of lands, buildings or urban technical facilities;
- Evaluation and recording of the qualitative and economic data about lands and buildings;
- Establishing the juridical situation of the immovable and recording of the correct real estate rights over these properties in official documents;

The purpose of town planning cadastre is to provide exact data on the situation of the urban fond in order to identify the need:

- to provide documentation: real, accurate and complete needed for the systematization in order to obtain an optimum solution;

- to provide exact information on the identity of the beneficiaries who use immobile goods owned by the state and their exact state;
- to provide an exact and real situation of all the private real estates, in what the surface and the configuration of the land parcels are concerned, the size and type of the constructions;
- to determine the location line of the underground networks (water, drainage, electricity, telephony, natural gas) in view of locating new constructions;
- to identity the vacant lands or those partially occupied which can allow the construction of new buildings and an efficient use of the existent urban technical-equipment;
- to provide and consolidate a technical and juridical base of the property rights, able to discard any litigation against real properties, to provide accurate information in order to establish the taxes and to ensure an efficient control over the circulation of immobile goods.

Due to the modernization and of the efficiency of the present day measurement systems the tendency is to use all the data as digital information.

Complex automation is the main quality of a modern cadastre, meaning the introduction of digital data in absolutely all the phases of the cadastre works.

The main technological phases refer to the data collection, data processing and data recording in order to obtain a topographic- cadastral data bank for an administrative territory.

The automate system allows the organization of data on independent files with a detailed description of all the information regarding the digital plan and with the data needed to make up the cadastre registers. All these files are interconnected, with the aim of setting up a cadastral data bank.

This thing requires the introduction of an automation system in all the precursory phases, i.e. data collection and data processing up to data representation and the use of data.

The digital cadastral data are collected and automated on 4 ways:

- GPS data (Global Positioning System);
- Data from the total stations;
- Photogrammetric data;
- Digital data.

All these data, irrespective of the method of acquisition and processing, must be brought to the data bank with the same characteristics, i.e. format and thematic attributes.

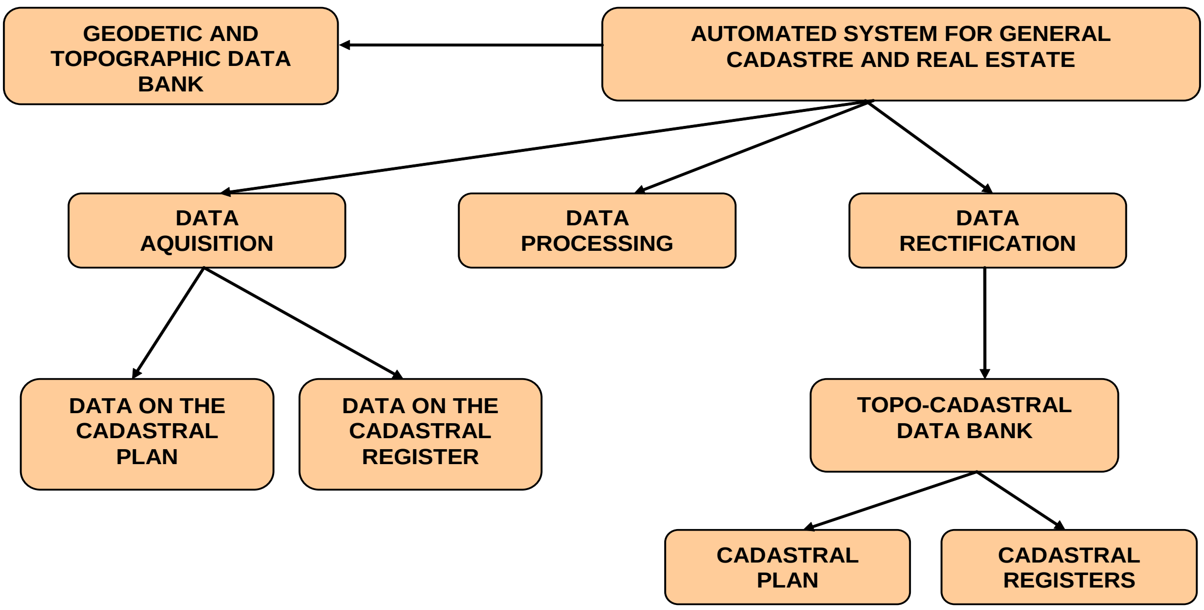


Fig. 2.2 Setting up the automated system for general cadastre and land registration

Any data base has to meet the following functions:
*data definition;
*use of data;
*program management;
*administration;
*use of the data bank.

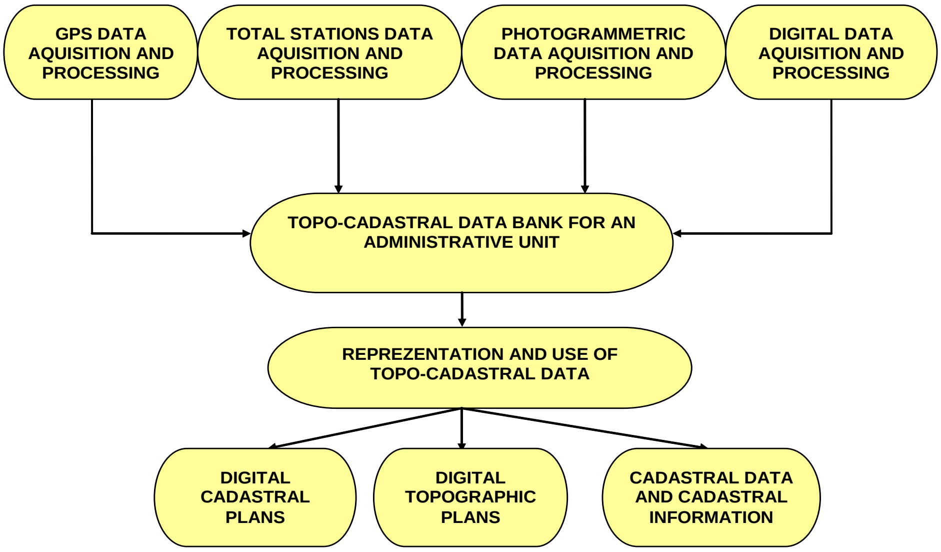


Fig. 2.3 Collection and processing of geodetic data

The objective of the cadastral information system is to provide data on the inventory of the situation of the territory in view of setting up specific activities.
The component parts of the cadastral information system are the following:

1. ***technical part,*** which operates with data obtained by topographic measurements, photogrammetric or other measurements

obtained by the digitalization of the needed plans, for the calculus of the surfaces and for the boundary rectifications.

2. ***economic part*** takes into consideration data regarding the evaluation of real estates and the technical state of the buildings.
3. ***juridical part*** considers the owner and the legal situation of the building.

The quality of the data in an information system depends on a series of factors regarding the system characteristics, training level of the personnel who use it, quality and the way of data acquisition, the data processing, data analysis and the upgrading of the information.

2.5 Implementation stages of the new cadastral system in Romania

Since 2007, Romania has implemented a filing system called E-TERRA real estate. Thus, each administrative territorial unit and all properties subjected to land operations (first entry, split, merge, change of use category) will be entered into the computer system E-TERRA by converting analog data into digital format. Each property is assigned a new cadastral number called parcel identifier which will be enrolled in a New Land Registry. All data relating to real estate (administrative territory, area name owners, acquiring property mode, category of use) are included in the three parts of the book converted land. Land book also includes the buildings and the construction sketch on this, as well as the coordinate inventory points that define property boundaries in the stereographic projection system 1970. Implementation was done in 2 stages, so that at the end of 2012, the E-TERRA became operational and binding in all counties of Romania.

2.5.1 Institutional frame

Making the general cadastre is of interest to all the building owners in a territorial administrative unit. This implies their effective participation to the process, by involving themselves not only in the field activities but also in the stage of the publication of results.

In the process of general cadastre works juridical information will be used, i.e.: the ones which envisage the identification of all the owners, the transcript of the property right in the land registry, as well as the transcript of other real and possession rights. This will be done according to transfer acts, constitutive or declarative rights, as well as on the grounds of possession documents which prove the possession exert rights.

The general cadastre represents:

- Identification, description and recording of constructions in cadastral documents, the measuring and the representation of constructions on cadastre plans and the storage of data on information supports;
- Identification and recording of all owners of buildings and individual units of the condominium in order to record them in the land registry.

The general cadastre ends up by recording all the buildings of an administrative territory in the land registry. Therefore, the citizens have to collaborate with the teams that gather field data by providing information regarding the identification of buildings they own, by showing the limits of the properties and by showing the legal acts that indicate the owner property rights on the respective buildings.

In the stage of the result publication, it is important that all the owners to consult and analyse the published documents and to confirm the accuracy of the data. The authorities, due to their official attributions, are also involved in the process of general cadastre works, as far as the implementation and accomplishment of the process are concerned.

The institutions in charge with organizing and conducting the general cadastre works are the following:

- The National Agency for Cadastre and Land Registration (ANCPI) is the only official authority and is in charge of the organization, coordination, monitoring and control of the activities connected with doing the general cadastre;
- The Office for Cadastre and Land Management (OCPI) organizes, at local level, the activities connected with doing the general cadastre. Thus it observes and accepts the field works; designates representatives to represent it in case of disputes after the publication of technical documents. The territorial offices open the land registry for the particular administrative-territorial unit, and facilitate the communication of the information regarding building registration.

The authorities involved in the general cadastre works are:

- The Prefecture in the area in which administrative-territorial units develop their general cadastre works. As the Government representative, the prefect has to ensure the implementation of all the objectives of national interest as well as of all the provisions of the government program. Consequently, this institution is involved in the organization of the activities developed along the process in the administrative-territorial unit.
- ***The City Hall, in the area in which the buildings of interest are placed and are envisaged for the general cadastre works. The City Hall has to provide all the data regarding the buildings and their owners within its competence area, designates representatives to represent it during field works and at the organization of the publication of results. More than this, it summonses the owners to identify the buildings on the ground.***
- The Police, within the area of the building location, have to reconcile conflicting states, solve social cases, analyze and solve the cases.

2.5.2 Property registration

The recording in the cadastre and in the land registry of the buildings identified is done free of charge by the authorities in charge. During the process of general cadastre works, OCPI provides, free of charge, the possibility to make legal copies of the juridical deeds subject to cadastre registration. The guiding principles are:

- the principle of registering all the buildings of an administrative-territorial unit, with the identification of all the owners.
- the principle of mass registration in compliance with the field reality, in a short time and with low costs.
- the principle of the general cadastre is an official act. This process takes place in compliance with the law provisions and is made by OCPI without the need for a special request.
- the principle of opposability effect of the recordings in the land registry. According to this principle, from the time of starting the land registry it is assumed that the third party is aware of the recordings made in the land registry.

The general objective of the project, at the national level, is to develop the general cadastre works in administrative-territorial units.

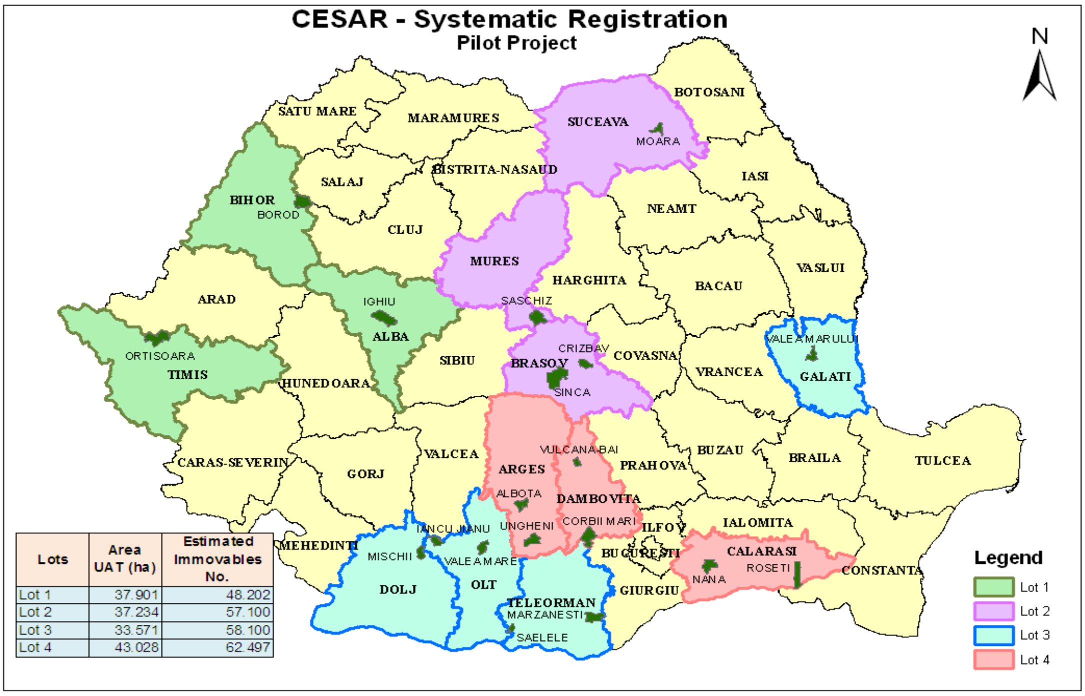
The main objectives envisaged are the following:

- to do all the technical documents for the general cadastre (cadastre register of buildings and owners, alphabetic index of the owners, cadastre plan);
- to start up the land registries after the identification of the building owners and after recording the real correlative real estate rights.

The identification of the buildings and the owners is to be made by processing the data obtained from OCPI, city halls, other institutions and by integrating them with other data obtained as a result of the field works.

The main technical documents of the general cadastre, at the level of the administrative-territorial units (UAT), are the following:

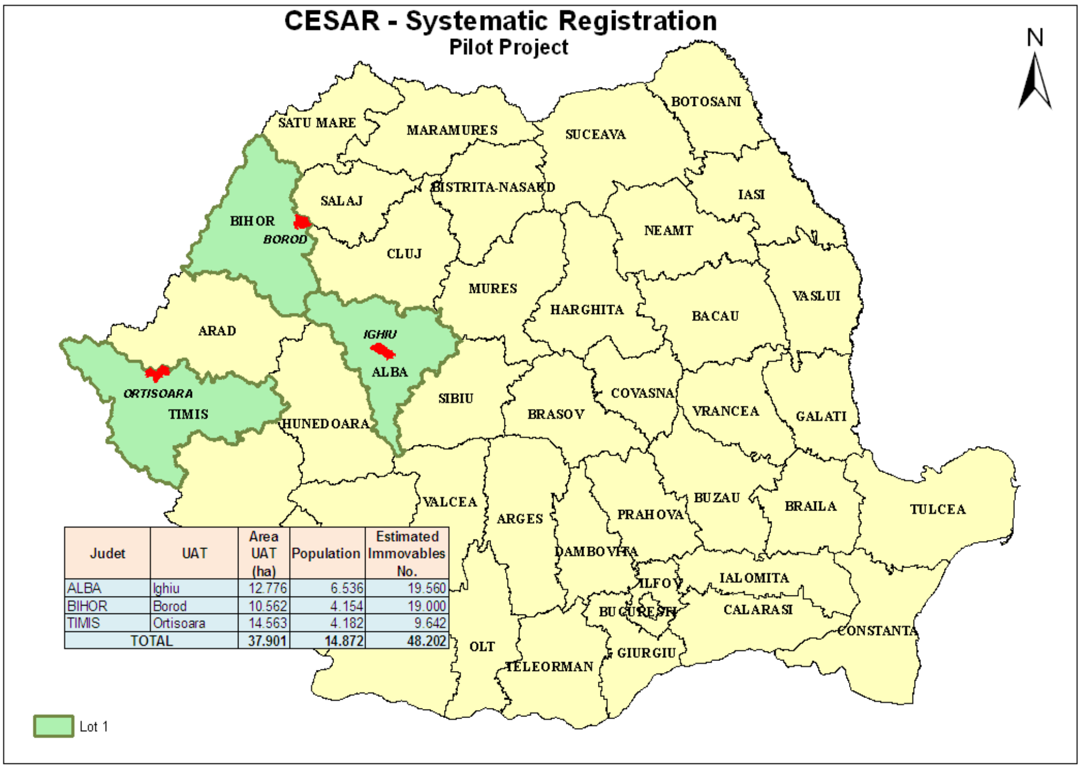
- cadastre register of the buildings and of the owners;
- alphabetic index of the owners;
- cadastral plan.



Lots	Area UAT (ha)	Estimated Immovables No.
Lot 1	37.901	48.202
Lot 2	37.234	57.100
Lot 3	33.571	58.100
Lot 4	43.028	62.497

Fig. 2.4 Implementation stage of the cadastral system for property systematic recording

It can be seen that the Timiş County is included in Group 1, and the administrative-territorial unit for which the general cadastre project started is: the commune Orţişoara. Data and information will be provided to the contractor only for this particular objective, i.e.: only with the purpose to do this particular work.



Judet	UAT	Area UAT (ha)	Population	Estimated Immovables No.
ALBA	Ighiu	12.776	6.536	19.560
BIHOR	Borod	10.562	4.154	19.000
TIMIS	Ortisoara	14.563	4.182	9.642
TOTAL		37.901	14.872	48.202

Fig. 2.5 Pilot Project to be implemented in various counties

2.5.3. The use of CADGEN application to check the cadastral data used by ANCPI

The DESKTOP CADGEN application is part of the information instrument package used to transfer data from the General Cadastre into the integrated system of Cadastre and Land Register **e-Terra.**

The main objectives of the DESKTOP CADGEN application are:

- to make efficient and to automate the process to validation/check files .cgxml, with cadastral data and land registry data, follwing the General Cadastre works;
- to standardize the working documents: standard forms of information sheets with cadastral data (extracted from e-Terra and sent to e-Terra);
- to secure information;
- to follow the events in the system;

”Data validation CAD” is the functionality to check data in the reception stratum by the technical Validator ANCPI.

The User has to authentify himself in the system, to select the function *technical Validator ANCPI* he wants to act/process in application, then select from the available list of action *Validate CAD data* and then press *OK* to start the action.

The GIS medium is uploaded automatically with the following graphic layers:

- Lands (Reception Cad Gen)
- Constructions (Reception Cad Gen)
- Lands (e-Terra)
- Constructions (e-Terra)

- Lands from other lots
- Constructions from other lots
- Administrative Territory - County

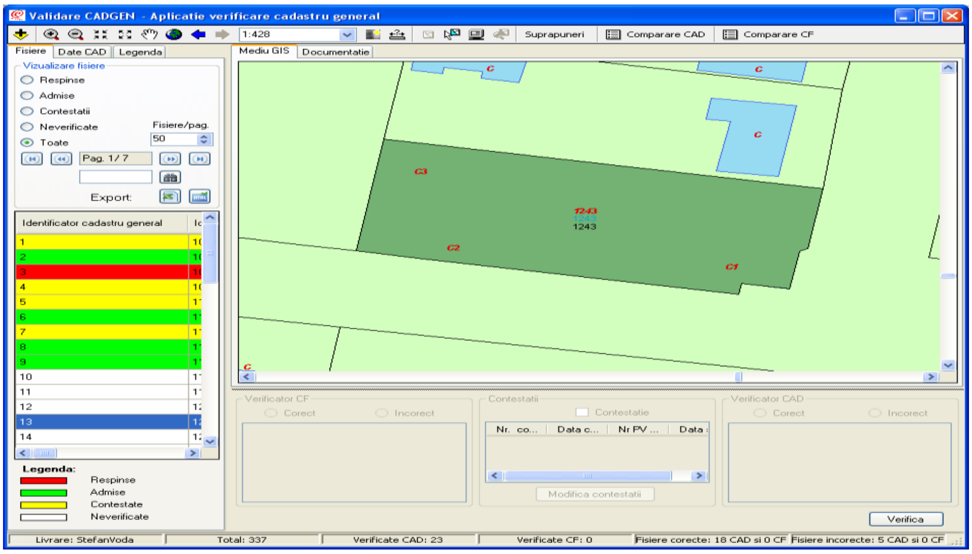


Fig. 2.6 Verification of data specific to general cadastre

The main window to verify cadastral data offers the following functionalities:

- a list with the buildings existent in the reception medium with the following attributes:

1. lot number
2. general cadastre indicator (indication made by the provider)
3. electronic identification (e-Terra sporadic)
4. sporadic cadastral number
5. sporadic topographic number
6. sporadic land registry number
7. number of parcels
8. number of constructions
9. number of parcels
10. number of individual units
11. data of uploading in the reception stratum;
12. technical reception state (Accepted / Rejected / Non-validated);
13. name and surname of the technical receptionist;
14. legal validation state (Accepted / Rejected / Non-validated);
15. reason for rejection:
16. name and surname of the legal receptionist;
17. uploaded in the production stratum.

- a function to filter list (look for building) according to: lot number, general cadastre indicator, sporadic electronic indicator, paper cadastre number, topographic number, land registry number on paper, validated, non-validated;

- a function to filter list according to: files rejected, files accepted, files contested, files non-checked, all files;

- a section in the window to visualize textual information of a certain building hierarchically organized, which observes the relations between the building components of the building assembly;

- specific instruments to GIS medium: zoom, pan, etc.;

Fig .2.7 Specific instruments to GIS medium

- tool for raster uploading: the user selects the raster desired from a list of available rasters in the area;
- command to generate a rapport with topological errors belonging to the building geometries of a lot;
- command to highlight, on the map, a building selected from the list;
- command to eliminate a building from the reception stratum;
- command to eliminate a LOT from the reception stratum;
- command to validate a building from the technical point of view;
- command to validate a building from the legal point of view.

2.5.4 Comparison between General Cadastre data with the production stratum

The user activates command *compare CAD* (command active only when the electronic identifier is filled in).

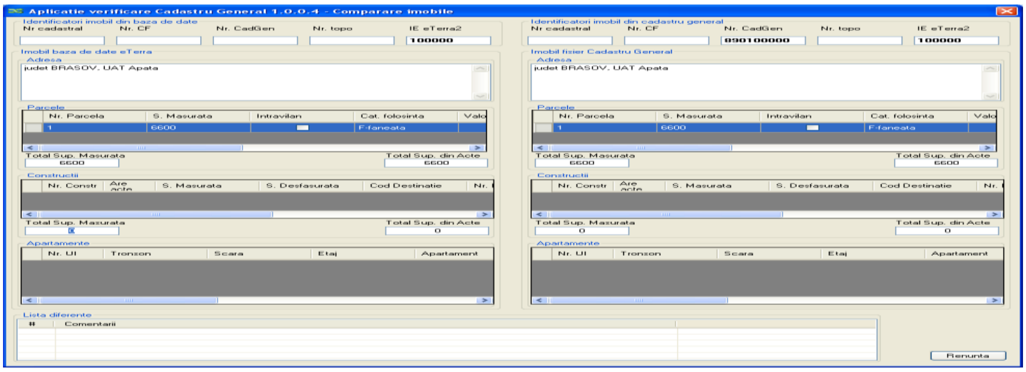


Fig. 2.8 Comparison of buildings for data transfer in e-Terra

The below window is displayed and it contains the following information:

- Comparison of indicators from the data base (production stratum) with the ones from the general cadastre;
- Comparison of addresses;
- Comparison of the number of parcels as well as of their data;
- Comparison of the number of constructions as well as of their data;
- Comparison of number of apartments as well as of their data.

Data reception and migration into the informatic system e-Terra

After the validation of a transfer the production medium can be uploaded. This operation can be done by the administrator only. In the log in window the administrator chooses *migrate transfer to e-Terra.*

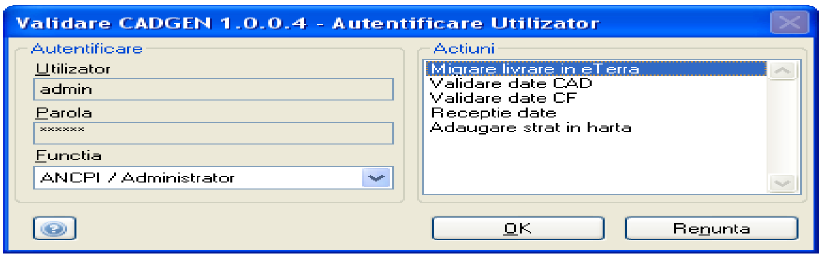


Fig. 2.9 System user authentification

The window displays import data *of the files from the Suppliers of the cgxml General Cadastre Works.*
To continue the action to import data press the button *forward*.

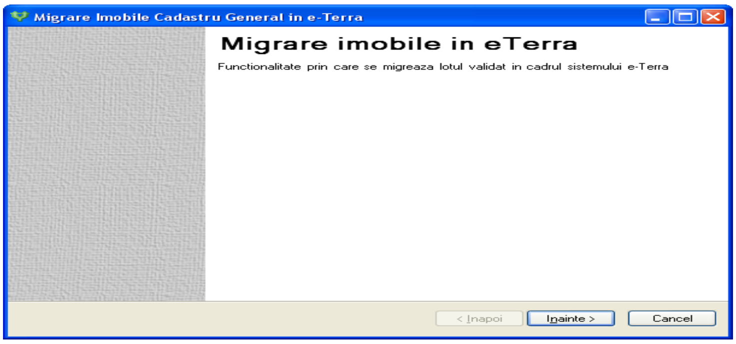


Fig. 2.10 Data import into the information system e-Terra

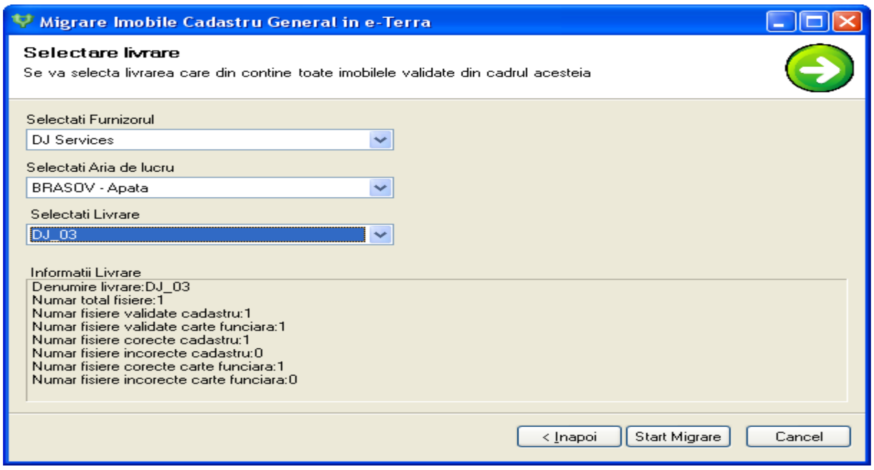


Fig. 2.11 Import data into the informatics system e-Terra

Select the Supplier, from a list of suppliers displayed, for which data is to be uploaded.
Select *work area* for the above Supplier and the transfer, too.
Press buttton *Start Migration*.
At the end of migration a window displays a message to inform the users the transfer was successful.
Making the general cadastre is of interest to all the owners of buildings from an administrative territorial unit. This implies their effective involvement in the process both in the field activities and in the stage in which results are published.
Several general principles can be drawn from the general cadastre activity, which contribute to the successful and systematic recording of the properties.
ANCPI estimates that by the year 2020, the action to record systematically the buildings, totaling a number of 6 million, will be completed in Romania, so that e-Terra can provide, in real time, all the information connected to each building in an administrative territory.

2.6 Real estate cadastre

The real estate cadastre is part of the general cadastre and it deals with the inventory and systematic recording, from a technical and economic point of view, of the buildings and the lands from intra-urban localities.

The real estate works have the following purposes:

1. to set up of data base for the real estate cadastre and the administration of the localities;
2. to collect data and information regarding the updating of the data - technical, economical
and juridical - from the general cadastre, and the introduction of new information on :
   - the delimitation of the territory to be cadastrated and the delimitation of the intra-urban limits of the localities;
   - the updating or the drawing up of the topographic plan or the cadastral one, which represents the basic point of the cadastre works;
   - the identification of the land owners and of the buildings parts;
   - the introduction of all the data contained in the *property sheet*, i.e. information on the functional characteristics of the buildings, the existence of the urban facility equipment, up to the land parcel level, and other requirements made by the beneficiaries, too;
   - data collection and other detailed information, on the constructive characteristics of the buildings, extra elements regarding the geotechnical characteristics of the land.

All these data and the detailed information collected during the real estate cadastre works have a technical character, as well as an economic and juridical one and use as basic elements, the data from the basic cadastre, in what the parcel, the construction and the owner are concerned.

2.6.1 Data and information specific to the real estate cadastre

The real estate cadastre has two phases of execution:

The first one is represented by the basic real estate cadastre, which deals with the technical inventory of the buildings in the localities.
The technical inventory of the land refers to the entire land area, its usage category and destination. Whereas the technical inventory of the buildings refers to the measurement of these buildings, the ground building area, the number of levels, the construction materials and the urban technical installation equipment.

The second phase consists of the current real estate cadastre, which has the same content as the basic cadastre, but its activity begins immediately after the basic real estate cadastre is finished. It is done continuously, in view of recording all the changes that occur on the buildings and lands, with or without buildings. In order to better understand the role and the importance of the real estate cadastre, we have to be aware of the constructive elements that constitute the real estate cadastre and of the way in which they are defined.

Cadastre sector, represents the surface unit defined by stable linear elements (highways, railroads, streets, rivers, canals), where one or several immovable are placed.

Building unit is the component part of a building delimited by the following criteria:

a) constructive architectonic system and determined by facades and construction materials of the external walls.

b) separate entrance in the building;

c) independence from the other adjoined buildings;

The basic document of the real estate cadastre is the *property sheet* which has the following information:

1. Identification of the building;
2. Identification of the owner or the person who uses the building;
3. the built ground surface and the developed ground surface;
4. information on urban equipment;
5. Constructive data on buildings and annexes

A. DATA BASE FOR BUILDINGS gives information on:

1. Destination of the buildings
2. The use of the buildings
3. Number of levels
4. Number of basements
5. Structural strength
6. Type of foundation
7. Type of walls
8. Type of roofs
9. Type of heating
10. Urban equipment of the building
11. State of the construction
12. Year of construction
13. Type of property
14. Type of administration
15. Type of capacity
16. Number of families and number of persons

B. DATA BASE FOR LANDS refers to:

1. Number of quarter (cadastral sector)
2. Number of parcel
3. Number of sub parcels
4. Owner or holder
5. Propriety right or holder's right
6. Use category
7. Urban equipment of the parcel
8. Entire surface of the parcel

According to the lows in force, issued by the Agency for Cadastre and Land Registration, all these elements that make up the data bases and which represent the support for the property *sheet* are identified by codes, for an easy completion of the sheet.

Next, it will be explained the elements which constitute the data bases for the buildings and lands:

1. *Destination* is mentioned only if the initial destination is different from the present day one and if this can be known

2. *Use,* present day main use, is established approximately, due to its percent out of the developed ground surface of the building

3. *Number of levels* is established for buildings with one or several levels and the information is written with figures, as an exponent of the mapping index.

4. *Number of basements,* is mentioned only if they do not have a technical destination and if they are inhabited. They are indicated by "**s**", marked as the index of the mapping index.

5. *Structural strength* , is indicated by mapping indices, like this:

A – for buildings made of resistant masonry, reinforced concrete or steel structure and reinforced concrete boards;

B - for buildings of bearing masonry without structural strength and boards made of reinforced concrete or wood;

C – for buildings made of wood, with foundations made of concrete or stone;

D - for buildings made of framework, earth material or adobe;

6. *Type of foundation,* is recorded in all the cases, function to the main material used at the construction, as follows:

B – concrete; **P** - pillars; **R** -raft; **L** – wood

7. *Type of walls,* is mentioned considering the construction material:

CP - reinforced concrete frames
D - mixed diaphragm
Z - masonry
L -wood
PM - large reinforced concrete boards
P - framework and adobe
A - others

8. *Type of roof* or covering; it may be made of:

AZ - asbo-cement
B - bitumen
OL - pantile
Ş - shingle
T - tile,
TB - metal sheet ; A - others

9. *Type of heating,* is recorded for each part of the building, function to the type of fuel used or the source used: wood, gas, crude oil, central heating, electricity.
10. *Urban equipment* is recorded for each part of the building and parcel, as follows: water, drainage, electricity, natural gas, central heating, and telephony.
11. *The construction state* is established ratio to the age of the building, technical equipment, level of comfort, improvement state and external and interior finishing. Considering these characteristics, the buildings are grouped as follows:

Very good buildings - F, are extremely well executed, made of durable materials, reinforced concrete or bricks, with reinforced concrete boards and have complete finishing, are well maintained, and are provided with fully urban equipment

Good buildings B, are made of durable materials, with reinforced concrete boards or wooden boards, with carefully made finishing and urban facilities;

Satisfactory buildings S, are the buildings made of durable materials, where it can be seen a commencement of the destruction of the structural strength and of the finishing and which have incomplete installations;

Weak buildings R, are those made of durable or non durable materials, with significant deteriorations at the structures and at the finishing, have fissures in the walls and in the foundations, as well as cracked boards or curved boards.;

Insalubrious buildings I, are the buildings which are not fit for use, as a consequence of degradations and they are a real risk for the health and life for the inhabitants;

Ruins X, are the buildings which are wrecked or have parts which cannot be used for living purposes.

12. *The year of construction* is established according to the property deed, construction authorization, property tax from the Financial Administration, declaration of the owner, or verbal testimonies of the neighbours. The year of the construction is established starting with the date when the building has the foundation, the walls and the roof made.
13. *Type of property* is established ratio to the right owner of the real estate, based on the documents that this person has for each part of the building. The data about the owners refer to:

- The category of the real estate;
- Type of possession;
- Name and surname of the owner;
- Address;
- Personal identity code taken from the identity card;
- Individual quota.

2.7 Geospatial technology for 3D city and Urban Modelling

Geospatial Technology, known as ***Geomatics***, refers to technology used for visualization, measurement, and analysis of features or phenomena that occur on the Earth.
Geospatial technology includes three different technologies that are all related to mapping features on the surface of the Earth. These are: **GPS** (**G**lobal **P**ositioning **S**ystems), **GIS** (**G**eographical **I**nformation **S**ystems), and **RS** (**R**emote **S**ensing). The consequence of the sustainable development implementation is a necessity of spatial system designing. Geographic Information System (GIS) can be such a tool. It gives quick access of updating and analyzing spatial database. Nowadays, there is an increasing interest in 3D technology which can be seen also by major cities developing three dimensional models, and global technology companies developing solutions to capture, display and manipulate this type of data.
It is well known that, a significant factor of economic stabilization and development is the implementation of modern, efficient tools based on better Information Systems needed both for everyday land administration operations and for large-scale reforms related to land.
GIS as modern technology of analysis and graphical-textual database processing method is a very important element in urban modelling and also in environment resources management. This is a basic purpose in case of multifunctional spatial system.
The problem of urban modelling represents a very important activity regarding interdisciplinary interest for technical, economical and social development improvement.
It can provide accurate and efficient solutions in order to cover basic needs of land administrative information and decision making for the Local Authorities.
The process of urbanization and metropolitan growth in the 20th century was a consequence of rapid technological evolution, rising living standards, as well as general well being. Compact city policies has resulted in an increasing demand for land within city.
The increased availability of high-resolution satellite images and aerial photography in support of detailed terrain surface elevation models assists urban planners and municipal managers to create a model and visualize the urban space in three dimensions.
3D visualization have a variety of applications in geography and urban studies. Accurate cartographic feature extraction, map updating, digital city models and 3D city models in urban areas which are essential for many applications, such as mapping of buildings and their heights, simulation of new buildings, military operations, disaster management, updating and keeping cadastral databases current, and virtual reality. While they are generally used to simply visualize the built environment, there are early signs of them being used as 3D interfaces to more sophisticated simulation models.
In most cases the models of buildings, urban features, terrain surface, and vegetation are the primary data of interest. This data, when combined with satellite and aerial imagery can be used to create highly detailed Digital Surface Models (DSMs) and eventually Digital City Models.
A pressing problem facing many urban simulations is their general inability to engage the vast majority of their users and the people whose lives they influence in a meaningful and intuitive fashion.
3D models can be used as a user-friendly interface for querying the urban environment as a Geographical Information System(GIS) for Web-based information, for visualizing model results, and for accessing functional simulation models.
A general classification of 3D city models, based on their operational purposes, might be organized around four main types:

- **3D CAD (computer aided design) models of cities**

3D CAD models of cities are by far the most common example of 3D urban model, with several applications applied to many cities around the world.

Generally, these models depict cities or scenes from the built environment in three dimensions with varying degrees of attention to detail and artistic rendering. The models can be developed using standard CAD software packages such as 3D Studio Max, or programming languages such as C++ and VRML (virtual reality modelling language). *3D CAD* models are often delivered as animations, static screenshots, and navigable VRML environments. Models may be navigated by the user or may be static. The applications to which these models are used are diverse, ranging from advertising and promotion to design review and public outreach.

Fig. 2.12 *3D CAD* models of cities

- **Static 3D GIS (geographic information systems) models of cities**

3D GIS models are identical, in many cases, to the CAD models. In many cases they are generated using the same software and delivered via the same media. The difference is in functionality.

While the CAD model offered no functionality to the user, the incorporation of a geographic information system (GIS) underpinning a CAD display model enables users to perform spatial queries of the buildings and built space depicted in the model environment. A GIS, essentially, acts as a spatial database with a graphical interface for performing queries, operations, and manipulations on data in a spatial plane. *3D GIS* models introduce that functionality (if available data permits) to the CAD model. Users can query the built environment and have the results displayed visually and interactively in three dimensions on the screen. For example, a user might wish to find out where available office space fitting several price, situation, and structural characteristics lies within a downtown district of a major city.

The models depicted in the pictures below all illustrate the visualization of queries on underlying spatial databases. The large majority of these models are static, so that; users cannot navigate and query the modelled environment in real-time.

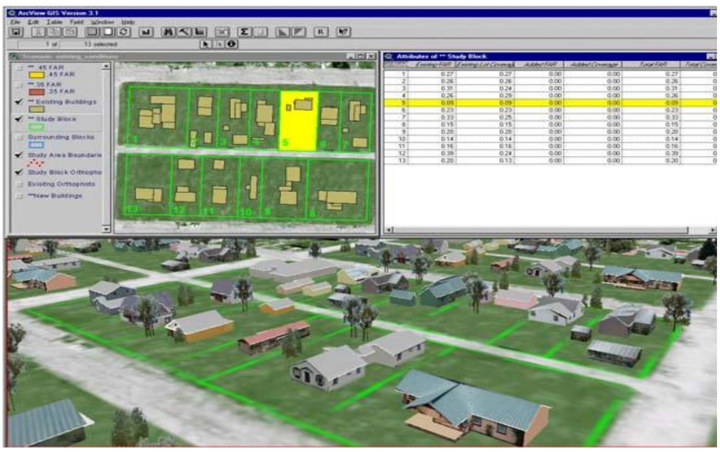


Fig. 2.13 Static *3D* GIS models of cities

➢ **<u>Navigable 3D GIS models of cities</u>**

3D city models are increasingly considered as important resources for municipal planning and decision-making. An important aspect of cities is the navigable space within them. There is a need for *3D* city models to incorporate topologically connected navigable spaces, in which space internal to buildings is topologically connected to space outside buildings and in which the terrain is part of this navigable space rather than a simple surface upon which buildings are placed. Navigable space in cities can be considered to be a set of topologically-connected discrete spaces, juxtaposed in three-dimensional space. Access to these spaces is governed mostly by the geometry of these spaces.

Such navigable details of space in cities are difficult to obtain, but some of the general-purpose semantically-rich 3D city models may provide opportunities for obtaining this information.

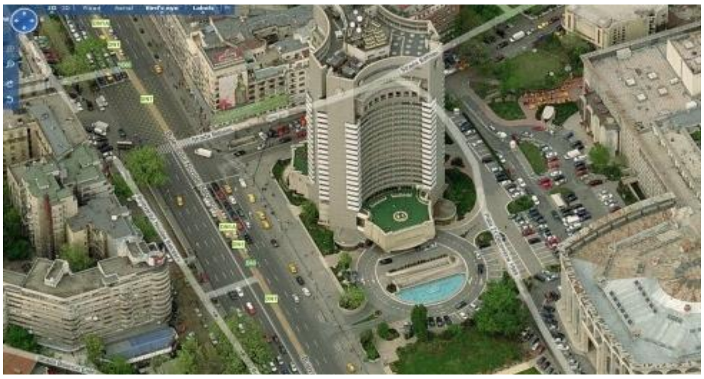


Fig. 2.14 Navigable *3D GIS* models, Bucharest-Romania

➢ **<u>3D urban simulation model</u>**

In recent years, significant advances have been made in the development of intelligent 3D models of the built environment. Our days technology enables us to render visually stunning and richly detailed simulations of urban environments in a manner that renders an ease of interaction and understanding that is not currently present in many simulation models.

Geospatial technology includes different technologies that are related to mapping features on the surface of the Earth, such as: **GNSS** (**G**lobal **N**avigation **S**atellite **S**ystems), **GIS** (**G**eographic **I**nformation **S**ystems), **RS** (**R**emote **S**ensing).

❖ **Satellite Positioning Systems**

Lately, positional science has been adding space-based telemetry techniques to obtain ground coordinates. These new passive and active space-based measurement systems are changing the very nature of positional science to one that can give precise coordinates very quickly for any ground position. Satellite positioning systems have one thing in common – receiver hardware has to be taken to every field location to be mapped. Currently operational satellite positioning systems available for land management coordinate determination activities (GPS, GLONASS, GALILEO) are designed to provide worldwide, all weather, 24 hours/day instantaneous geographic positioning and time information.

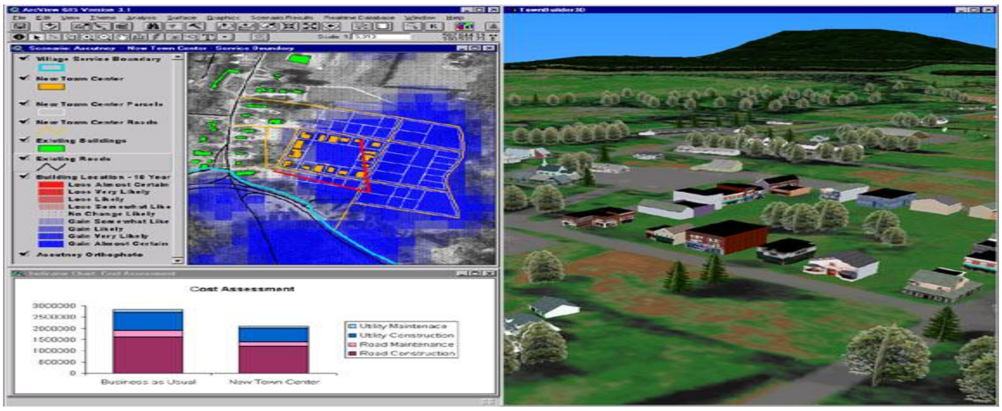


Fig.15 Simulation model

Global Positioning System (GPS) is a fully functional Global Navigation Satellite System (GNSS). Using a constellation of at least 32 Medium Earth Orbit satellites that transmit precise microwave signals, the system enables a GPS receiver to determine its location, speed, direction, and time. The technology collects and processes signals from GPS satellites in orbit around the earth to determine the location of points of interest on the ground.
The accuracy of a calculation can be improved through precise monitoring and measuring of the existing GPS signals in additional or alternate ways.
The typical nominal accuracy for dual-frequency systems is 1 centimeter ± 2 parts-per-million (ppm) horizontally and 2 centimeters ± 2 ppm vertically.

❖ **Geographic Information System -GIS**

Geographic Information System, or GIS is technology that offers a radically different way in which we produce and use the maps required to manage our communities and industries. GIS is a computer system capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location. Specialists also define a GIS as including the procedures, operating personnel, and spatial data that go into the system. A Geographic information system technology can be used for scientific investigations, natural resource management and mining, government, environmental impact, urban planning, law enforcement, route planning, and natural hazards.

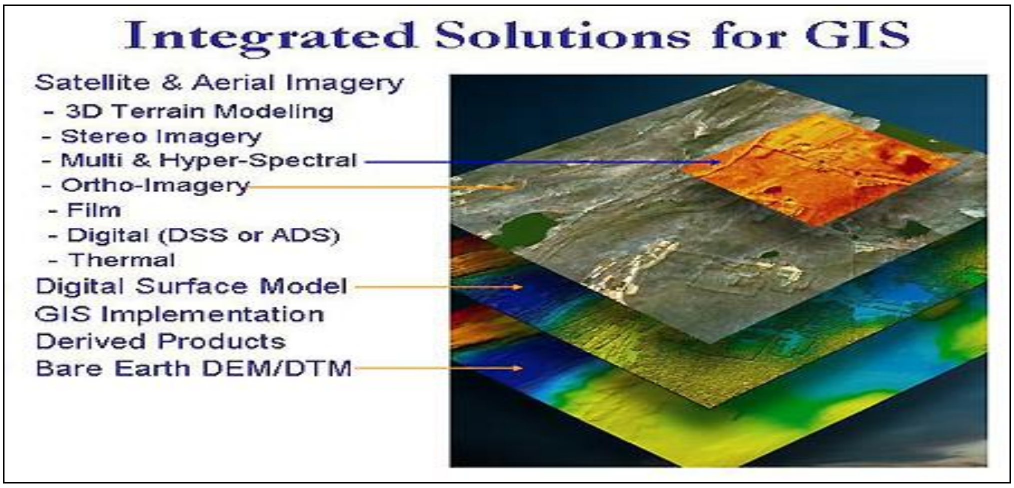


Fig. 2.16 *GIS* architecture

❖ **Remote Sensing**

Satellite Imaging Technology (Remote Sensing) has led the way to the development of hyperspectral and multispectral sensors around the world, a tool that can be used to map specific materials by detecting specific chemical and material bonds from satellite and airborne sensors. Multispectral data acquired in space and by airborne sensors have been utilized extensively for the past many years in research projects dealing with such diverse problems as land cover and topographic mapping, physical and biological oceanography, and archaeology.

Research has expanded to include analysis of hyperspectral data acquired simultaneously in tens to hundreds of narrow channels. New algorithms have been developed both to exploit the spectral information of these sensors and to better deal with the computational demands of these enormous data sets. It is an excellent tool for environmental assesments, mineral mapping and land cover mapping, wildlife habitat monitoring and general land management studies.

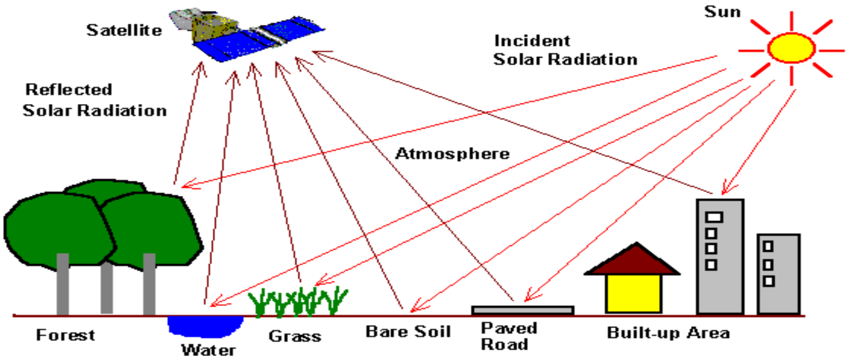


Fig. 2.17 Principles of remote sensing

At present, considerable development of GIS-technologies and GIS-complexes are carried out in Romania and there is a good basis to create own standards for the Geographic Information System, especially for governmental and regional authorities.

Conclusions

Much of the information the decision-makers have to take into account has a dynamic quality; the information changes continuously in time and space.

In such a situation, the challenge is to maintain community services at a high level and stimulate change and development in spite of the difficulties. To be able to handle these challenges and problems in an efficient way, there is a need for improved planning and decision support systems. At urban and out-of-urban high stocked areas the multifunctional exploitation rule of resources can concern nature resources (water, soil, etc.) and human resources (technical infrastructure, housing etc.). **The sustainable development of specified spatial systems stands for economic-social and ecological equable development.** It results in a creation of more and more complicated and effective systems, such as multifunctional systems, which have a high economic, social and ecological effectiveness.

The consequence of the sustainable development implementation is a necessity of spatial system designing. Geographical Information System (GIS) can be such a tool. It gives quick access of updating and analyzing of spatial database. A GIS is capable of integrating large amounts of geographic data from different sources and is able to respond to non-routine questions. As a result, it can be a most powerful instrument in the development of Environmental Information Management System (fig.2.18).

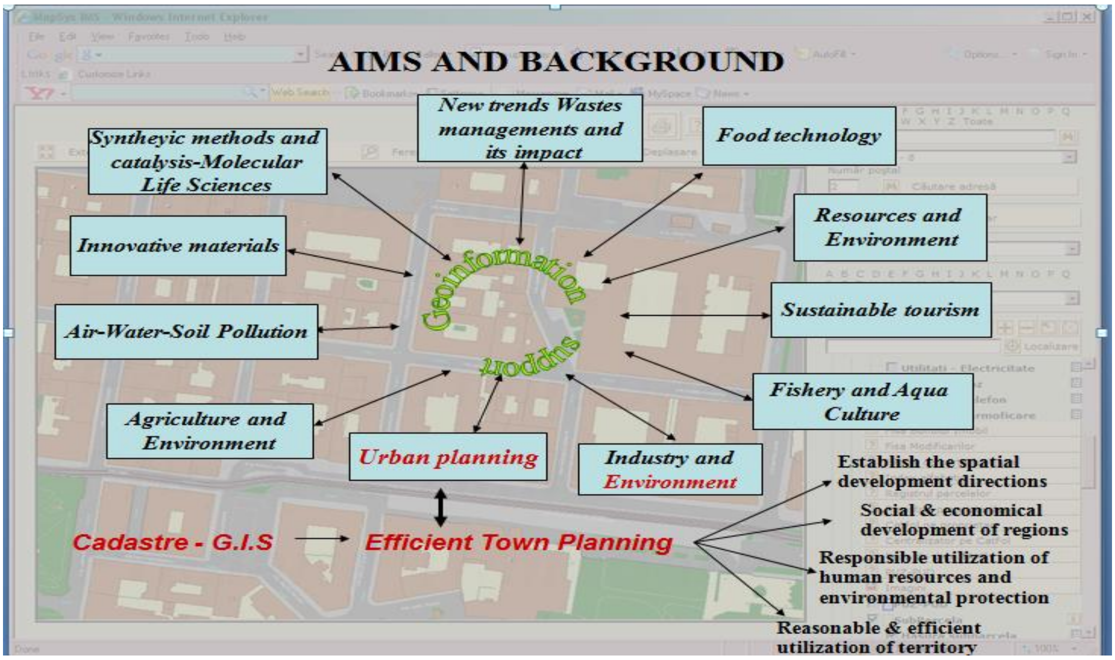


Fig. 2.18 Geo- information support - aims and background

Designing a dynamic framework for planning and development, based on spatial information like Geographic Information System (GIS), can be created the master plan of any populated area. The Master Plan is part of a larger process implying the use of Geographic Information Systems in order to develop an urban quarter. In this sense, the Master Plan is much more than a document for spatial development orientation; it is, above all, ***a strategic vision of the city*** based on directive principles that make a coherent combination of respect for natural balances, economic efficiency, market forces and social equity.

2.8 Study case 1: ”*GIS URBAN*” *Timisoara*

According to all these presented trends, Timisoara represents an example in the process of automation of land registration for urban cadastre; Geomatics is regarded as a useful support for developing efficient urban planning, thus being able to provide accurate and efficient solutions for local authorities**,** in order to meet the needs of administrative information and decision making.

Starting with 1997 the first information system started to be implemented at the level of Timisoara municipality, called **”*GIS URBAN*”.**

The main reason for this project was to ensure the harmonious development of city with control over its expansion.

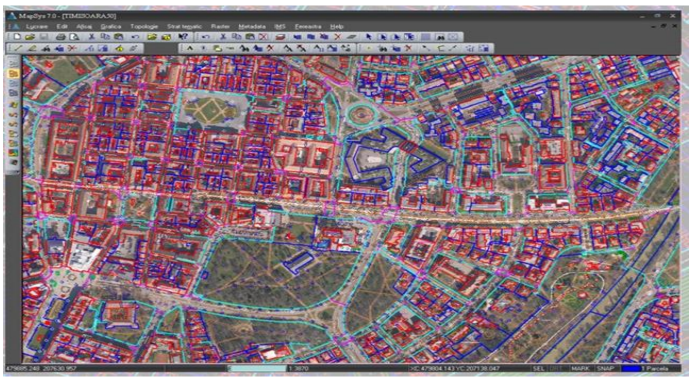


Fig. 2.19 Timişoara GIS Urban– extract

The Town Hall of Timisoara is the first institution from Romania starting the GIS for urban purposes, at present, being one of the most advanced city in this domain.
Here is such an example, for the updating the database for urban cadastre in Timisoara. The field campaign lasts from summer 2007, and the results completed the information from the Urbanism Department of the Local Administration Agency.

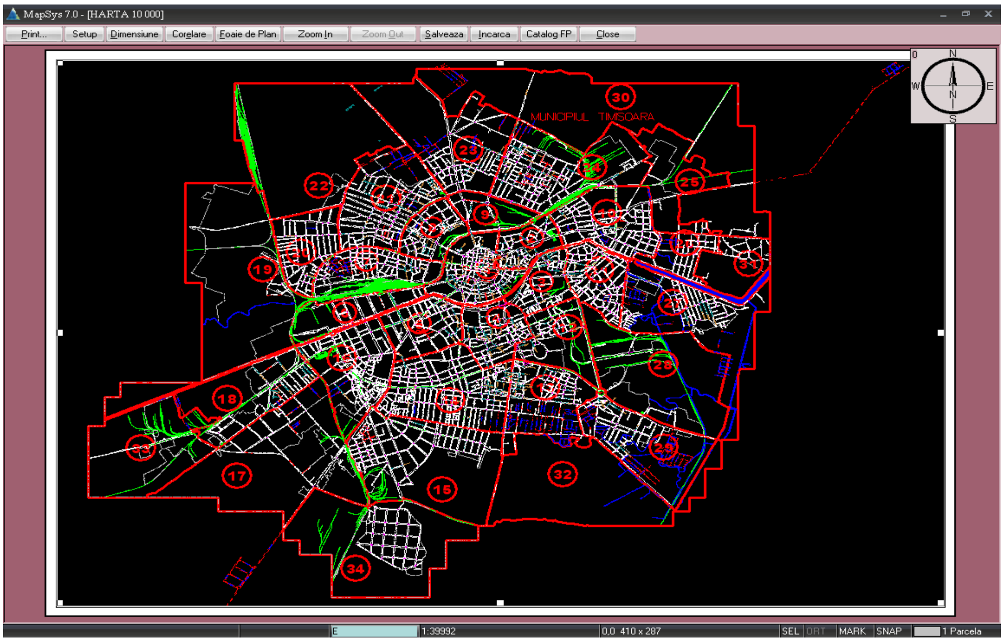


Fig.2.20 Cadastral sectors in Timişoara

The complexity and the amount of estimated work established useful and effective connections between: State Agencies, Departments of the Local Administration, Private Companies and also Academic Environment - in order to be able to ensure a real and deep understanding of the situation.
After the data acquisition, in the first stage, there was performed a number of 13.500 coins of immoveable property, with processing by: archiving, updating, localization, editing, printing reports or generating files of different types.
The result should assure the complete loading in the database already created for a computer system to analyze urban development efficiency of the Timisoara municipality.

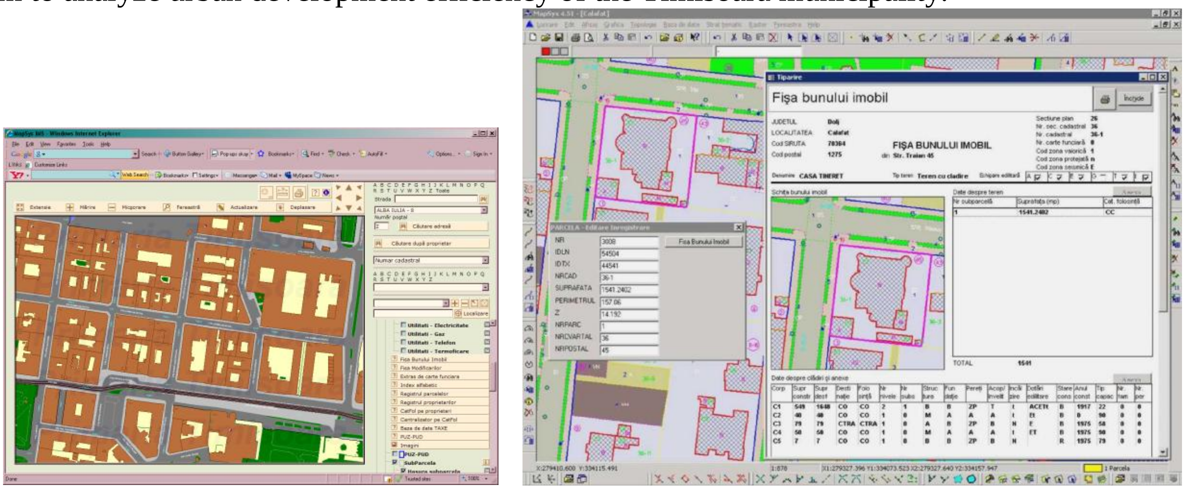
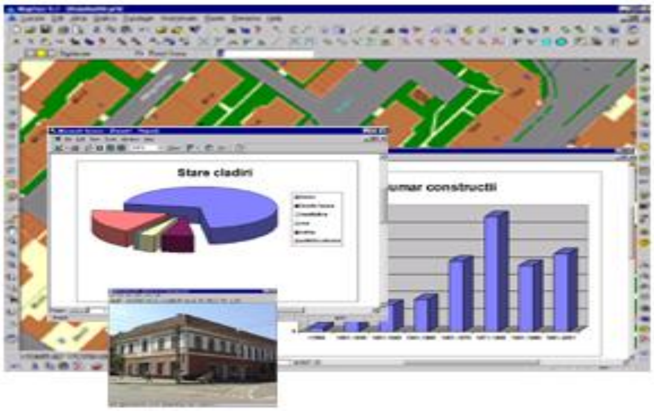


Fig. 2.21 Immovable information for urban Cadastre in Timişoara



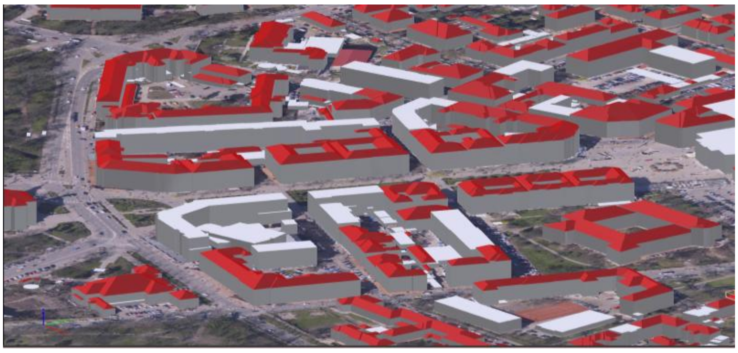


Fig.2.22 *3D* model for buildings on ortophotos

Main objects defined in Urban Information System of Timişoara are: parcel, sub parcel, building, property, duties, person, and property rights.
Updating the Information System and its applications continue permanently improving solutions in:

1. *Property information :* where, all communities have access to the national property system, or systems that permit property planning and administration, also illustration of community properties;
2. *Demography:* within this area are lots of databases for the total population, old care, social care, school children etc. ;
3. *Public Utilities Planning and Management:* GIS systems for this area were among the first to be developed, and area is also well supported with such systems In Timişoara, most of the inquired communities use GIS systems for this purpose ;
4. *Transportation Planning:* concerning transportation planning, there are some national projects, but in local communities there are hardly any GIS systems in use, although there are many traditional data base systems such as traffic flows, traffic capacity, traffic accidents etc. ;
5. *Natural Resource Management:* for ages, paper bound thematic maps have been used to point out the occurrence of natural resources. Such maps have naturally been easy to translate into digital maps and thereby easy to implement in GIS systems. This kind of systems are frequently used in the communities;
6. *Environmental Protection:* the number of GIS systems is rapidly growing, due to the increased need of control and the environmental consciousness among the population ;
7. *Urban and Regional Planning:* most of communities use GIS systems for urban planning. This is natural as the information content in the map is the basis for urban planning.

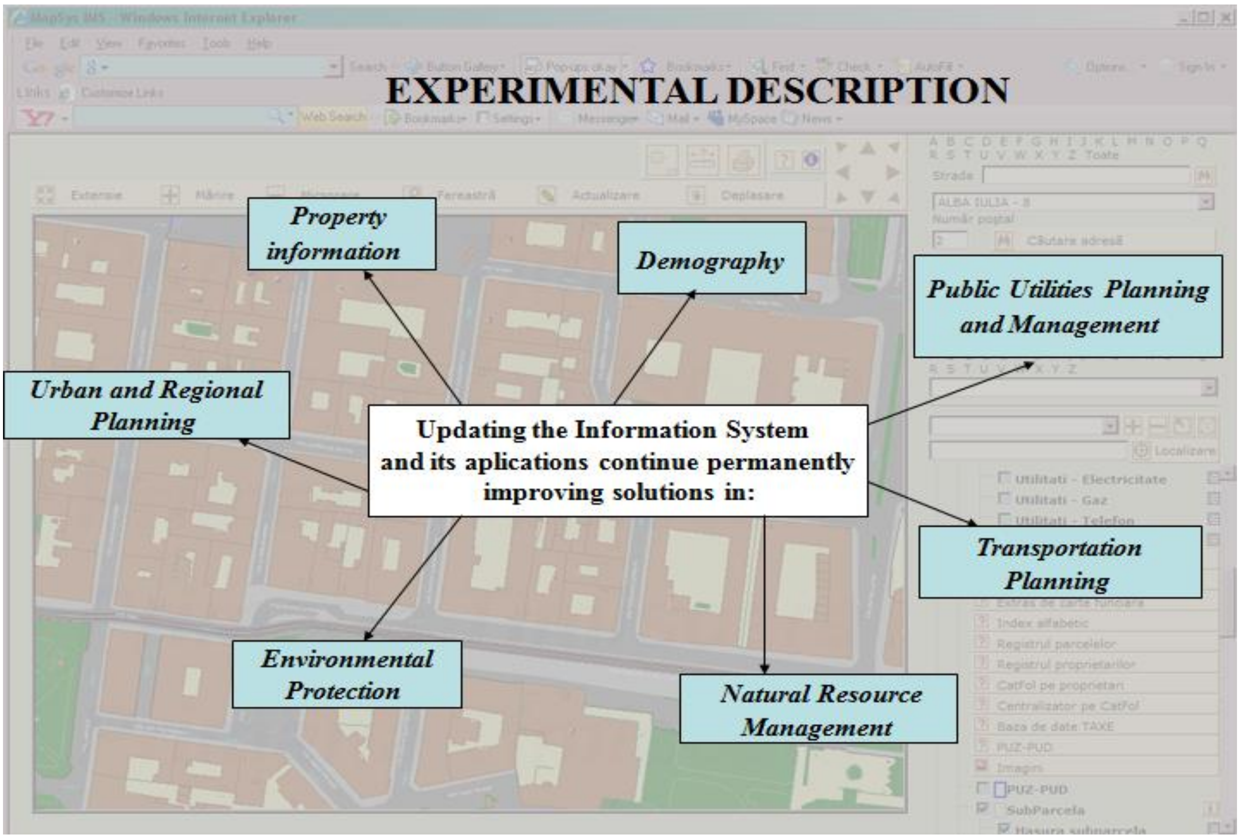


Fig.2.23 Updating the Information System

Transformation of the present informational system into database system supposes the organization of all information into separate files, which are closely, related one to another.
The primary data processing for computation of the land surfaces for a property is quite simple at this first level but it becomes very difficult due to the huge number of parcels and owners and also to the existence of a great amount of corrections in the adjustment of the territory.
Designing a dynamic framework for planning and development, based on spatial information like Geographic Information System (GIS), can be created the master plan of any populated area.
The Master Plan is part of a larger process implying the use of Geographic Information Systems in order to develop an urban quarter. In this sense, the Master Plan is much more than a document for spatial development orientation; it is, above all, a strategic vision of the city based on directive principles that make a coherent combination of respect for natural balances, economic efficiency, market forces and social equity.
In recent years, Timisoara has enjoyed a significant economic boom as the number of foreign investments has risen constantly.
The idea of generating a unitary information system managed by the Municipality started in 1996 being updated and completed permanently.
In this context the project covers a total area of 129,2 km^2;

- 34 Cadastral Sectors;
- 900 blocks;
- 27.000 property sheets

The process of completing and updating the database is a continuous one, at present in Timişoara there are performed projects regarding the town cadastre, transportation, green and cemeteries cadastre.

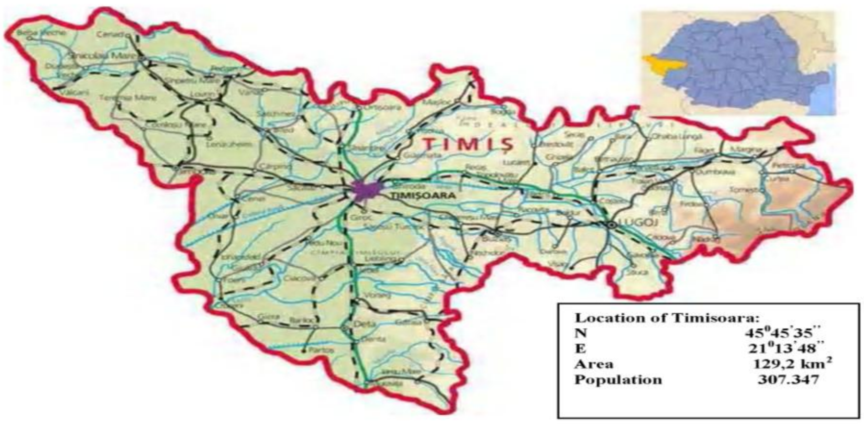


Fig. 2.24 Timişoara – positioning and statistics

Depending on the extension of municipality and the development tendencies, the Town Hall of Timisoara is currently working on a third edition of the General Town-Planning Scheme.
Its main goal is to ensure the harmonious development of the town with controlled growth.
Timisoara metropolitan area includes the settlements situated at 30 km distance from it. The development decisions for this area are taken by the Metropolitan Consultative Council.

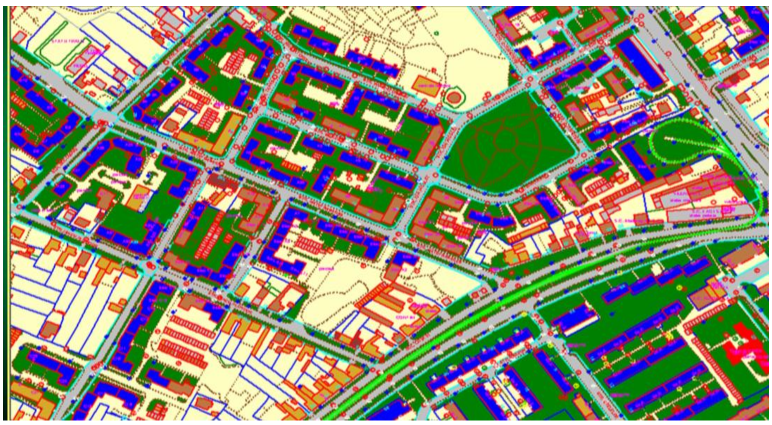


Fig. 2.25 Timişoara urban GIS – extract

Specific strategies in Timisoara Urban Agglomeration: infrastructure, housing, retail /commercial, industry and services, parks and environment protection, social balance, history, academic, sport and leisure GIS.
This concept implies the elaboration of an information system integrated at the level of all Town Halls-as components of the Metropolitan area.

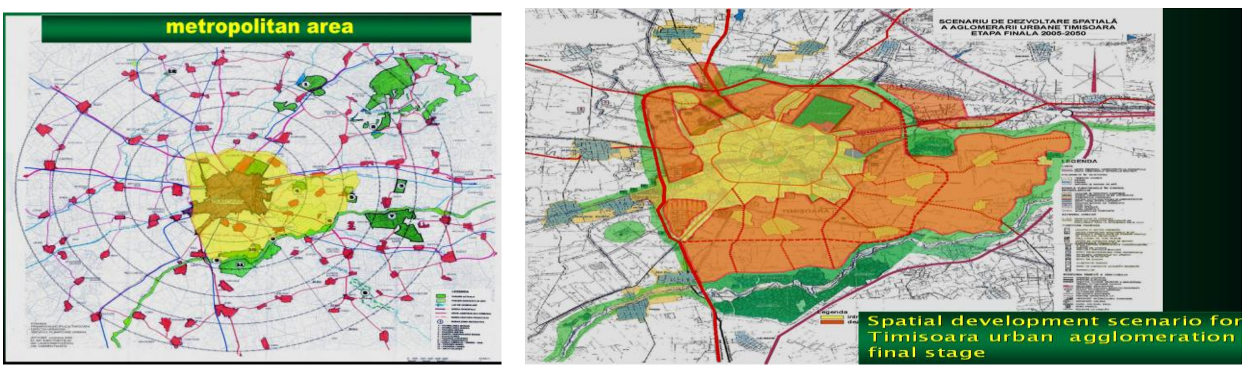


Fig. 2.26 Spatial development for Timişoara urban agglomeration - proposal

The updating of the database for Urban Planning and for the digital plan, implies also the acquisition and registration of all information.
In this case the database consists of two logical components:

- DB_MAP (*Data Base-Map*) contains information from the maps and the primary attributes associated
- DB_ REGISTER (*Data Base - Register*) contains data from the existing registers
  As reference for data acquisition from the field are used graphical products obtained from:

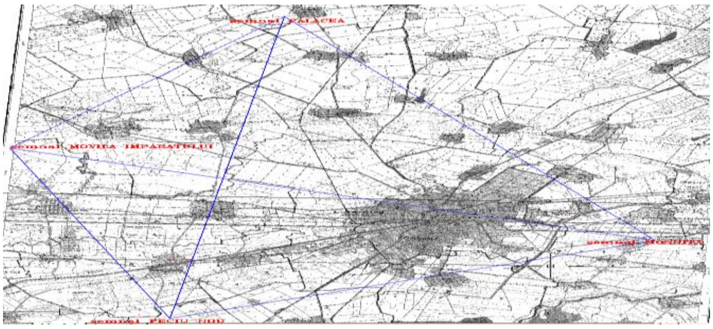


Fig.2.27 Acurate satellite measurements using the national geodetic network of Romania

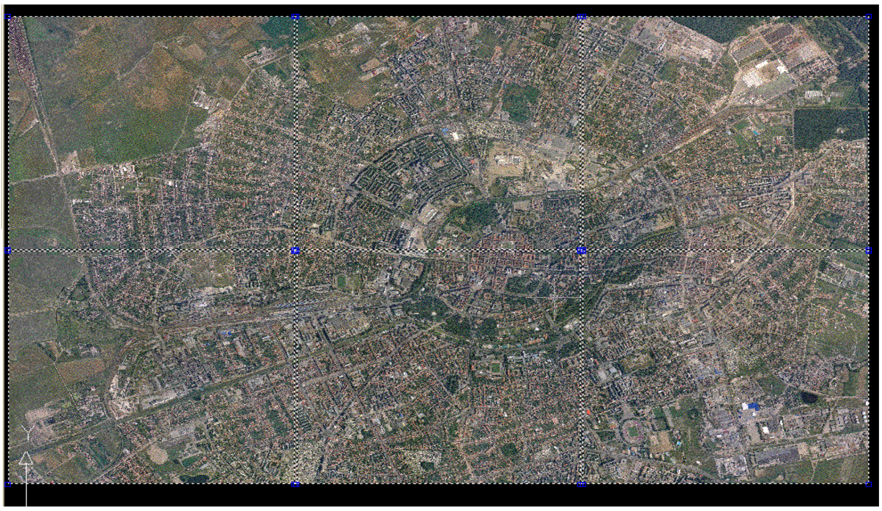


Fig.2.28 Photogrammetric methods (2008 surveying flight)

After the file is uploaded in the information System (MapSys application), the parcels are divided on plan sheets. The plan sheets will have an A1 format and scales from 1:100 up to 1:200, and - as background - the coloured ortophotos obtained in 2008.
On the plan sheet the position of any entity is identified and marked, and then it is given an identification number: it consists of the number of the grave and the number of the row where it is located. When the data collection operation is completed it will continue the next stage: insert the data into the computer. The graphic data, marked on the plan sheets are inserted in MapSys application.
The MapSys - GIS offers specialized functionality for each stage of processing including the digital map creation, plotting plans, generating geo-database.
This can be used in MapSys or in other GIS programs or database application.
After the completion of all the graphic and alphanumeric data, these are integrated in the data banks DB_MAP and DB_REGISTRE, which can be interrogated later with application IMS (Internet Map Server). By using MapSys Internet Map Server, the value of the geo-data can be multiplied by providing it globally to those who need them, when they need them, as soon as the administrator of the data and the potential users are connected to the Internet.

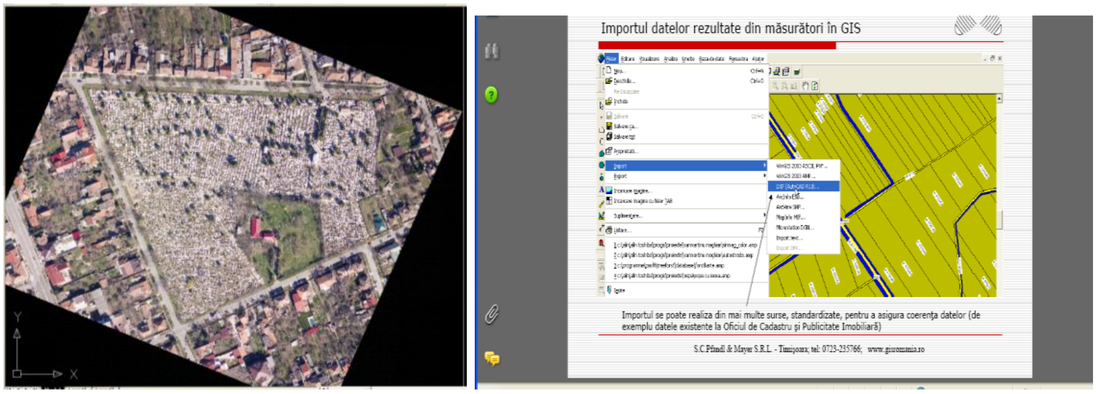


Fig. 2.29 Example of plan sheet for a particular case

For local network-based Intranet networks the same configuration and browser settings apply as for the Internet.

The consequence of the sustainable development implementation is a necessity of spatial system designing too; Geographic Information System (GIS) can be such a tool. It gives quick access of updating and analyzing of spatial database. A GIS is capable of integrating large amounts of geographic data from different sources and is able to respond to non-routine questions. As a result, it can be a most powerful instrument in development of any Information Management System.

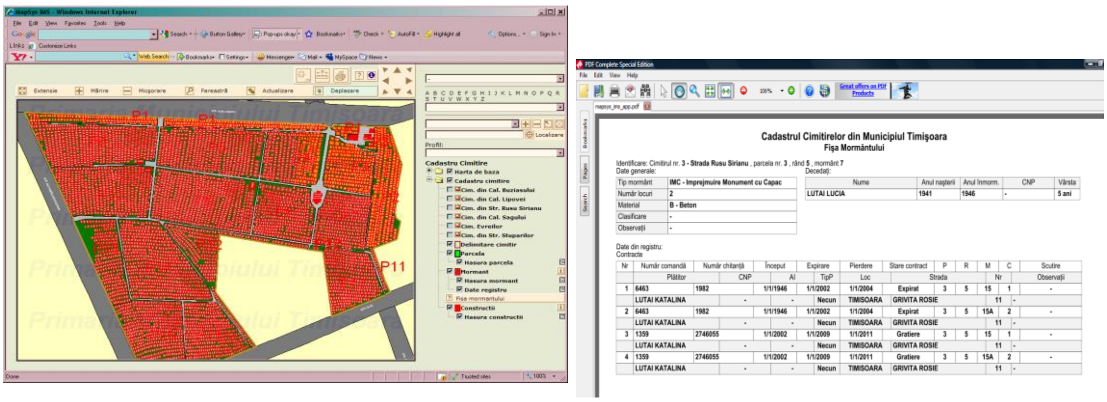


Fig. 2.30 Interface user software – MAPSYS IMS

Fig. 2.31 Digital map of Timişoara

At present, considerable development of GIS-technologies and GIS-complexes are carried out in Romania and there is a good basis to create own standards for the Geographic Information System, especially for governmental and regional authorities.
GIS can be regarded by two separated blocks, such as cadastral and analytical.
The first block assures the function of inventory, database designing and maintenance, including information on natural and technical resources of a region. The analytical aspect provides tools for management and decision making.
Such GIS-technology provides:

- ▶inspection and detailed investigations of subject areas for information database
- ▶adoption of a suitable GIS-environment
- ▶development of standard user interface
- ▶database design for each information and thematic block with a simultaneous adaptation of standard user interface according to the defined subject
- ▶development of information database structure with a separate information and thematic block extraction
- ▶input data acquisition and spatial database generation
- ▶use of information database simultaneous with creation of standard query and thematic map libraries.

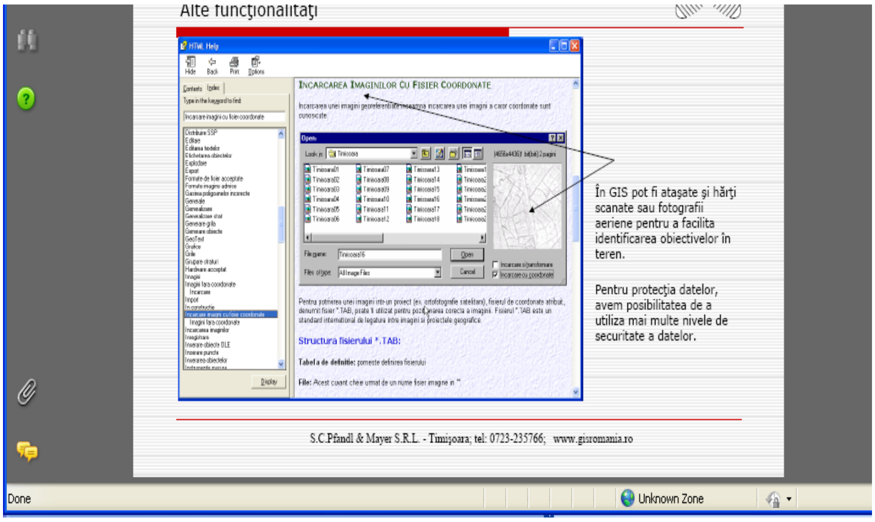


Fig. 2.32 Other facilities

Conclusions

The large use of the automatically tools of measurement and processing, the elaboration of digital plans and maps lead to a modern cadastre which can face the present request from this field of activity.
The applicability of the informational systems will last a long period of time, while both categories of classic and digital cadastral materials will operate.
During all this period, the technical equipment for data collection, processing, storage and overview will continue developing, in order to accelerate the complex project of informational systems achievement.

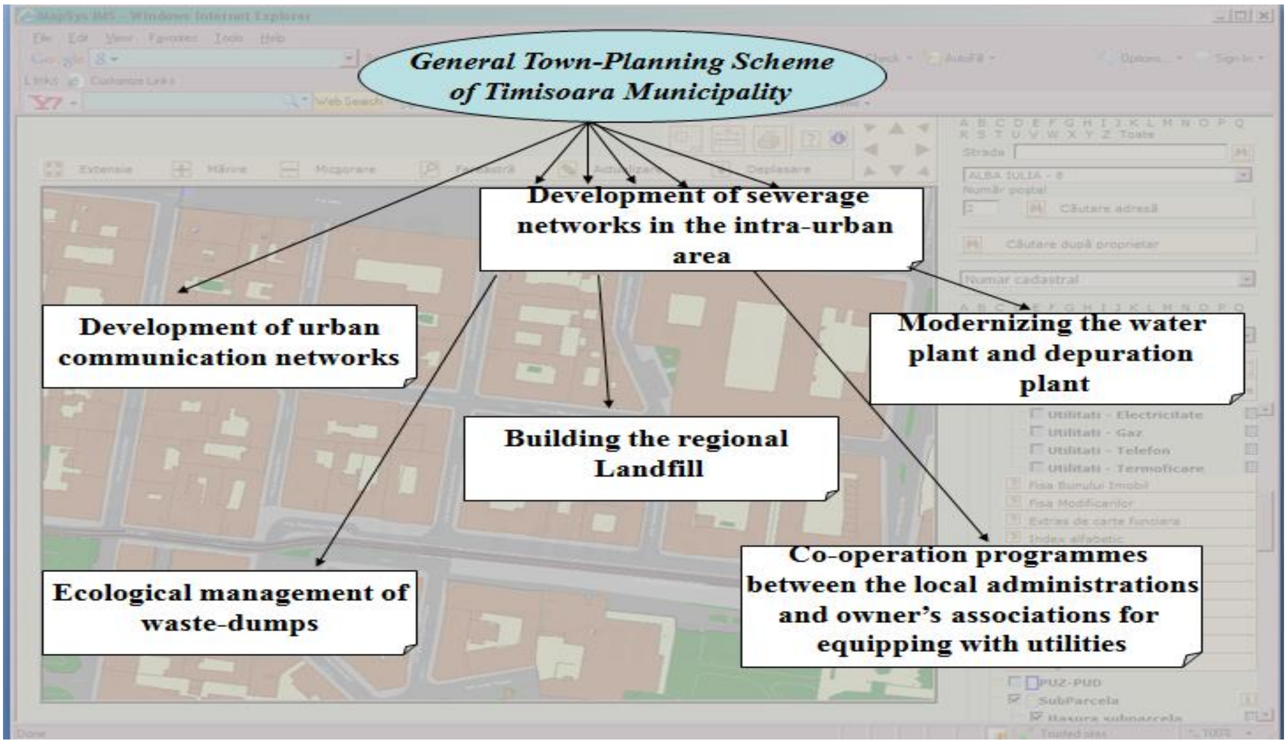
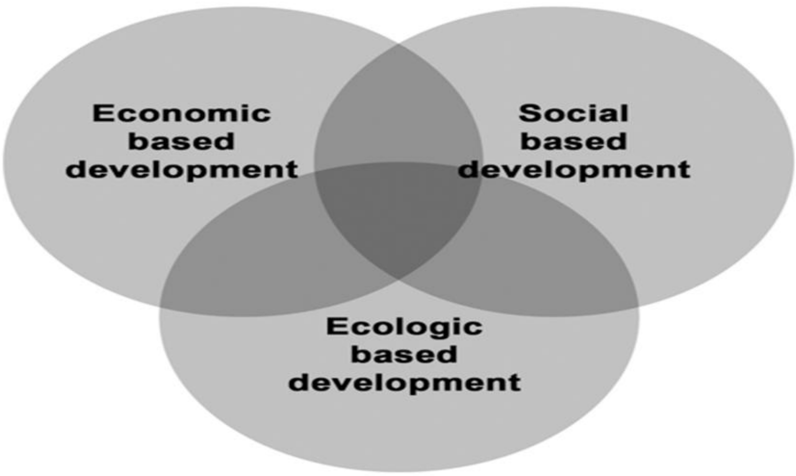


Fig.2.33 Timişoara Town Planning Scheme

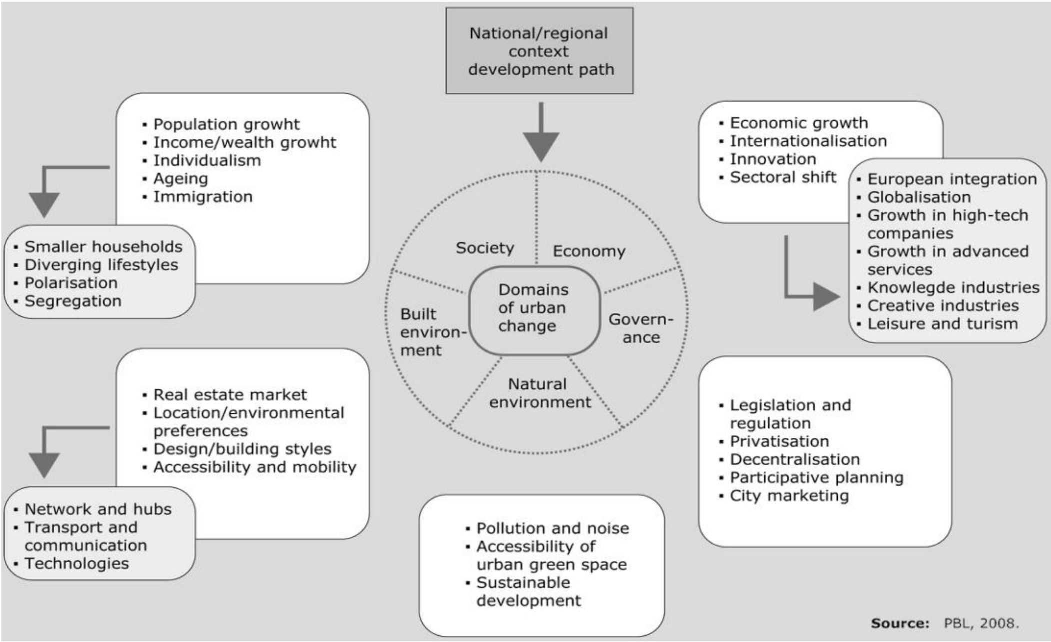
(Research contract nr.674/11.06.2007-2009)

Each of the three theories used during the last two centuries - development based on strengthening the economic aspect, the ecologic aspect and the social one, applied by itself or even coupled, only produces crises and not sustainable development. This can only be achieved at the intersection of the three types of development, a very small area, hard to define and accept by the stakeholders of development: business environment, local administration, politicians and local community.



It is important to mention that none of these should develop to the detriment of another. When in real life a quality is developed in excess, the sustainable development should be corrected through interventions that allow the development of other qualities as well.
Unfortunately, urban sprawl is neither self-regulating nor allows self-correction; therefore, it needs exterior interventions. However, this cannot be efficiently undergone except in areas of large populations meaning high density, increased accessibility and high income.

The errors of urban growth without sustainable rules may lead to uncontrolled urban growth.
To avoid these possible errors and succeed in an area's sustainable development, it is necessary to follow a few basic principles:
•balance between urban modernization, controlled urban growth through development of rural areas and conserving spaces dedicated to agricultural activities;
•social and urban functions' diversity, both in the rural and urban environment;
•balanced and economical use of natural, urban, conurbation and rural areas, controlling the movement and car traffic necessity, conserving air, water, soil, underground resources, green spaces, natural or urban landscapes' quality, reducing noise pollution, protecting valuable urban developments and national heritage buildings, preventing foreseeable natural and technological hazards and general pollution.



<u>2.9 Study case 2: "*TIMCIM" Timişoara*</u>

The completion of the urban database at the level of the Municipality required also the component of generation and establishment of data base for the cemeteries managed by Timisoara City Hall.
The main reason was to accounting entities forming part of the system of cemeteries managed by the City Hall, and conducting management operations and calculation.

The research theme involved:
❑ 80 parcels
❑ more than 20.000 entities introduced in the data base created for the development of the information system TIMCIM. The data can be accessed within this information system for permanent update, the query information regarding the time and type of operations carried out on entities obtaining a history of changes made in time for each entity in the database.
TIMCIM-Cadastre of the Cemeteries, for the City of Timisoara represents a complex project designed in order to be able to keep the records of all entities –as parts of the cemetery system, and also to monitor their status, for an efficient local administration.
The main purpose of the project is the generation and elaboration of a cemetery data base which will include: type of the cemetery, parcels, graves and also possible connections between these entities.

In the same data base there can be stored even present-day information regarding entity and any operation applied to it. Initial data will be saved in archives with the possibility of being accessed at any moment.

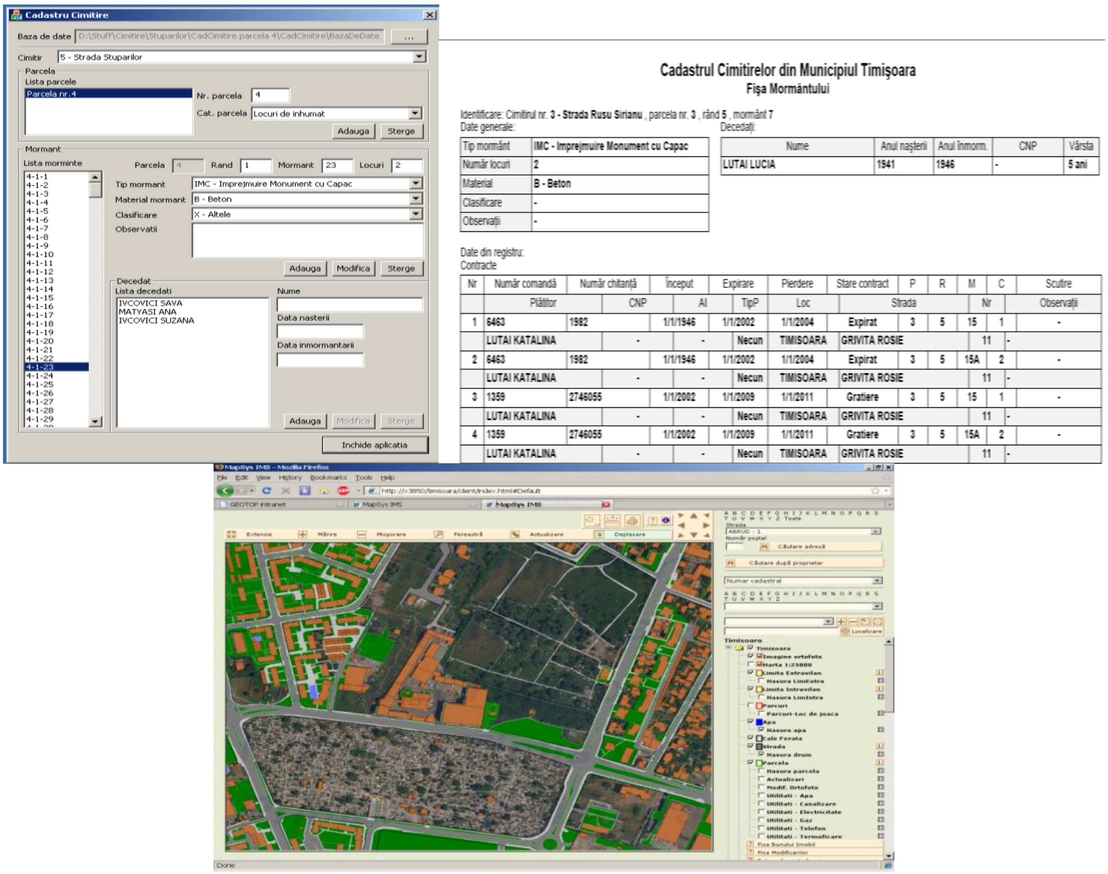


Fig. 2.34 Interface user software – alphanumeric data collection

The project started in 2008 and is to be carried out for few years being collaboration between the Politehnica University of Timisoara, Geotop Company, and Timisoara City Hall, as the beneficiary.

The process of setting up a data base and a data bank specific to the cemetery administration receives an increased importance in the context of the tendencies manifested nationally, i.e. the informatisation and automation of all the activities managed by the public administration sector.

Thus, the geospatial information is developed on digital maps and satellite images or coloured ortophotoplans.

An eloquent example is the information system TIMCIM - *Cemetery Cadastre* – implemented within the City Hall of Timisoara.

Geographic Information System (GIS) is an assembly of people, equipment (hardware), programs (software), algorithms and procedures (methods) which ensure the processing, management, manipulation, analysis, modelling and visualisation of spatial data in view of solving some complex problems regarding planning and territory management.

TIMCIM keeps the record of all the entities which belong to the cemetery system and allows certain administrative and calculus operations, thus contributing to the efficiency of all the applications of this type. The main purpose of this system is to generate and to set up of a cemetery data base, which will contain information, like this: cemetery, parcel, grave, and the links between these entities. In the same data base, there are going to be stored information regarding the exact moment and the type of operations made on the entities.

Before any action that can imply data modification, the initial information is to be saved in archives. Thus it will be possible to record the history and all the changes made in time, for each and every entity in the data base.
The entity position is to be made according to the information given by the Geographic Administration System of the city, (TIMSIG); the digital plan having a scale of 1:500 and it is continuously updated. The update of the digital plan is made on the basis of the photogrammetric plan at a scale of 1:500 by using the existing records, parcelling projects, urbanism certificates, documentations available in the archives, documents on land retrocession, and modifications on the street scanning as a consequence of systematization and of the governmental ordinance: H.G. 834 of 1991. In the process of updating the information, the technology for the use of digital ortophotoplans and of GPS measurements was elaborated. The update of the digital plan was made on the basis of the coloured ortophotoplans, made in 2008, with a special resolution of 11cm and by using high precision GPS measurements.

1. The proposed GIS system

The data base staging is conceived for a computer network with on-line access to the data, includes the basic functions for the server and WEB client, in order to manage the cemetery administration activities.
The system has a client-server general architecture, being made of two main components:

- Map management and the management of the primary alphanumeric attributes;
- Management of the complex alphanumeric attributes.

These two components will function integrated in the GIS system. The information administered by the system will be kept in data banks under the form of well defined entities.
This data bank is composed of two logical components:

- DB_MAP (*Data Bank-Map*) contains information from the maps and the primary attributes associated;
- DB_ REGISTER (*Data Bank - Register*) contains data from the registers kept in cemeteries.

The basic digital plan is the Cadastre Plan at a scale of 1:500, designed within the project TIMSIG, being permanently updated at the level of the specialised service within the Timisoara City Hall.

The entities with graphic part within the Data Bank-Map are the following:

- **cemetery**: cemetery boundary:

- are represented by polygons; all these entities having a unique identifier, the cemeteries being divided into parcels.

Parcel: parcel boundary within the cemetery;

- are represented by polygons; all these entities having a unique identifier. The parcels are divided in rows and graves.

- **Building:** building boundary within the cemetery;

- are represented by polygons; all those that have a unique identifier.

- **Grave**: grave limit;

- are represented by polygons; which have a unique identifier.

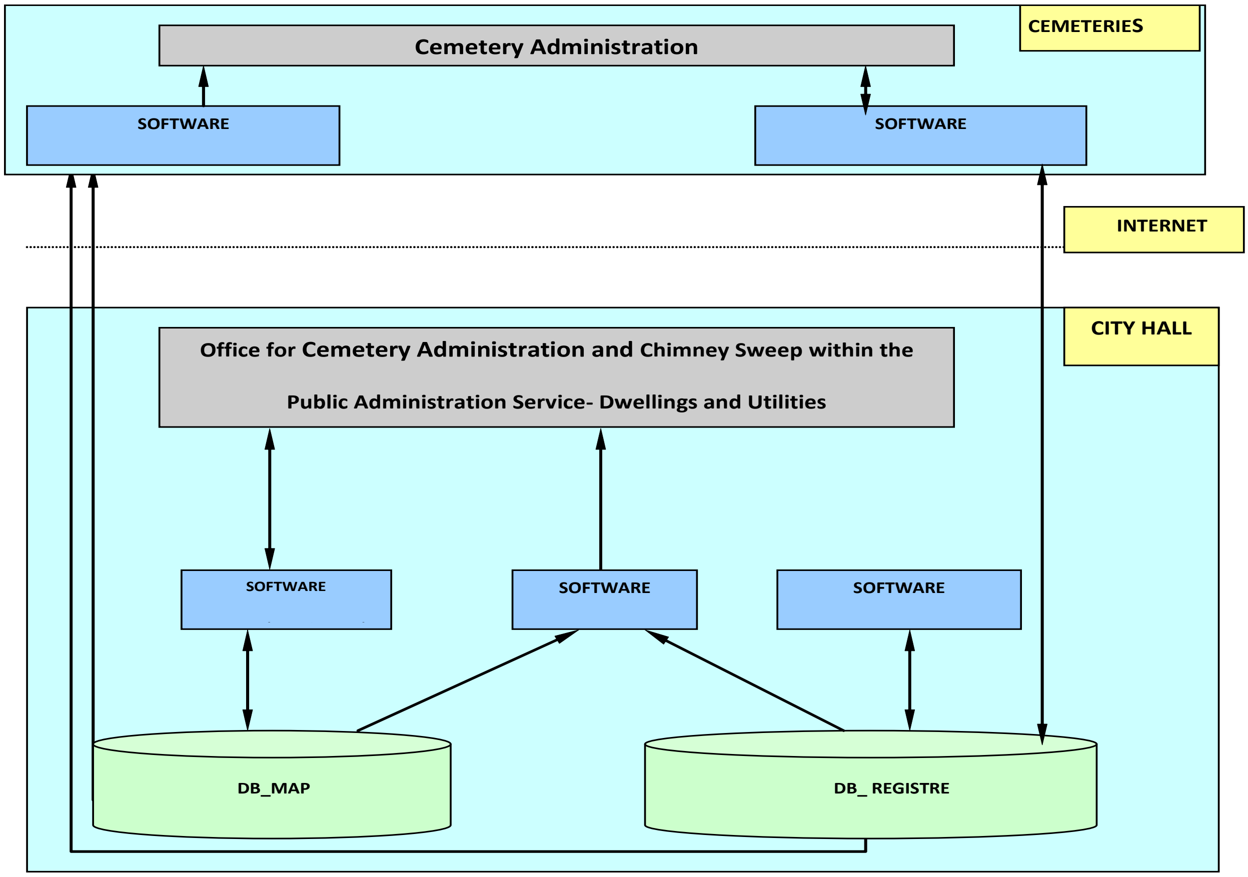


Fig. 2.35 The logical schema of the system proposed

The attributes of these entities are:

- **Cemetery**
  - Cadastral Number
  - Name
  - Cemetery Code
  - Surface
  - Perimeter
- **Parcel**
  - Cadastral Number
  - Parcel Code
  - Category (burial place, vacant place, alley, etc.)
  - Surface
  - Perimeter
- **Building**
  - Cadastral Number
  - Category (Monument, chapel, etc.)
  - Surface
  - Perimeter
- **Grave**
  - Cadastral Number
  - Surface
  - Perimeter

Table 2.1. Layers Distribution

Name	Description	Type
1. Grave	Grave Limit	Line
2. Parcel	Parcel Limit	Line
3. Cemetery	Cemetery Limit	Line
4. Constructions	Construction Limit	Line
5. Grave Code	Grave Code	Text
6. Grave Cat.	Grave Category	Text
7. Park Code	Parcel Code	Text
8. Park Cat.	Parcel Category	Text

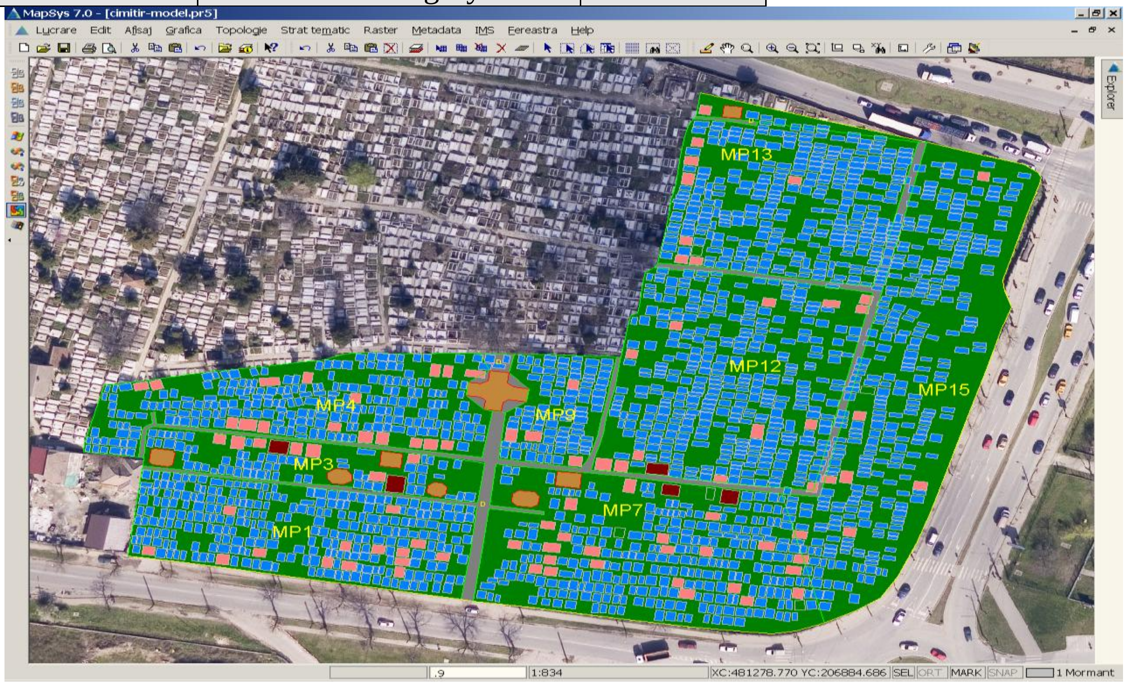
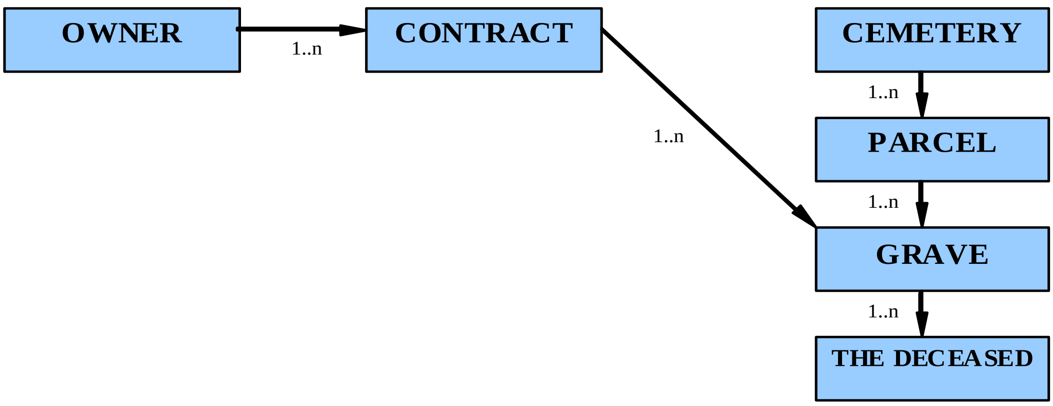


Fig. 2.36 Graphic Data Bank - Rusu Şirianu Cemetery, Timişoara

In the *Data bank Register* (DB_REGISTER) we have the following structure:



2. Data acquisition and data processing

In order to set up a data base, valid and up- to- date, all the information regarding the graves, the parcels and the cemeteries are to be collected on site, on printed forms. The topographic support for this stage is the digital cadastre plan, scale 1:500, provided by the Timişoara City Hall.

This basic digital plan is continuously upgraded on the basis of the coloured ortophotoplans made in 2008, with a spatial resolution of 11cm, using high precision GPS measurements. The digital cadastre plan can be continuously updated since it contains ortophoto images and GPS measurements.
A file of the MapSys application is taken from this digital plan, containing the following elements:

- Parcel limit;
- Street limit;
- Segment, street, crossroads limit;
- Building;
- Street name;
- Post number;
- Name, parcel inscription;
- Name, building inscription.

After the file in MapSys application is made, we divide the cemeteries under the Timisoara City Hall administration, on plan sheets. The plan sheets will have an A1 format and scales from 1:100 up to 1:200, and as background the coloured ortophotoplans made in 2008.

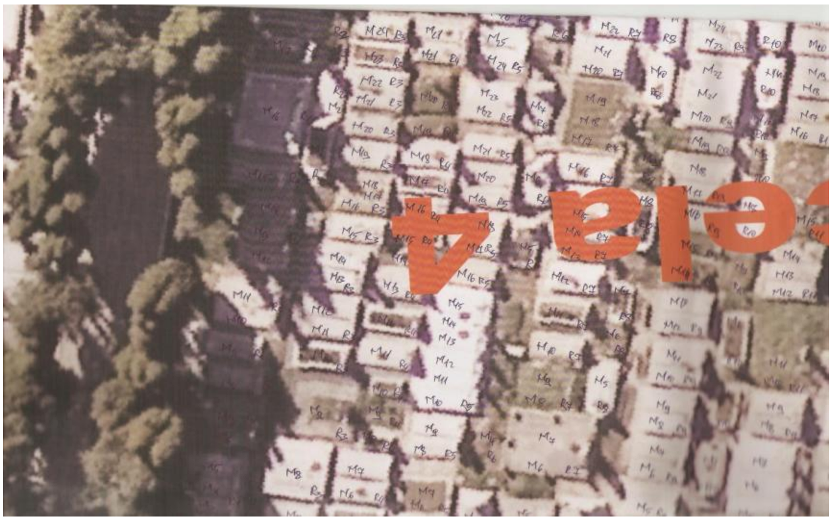


Fig.2.37 Ortophotoplans with graves identified-Cemetery Rusu Şirianu

After the A1 plan sheets are generated the following stage is printing. This has two stages:

- to generate PDF files, separately for each plan sheet (a PDF is generated);
- to print the PDF files, in colour, with a plotter.

Data on the site are collected with the help of the plan sheets and the printed forms (see Fig.29). Each grave is recorded.
On the plan sheet the position of the grave is identified and marked, and then it is given an identification number. It consists of the number of the grave and the number of the row where it is located. For example G15 R3 (grave 15 row 3- Fig.28). The identification data and the grave attributes are recorded on the printed form.
When the data collection operation is completed we continue with the next stage: to insert the data into the computer. The graphic data, marked on the plan sheets are inserted in the MapSys application. The alphanumeric data are inserted the data base, using the information written on the printed forms.

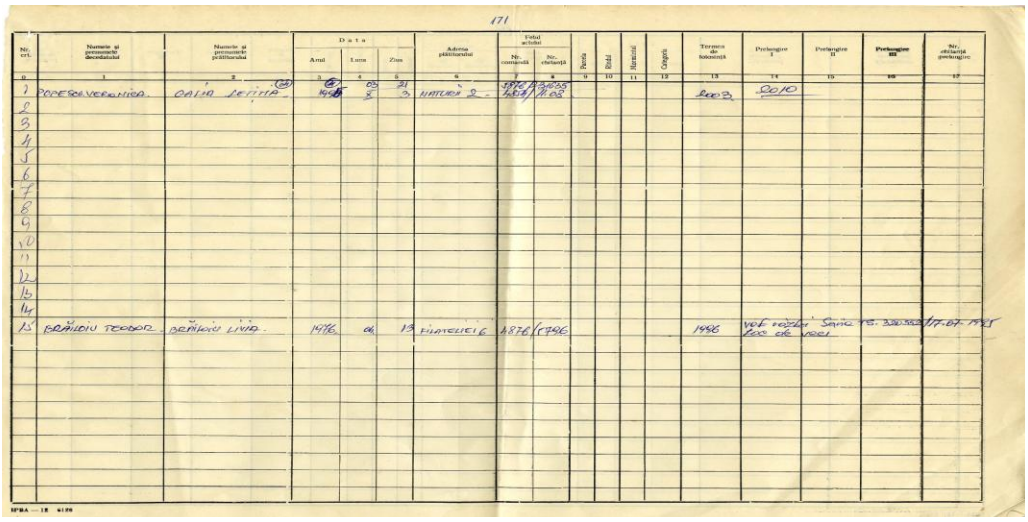
Cimitir RUSU ŞIREANU nr.3 NrFisa 1 Intocmit JURCĂ DANIA Data 02.07.2008

P	R	M	Decedat	NA	IM	T	L	M	A	X	Observatii
10	4	1	GROZA ELENA	1926	1998	IM	1	B+P			
		2	IARCIC SLAVIANCA		1996	G	1	P			
		3	HISTORAN ANA	1893	1948	IMC	6	B			
			BADESCU ILIE	1900	1981						
			BADESCU ANA	1908	1999						
		4	NEAMŢU NICULAE	1915	1979	IM	4	B+P			
			NEAMŢU NATALIA	1912	1997						
			CHIPER MARIA	1888	1965						
		5	KIPER MARIA	1930	2003						
		5	VACARESCU JOHANNI	1938	2006	G	1	P			
		6	STEPANESCU ILIE	1926	1990	G	1	P			
		7	BRINZEI IOAN	1916	1947	P	1	B			
		8	VREDNICU IANCU	1925	1983	IM	2	P+B			
			VREDNICU ANICA	1928	1998						
		9	VOINOV SREMA	1921	1947	IMC	5	B			
			NEGREII BARBARA	1891	1974						
			VOINOV MIRCO	1900	1986						
			PAUL CAROLINA	1898	1981						
		10	IATICA IOAN	1906	1948	IMC	2	B			
			IATICA ROZALIA	1911	1967						
		11	MIHAI PORCIANU	1911	1998	IM	1	B+P			
		12	BACALOV NADEJDA	1878	1957	IMC	6	B			
			CERHEA TIMOTEI	1908	1967						
			CERHEA NATALIA	1904	1989						
			CHERLER CONSTANTIN	1902	1985						
			CHERLER MARIA	1902	1995						
			CHERLER ALEXANDRU	1929	2003						
		13				IMC		B			- nu are trecut nume
		14	ARDELEAN GETA	1940	1953	IMC		B			
		15	GOIA IOAN	1887	1953	IMC	4	B			
			GOIA EUFIMIA	1908	1980						
			GOIA IOAN	1914	1982						

Cimitir
Denum. cimitir
NrFisa
Numarul fisei din cimitir
Intocmit
Intocmit de
Data
Data actuala

P/R/M
Par./Rand/Morm.
Decedat
Nume si pren.dec.
NA
Data nasterii
M
Data inmorm.
T
Tip mormant
C - Cavou
G - Groapa
P - Placa
M - Monum.
CA - Capela
X - Altele
L
Numar locuri
M
Material morm.
B - Beton
M - Marmura
G - Granit
P - Pamant
X - Altele
A
Tip administ.
F - pers. fiz.
J - pers. jurid.
X
Alte tipuri de mor
MI - monu. ist.
OA - opera de arta
PN - Patrim. national

Fig.2.38 Printed form



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Nr. crt.	Numele şi prenumele decedatului	Numele şi prenumele plătitorului	Data: Anul	Luna	Ziua	Adresa plătitorului	Felul actului: Nr. comandă	Nr. chitanţă	Parcela	Rândul	Mormântul	Categoria	Termen de folosinţă	Prelungire I	Prelungire II	Prelungire III	Nr. chitanţă prelungire
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	POPESCU VERONICA	GALIA LETITIA	1996	03	21	NATURII 2	3876 / 4854	31655 / 11.08					2003	2010			
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15	BRĂILOIU TEODOR	BRĂILOIU LIVIA	1976	06	13	FILIMELIC 6	1876	17996					1996	[illegible]	[illegible]	[illegible]	17.07.1995

Fig.2.39 Extract from the Special Register of cemeteries (Timişoara, Rusu Şirianu)

After the completion of all the graphic and alphanumeric data, these are integrated in the data banks DB_MAP and DB_REGISTRE, which can be interrogated later with application IMS (Internet Map Server).

The insertion and the processing of alphanumeric data are ensured by a special software special named Cemetery Register (CR).

The program *Cemetery Register* allows the insertion of the data collected on the site, regarding the graves , as well as the insertion of the data from the registers found at the cemeteries administered by the City Hall, *CR* will also allow the insertion of new information, the modification and the interrogation of the data introduced.

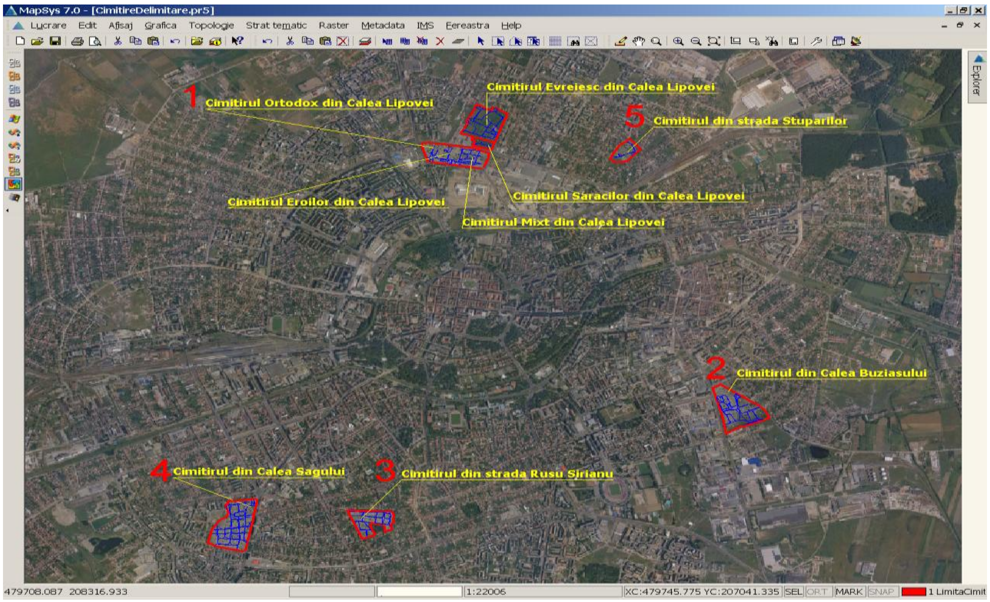

Fig.2.40 Cemeteries administrate by the Timişoara City Hall

This software will have the following functions:

- <u>Modification function:</u> Cemetery, Parcel, Grave, Contract, Period Contract, Owner, The deceased;
- <u>Interrogation Functions:</u> Vacant places information, occupied places, Name of the deceased, Location of the grave, Directions to the grave, Statistics.

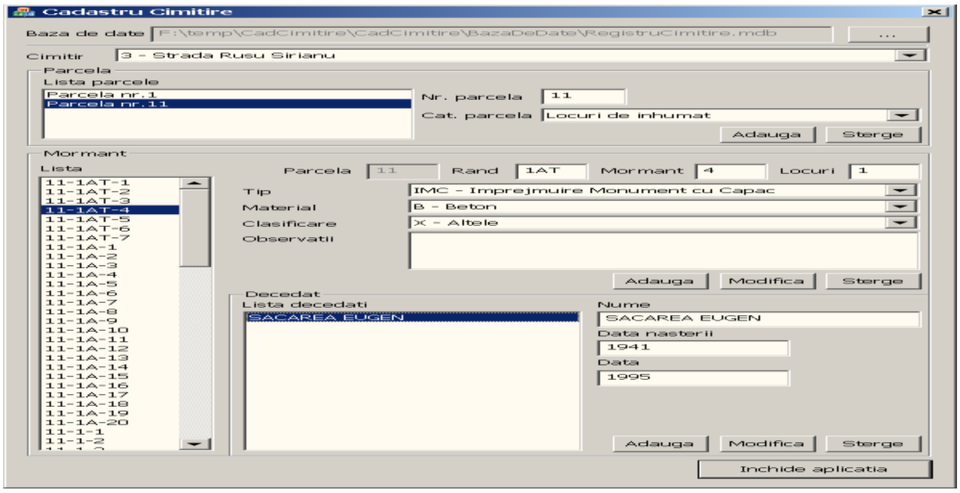

Fig.2.41 Interface user software – alphanumeric data collection

The implementation of the geographic informatic system process for the management of the cemeteries administrated by the Timisoara City Hall is made in a way which unitary, controlled and structured, thus ensuring the quality and the public utility of the data.

The geographic information system *(TIMCIM)*, which uses data collection and of all the associated information, is ready to generate and manage all the information kept in data banks. The data banks are kept by institutions of the public administration and are operable by software functions and interfaces.

(***Research contract nr. 182/11.12.2008-2010)***

Conclusions

The described applications, as part of the Urban Planning development have to promote efficient resolution of land use and zoning conflicts, and regulate various aspects of land use based on its comprehensive assessment from the aspects of the expected outcome of Urban Planning implementation:

- **economic:** Urban Planning Cadastre will continue to stimulate the adoption of national and local laws regulating land and real estates markets, and will provide information support for such markets with a comprehensive account of spatial organization in the assessment of land value and determining taxation rates;
- **social and political:** the uniform system of land regulation and equitable treatment of different groups of owners and land developers will lead to stabilization on the social and political arena, improving business climate for international investments;
- **spatial organization:** the currently spontaneous process of land use will be placed into the framework of realization of adopted projects of regional planning and master plans of cities.

******The dissemination of the proper research work regarding the geodetic applications in relation with urban environment and cadastral support impact is subject of several research projects and contracts and also research papers presented in different scientific events.***
<u>Here are some relevant examples:</u>

RESEARCH GRANTS - ex: 5 projects

- *Research grant nr. 674/11.06.2007,2009: ”***Real estate mapping works and completation of immoveable property data from the field with the granting of technical assistance for performers***”* (Lucrări de cartare imobiliară şi completare a fişelor de bun imobil efectuate pe teren cu acordare de asistenţă tehnică pentru executanţi*) ;*
- *Research grant nr.182/11.12.2008,2010: ”***Development of a database for the use of geospatial information in order to manage cemeteries from Timisoara-data aquisition and processing** (Elaborarea bazei de date pentru utilizarea informaţiei geospaţiale în vederea gestionării cimitirelor din municipiul Timişoara - culegere şi procesare date), Timişoara City Hall;
- *Research grant* - CNMP, *Partnerships in priority areas (Parteneriate în domenii prioritare) nr. 14418 / 14.09.2007, 2010: ”***Structural systems and innovative technological solutions for the protection of buildings from extreme actions in the context of the requirements for sustainable development***”* (Sisteme structurale şi soluţii tehnologice inovative pentru protecţia clădirilor la acţiuni extreme în contextul cerinţelor pentru dezvoltare durabilă), MECTS;
- *Research grant nr.*299/2005: ***”*Topo-cadastral survey for objectives of the Timisoara City Hall, according to the Urban Area Plan - study case: market Wholesaler Timisoara*”*** (Studiu topo-cadastral pentru întocmirea documentaţiei de scoatere din CA, conform Planului Urbanistic Zonal, Piaţa de Gros Timişoara), **Primăria Municipiului Timisoara**
- *Research grant nr.* 130/2004, 2005: ***”*Topo-geodetic survey for the construction of housing for the ANL - Timisoara City Hall*”*** (Studiu topo-geodezic pentru terenul aferent construcţiei de locuinţe ANL**,** L15/2003 şi Piaţa de Gros, Timişoara)

SCIENTIFIC RESEARCH – ex: 10 papers

- Grecea Carmen - *Geoinformation support - impact on urban planning, environment and society* - LATEST TRENDS ON URBAN PLANNING AND TRANSPORTATION UPT 09- Rodos Greece 2009, pag 136-141 **(ISI Proceeding);**
- Grecea Carmen, Bălă AC, Huba Marton - *Geospatial Information – Modern Tool For An Efficient Administration of Cemeteries in Timisoara* - REVCAD - JOURNAL OF GEODESY AND CADASTRE – Alba Iulia 2009, Romania, **(BDI: B+, Copernicus);**
- Grecea Carmen, Bălă AC, Herban S, - *Cadastral Requirements for Urban Administration, Key Component for an Efficient Town Planning*- JOURNAL OF ENVIRONMENTAL PROTECTION AND ECOLOGY – 2010 pag. 363-371 **(ISI Journal);**
- Grecea Carmen, Rusu G, Muşat CC, Moscovici AM, - *Challenges in implementing the systematic land registration in Romania* - EUROPEAN CONFERENCE OF GEODESY AND GEOMATICS ENGINEERING GENG'13, Antalya, Turkey 2013 **(Scopus, ISI);**
- Herban S, Grecea Carmen, Musat C - *Using a Geographic Information System (GIS) to Model, Manage And Develop Urban Data of Timisoara City*- JOURNAL OF ENVIRONMENTAL PROTECTION AND ECOLOGY (JEPE) 2012, Vol 13 / ISSN 1311-5065, pag. 1616-1624, **(ISI Journal)**
- Carmen Grecea, Alina Corina Bălă, Claudiu Ioan Bota - *Spatial Planning - Modern Tool of Urban Management and Control* - REVCAD, JOURNAL OF GEODESY AND CADASTRE, 2010, Vol 10/ 1583-2279, pag. 91-99, **(BDI: B+, Copernicus)**
- Carmen Grecea, Maria Roberta Gridan - *Geospatial Technology for 3D City and Urban Modelling* - REVCAD - JOURNAL OF GEODESY AND CADASTRE, 2011, Vol 11/ 1583-2279, pag. 69-75, **(BDI: B+, Copernicus)**
- Grecea Carmen, Ienciu I, Dimen L,Bălă A, Oprea L - *Cadastral Support for an Efficient Town Planning in Timisoara, Romania* - JOURNAL OF ENVIRONMENTAL PROTECTION AND ECOLOGY (JEPE), 2012, Vol 13 / ISSN 1311-5065, pag. 1099-1107, **(ISI Journal)**
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*** H.G. nr.1210/2004 regarding organization and functioning of the National Agency of Cadastre and Real Estate (privind organizarea şi funcţionarea Agenţiei Naţionale de Cadastru şi Publicitate Imobiliară, republicată, M.Of. nr.386/5 mai 2006

*** National Agency of Cadastre and Real Estate - Desktop Cadgen Application
(Agenţia Naţională de Cadastru şi Publicitate Imobiliară - Aplicaţie Desktop Cadgen destinată verificării datelor rezultate în urma lucrărilor Cadastru General)

*** http://www.ancpi.ro/pages/download.php?lang=ro

*** http://www.adrcentru.ro

*** http://www.ancpi.ro/pages/comunicate.php?lang=en&action=show

*** http://www.teamnet.ro/projects/eterra.html

*** www.satimaging corp.com

*** www.esriro.ro/

*** www.primariatm.ro

*** www.geotop.ro

***http://en.wikipedia.org/wiki/Infrastructure_for_Spatial_Information_in_the_European_Community
***http://inspire.jrc.ec.europa.eu/index.cfm/pageid
***http://www.esri.com
***http://www.ancpi.ro/images/INSPIRE_Report_Romania_2013
***www.leicageosystems.com/civil/application.htm

3. GEOMATICS, IMPACT ON THE ENVIRONMENT AND SOCIETY

3.1 Introduction - Geo Information Support

Nowadays, in order to find better solutions, more and more information is required in every domain. Having passed through different stages of agricultural or industrial societies, we now live in an information world. Creation of any Geographic Information System for governmental and local authorities represents a very complicated process, where a complex of scientific, technical and organizational problems should be solved. These problems have usually a specific character, also in Romania due to particular features caused by general economic status, financial and social situation, and also, political changes.

A significant factor of economic stabilization and development is the implementation of modern, efficient tools based on better Information Systems needed both for everyday land administration operations and for large-scale reforms related to land.

GIS as modern technology of analysis and graphical-textual database processing method is a very important element in urban planning and also in environment resources management. This is a basic, crucial purpose in case of multifunctional spatial system.

At present, a particular attention is paid to using GIS-technologies for support of analytical activity and making effective decisions by the authorities of State Administration. An urgent solution of this problem is specified by three major circumstances:

- efficiency of management directly depends on organization level of the information support, because almost 70% of the total volume of management decision are related to territory. Therefore, the need for a wide use of databases is evident;
- the demand for acquisition and processing of a large amount of interdisciplinary information from different branches of knowledge by actions of economic and natural factors are of a world-wide character. They require coordination and integration of all forces of neighbouring territories in order to realize the common projects. Integration of this thematic information, comparison and analysis by a human being requires to introduce any unified binding environment;
- cartographic method of representation, generalization, perception and analysis of cartographic information is particularly unique for knowledge analysis on territories, phenomena, events and processes involved.

International and national experience offer for this purpose a territorial GIS providing a unified spatial referencing for all required data for territory management. The main advantage of such system is a possibility for spatial analysis being a powerful instrument to reveal and investigate a character and interrelations of different phenomena and environmental objects.

The consequence of the sustainable development implementation is a necessity of spatial system designing. Geographical Information System can be such a tool.

It gives quick access of updating and analyzing of spatial database. A GIS is capable of integrating large amounts of geographic data from different sources and is able to respond to non-routine questions. As a result, it can be a most powerful instrument in the development of Environmental Information Management System.

3.2 Geodetic engineering – important tool for seismicity studies

Geodesy provides facilities to investigate the Earth’s crust movements and shares these data with other disciplines. With the rapid developments of geodetic techniques and the accuracy and reliability in geodetic measurements, the surveying methods have gained importance for monitoring crustal deformation on earthquake researches. It's important to have a real overview regarding crustal deformation in a certain area in order to be able to propose solutions for future monitoring from geodetic points of view.

Contribution of Geodesy in interdisciplinary studies for Earth's crust movements

The study of the recent crustal movements could be integrated in the ensemble of the scientific research with a fundamental character involving all geosciences that study the Earth dynamism, understanding the description of all complex phenomena which are permanently taking place in the Earth's crust and much deeper. Combining the results obtained by the geology, geophysics, oceanographic sciences with the component of geodetic determinations, a multitude of issues regarding the evolution of the changes from the internal structure and from the upper side of the Earth crust can be elucidated.

The participation of Geodesy in the studying programs of the crustal movements was determined and developed with the agreement of the global tectonic concept. The Geodesy provide accurate information about the movements of the crust deformation, out of which could have been computed the quantity of the potential accumulated energy between several series of measurements made into the determined limits.

Thus, according to the theory of tectonic plates, which confirms the fact that nothing is inflexible in the whole nature, in time or space, it has been enforced as very necessary the introduction of the fourth dimension (time) in processing of repeated geodetic measurements.

Identifying movements (including deformations) of the upper side of the Earth's crust, which are happening before, during or after the earthquake, by geodetic methods, give them a fundamental research character, and also a practical one, competing to the determination of stability degree of the ground in the populated areas or in the areas where important industrial or town objectives are about to be placed.

Classification of geodetic determinations of the Earth's movements can be done:

- **REGARDING THE REFERENCE SYSTEM**
  - absolute determinations
  - relative determinations of vertical, horizontal and three-dimensional movements
- **REGARDING THE AMPLITUDE OF RECENT MOVEMENTS DETERMINATIONS OF THE EARTH'S CRUST**
  - global determinations
  - regional determinations
  - local determinations
- **REGARDING THE GEODETIC DETERMINATION PRECISION**
- **REGARDING THE RESULTS OBTAINED BY PROCESSING**
- **REGARDING THE FINAL RESULT OBTAINED BY REPEATED GEODETIC MEASUREMENTS**
  - vertical movements map
  - horizontal gradients of vertical movements
- **REGARDING THE PROCESSING METHODS OF REPEATED GEODETIC MEASUREMENTS**
  - processing models in a status concept
  - processing models in a quasi-status, quasi-cinematic concept
  - determination of movements and of mobile entirely deformations

Natural disasters involve the intersection of **society**, the **built environment and natural processes**. The hazard is inevitable because we don't know when an earthquake will strike, or how severe it will be.

The permanent development and application of broad spectrum of satellite remote sensing systems and attendant data management infrastructure contribute needed baseline and time series

data, as part of an integrated global observation strategy that includes airborne and in situ measurements of the solid Earth. Seismic hazard modelling capabilities will result in more accurate forecasting and visualizations for improving the decision support tools and systems used by the international disaster management community.
It is anticipated the transfer and the applicability of the results for initiation of other projects about the natural precursory phenomena of the earthquakes.

Global Positioning Systems – tool for crustal movements evaluation

The key to understand the Earth's dynamics and system complexity is to integrate satellite observations at local, regional and global scales, over a broad portion of the electromagnetic spectrum with increasingly refined spectral resolution, spatial resolution and over times scales that encompass phenomenological lifecycles with requisite sampling frequency. Recent advances in computational science and numerical simulations are allowing the study of correlated systems, recognition of subtle patterns in large data volumes, and are speeding up the time necessary to study long-term processes using observational data for constraints and validation. Integrating remotely sensed data into predictive models requires measurements at resolutions substantially superior to those made in the past when the observational systems and the discipline of natural hazards research were less mature than they are today. Furthermore, assimilation of data and model outputs into decision support systems must meet operational requirements for accuracy, spatial coverage and timeliness in order to have positive impact on disaster risk management.
Global Positioning System measurements can be used as reference to satellite remote sensing results, being necessary to interpolate deformations between the GPS points. By combining these data sets can be also improved the temporal resolution of the deformation.

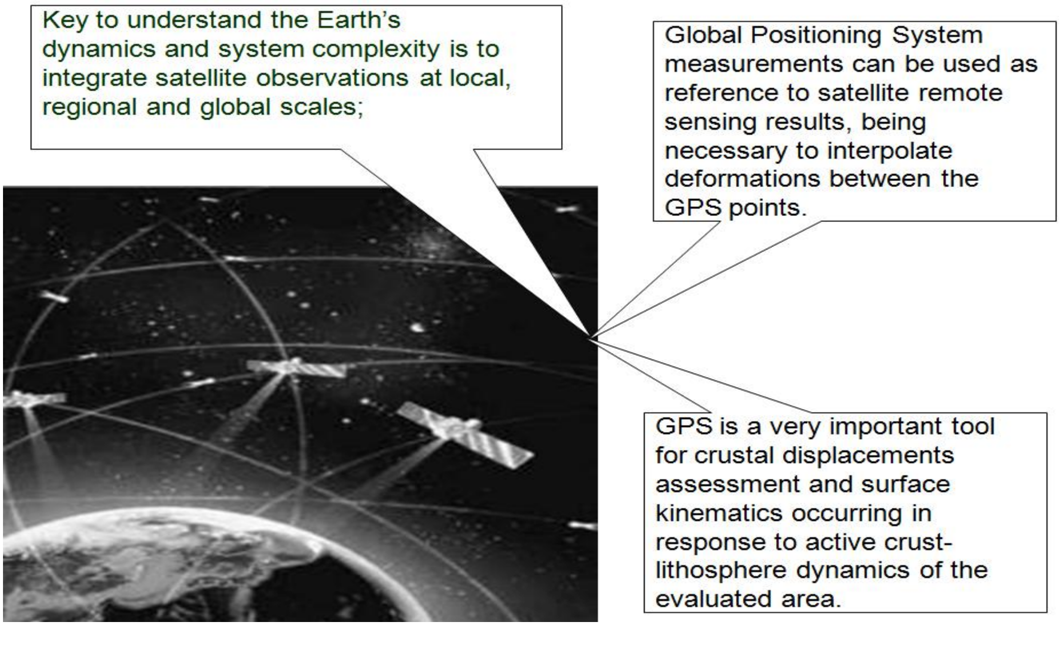


Fig. 3.1 Global Positioning Systems – tool for crustal movements evaluation

Romanian seismicity aspects

Medium- to short- term earthquake prediction is becoming ever more essential for safeguarding man, but until now there is no method for reliable earthquake prediction developed.
Having one of the most seismically active area in Europe, Romania presents a relatively high potential of seismic risk mainly due to the sub crustal earthquakes located in the South-eastern Carpathians.

Seismic activity in Romania is due to Vrancea intermediate-depth sub crustal source(focal depth between 60 and 170km), and to several shallow crustal source(Banat, Făgăraş, etc).
Vrancea source dominates seismic hazard not only in Romania but also in Republic of Moldova and affects large areas in Bulgaria and Ukraine.
Romania is a moderate to high seismic area and its history reminds of frequent disasters caused by earthquakes. Of all its seismic zones, the most important and well known is the Vrancea zone, in the Carpathians Arc Bend. This area is characterized by intermediate deep and crustal earthquakes, seismic high rate (4 to 5 destructive earthquakes per century) and intensive looses on large areas, surpassing Romanian borders. For the Vrancea seismogenic Region (VSR) the historical records of sub crustal earthquake occurrences are fairly more than a millennium. The earliest event in those catalogues is an earthquake occurred during the year 984. During this time period at least 37 strong events, that is with maximum intensity VIII (MSK) or more are gathered into file. In fact that intensity is the level/threshold at which the tremors are damage. The earthquakes of 10 November 1940 (M=7.4), and of 4 March 1977 (M=7.2) were the largest in this century. It is believed that the great earthquake of 1802 may have reached M=7.7. The upper limit of magnitudes for Vrancea earthquakes is in the region of M=8.0. Other source zones (in the Fagaras Mountains and Banat) are crustal, and generate lower magnitudes - seldom exceeding M=6.0. Seismological information for Vrancea earthquakes is plentiful, primarily due to their high frequency of occurrence. Assuming that the data are complete for large magnitudes for the last 600 years, this time interval shows 3 earthquakes/century with Mw > 7.2 and 6 events/century with Mw > 6.8.
In Romania there are several significant areas of seismicity with earthquakes at normal depths (less than 60 km). The most active zones are in the western part of Romania near the city of Timisoara (Banat and Danube seismogenic zones), in the central part near Sibiu (FC) and in the north western part at Baia Mare.

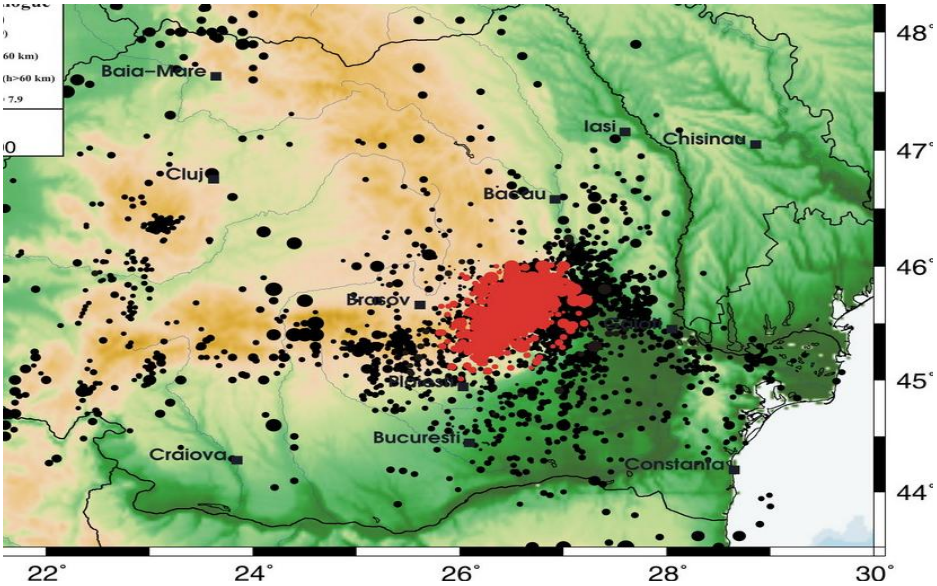


Fig.3.2 Seismicity in Romania (www.infp.ro)

The development of seismic monitoring in Romania is a major contribution to research evolution in this domain, creating the premises for a better understanding and modelling of earthquake ground motion, site effects and building response.

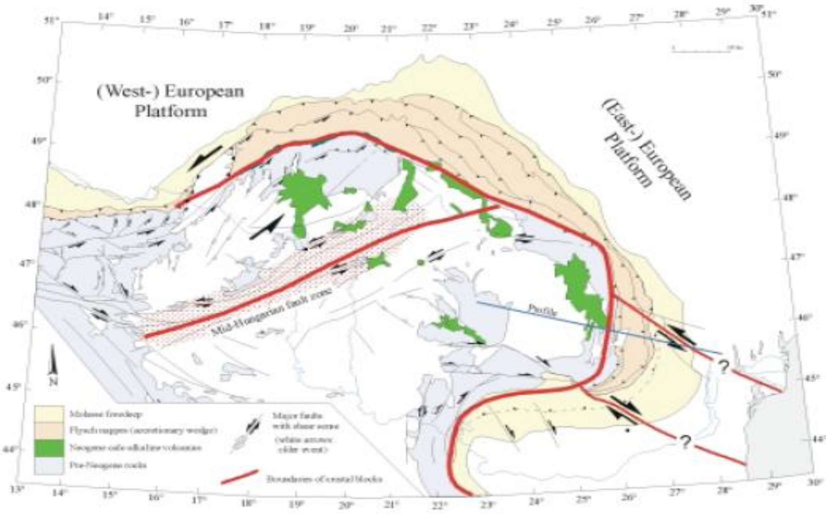


Fig. 3.3 Tectonic overview map of the Carpathian region

Deformation monitoring is conducted for the purpose of detecting and interpreting small changes in the geometric status of the Earth. With the rapid developments of modern geodesy, and with the unprecedented accuracy achievable in geodetic measurements using advanced techniques, the geodetic methods have gained world-wide acceptance for monitoring crustal dynamics for earthquake studies. It is important to measure both the long-term rate of deformation and the short-term deformation associated with the seismic activity along individual faults. The first type of measurement requires accurate topographic maps to quantify the cumulative displacement of surfaces. The second type of measurements requires the capacity of estimating displacements of the ground at millimetre level of precision over short time intervals. Contrary to the geological research, the studies of crustal deformation are based on the analysis of repeated geodetic measurements, and their combination with results of other geophysical investigations. Geodesy provides facilities to investigate the Earth's crust movements and shares these data with other disciplines.

Using a growing network of instruments, methods and information, scientists and engineers can be able to suggest further improvements in order to help and protect citizens from loss of life and property in future events.

Lately, due to the development of geodetic and surveying techniques and methods, also the accuracy and reliability in geodetic measurements, this science of terrestrial and spatial measurements has gained importance for monitoring crustal deformation on earthquake researches.

Fusion of satellite, GPS and field data in the evaluated area can provide a better monitoring of different geophysical parameters and long term deformation in relation with earthquake activity.

Multispectral and multitemporal satellite images covering the last 30 years have been analyzed for recognizing the continuity and regional relationships of active faults as well as for geological and seismic hazard mapping. Permanent GPS Romanian network data revealed a displacement of about 5-6 millimetres/year in horizontal direction relative motion, and also a few millimetres/year in vertical direction.

During recent years remote sensing and geospatial information tools and technique, including numerical modelling, have advanced considerably. These tools offer a greater understanding of the Earth as a complex system of geophysical phenomena, including where and when hazards may occur, and what impact they may have on the natural and built environment, and society itself. The information obtained from such systems is beginning to be operational to decision makers for management in case of emergencies.

Satellite Remote Sensing sensors gives a systematic framework for advancing scientific understanding of the Earth, as a complex system of geophysical phenomena, that directly and through interacting processes, often lead to natural earthquake hazards.
Space-based geodetic measurements of the solid Earth with Global Positioning System, combined with field seismological measurements provide the principal data for modeling lithospheric processes as well as for accurately estimating the distribution of potentially damaging strong ground motions, critical for earthquake engineering applications.

Seismological characteristics of the Banat Region

The western and south-western part of Romania, often called the Banat Seismic Region (BSR), lies on the complex tectonic contact area between *i)* the Carpathian orogen (South Carpathians and Apuseni Mountains) and *ii)* the subsidence structures of the south-eastern border of Pannonian Depression (grabens, intra-mountains depressions).
Banat Seismic Region is the most important seismic region of Romania when we refer to the seismic hazard determined by crustal earthquakes sources (focal depth smaller than 60 km). The seismicity studies accomplished for defining the seismic hazard sources from BSR define two main seismogenic zones: *Banat Seismogenic Zone* and *Danube Seismogenic Zone*
(Radulian et al. 2000) that correspond to the main regional morphological units developed in the region, the Western Plain of Romania and South Carpathians mountain ranges, respectively.
The geology and tectonics of this zone is very complex: two major grabens elongated in NW-SE direction, prevail in the zone: Sinnicolau Mare- Caransebes. Between these structures an uplifted tectonic block extends from Buzias to Hungary (Battonya-Buzias horst). In the South, the Caras graben is developed.
The historical earthquake epicentres distribution reveals a very good spatial with the principal faults from the region. The current seismicity emphasizes three clusters around Timisoara. The first one occurred about 15 km NNW from Timisoara and the fault plane solution of the main event show a normal faulting on a NE oriented plane. The other cluster is located about 30 km NE from Timişoara.

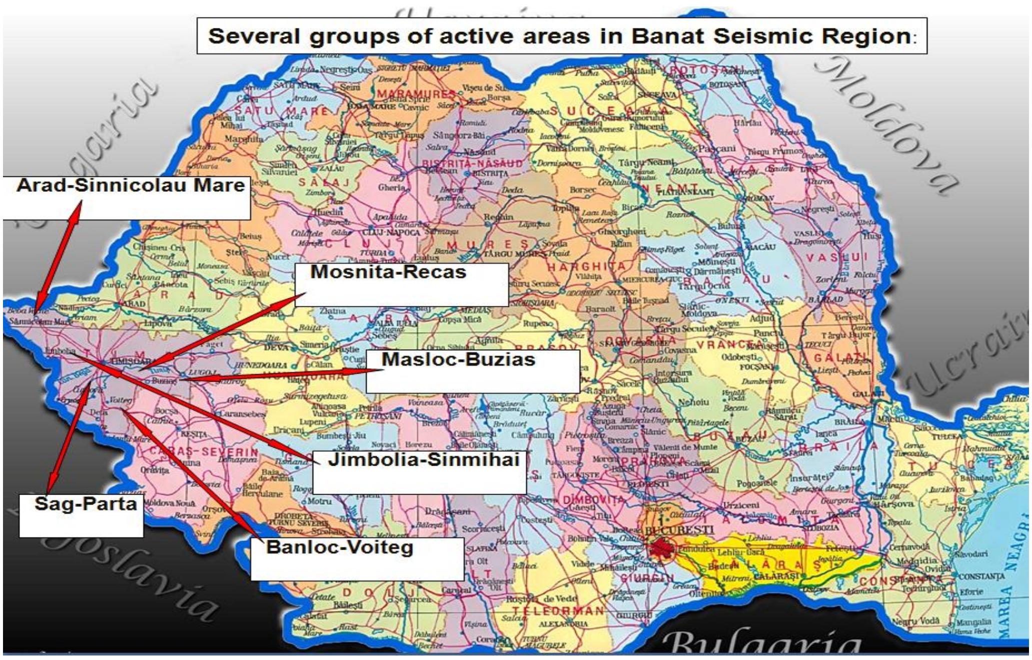


Fig. 3.4 Banat seismic region

Banat seismic region can be considered the most hazard crustal seismic zone of Romania taking into consideration :

- six sources with high earthquake potential confirmed by their history (Imax=VIII^o);
- events with lo ≥ VII- VIII^o MSK appear and repeat once at 37 years time interval in the region;
- 35 events with lo = VII^o MSK occurred into the region until 2006;
- sequences of the strongest events often have more aftershocks that may be an additional earthquake threat into the epicentre areas;
- shallower focal depths (5-8 km) may be an important element for the seismic hazard and risk into the epicentre area because of the possible damaging effects of the event on the surface (M=4,5; h=5km – lo= VII^o).

The earthquake potential of the known local seismic sources has been confirmed either by the maximum intensities/magnitudes observed in the historical period (1443-1970): I_{MAX}=8 degree on European Macroseismic Scale (EMS) /Ms=5.7, and the frequency of occurrence of the earthquakes (over seven thousands events are catalogued between 1443 and 2007 in the region; since 1880 the events with I>6 EMS occurred with an annual average frequency of 0.4). The epicentre are scattered all over in the Banat Seismogenic Zone (Western Plain of Romania), but they cluster into small source zones that form several groups of active areas: Arad-Sinnicolau Mare, Vinga-Varias, Masloc-Buzias, Jimbolia-Sinmihai, Sag-Parta, Mosnita-Recas, Banloc-Voiteg and small areas along the border of Romania with Serbia and Hungary.
The maximum magnitude/intensity observed in the region is Ms=5.7/8EMS (Banloc-Voiteg, 1991).

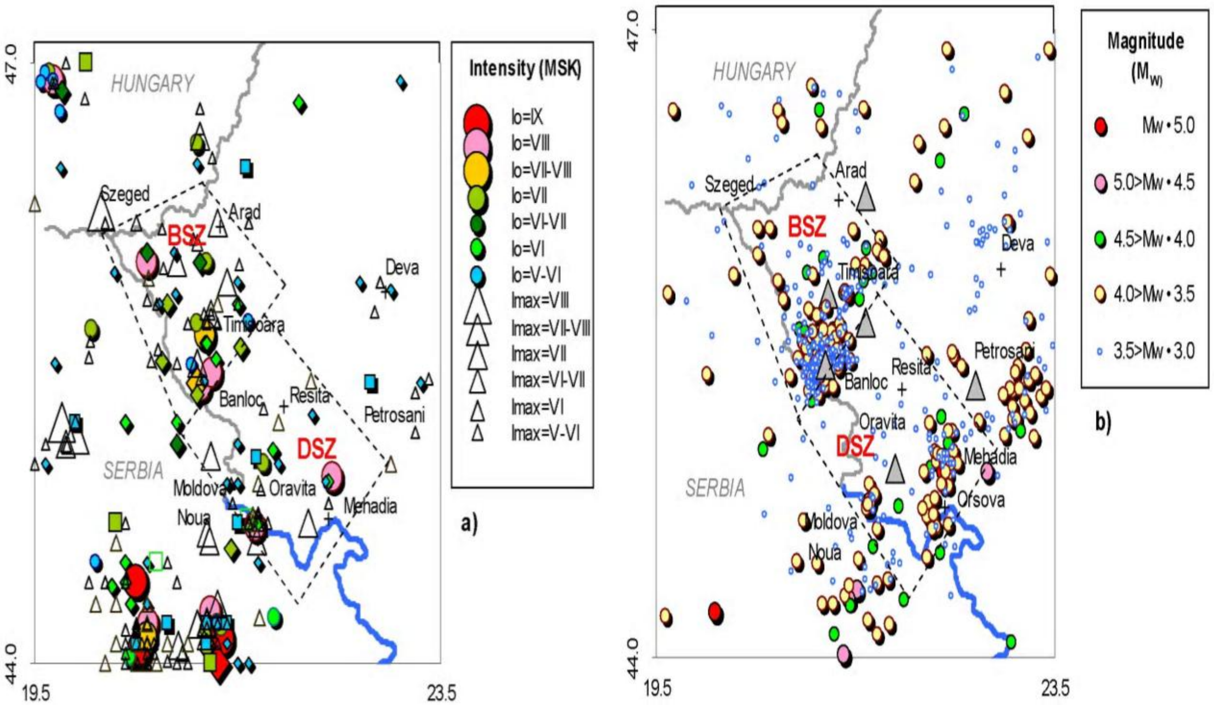


Fig. 3.5 Banat seismogenic zone

The focal depth of the local earthquakes do not exceed 25 km. The last stong earthquakes occured in the Banloc-Voiteg area. This seismic source prolongs to the NNE up to South-South-East of Timisoara and continues uncertain to the North of Buzias (the Banloc-Recas Fault). Between 1915 and 1991 it generated three strong earthquakes:
19.09.1915, Io=VII-VIII^{O}MSK/Mw =5.4;
12.07.1991, Io=VIII^{O}MSK/Mw =5.6 and
02.12.1991, Io=VIII^{O}MSK/Mw=5.5.

The subsequent seismic activity on a complex system of faults, triggered by the 1991 strong earthquakes, lasted many years, the area being actually one of the most active areas from the region. The seismic activity level recorded during the last years recommends this seismic source area for a multidisciplinary study and monitoring to know and better understand the seismogenic processes in the region.
Taking into consideration the history of the field movements in Banat area, causes, intensity, propagation, it is interesting to establish a permanent solution for their evaluation using accurate geodetic technologies. It is planned to obtain 3D realistic models of seismic faults from Banat and also to estimate their seismogenic potential and improving the seismotectonic models. The faults should be investigated also by complementary seismic measurements. It is anticipated the transfer and the applicability of the results for initiation of other projects about the natural precursory phenomena of the earthquakes.
Such a project could be developed for a multidisciplinary and interdisciplinary research of earthquakes from the western part of Romania, several groups of active areas being implied: Arad-Sinnicolau Mare, Vinga-Varias, Masloc-Buzias, Jimbolia - Sinmihai, Sag-Parta, Mosnita-Recas, Banloc-Voiteg and small areas along the border of Romania with Serbia and Hungary.

3.2.1. Study case 1: Monitoring crustal movements in Banat seismic area

Banat Seismic Region is the most important seismic region of Romania when we refer to the seismic hazard determined by crustal earthquakes sources (focal depth smaller than 60 km).
The geology and tectonics of this zone is very complex: two major grabens elongated in NW-SE direction, prevail in the zone: Sinnicolau Mare, Caransebes. Between these structures an uplifted tectonic block extends from Buzias to Hungary (Battonya-Buzias horst).

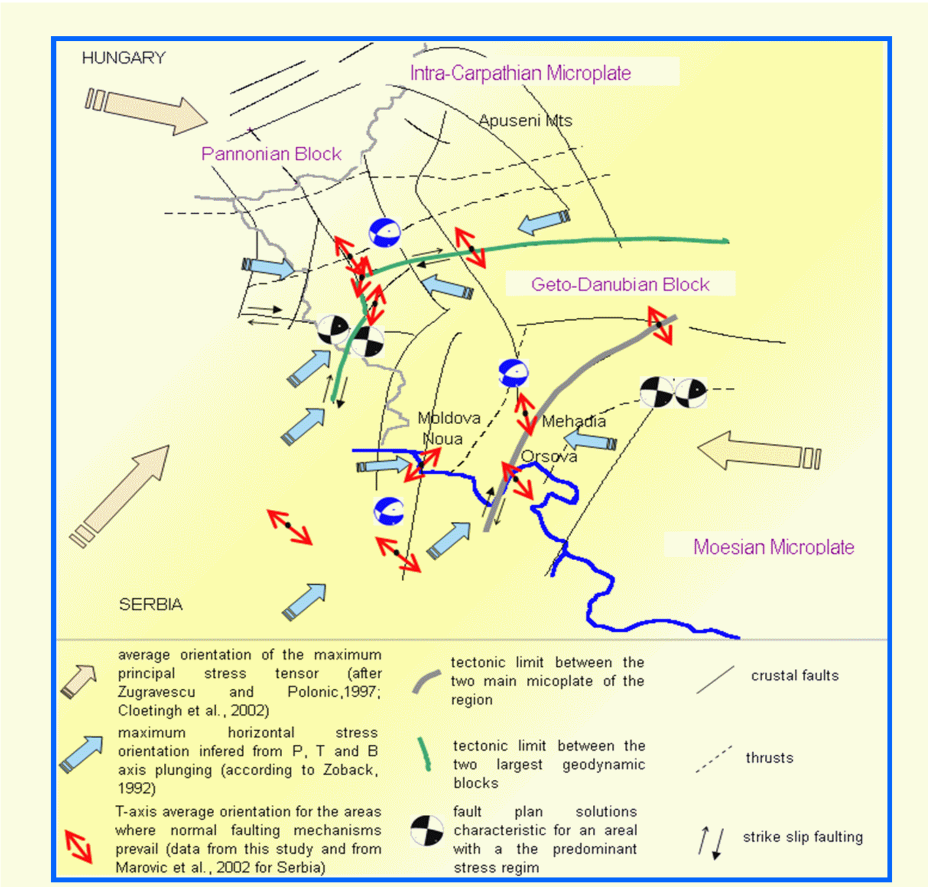


Fig. 3.6 Sketch of maximum principal stress tensor

In remote sensing field, synergy use of data provides means to combine satellite multispectral and multitemporal data. GPS is a very important tool for crustal displacements assessment and surface kinematics occurring in response to active crust-lithosphere dynamics of Banloc area.
In figure 3.8 and 3.9 is presented a sketch of the seismotectonic features that support the GPS network (consisting 4 permanent stations: Baia Mare, Deva, Bucureşti, Oros – Ungaria and 4 points of the national network: Moşniţa, Gomila Mare, Grăniceri, Partoş) draft proposed for monitoring the faults system developed in the Banloc-Voiteg seismogenic area.
The research involved interdisciplinary studies and geodetic solutions based on physical evaluation of the Earth, crustal observation and monitoring in order to improve regional seismic models.

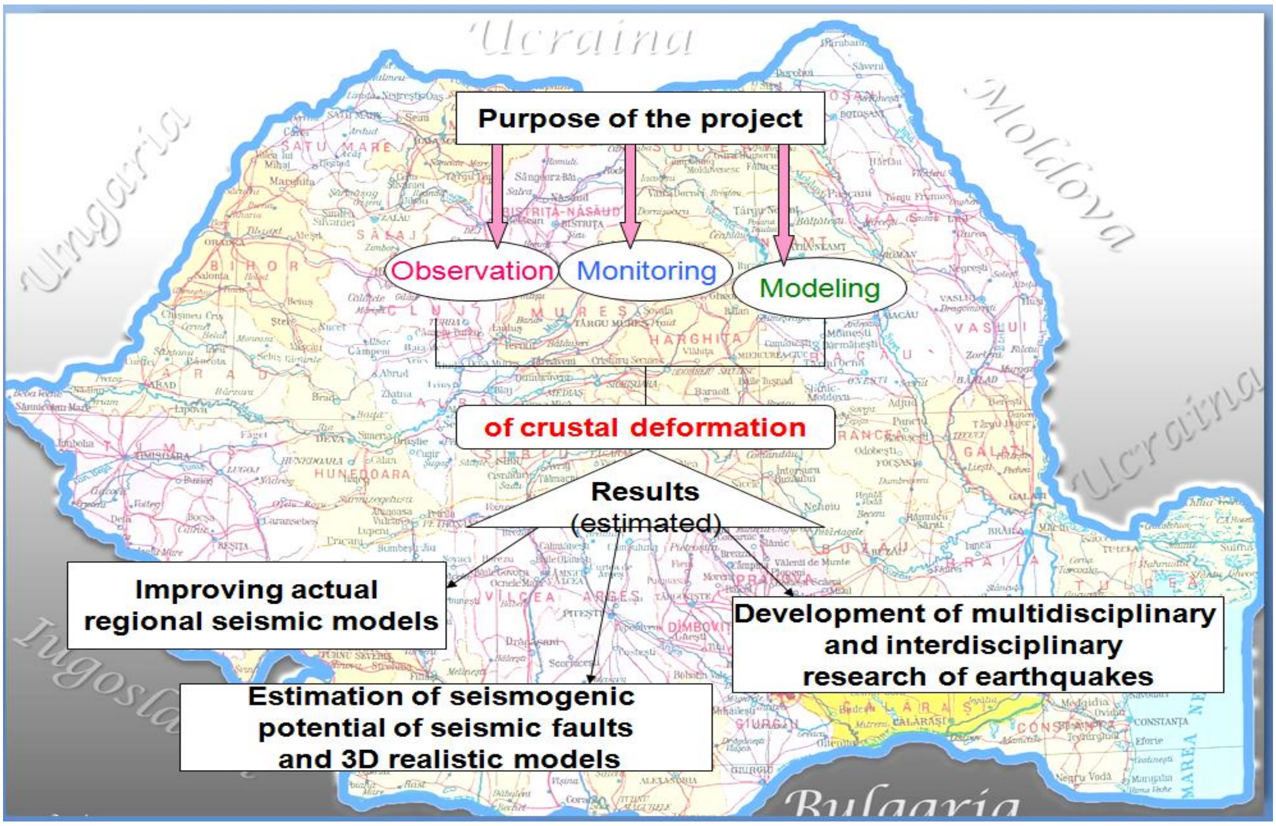
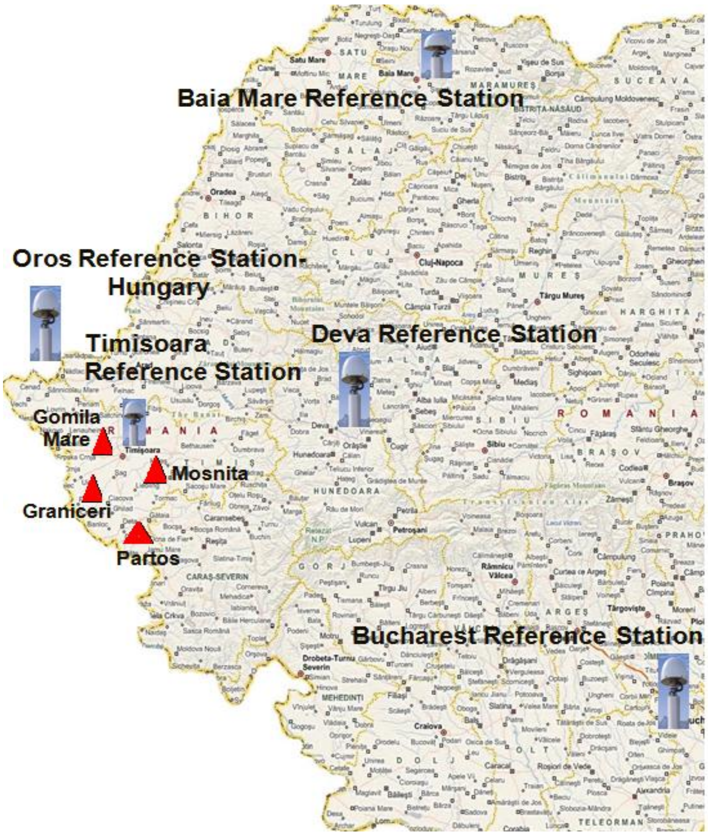


Fig. 3.7 Research goals

The project is related to one of the most important research topics related to the quality and security of civilized society in the context of the implementation of the concept of sustainable development: Research priority area 8, space and security.
Regarding specific research objectives, the project aims at offering the following topics:
- systems and platforms for observation and monitoring ;
- monitoring natural disasters.

Natural disasters (in particular the earthquakes from Earth) and the dangers posed by man are monitored over the past decades through the most modern technologies using techniques of high precision and accuracy, based on unprecedented evolution of the IT industry, nanotechnology, etc. Contribution of the project to the development of knowledge in this field is done through the proposals made for innovative systems and technologies applied in the experiment proposed by the project.
Ways of disseminating the results mainly consist of promoting their academic level, through scientific articles published in magazines and also scientific papers presented (poster/oral) in the context of events in the field.

The proposed area for monitoring the faults system is approx. 500 km^2.
Starting from this control network it will be developed a secondary network of detail points on the direction of the estimated faults.
The proposed area for monitoring the faults system in Banloc is approx. 500 km^2
The idea of the project consists of combining the satellite information from EUREF permanent stations with data collected periodically from proposed interest points shown before.
It is also proposed the installation of a permanent station inside the yard of the seismologic observatory in Timişoara which, together with the other 4 points(Moşniţa, Gomila Mare, Grăniceri, Partoş – all of the first order in the national geodetic network), will generate a control network for measurements in the Banloc area.



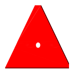
- 3 Reference Station of EUREF

Reference Network:

Oros-Hungary, Baia Mare, Deva;

and 1 Reference Station of National

Network of Permanent GPS Stations: Bucharest



- 4 points of National Geodetic Network:

Gomila Mare, Mosnita, Graniceri, Partos

Distance maximum: 48 km

Distance minimum : 2 km

Fig. 3.8 GPS network

Starting from this control network (fig. 3.9) it will be developed a secondary network of detail points on the direction of the estimated faults.
Integration of these data with crustal seismicity, surface geology, and topography through a Geographic Information System (GIS) approach places critical constraints on the geodynamic settings for identifying the distribution, geometry, and type of active crustal faults, for elucidating the spatial relationship between the crustal structures and mantle seismicity.
With GPS geodesy can be recognized times and locate areas of increased geophysical activity by mapping crustal deformation, seismicity, and other factors.
The experiment to be achieved within the proposed project can become a permanent and viable component of a ”natural pilot laboratory”, with the possibility of being developed for an interdisciplinary research of earthquakes from the western part of Romania.

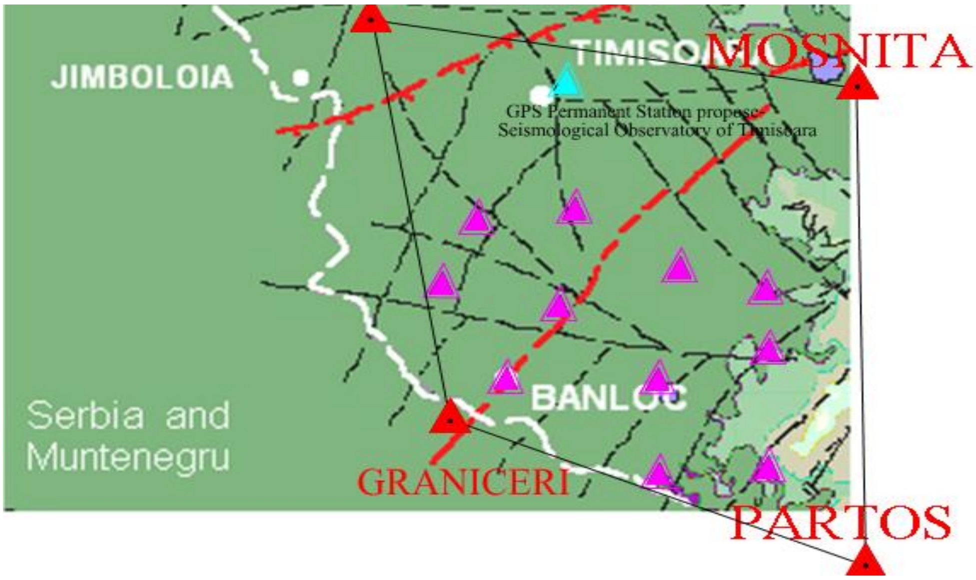


Fig. 3.9 GPS monitoring network (proposal) of the Banloc seismogenic area

The results obtained from the experimental measurements in the framework of the project – seismic and geodetic – can contribute to obtain information to improve the actual regional geodynamic models.
The 3D realistic models of seismic faults and the estimation of their seismogenic potential represent a key element to seismic risk mitigation. We expect to apply the results to initiate future research projects related to precursory phenomena for earthquake prediction in the area. The experiment within this project has real chances to be a permanent and viable component of a "Natural pilot laboratory", which can be developed for a multidisciplinary and interdisciplinary such researches.
It is anticipated the transfer and the applicability of the results for initiation of other projects about the natural precursory phenomena of the earthquakes willing to minimize destructive effects on the natural environment and society.

(Național Research Project PN II,
Monitoring crustal deformation field in seismic area of Banat County using satellite positioning techniques in Geodetic micro networks for realistic modelling of the local sources and evaluation of their seismogen potential.
Research theme: Observing the parameters of natural field in order to ensure safety threshold in the management of the territory)

3.3 Noise management and noise monitoring with GIS

Noise is defined as a multitude of overlaid sounds. However, the sounds are part of our everyday life and help us communicate. Physically they represent waves which make up stimuli (physical) for ears. The problem occurs when the noise becomes annoying, i.e. when it exceeds the accepted noise limit.
The phonic pollution is a result of industrialization, migration of people, and of the large demand of products. All these factors lead to an excessive traffic increase. Noise has become a major problem not only in metropolitan cities, but also in small villages traversed by national or county roads.

This kind of pollution is generated by all kinds of means of transport. One of its peculiarities is the repercussion it has on people.
Noise is a very annoying phenomenon which contaminates the environment and affects negatively the health of the people exposed to high levels of ambient noise, i.e. over 70dB (A) or even lower. The main objective of applying the provisions of *The White Paper on the Common Transport Policy of EC*, since 2011, and of the package *Ecological Mode of Transport* is to reduce the excessive exposure of the population to noise levels above the average ones admitted /tolerated. Thus, a careful control and monitoring of the decibel levels emitted, mostly in urban areas or within their surrounding areas, would be possible, together with the identification of certain solutions and the implementation of some programs able to considerably reduce the phonic pollution.
Even if the urban noise is not a recent issue, the research on the phonic pollution is rather new. The first main important research in the world on noise was made in London in the 60s.
A corresponding network, both from the qualitative and quantitative point of view, can constitute the support of the mobility requirements of the population, i.e. mobility as purpose and means.
However, out of all the means of transport, the road transport seems to be the most attractive, as it favours a fast transport anytime and anywhere. This road mobility comfort has led to an exponential traffic raise and implicitly to the increase of the phonic pollution produced by it. Therefore, there is a need of research able to identify measures to reduce the level of the noise caused by road traffic. Various solutions are foreseen to ameliorate or even reduce the noise levels, not only from the technical point of view but also from the economical one, too.
The cheapest solutions for the reduction of the phonic pollution refer to: speed limitations, restrictioning the access of heavy vehicles in certain areas or in certain time intervals; this reduction reaches a non-negligible value of 6 dB (A). The variant of a phonic and thermic isolation of the buildings is also economical, reaching a diminution of 54dB (A), but it is a partial protective measure as it protects only the people inside the buildings and does not really reduce the noise level. Other feasible options are much more expensive and require funds from the local budgets or non-reimbursable European Union funds.

NOISE MAPS

To apply the norms on the control and monitoring of noise, as well as, to create common references and standards, it is necessary to draw up documentation and maps. Modern GIS technologies use digital information, for which various digitized data creation methods are used. The most common method of data creation is digitization, where a hard copy map or survey plan is transferred into a digital medium through the use of a computer-aided design (CAD) program, and geo-referencing capabilities.
New informatics technologies, such as Geographic Information Systems are used in the policies of making traffic more efficient. They are totally in compliance with the needs and health requirements of the territorial communities. The accuracy of the noise maps depends to a great extent on the data gathered and introduced into the Geographic Information Systems data bases. Therefore, it is advisable that monitoring noise installations be installed for urban agglomerations, function to the number of inhabitants and the allotted budget. These are the important textual elements of the Geographic Information Systems and have the purpose to record the noise level along a whole year.
We can obtain high accuracy noise maps with the help of the data stored and periodically updated with the measurements made in pre-established strategic points. Having real data, the plans with measures to reduce the noise caused by road traffic would be realistic, i.e. it would be certain that the money invested in the studies as well as and in the attenuation measures would have results. The effect would lead to the reduction of the number of people exposed to noise, and consequently to the increase of the health level of the urban inhabitants.

A useful tool leading to noise pollution evaluation is represented by **topographic maps** which can also integrate the corresponding database, type GIS; all these are necessary in order to monitor the road traffic noise generated on the national roads with the software SoundPLAN.
From 2006-2008, it took place the first stage in the process of developing, evaluating and monitoring the noise made by the road traffic on the national roads. It recorded, at least, 6.000.000 crossings/ year. The second stage of data gathering was in 2012, and recorded all the road sectors with an annual traffic, higher or equal to 3.000.000 crossings. The Geographic Information System was to be implemented in 2013; for its update, the same level of detail of the common elements was met: to reduce costs and the execution time, on the whole.

THE ADVANTAGES OF USING THE GEOGRAPHIC INFORMATION SYSTEM

The use of the GIS in noise mapping has certain advantages:

- The management of information in the system GIS leads to data standardization that can be used for future reference;
- The quality of the data is superior thus offering a better comprehension;
- The possibility to centralize a large quantity of acoustic data in a single reference geospatial data base;
- The gathering of all important geo-spatial elements in a single unitary database system provides a better use of the information, as well as the possibility to make correlations;
- The correlation of the information obtained through systems GIS with the ones obtained from the programs to compute noise mapping determines a more efficient and precise monitoring and evaluation of the noise impact on the environment and on the public health.

Conclusions

Noise mapping is a new way to comprehend phonic pollution. An acoustic map has as the main purpose the identification of the strategic points, where pollution reaches peak levels, the identification of the noisiest zones and also of the non-impact areas, where pollution caused by road traffic is neglectable.
Considering the current need of permanent updating these maps can only be made with the use of a preformatted Geographic Information System. More than this, if the system is managed and monitored adequately by highly trained personnel it can provide useful information in fighting and preventing phonic pollution.
GIS usually aims to producing maps and plans, managing the number of persons affected by phonic pollution, identifying the optimal location for an investment, the study of the impact of a objective upon the environment complying with the general policy of sustainable development.
It is necessary to conduct a series of surveillance operations, evaluation, prognosis and warning for operative intervention in order to maintain environmental quality. Monitoring and management activity using GIS strategic noise maps has the effect of contributing to environmental impact assessment to improve environmental management.
By obtaining the above results mutual cooperation could be encouraged, experience could be shared. More than this, they could lead to European partnerships able to ensure a good management of the road mobility in compliance with ensuring an adequate public health. Thus, the use of the system GIS is foreseen as an indispensable tool in noise mapping.

3.3.1 Study case 2: Monitoring phonic pollution for Romanian road infrastructure

In recent years, Geographic Information Systems and spatial database technology are fast spreading across the tight circles of experts, working in the fields of geodesy and geography. In the first wave, GIS functions have been built into engineering applications, which were not just

GIS cantered (as for example road design, emission calculation, building site-plan, environmental management etc.).
If the Geographic Information System is properly queried, it will lead the appropriate information on the type of pollution and also on the features of the transport network. The databases specific to phonic pollution that assist the Geographic Information System have to contain all the elements required to combine the field of transport with that of phonic pollution (Fig. 3.10).

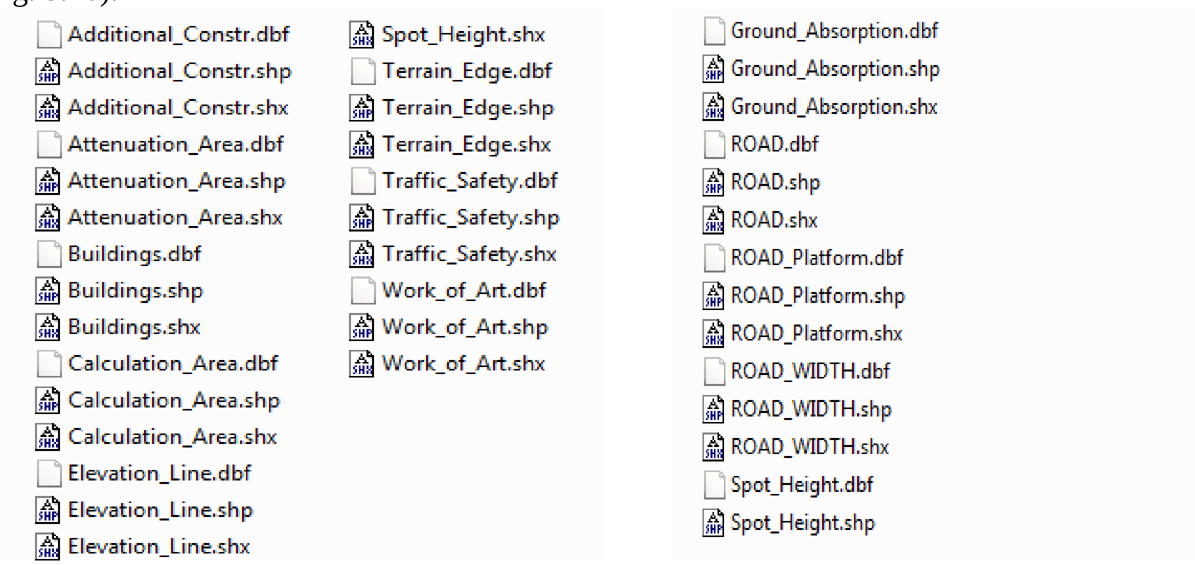


Fig.3.10 Elements of a database

The identification of those areas having high levels of noise and the drawing up of acoustic maps have become key elements within the context of sustainable development.
The research theme concerning the impact of noise pollution over the environment involvesthe national road infrastructure; part of the studies are presenting, as example, the surroundings area of the national road DN 15 11+600-21+0, near the locality Turda, Cluj County, Romania (Fig.3.11).

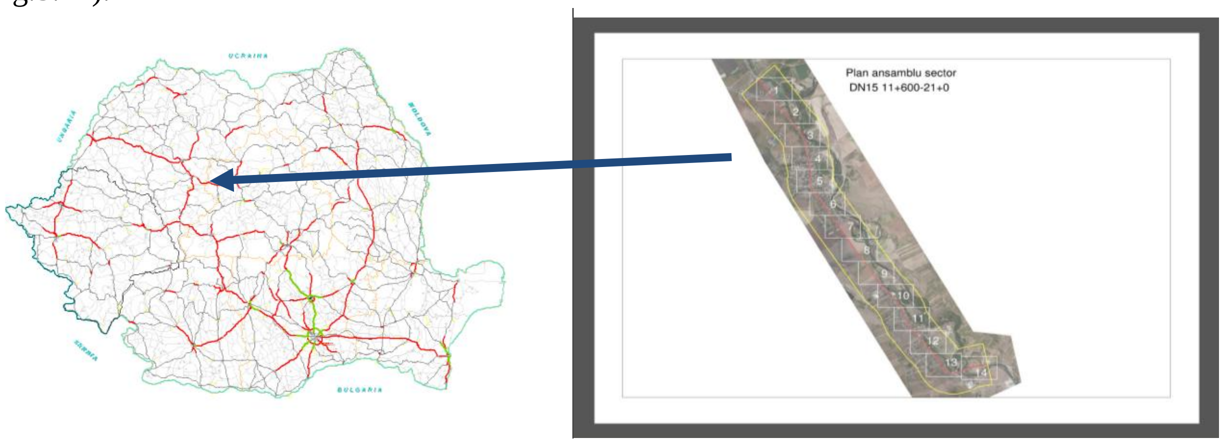


Fig. 3.11. Infrastructure sector under study

The support Geodetic Network that delimits the zone of interest (Fig.3.12) is in fact made by crowding the Spatial National Network and by static GNSS surveying, on the basis of, at least, three stations included in the service ROMPOS, framing the working area. It is intended to provide a density of 0.5 points per km/ traffic course.

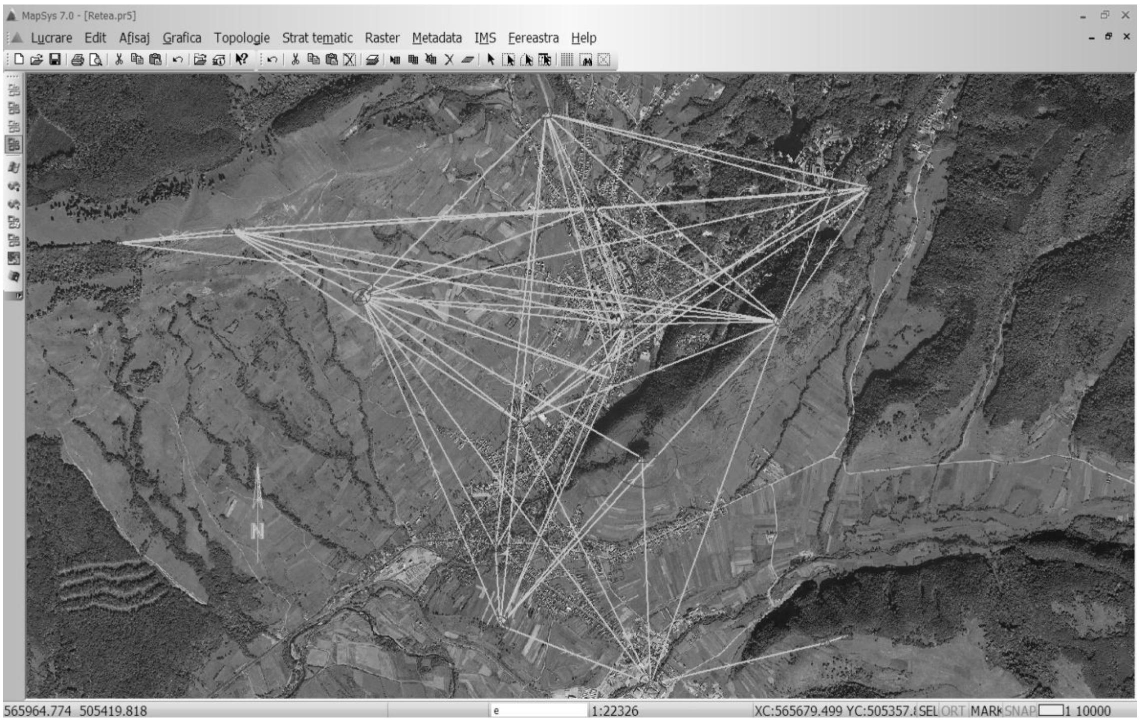


Fig. 3.12 Support network in the area (Turda)

Four FENO type benchmarks have been placed on the road section. The FENO landmarks have been used to create the geodetic support network which is in fact a thickening network of the Spatial National Geodesic Network. By setting the four terminals, one has intended to secure 1pt/ 2km road section as required. It has been decided that the placing of the terminals should be in the vecinity of existing milestones so as to find them as fast as possible, to grant easy acces, to protect them and to easily identify them as can be seen in figure 3.13.

Fig.3.13 Positions of the FENO landmarkers

The planimetric elements are edited at a scale of 1:500.

Contour lines have been generated out of the field data. These could be generated only by interpolation, with the provision to meet an imposed requirement of an equidistance of 1m. For each level curve, descriptive texts are to be attached with information on the its value.

The need of contour lines is essential to make the digital model of the field (Fig.3.14).

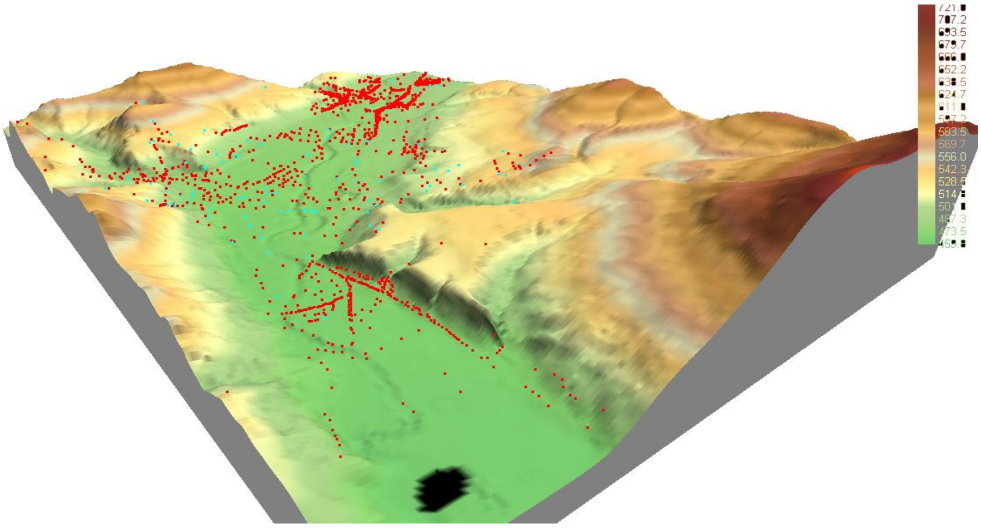


Fig.3.14 The digital model of the field in Turda area

The details of the digital map are reported by coordinates, with the help of conventional signs for a scale of 1:500 (Fig.3.15).

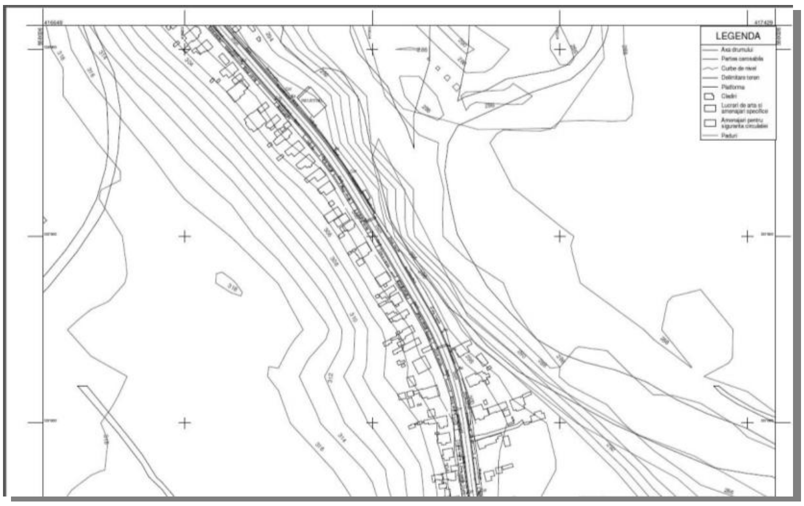


Fig.3.15 Topographic map made with Geographic Information System

The database, with geographic information for mapping a strategic noise map, is made up of an assembly of layers, called *Geo-Files,* in SoundPLAN language, which are to be created for each and every road sector and adjacent area. The files contains land information able to build its land digital model, regarding the road, its surrounding areas within the limits specified in the annex, constructions built in the area, as well as the number of inhabitants of the respective zone.

In the database (Fig.3.16), in order make a noise map, it is recommended that the noise absorption zones to be highlighted too, function to the type of soil: absorbent or secular.

The digital map contains information in .dwg format, the connection with the ortophotogrammetric images of the zones crossed by the road. The images have been used to mark off both the contours of the buildings and the layer as background for ensuring the suggestively of the map content in crowded urban clusters.

The digital map, corresponding to a road section, is to be made as a multiple of the interval between two successive kilometric boundary marker stones, thus ensuring their connection. In the cases where this condition cannot be met, the sectioning is to be made together with the beneficiary, so that the constitutive road elements be able to be connected easily.

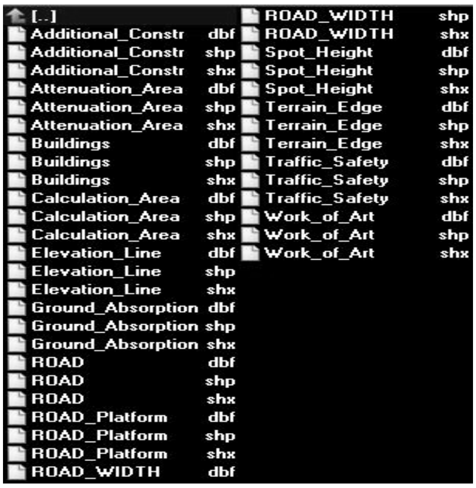


Fig.3.16 Elements of a database

The ground elevation of the planimetric details is to be made with instruments and technical methods able to ensure a precision determination of ± 7 cm. The planimmetric elements are to be edited for a 1:500 scale map.

In compliance with Directive 2002/49 CE relating to the environmental noise, it has been decided that the area of noise mapping should stretch across 500 meters both to the right and left sides of the road axis. Elements from the field have been topographically gathered as precisely as possible, thus allowing the drawing up of the electronic digital map in MapSys format but afterwards saving it in a DWG extension. For each element of a kind, one has used a specific layer and, for the urban areas, one has also introduced the corresponding photogram.(Fig.3.17).

For the described GIS to become a very complex one, considerable data input should be performed, such as:

- Land: contours lines, land boundary (footprint, safety zones and protection areas)
- Road: road axis, mileage, roadway platform, works of art, specific facilities, traffic safety facilities;
- Buildings: floor space, height, number of floors, use of the building (residential, industrial), the estimated number of housing, the estimated number of inhabitants;
- Soundproofing panels
- Ground attenuation: it implies highlighting the sound absorption areas by the type of the soil, absorbing or reflecting (table 3.1).

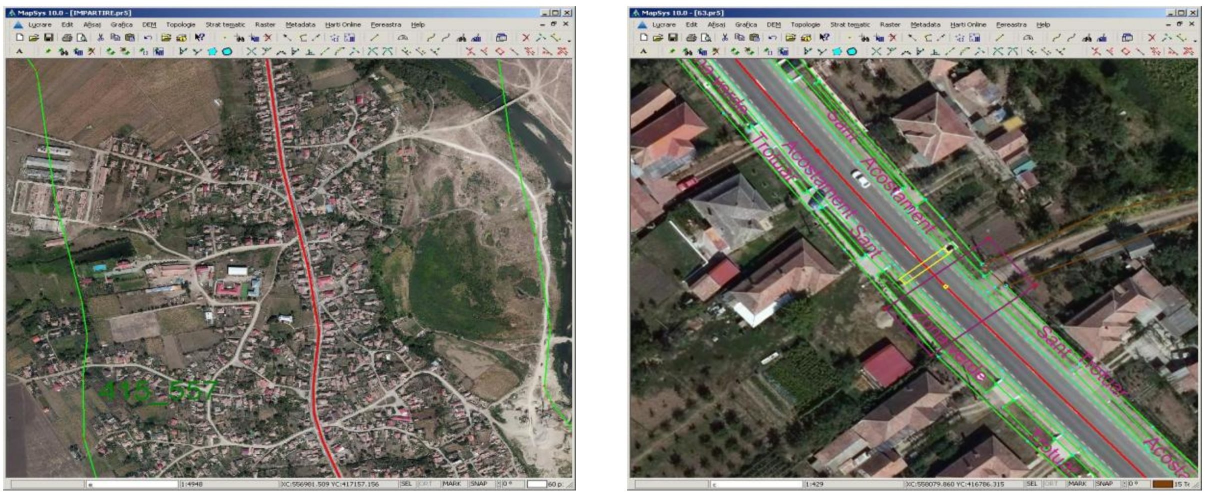


Fig. 3.17 Elements from the field with the specific layer

Table 3.1 Attenuation area

Layer name	The entity type	Colour code	Signification
Attenuation Area_G	Closed polyline	11	Representation of attenuation area
Attenuation Area_T	Text	11	Information about soil absorption(1) and reflective soil (2)

Ensuring that debates are underpinned by solid information we were able to achieve noise maps. The simplicity of using intelligent digital map makes it possible to effectively and clearly display the relevant information, which is so necessary in the process of decision making.
Modern GIS technologies use digital information, for which various digitized data creation methods are used. The most common method of data creation is digitization, where a hard copy map or survey plan is transferred into a digital medium through the use of a computer-aided design (CAD) program, and geo-referencing capabilities.

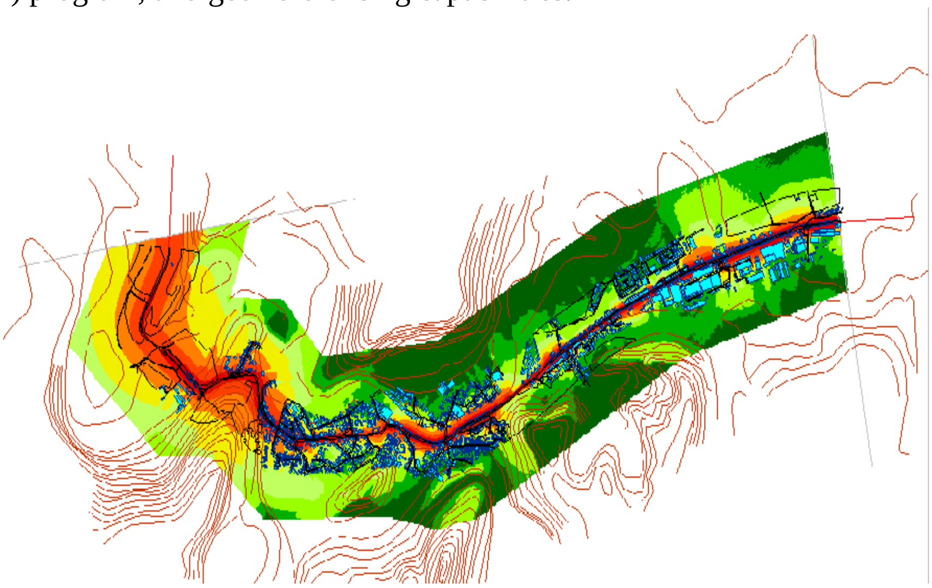


Fig .3.18 Noise map: DN15 11+600-21+0, Romania

The position of all the constructions typical of a road (bridges, footbridges, viaducts, tunnels, dams, drainage channels, protected slopes, parapets, protective forest belts, passages, gutters, ditches, etc.), as well as their planimmetric shape, was established once some topographical measurements had been made. Every single project form the ones listed above follows a series of technical characteristics established according to the topographical plans (detailed plane). The focus was laid on the accuracy of the data, as once these were introduced correctly, they were expected to offer clear and convincing results. To this aim, the process of mapping involves a constant updating and verification of all the parameters and coordinates from the field.
The strategic noise maps are created on the basis of some geographical information gathered in a collection of layers. The data collected from the field are transposed into a digital format of the field, where the following are marked down: the road, the neighboring areas having the limits specified in the appendix, the buildings erected in the vicinity. The number of inhabitants living near the road in question, is also mentioned, so as to better estimate the impact noise has on human beings. The digital format of the field under study will eventually be transposed in a .dxf file meant to include each layer separately. The segment we are interested in will be renamed as follows: “sectordrum.dxf”.

The data provided for illustration in table 3.2 include both .dxf files, as well as .dwg ones. The elements presented here include: geographical network, control point, precise reference mark, station point, offshoot points and other detail points.

Table 3.2 Elements introduced in the .dxf file

Layer name	**Colour Code**	**Signification**
CAROIAJ_L	7	Geographical network, line or conventional sign
CAROIAJ_T	7	Geographical network, inscription on grid (coordinate values), text 1.5
PUNCTSP_P	7	Control point, Actual point
PUNCTSP_S	7	Control point, conventional sign
PUNCTSP_T	7	Control point (nomenclature), text 1.5
REPNIV_P	1	Precise reference mark, actual point
REPNIV_S	1	Precise reference mark, conventional sign
REPNIV_T	1	Precise reference mark (nomenclature), text 1.5
PUNCTST_P	4	Station point, actual point
PUNCTST_S	4	Station point, conventional sign
PUNCTST_T	4	Station point (nomenclature), text 1.5
PUNCTRD_P	2	Offshoot points and other detail points
PUNCTRD_T	2	Offshoot points and other detail points, (nomenclature, cod), text 1.5
PUNCTCT_P	10	Altimetric point, actual point
PUNCTCT_T	10	Altimetric point (height) text 2.0

For a better administration of the elements drawn from the database, the following colour code was preserved: 1- red, 2- yellow, 3- green, 4- cyan, 5- blue, 6- magenta, 7- black 10- dark brown.
The databases that assist the Geographic Information System specific to the noise pollution has to include all the elements required so as to combine the domain of transportation to that of noise pollution. The information obtained via the Geographic Information System, along with the results obtained from the calculation software for mapping the noise, determines both a more efficient and concise monitoring and evaluation of the impact noise has on the environment and on people's health.
Some of the negative/ harmful effects the increase in number of dB has on the human factor are presented below:

a) The first noticeable effect is that of the altering of hearing, as the repeated exposure of the eardrum to noise might harm it for a temporary or even permanent period of time;
b) Noise affects sleep, and the worst aspect of this drawback is represented by the high noise pollution near hospitals, where patients are in need of a restful sleep;

c) The heart, the brain and even the liver are the most affected internal organs;
d) The noise creates discomfort that leads to migraines, to the dilatation of the pupils, high blood pressure;
e) The noise has bad effects from both a social and emotional point of view, conversations are interrupted due to noise, people tend to raise their voices so as to be heard by their interlocutors, thus forcing their vocal strings

In order for noise pollution to be reduced, more than one measure could be taken, such as: appropriately keeping in good condition the roads and the vehicles, planting trees, the assembling of some sound absorption panels. Another measure to be taken into account is the constant analysis of the traffic and of the way in which it might be kept under control by the road police. Considering the current need of permanent updating these maps, it can be efficiently made with the use of a preformatted Geographic Information System. More than this, if the system is managed and monitored adequately by highly trained personnel it can provide useful information in fighting and preventing phonic pollution. GIS often leads to identifying the optimal location for an investment, the study of the impact upon the environment complying with the general policy of sustainable development.

(Doctoral Advisor UPT,
Phd Thesis, Anca-Maria Moscovici)

3. 4. Using geographic information system analysis in the management of flood risk and landslides areas

Such a research subject is integrated within the larger context of global change, which is at this time in a stage of unprecedented evolution. In the last decades, the number of meteorological and hydrological disasters has gradually grown worldwide, thus affecting hundreds of million people every year. As a consequence, it is absolutely necessary to understand the vulnerability and the sensibility of the human community on medium and long term to hydro meteorological risks and the stringency for interdisciplinary studies related to flooding. Therefore, the experts in this field are faced with the assignment of developing evolution and prediction models. Floods represent the most frequent disaster that can occur on various scales, ranging from large to small rivers, with impact on the state of the environment, including not only economic loss and ecological imbalance, but also claiming numerous human lives. As Geographic Information Systems (GIS) and spatial database technology are fast spreading across the tight circles of experts, working in the fields of geodesy and geography, managing areas prone to floods by means of this new technology became a challenge

The beginning of the third millennium finds mankind in the face of a considerable number of unsolved problems. One of the most concerning, through the immediate long term effects, is tied up to the environment. The society is more conscious of the profound significance natural hazards have in its development. A hazard is a very damaging natural or anthropic phenomenon, whose occurrence is due to the overstepping of safety measures each society has to observe. A hazard turns into a disaster if there are at least 10 human lives lost or 50 people injured and material losses of over a million dollars. Therefore, in case of disaster’s occurrence, our top priority should be to prevent the consequences, especially to avoid human and material losses.

Floods represent one of the most destructive natural disasters worldwide and, as it is highlighted in the figure below, (Fig. 3.19) they are the most wide-spread type of hazards on our planet, representing up to 37% of the total number of hazards.

The impacts of floods are expected to increase due to **population growth**, **population migration** to coastal areas, and **climate change effects**, though risk assessment projects are needed.

They involve (1) hydrological, (2) hydraulic, and (3) socio-economical studies and usually require a large amount of data. Unfortunately, high costs and technical difficulties are involved in the implementation of each project component and limit flood mitigation efforts.

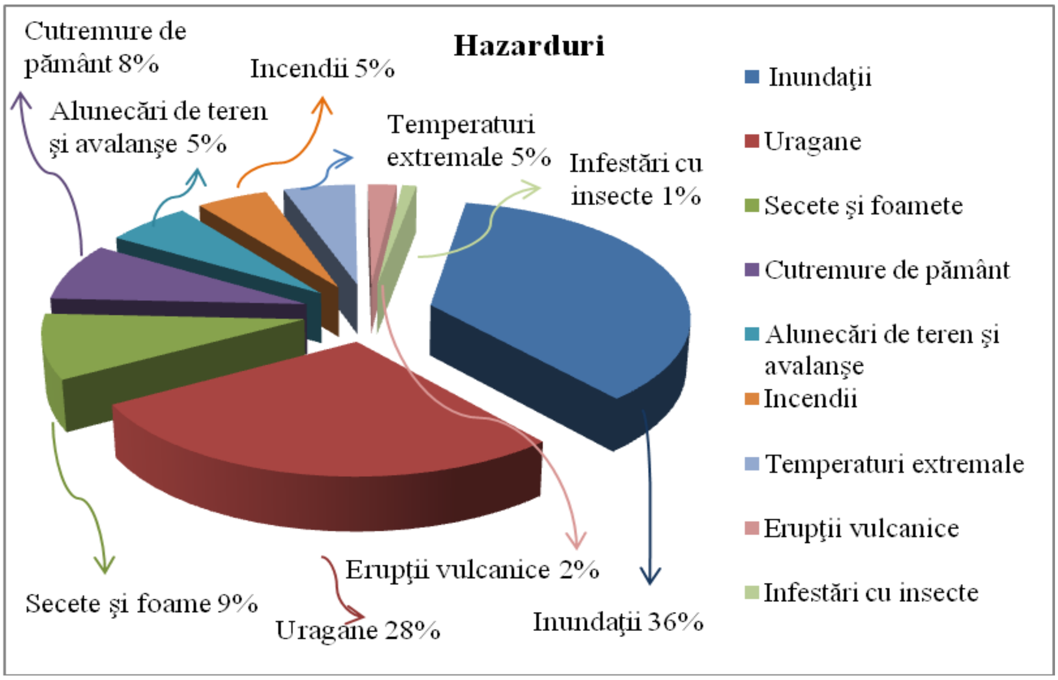


Fig. 3.19 The proportion of different disasters (%) worldwide at the beginning of the XXI[th] century

The aridity tendency, manifested especially in the last two decades of the past century and continuing in the current century, is due to the rising of air temperature, associated with the decreasing in precipitation quantity. On this climatic background, respectively arid, at least in Romania, many floods occur, caused by the large quantities of precipitations, which fall in short intervals of time, in the order of hours, sometimes even minutes.
An analysis on the periodicity of the meteorological and hydrologic regime on the territory of Romania on 120 years (1881-2001) outlines three regime states: rainy, normal and arid, with periods ranging from 11 to 20 years.
What is happening in Romania, referring to the two categories of hydro meteorological phenomena – droughts and floods – represents a consequence, firstly, of the global climate changes or the variations of climate at global and regional level, and secondly, of the anthropogenic intervention in the landscape.
The studies undertaken by the Intergovernmental Committee on Climate Changes and the European Environment Agency show that the average temperature of air on planet Earth has increased with 0.6°C in the last century and that, this increase in temperature has been three times faster after 1975, on one side, and that the atmospheric precipitation increased with 10-20% in Romania (like in other European regions), on the other side. If in terms of the thermic regime, predictions can be made with a certain degree of accuracy, the precipitations regime is seldom, with a high degree of unpredictability.
These climatic states can be attributed to the increase of greenhouse gases and aerosols, significant deforesting at global level – which modifies the circulation of air masses – and the expansion of the irrigated areas and of the reservoirs on major hydrographical arteries.

In Romania, due to these overall changes, the accentuation of floods occurrence in the small hydrographical basins is caused by uncontrolled deforestation effectuated after 1990, triggering a rapid flow of water on slopes, the intensification of soil erosion and landslides, the warping of river beds and house holdings construction and other utilities in floodable areas.

The necessity of this study arises from statistical records which show that catastrophic floods have occurred with regularity in Romania, these being a consequence of the temperate continental climate: in the 16th century 10 major floods have occurred, while in the 17th century there have been recorded 19 floods, in the 18th century, 26 floods are mentioned, in the 19th, 28 and in the 20th century, 42 floods. As it can be observed, the frequency of floods has increased, first of all due to climate changes, but also as a consequence of the reduction of the transport capacity in the river beds of the hydrographical arteries, as a result of river deposits, damming, deforesting in the reception-collection basins and different constructions in the floodplains.
The year 2005 can be considered a year of floods for Romania. The high floods have been generated, in the first month (from February to April) by the superposition of rains and snow melting, especially in the Banat area; afterwards from June to September, the high floods were caused by brief torrential rains (heavy rains) with a high intensity in short intervals of time, in the order of 2 to 3 days.
An analysis of the floods produced in Romania in the last 35 years, taking as landmarks the years 1970 and 2005, underlines the following:

- floods in 1970 have been restrained, as interval of time, to the months May to June and have occurred especially on the Rank (Order) I rivers – Someş, The Criş rivers, Mureş, Olt, Argeş, Siret, even on the Danube;
- in the year 1970 there have been recorded the largest homologated river flow rates;
- in the year 1970 there were fewer reservoirs to mitigate the floods and fewer dammed areas in the river beds;
- material damage and life loss have been much greater in 1970 in comparison with the ones in 2005;
- floods in 2005, with the exception of some first order streams (Siret and its tributaries, Buzău, Trotuş, Putna, Mureş, Ialomiţa), have occurred on small rivers, but have had a greater degree of territorial expansion, sometimes with a repetitive character (Trotuş, Buzău, Ialomiţa).

Managing flood risk areas by means of GIS technology can serve as a basis as for creating flood warning systems which are developed all over the world with the fundamental aim of increasing safety and reducing the harmful effects of floods.
Geographic Information Systems are suitable for handling vast amount of geospatial data characteristic to both urban and rural areas. Beside the ability of producing maps and plans, GIS is the right tool for managing network utilities (water-supply, sewerage system, mains, district heating, roads and railway system etc.), identifying the optimal location for an investment, the study of the impact of a certain objective upon the environment complying with the general policy of sustainable development in lower costs. Constructing a GIS is a difficult process, where a complex of scientific, engineering and organizational problems should be solved.
The modern GIS was used for creating the experimental part of the research as it includes traditional flood mapping and represents a pillar in the decision making phase referring to the management of areas affected by the flood phenomena.

3.4.1 Study case 3: Monitoring flood risk areas and landslides in west side of Romania

The Western Region has a surface of 32.034 sqkm (13.4% of the country's surface) and is formed by four counties (Arad, Caraş-Severin, Hunedoara and Timiş); it is composed by 42 towns (out of which 12 are cities) and 276 communes (318 administrative units). The population of the region is in the range of approx. 1.930.458 inhabitants, with a density of 61.1 inhabitants/sqkm. The urbanization level of the area (63.3% of the population is urban) is higher then the national level (54.9%). The Region is composed by four counties:
•the Timiş County, with a population of 660.000 inhabitants and a surface of 8697 ha;
•the Arad County, with a population of 462.000 inhabitants and a surface of 7754 ha;

•the Hunedoara County, with a population of 486.000 inhabitants and a surface of 7063 ha;
•the Caraş-Severin County, with a population of 333.000 inhabitants and a surface of 8514 ha.

In the Timiş County there are some areas with natural risks (fig. 3.20), such as areas liable to inundation, unstable areas, pollution sources, terrains sensitive to humidity, terrains with high deformations, areas for attenuation of freshets, areas with landslide risk, zonification from the point of view of the seismically activity or areas where flooding occur due to the overflowing of the rivers. One can acknowledge the presence of areas with landslide risk, areas with high deformations of the terrain, as well as areas exposed to flooding due to torrents, which are concentrated in the Eastern, North-Eastern and South-Eastern parts of the city of Timişoara. In the Western and South-Western parts of Timişoara, one can find pollution problems, near the settlements with zootechny, while in the Southern part of Timişoara lays an area with high seismically risk (surface earthquakes, characteristic only for this area).

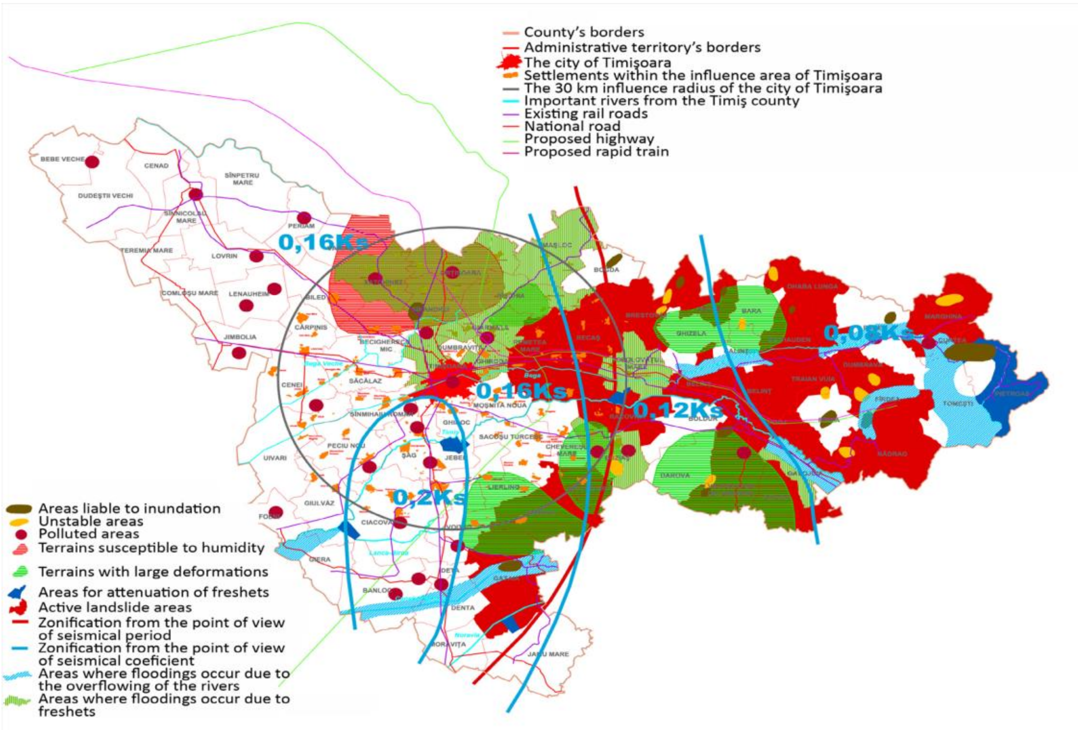


Fig. 3.20 Timiş County - areas with natural dangers

A) Our methodology was based on using the GIS technology due to its advantages for the management of **flood risk areas in Timiş County**. The first step consisted in procuring the raster images in *.tif format (Fig. 3.22) needed in the study.

Fig.3.21. Location of the studied area

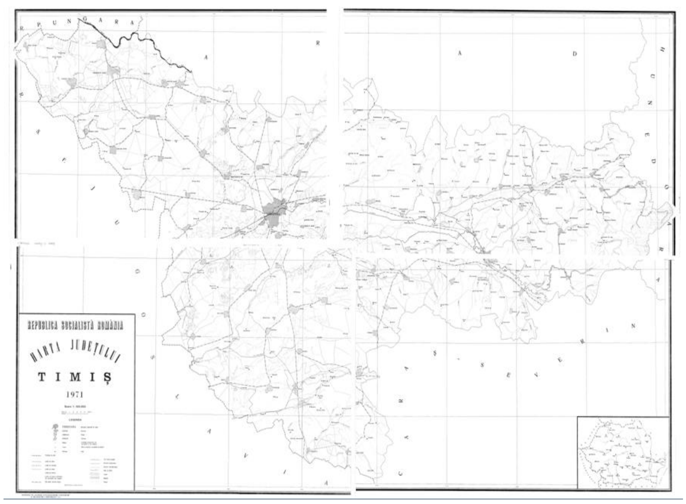


Fig.3.22 Raster images of Timiş County

For their geo-referencing in GeoMedia software, we had to transform the rectangular coordinates characteristic to the Stereographic 1970 Projection into geographical coordinates (longitude and latitude) using the TransDat 4.01 program (Fig.3.23), available for free on the Internet.

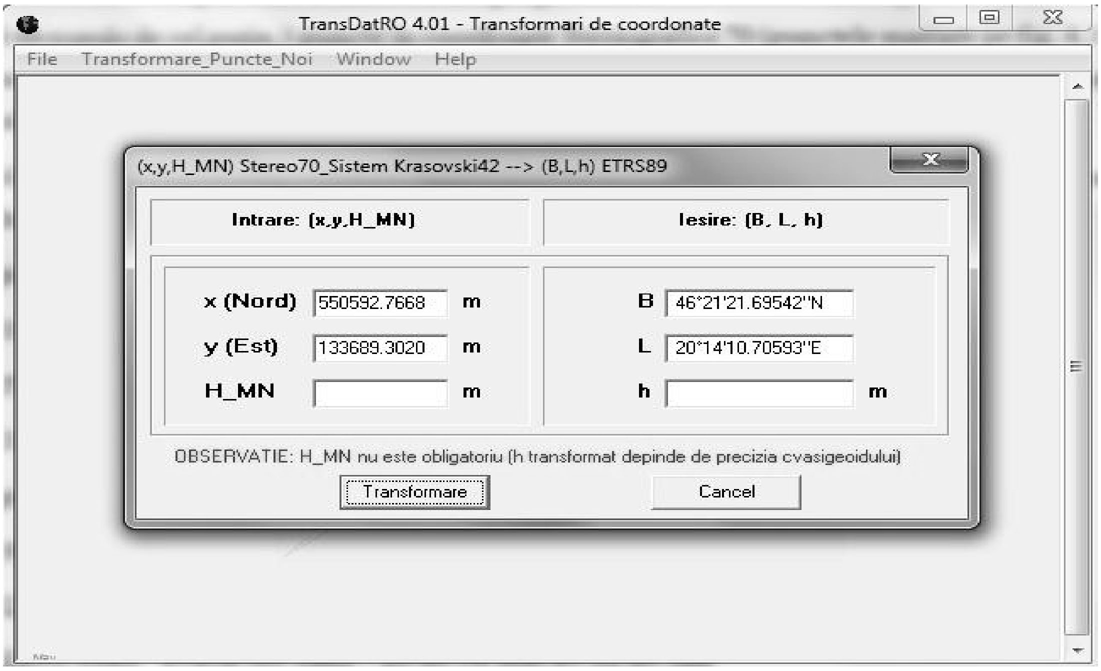


Fig.3.23 Transformation of the rectangular coordinates into geographic coordinates using TransDat 4.01

Geo-referencing the raster images implies inserting the reference points (Table 3.3) into the map window, bringing the images by turn and then using the ”Image Registration” command.

Table 3.3. The coordinates of the points used for georeferencing the raster images

Point number	X [m]	Y [m]	λ [º,´,´´]	φ [º,´,´´]
First image				
1	133689.3020 m	550592.7668 m	20º 14´ 10´´.705	46º 21´ 21´´.695
2	225334.1433 m	546417.2513 m	21º 25´ 40´´.257	46º 21´ 42´´.398
3	221188.0613 m	455418.4206 m	21º 25´ 37´´.323	45º 32´ 32´´.684
Second image				
1	219637.5331 m	408684.0721 m	21º 26´ 01´´.814	45º 07´ 18´´.531
2	222285.5761 m	478509.2903 m	21º 25´ 40´´.284	45º 45´ 01´´.283
3	162633.5343 m	458705.1862 m	20º 40´ 34´´.906	45º 32´ 45´´.388
Third image				
1	310985.8542 m	452299.6297m	22º 34´ 38´´.735	45º 32´ 40´´.774
2	219282.4469 m	455669.3259m	21º 24´ 09´´.074	45º 32´ 38´´.036
3	222147.1783 m	533630.5455m	21º 23´ 38´´.496	46º 14´ 44´´.141
4	313850.5855 m	530260.8493m	22º 35´ 01´´.810	46º 14´ 47´´.567
Fourth image				
1	219701.5343 m	474872.5754 m	21º 23´ 48´´.470	45º 42´ 59´´.878
2	311483.0607 m	471078.2419 m	22º 34´ 35´´.383	45º 42´ 49´´.238
3	308795.3203 m	406064.2110 m	22º 34´ 02´´.518	45º:07´ 41´´.664
4	217013.7939 m	409858.5445 m	21º 23´ 59´´.509	45º 07´ 52´´.733

The next step was to vectorize the graphic elements that were important in the study, such as localities' areas, villages, agricultural land affected by floods, hydrographical basins (Fig. 3.24) etc.

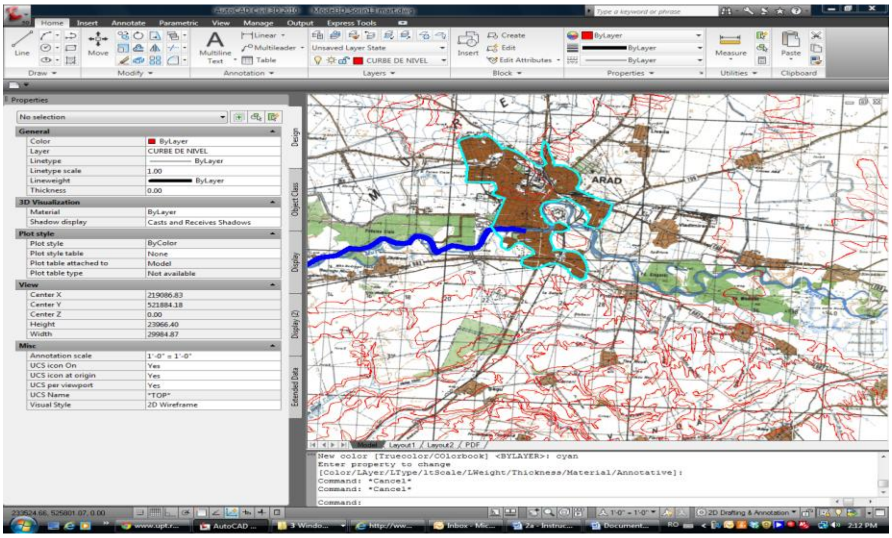


Fig. 3.24 Vectorization of hydrographical basins in Timiş County

At the end of each vectorizing process a dialog box appears (Fig. 3.25) offering the possibility of introducing the attributive data characteristic to that graphic element.
The management of flood risk areas by means of GIS technology presents several advantages, the most important one being the creation of digital maps which can be subjected to spatial analysis and interrogation of the data from the associated databases.

The maps of spatial distribution of flood risk areas can clearly indicate the most affected hydrographical basins, where preventive arrangements are necessary in order to stop or improve this phenomenon.
A good management of flood risk areas by means of GIS technology implies reading the adjacent digital maps in order to select those areas where the risk far exceeds the limitations conventionally (standardized, possibly) established and act locally through preventive and remedial measures.

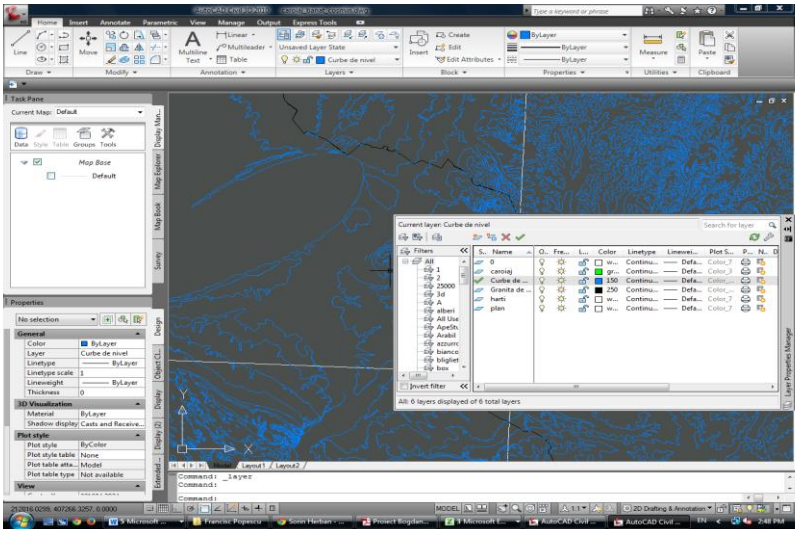


Figure 3.25 Introducing the attributive data

Conclusions

If Local Authorities in Romania would implement such systems, the management not only of flood risk areas, but also of landslides, erosion, earthquakes and fires affected areas would be facilitated. Thus, establishing risk ranges and colouring the map divided in sub domains, statistical study of the distribution of flood risk in the territory, extracting the areas of maximum attention on the map in order to locally prevent or remedy are some of the applications that could be available at a glance.
By means of GIS technology, after a thorough analysis of the map created, measures can be adopted in order to reduce the risk of flooding, such as:

- the development of maps with the areas in our country, alongside rivers, susceptible to flooding, but also of the areas cvasi-horizontal in the plains, where water can stagnate during periods with excess humidity;
- giving up on the generalized impoundment of the floodplains and of meadows and the construction of polders, as “breathing space’ in times of flooding;
- the construction of anti-erosive works in drainage basins and the de-warping of river beds;
- prohibition of any type of construction nearby the river beds, susceptible to flooding, on the strips marked with red;
- improving the efficiency of warning systems for dangerous hydro-meteorological phenomena;
- firm commitment of the authorities with responsibilities in terms of environmental protection, but also those of the national and local levels for the implementation of measures to prevent flooding and protect the population and the environment;
- educating the population to protect river beds from liquid and solid waste pollution and informing people about these phenomena and how they should behave if they occur.

B) The impact of landslides upon technological Peak access road Dranic – Orşova, Mehedinți county (stage 2010–2013)

The south-western region of Romania is confronted with instability phenomena, requiring timely detection of slide prone areas, in order to establish prevention methods and draft risk maps.

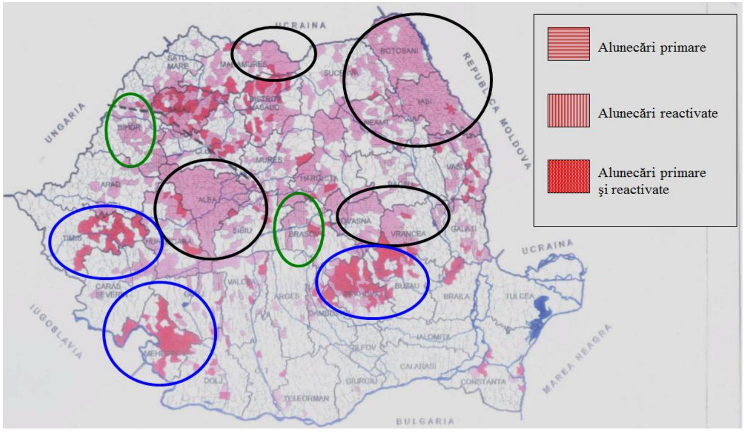


Fig.3.26 Romania – areas affected by landslides

Landslides are not characteristic to the Mehedinți County (Fig. 3.27), but in recent years there have been many such phenomena due to heavy rainfall, massive deforestation and lack of banks and slopes along overall communication ways.

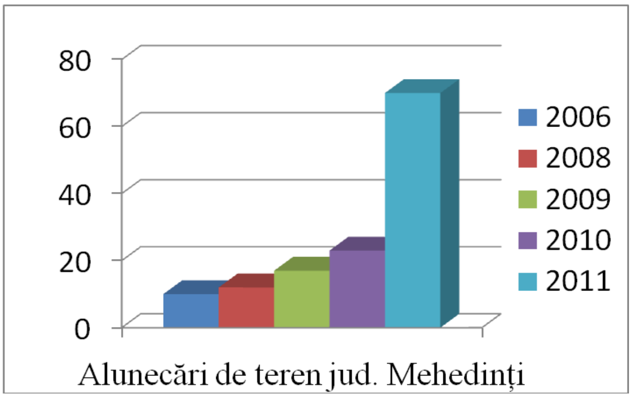


Fig. 3.27 Landslides in Mehedinți County

The research objective is to present the methodology, by means of modern geodetic techniques, of monitoring the behavior in time of a landslide occurred in Mehedinţi County which affected the approach road to 2 wind-driven electrical power stations of 3 MW located on Dranic peak. The necessity of the study emerged from the requirement of reengineering works. The technology used and the final deliverable, materialized as the three dimensional model of the terrain, emphasizes the importance and the applicability of geodesy in giving proactive solutions to engineering problems.

Purpose of the research study :

- ❑ the determination of the causes which have produced land slippage
- ❑ determining the movements of the tracking network
- ❑ the provision of measures to stabilize the road giving access to the 2 wind electrical power stations of 3MW set on the top of Dranic hill

The configuration of the terrain affected by landslides gives the incontestable basis for the considerations of topographical and geodetic monitoring.
The total station Leica TCRA 1205+ which has a sensitivity of 5^{cc} angle and distance of 2 ppm was used in order to perform the measurements of the landslide, under favourable conditions of temperature and environment (the temperature during the measurements was +20 º C in the morning and +30 º C at noon).
The processing of the field measurements was performed with the help of a software specialized in automatic data processing providing accurate results, Leica Geo Office Combined (fig.3.28).

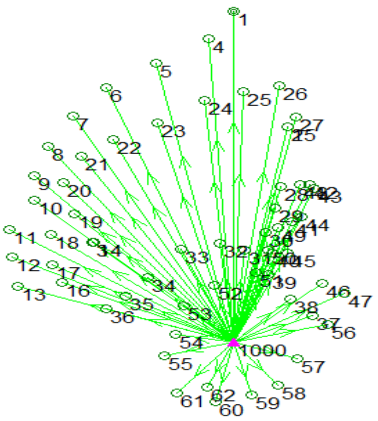


Figure 3.28 Sketch of tracking network for the landslide

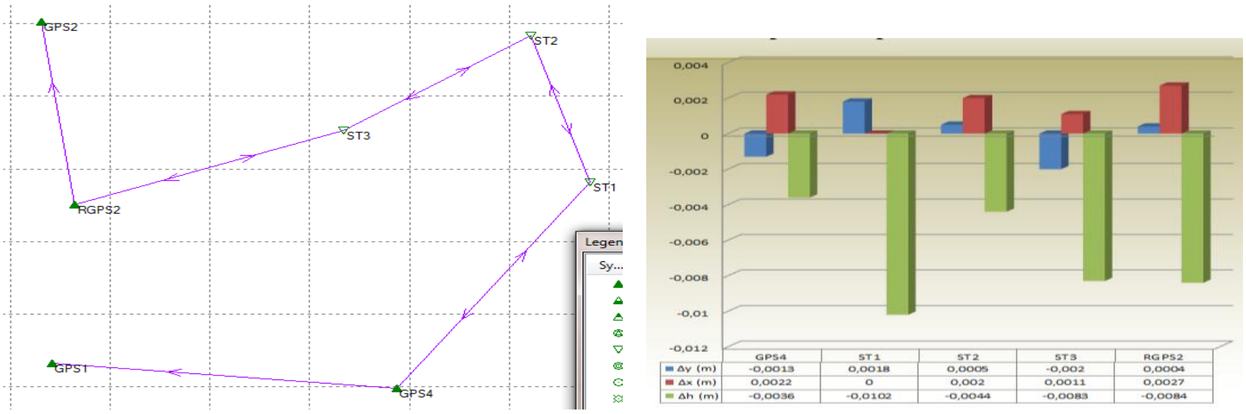


Fig. 3.29 The monitoring network and points displacement (2012-2013)

Digital Model of the Terrain allows a three-dimensional analysis of landslides; thus, using 3D models of terrain in a GIS application, volumetric calculations have become easier and more accurate, facilitating the process of obtaining the profiles and sections and also estimate of costs without having to build in reality.
For a better control and improving accuracy, there have been used both technologies, total station and laser scanner, starting with overlapping of the surfaces for the estimated period (2012/2013).
The scanning stage - field campaign, started on the 12^{th} of July 2012, at the same time with the topographic measurements performed with the total station.
Geodetic methods, as well as modern technology have been used for materializing a comparative study of digital terrain models of the area affected by landslides, obtained both with the TCRA 1205+ total station and with the C10 Scanstation terrestrial laser scanner. After performing and processing of the measurements, a file containing the planimetric coordinates of the points and their heights resulted. Then, this file was imported into the special software, Golden Surfer 8, in order to create the digital terrain model illustrated in Figure 3.30. Surface modelling is the process of plotting a natural or artificial surface through one or more mathematical equations.

Land surface modelling is therefore a special case of modelling surfaces in which specific issues related to the representation of the Earth, or parts of the Earth, need to be taken into consideration.

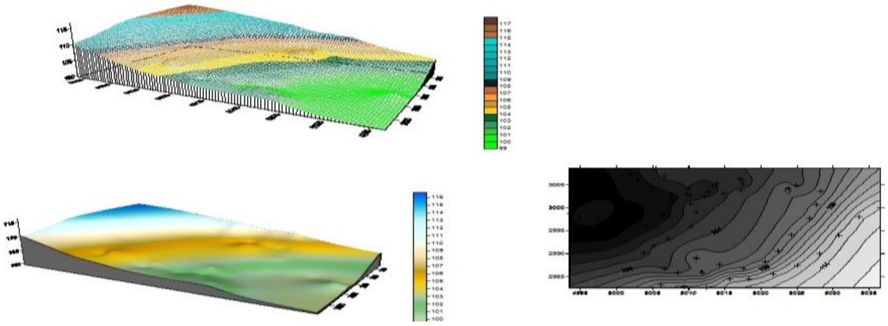


Fig. 3.30 Contour lines for the studied area (on the right side), schematic view of the created 3D object form and structure (Wireframe – top, left side) and the 3D model

Creating the digital terrain model through planimetric and altimetric precise measurements is of high importance because it can also be used for the calculus of:

- thickness and volume of the landslide body;
- length and width of the landslide body;
- partitioning surface area by establishing directions of slip;
- determining the longitudinal and transverse sections etc.

For creating land digital models, measurements must have a three-dimensional character. The measurements and the first iterations resulted in a data file with planimetric coordinates and absolute rates of measured points. Then, the file was imported into a CAD program, in our case the Golden Surfer 8 program.

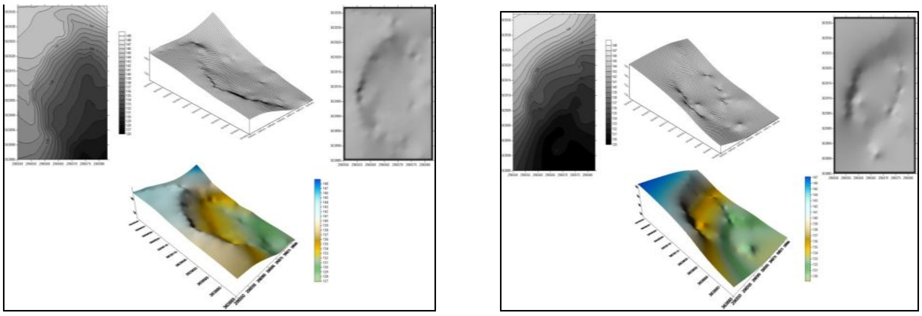


Fig.3.31 Surfer Processing

3D Model-2012 *3D* Model-2013

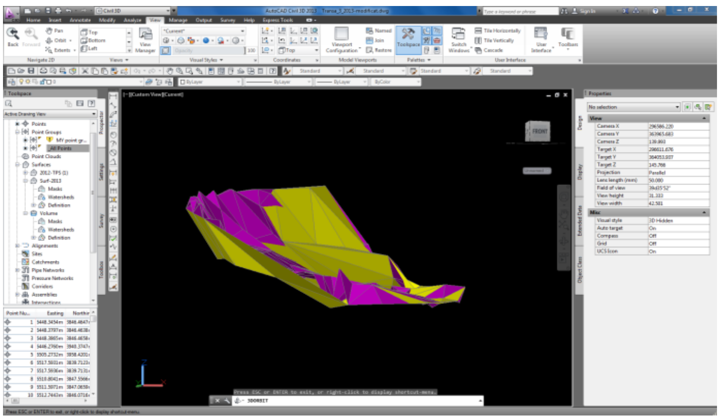


Fig.3.32 Overlapping surfaces (Civil 3D)

The three dimensional model offers multiple possibilities for working: correction rates, connecting elements that are part of the creation of a new product starting from the basic elements. Easy handling and complexity of information provided facilitates the design process. Finally, the data can be integrated and exported to other programs specialized in a particular field, such as: design, urban planning, tourism, real estates, police and security etc. Dimensional models can be, in turn, very helpful in specific analysis, but can also be sources for the implementation of another product.

By analyzing all data from the geotechnical studies as well as topo-geodetic measurements, it was concluded that the stabilization of the access road to wind aggregates can only be achieved through a complex work of embankments which necessarily must include:

- water drainage ditches at the intersection of two natural slopes that meet in the curve at km 1+ 642 having the purpose of discharging storm water and water from snow melting in the torrential valley at the base of the slope;
- compacting works of the earth massif at the base of the natural slope having the area between the layout line of the gabions and the torrential valley at the base of the slope. In carrying out this work crushed stone of large dimensions will be used for wedging of land in the area as well as layers of geogrid, for reinforcement of the massif, of a minimum thickness of 2.00 m;
- compacting works of the earth massif of the former alignment of the gabion structure that will be reinforced with geogrid layers to a depth of about 1.20 m;
- restoration of road embankment concurrently with the execution of gabions using layers of geogrid for soil fillings reinforcement up to the road structure;
- restoration of the gabion structure on the old alignment;

Future research will focus on the calculation of deformations and displacements for gauges placed on the sliding body that will result in future measurement instalments, thus further emphasizing the importance of collaboration of specialists from different fields in order to find pro-active solutions to engineering problems.

Table 3.4 Comparative study

Criterion	**Total Station TCRA**		**Scanstation C10**
	Civil 3D 2013	**Surfer 9**	**Civil 3D 2013**
Excavation volume	470,26m^3	482,041m^3	477,530m^3
Filling volume	235,47m^3	227,005 m^3	228,270m^3
Volume difference excavation – filling	234,79m^3	255,035 m^3	249,260m^3

Finally, the risk maps to landslides represent an important tool for management, useful for public local authorities in order to:

- establish measures of prevention and mitigation of natural risks from landslides
- the creation of early warning systems
- ensure the management of crisis situations in the event of a landslide
- identification and monitoring of risk areas
- detailing the minimum documentation demands of urbanism and landscaping in areas at risk
- the issuance of construction permits execution in risk areas

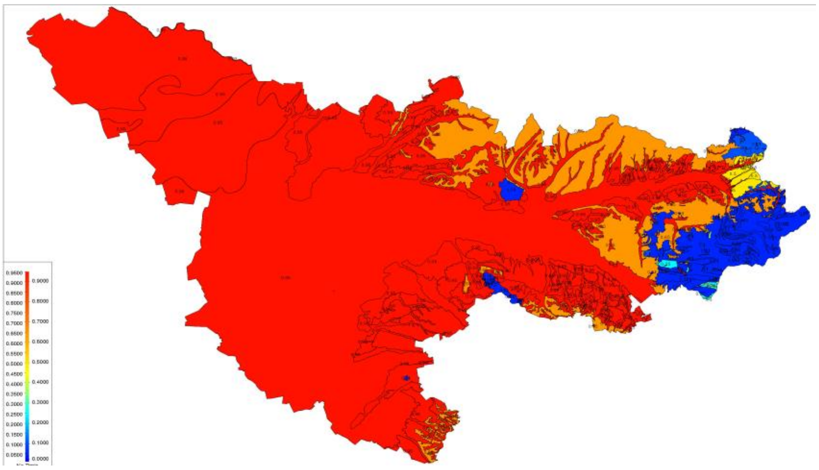


Fig.3.33 Risk map to landslides

(Doctoral Advisor UPT,
Phd Thesis, Timișoara 2014-Clara Beatrice Vîlceanu)

3.5 Monitoring special constructions behaviour in relation with environment protection

A) Dam monitoring

Environmental protection, as a relationship of mankind with nature, has evolved in time, as on the awareness of the entropic activities, with irreversible effects and with dramatic consequences on the modified natural environment.
Topographic and cadastral measurements have a special importance in the environmental protection research, especially for monitoring the effects of nature's geometrical modifications.
Dam monitoring has special importance because through a proper monitoring can be prevented unwanted events, that can be transformed in real social, economical, ecological disasters and therewith partially the design, execution and even exploitation errors effects can be removed. The surveying measurements made at Petrimanu dam have the porpose to determinate the vertical displacements of the marks, regarding environment protection, during Lotru - Ciunget HPP refurbishment.

3.5.1 Study case 4: Surveying monitoring for Petrimanu dam

Commissioned in 1972, Lotru-Ciunget Hydropower Plant (HPP) is an outstanding Romanian hydropower project, considering both its installed capacity of 510 MW, the largest in a project located on an inland river of Romania, and the complexity of the scheme.
Situated underground, 140 m below the thalweg of the Latorița River, Lotru-Ciunget HPP is equipped with three units of 170 MW each, with Pelton turbines and vertical, synchronous generators.
The technical characteristics of Lotru-Ciunget HPP ensure the following functions:

- peak load power plant, it covers the variable areas of the load curve;
- participation to power and frequency adjustment within the National Power System, being able to operate both under generator and synchronous compensator mode;
- emergency power plant; it can start operating at maximum capacity in 4-5 minutes;
- during high waters periods, it contributes to flash flood mitigation. These functions allow the plant to provide the services needed for the proper operation of the National Power System.

The storage Lake Petrimanu is made on the Latorița River and gathers most of the waters caught in the southern headrace network (without those accumulated in the Lake Galbenu and caption Înșiratele) from a 236km^2 surface. There are 28 captions; the gallery length is of 55,416m, and the caught flow is 5,384m^3/s. As a total the southern network has a number of 31 captions along the water course, the headrace length of 67.551m out of which 745m crossings and it catches a flow of a 7,514m^3/s.

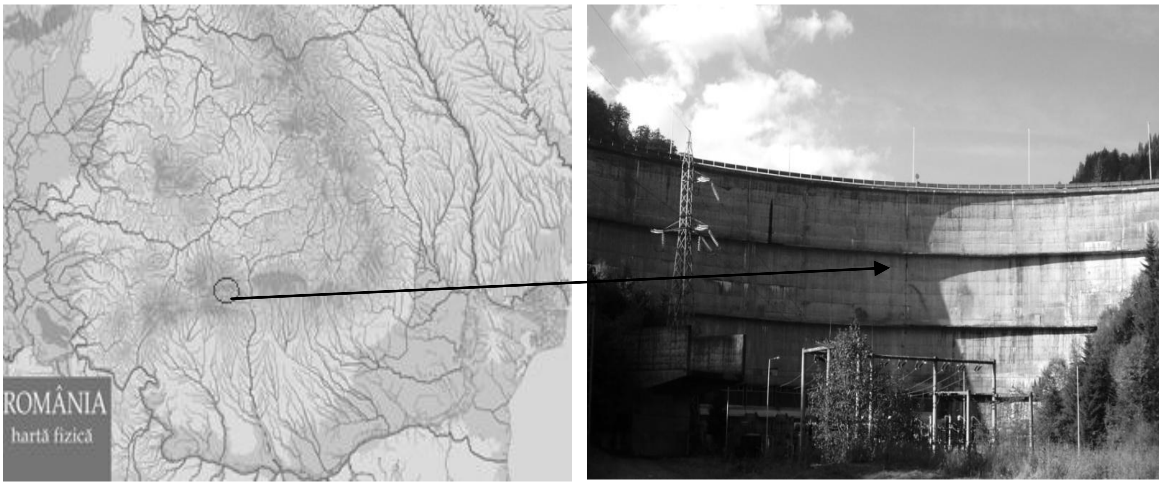


Fig.3.34 Petrimanu water dam

The development scheme of Lotru - Ciunget HPP is based on a modern principle regarding inflows and falls concentration, and consists of two main categories:

- The main diversion, where the inflows are collected and where the 4m^3/sec discharge is captured. It consists of the following elements: Vidra dam, creating a multi-annual storage with a volume amounting to 340 million m^3, water intake, a 13.7km long headrace gallery, surge tank, butterfly valve house, a 1.32km penstock gallery, spherical valves house, Ciunget underground power plant (510 MW), transformers hall, related cable gallery and tailrace.
- The Main Water intake network and secondary headrace – they collect the inflows both from the Lotru River basin and from the adjacent river basins. The collected inflows are gravitationally transported or pumped into Vidra reservoir, to provide the 809 meters head necessary for operation. This network consists of 83 water intakes, 4 concrete arch dams (Galbenu, Petrimanu, Balindru and Jidoaia) – three of them create pumped storages - and galleries amounting to 128.2km (fig. 3.32).

The storage Lake Petrimanu is made on the Latorița River and gathers most of the waters caught in the southern headrace network (without those accumulated in the Lake Galbenu and caption Înșiratele) from a 236 km2 surface. There are 28 captions; the gallery length is of 55,416 m, and the caught flow is 5.384 m^3/s. As a total the southern network has a number of 31 captions along the water course, the headrace length of 67.551 m out of which 745 m crossings and it catches a flow of a 7,514 m^3/s.

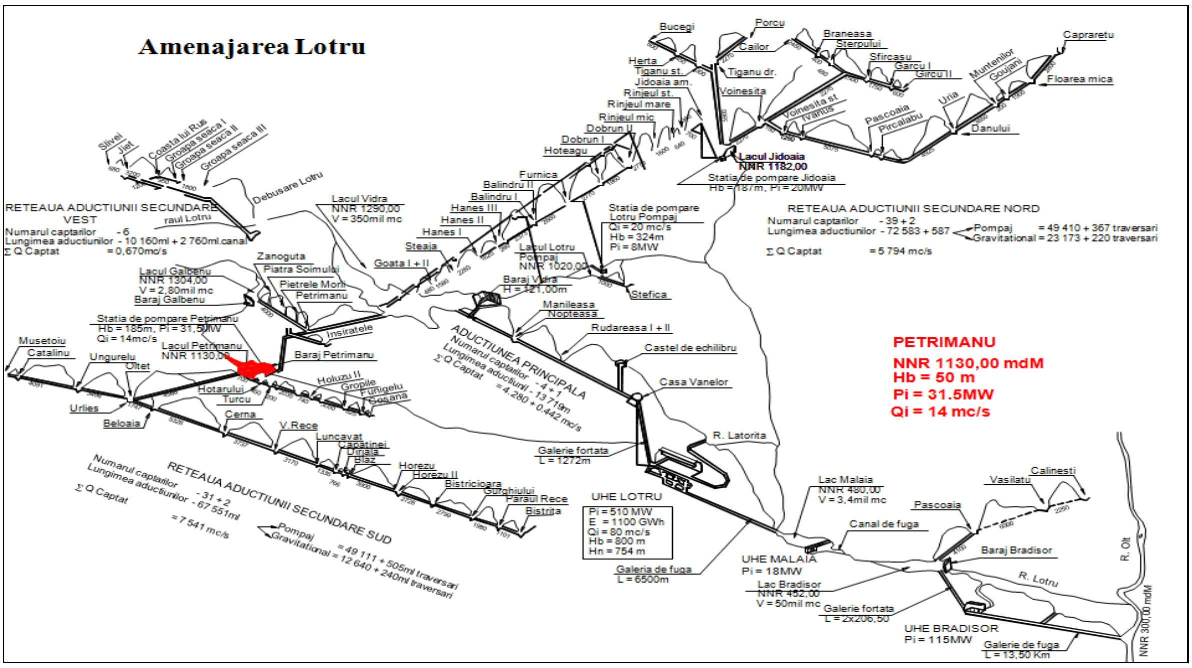


Fig. 3.35 Lotru water intake

RESULTS AND DISSCUSIONS

The refurbishment of Lotru - Ciunget hydropower plant, monitoring the hydro technical constructions is very important. During the refurbishment, the water dam was completely emptied.

The surveying measurements made at Petrimanu dam had the purpose to determinate the horizontal and vertical displacements of the landmarks.

For these determinations we used four measuring cycles: the ”zero” measurement (05.10.1976), the first measuring cycle (01.08.2009), the second measuring cycle (01.08.2010) and the third measuring cycle (04.10.2011).

”Zero” measurement was provided by the beneficiary. The following measuring cycles were part of our research. The first measuring cycle was made during special circumstances because the storage lake was emptied. During the second measuring cycle the storage lake was refilling and during the third measuring cycle the storage lake was completely filled. The atmospheric conditions, during the measurement cycles, were good (there were no rainfalls, the environment temperature varied between 12^0C and 15^0C), providing good working conditions.

The process for determining the horizontal and vertical displacements contains the following steps: surveying measurement performing, measurement processing and results interpretation.

The displacements were obtained as difference between the horizontal coordinates and heights, from ”zero” measurement and the same elements determined in the current measurement cycle.

For obtaining the water dams horizontal displacements (the direction upstream - downstream and left bank - right bank) we performed topographical measurements at the microtriangulation marks on the downstream parament of the dam. The microtriangulation network is composed out of six station points materialized by concrete pilasters and a number of twenty microtriangulation marks fixed on the downstream parament of the dam on three levels: at 1109m height - five marks, at 1124m height - six marks and at 1134m height - nine marks.

The measurements performed on the microtriangulation marks were made with a total station which has a measuring precision of 3 seconds. The measuring method used for the water dam horizontal monitoring was the complete series method. there were performed two complete series and the discrepancies in closing on the formed triangles do not exceed 20 seconds, satisfying the requirements of precision imposed by the beneficiary.

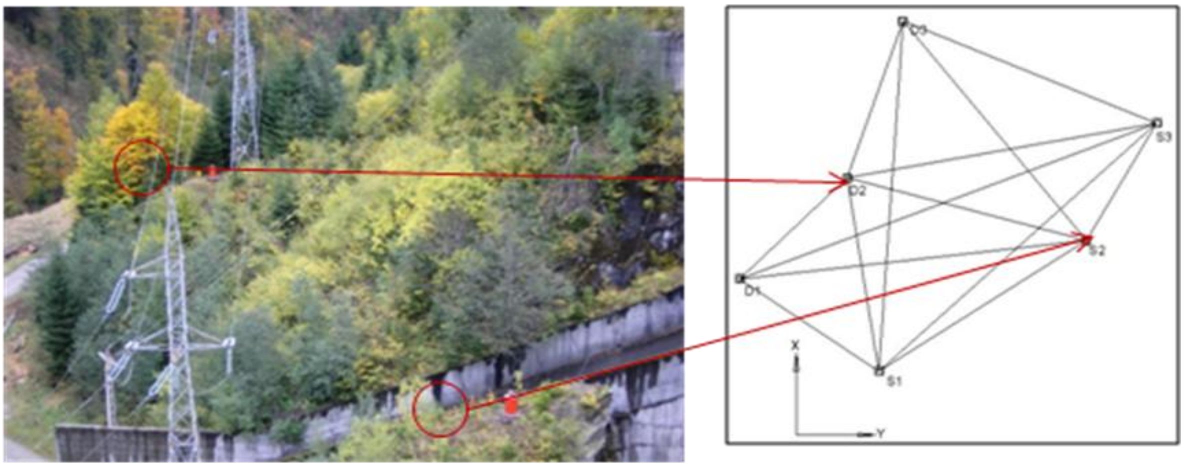


Fig.3.36 Station points from the micro-triangulation network

The measurements were processed with APORT 2000 software.
Below, are presented the processed results of the water dam monitoring as tabular form.

Table 3.5. The horizontal displacements from the micro-triangulation network

Differences from the reference cycle (mm)												
Mark / Measuring cycle	**D1**		**D2**		**D3**		**S1**		**S2**		**S3**	
	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy
Oct. 1976	*0.00*	*0.00*	*0.00*	*0.00*	*2.40*	*-1.90*	*0.00*	*0.00*	*1.80*	*0.60*	*1.80*	*-0.70*
Sept. 2009	-53.41	4.58	fix	fix	31.24	-8.97	6.75	-19.9	-5.18	-14.9	fix	fix
Aug. 2010	-56.45	12.6	fix	fix	30.26	-10.32	12.3	18.33	-2.31	-17.6	fix	fix
Oct. 2011	-60.75	12.93	fix	fix	30.42	-7.99	10.51	-20.9	-5.84	-16.8	fix	fix

a) The station points (D1-3, S1-3) horizontal displacements from "zero" measurement

Differences from the reference cycle (mm)																		
Mark	M1		M2		M3		M4		M5		M6		M7		M8		M9	
Measuring cycle	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy
Oct. 1976	inactive		-0.10	-1.20	0.70	-1.60	1.30	-0.20	-0.10	-0.20	-0.30	-1.20	0.70	-2.20	1.20	-1.70	0.40	-0.90
Sept. 2009	inactive		35.84	-25.90	41.27	-8.85	38.11	-0.25	36.36	4.29	28.11	11.73	14.90	18.36	10.89	12.88	0.99	10.98
Aug 2010	inactive		35.25	-19.13	38.89	-11.32	42.09	-3.23	39.37	1.10	31.44	9.78	18.69	17.03	13.68	12.08	2.27	7.57
Oct. 2011	inactive		37.79	-23.91	42.58	-10.14	38.56	-0.01	35.50	3.82	27.18	11.58	14.77	18.59	10.01	14.00	1.64	15.57

b) The horizontal displacements of micro triangulation marks (M2, M3, M4, M5, M6, M7, M8 and M9) fixed on the downstream parament of the dam at 1134m height

Differences from the reference cycle (mm)												
Mark / Measuring cycle	M10		M11		M12		M13		M14		M15	
	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy
Oct. 1976	0.10	-0.80	0.60	-1.50	1.40	-1.40	0.50	-1.60	0.30	-1.30	0.50	-1.50
Sept. 2009	40.89	-9.04	38.20	-0.72	35.31	4.28	27.79	11.54	18.56	13.02	9.48	11.23
Aug. 2010	46.08	-15.75	42.06	-3.54	40.08	2.17	31.15	10.21	21.36	12.95	12.05	11.39
Oct. 2011	43.04	-10.02	39.03	-0.12	35.14	4.79	27.04	12.11	18.06	14.57	8.61	13.77

c) The horizontal displacements of micro triangulation marks (M10, M11, M12, M13, M14 and M15) fixed on the downstream parament of the dam at 1124m height

Differences from the reference cycle (mm)										
Mark / Measuring cycle	M16		M17		M18		M19		M20	
	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy
Oct. 1976	-1.60	-0.40	2.70	-1.70	3.10	-0.60	2.30	-1.50	2.10	-0.60
Sept. 2009	32.63	-4.62	34.67	-1.42	32.92	3.44	23.64	8.87	16.74	6.67
Aug. 2010	36.17	-8.15	38.51	-1.98	35.98	3.42	25.76	7.90	17.52	8.07
Oct. 2011	36.29	-9.51	37.13	2.60	34.06	7.94	23.03	12.69	14.31	13.05

d) The horizontal displacements of micro triangulation marks (M16, M17, M18, M19, and M20) fixed on the downstream parament of the dam at 1109m height

For obtaining the water dam vertical displacements we performed topographical measurements in the levelling network. The levelling network comprised twelve height marks fitted to the crown of the water dam and three stationary height marks situated outside the water dam influence zone (fig.3.37).

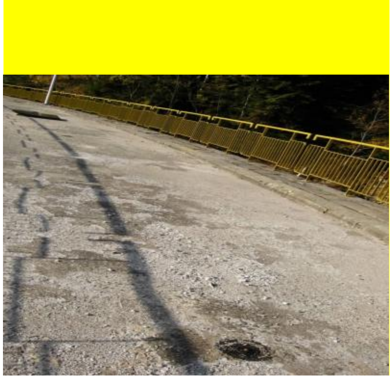



Fig.3.37 Stationary height mark and height marks on the crown of Petrimanu dam

The measurements performed in the levelling network were made with a levelling instrument which ensures a measuring precision of 0.3 mm/1 double levelling kilometre. The staff readings were made on a levelling staff with bar code.

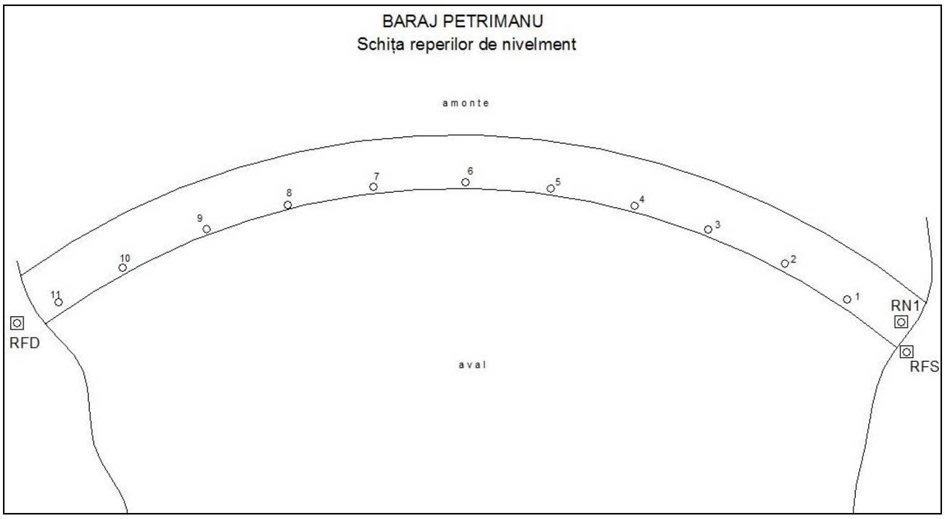


Fig. 3.38 Petrimanu dam- The levelling network

For the measurement setting off it was performed traverse method.
The displacements are obtained from the difference between heights determined on the initial measurement and various measurement cycles.
After processing the measurements the results are presented both in tabular (table 3.6) and graphical form (fig. 3.39).

Table 3.6. The height marks displacements

Nr. reper	Differences 0 measurement (mm)				
	Etapa mai. 1980	Etapa sept. 2009	Etapa sept. 2010	Etapa oct.2011	Obs.
1	2	3	4	5	6
RN1					fix
RFD					fix
RFS					fix
R1	0.00	3.08	3.40	3.93	
R2	0.00	3.52	3.39	3.34	
R3	0.00	4.59	4.73	5.38	
R4	0.00	4.39	4.43	4.67	
R5	0.00	5.25	5.47	6.13	
R6	0.00	3.65	4.09	4.9	
R7	0.00	4.08	4.44	6.16	
R8	0.00	2.41	3.20	4.47	
R9	0.00	0.95	1.93	3.3	
R10	0.00	0.89	1.80	3.30	
R11	0.00	-0.38	0.44	1.91	
R12					inactive

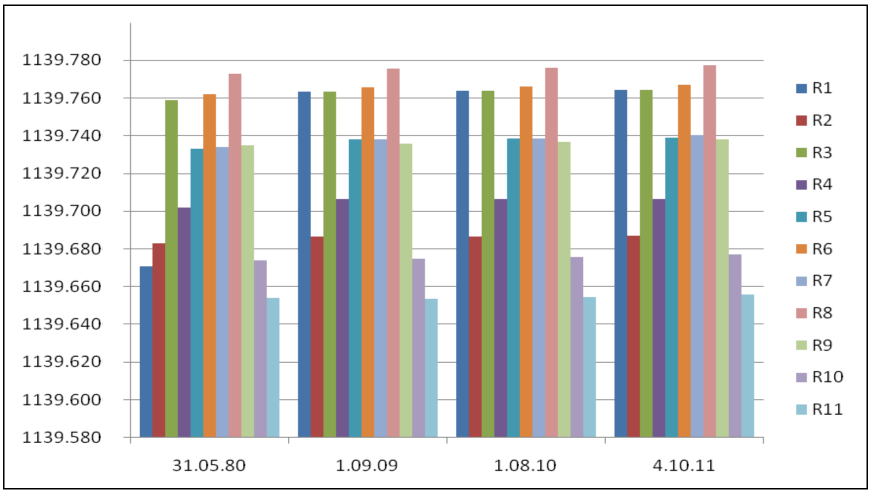


Fig. 3.39 The displacements evolution of height marks

Other important conclusions from these measurements are:

- Analyzing the events that produced these vertical displacements (in year 2009 the Lake Petrimanu was emptied along with Lake Galbenu and Lake Vidra because of the HPP Lotru - Ciunget refurbishment measures, and in year 2010-2011 these three lakes were refilled again) we can assert that these vertical displacements are normal, so, nonhazardous.
- Although these vertical displacements are nonhazardous they must be permanently monitored for observing in time the effects of the water dam emptying phase and on this way preventing possible catastrophes and environment management.

CONCLUSIONS

Monitoring this kind of constructions is made both with physical methods and topographic methods. The advantage of physical methods is that through the used gear they are providing information about the monitored construction behavior at small time intervals (hours, days, weeks). This information has a relative character because the measurements are made on certain construction elements related to other construction elements. The topographic methods have an absolute character because the measurements are executed towards the construction independent reference system.

- Analyzing the measurements, we can observe that the height mark number 7 has the biggest vertical displacement 6,16mm, in year 2011 (*Table 3.6*). This fact can be explained because the height mark is situated near the water dam abutment from the left bank.

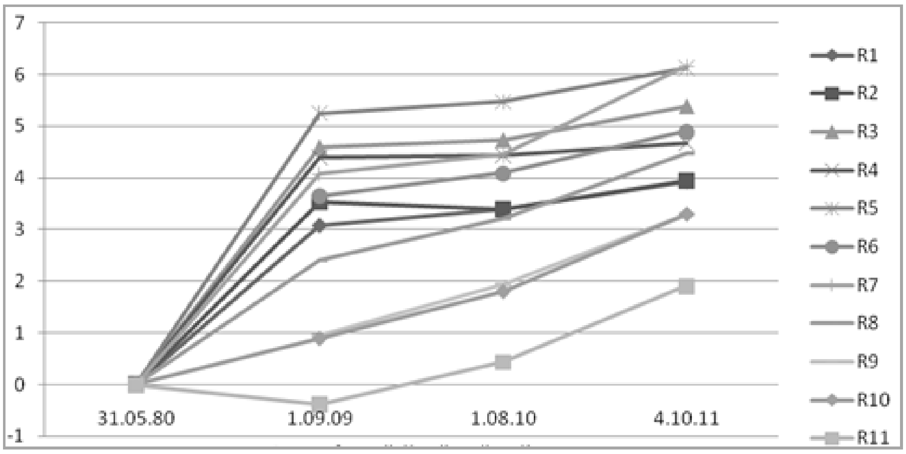
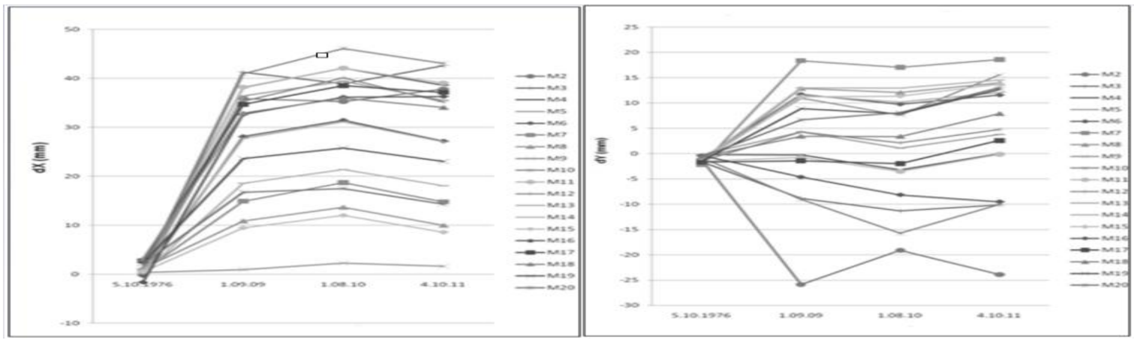


Fig.3.40. Displacements evolution of height marks

- Analyzing the displacements of micro-triangulation marks fixed on the downstream parament of the dam at 1134m height we observe that the maximum displacement on X axis appears at M3 micro-triangulation mark (42,58mm - in 2011 when the water dam was full) and the maximum displacement on Y axis appears at M2 micro-triangulation mark (25,90mm - in 2009 when the storage lake was emptied) (*Table 3.5.b*). These displacements appeared due to the position of these two micro-triangulation marks near the dam discharger.
- We observe the maximum the displacements of micro-triangulation marks fixed on the downstream parament of the dam at 1124m height appear both on X axis and on Y axis at M10 micro-triangulation mark (46,08mm and -15,75mm - in 2010 when the storage lake was filled) (*Table 3.5.c*). These displacements appeared due to the position of the micro-triangulation mark on the right part under the dam discharger.
- Following the displacements of micro-triangulation marks fixed on the downstream parament of the dam at 1109m height we observe that the maximum displacement on X axis appears at M17 mark (38,51mm - in 2010 when the storage lake was filled) and the maximum displacement on Y axis appears at M20 micro-triangulation mark (13,05mm - in 2011 when the water dam was full) (*Table 3.5.d*). These displacements appeared due to the position of these two marks.
- The maximum displacement on X axis appears at M10 micro-triangulation mark (46,08mm - in 2010 when the storage lake was filled) and the maximum displacement on Y axis appears at M2 mark (25,90mm - in 2009 when the storage lake was emptied) (*Table 3.5*).



a) The displacements on X axis- upstream-downstream; b) The displacements on Y axis- left bank-right bank

Fig.3.41 Evolution of the micro-triangulation marks displacements

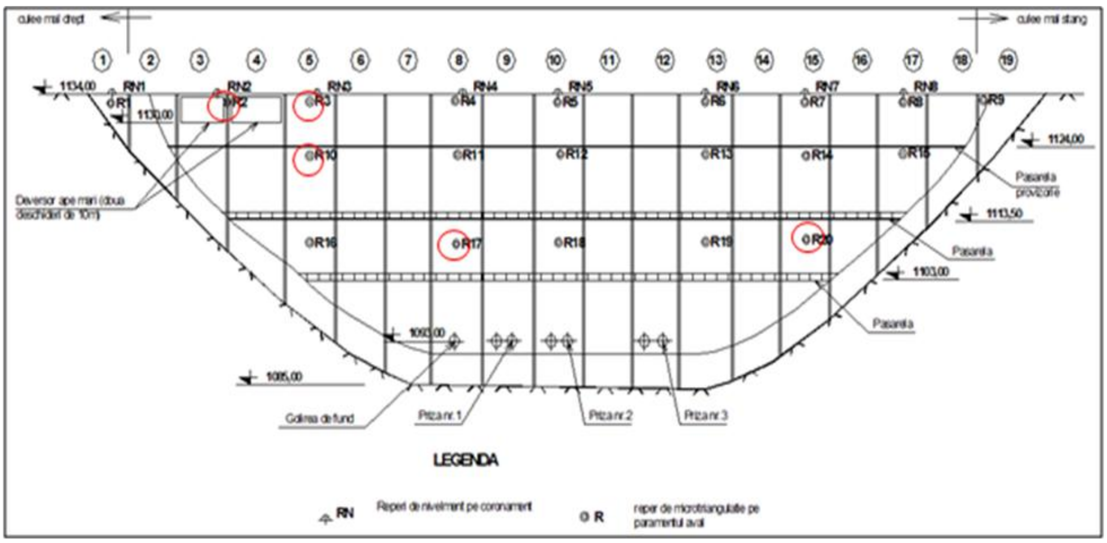


Fig.3.42 Displacements of micro-triangulation benchmarks

PERSPECTIVES

Measurement, processing, calculation and representation of settlements, horizontal displacements or high inclines construction can be done today with modern technology topo-geodetic, automated, which associated with the correct application of specific methods, gives a guarantee of fair highlights the phenomena of instability buildings.

For future strategy, appear the necessity for continuation the monitoring process through sensors and reference stations (GNSS), also the periodic 3D monitoring by laser scanning the dam strategic areas (Fig. 3.43).

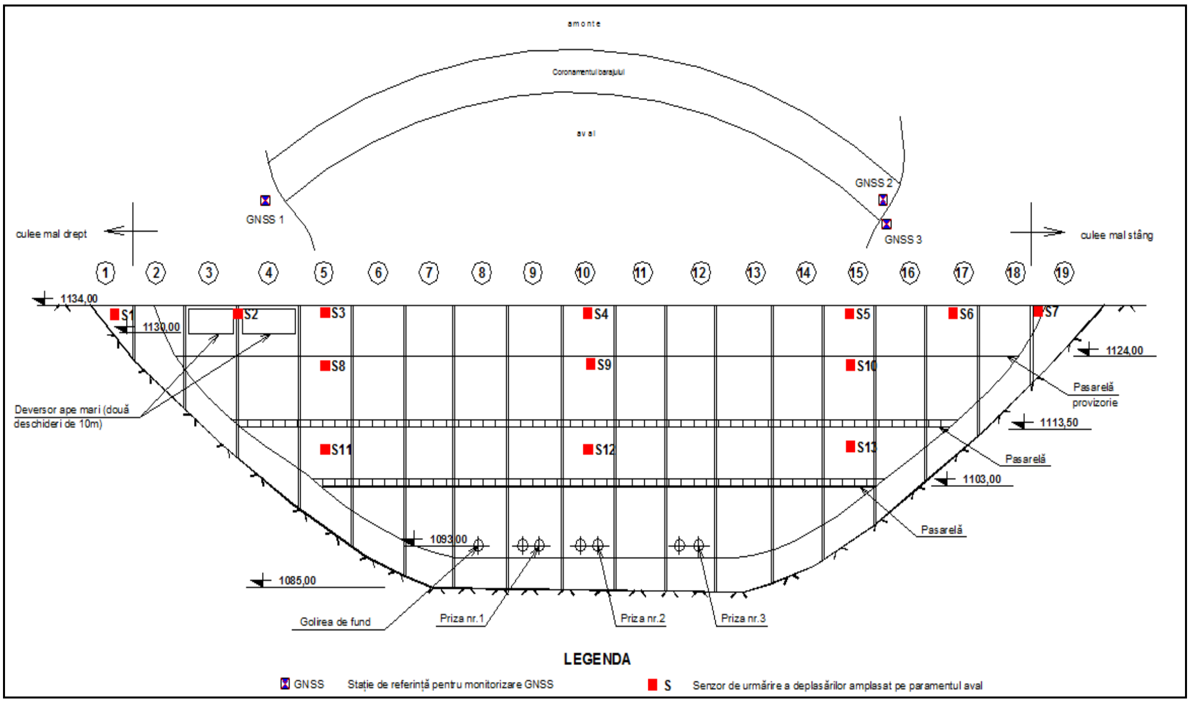


Fig. 3.43 Future strategy proposal

(Doctoral Advisor UPT,
PhD Thesis, Timișoara 2012- Maria Roberta Gridan)

B) Engineering surveying used for monitoring the behaviour of strategic constructions

Strategic constructions are of great interest because of the materials and the technology used, but they also require special attention in terms of monitoring their behaviour in time and in case of subsequent re-engineering works. All over the world, growing concerns regarding public safety, environmental protection, and efficient industrial production have dramatically increased the demand for automated deformation monitoring systems.

Surveying engineering contributes to constructions quality, especially by means of determining the quality requests and testing the procedures: observation, supervision of geometrical requests; documentations for different phases or stages of the construction etc.

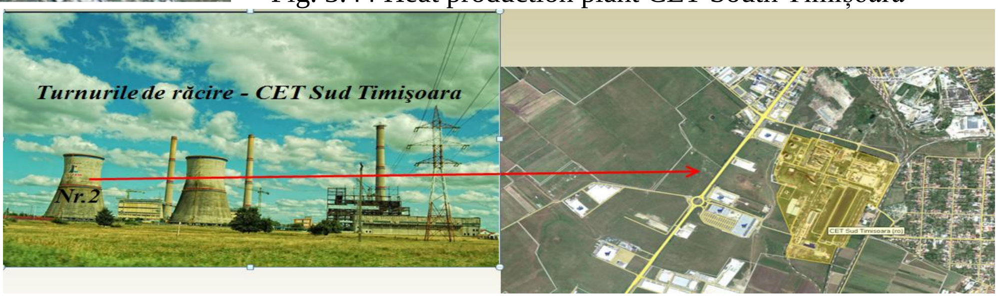
3.5.2 Study case 5: Monitoring and inspecting buildings for S.C. COLTERM SA Timisoara/CET Sud department

A representative strategic construction for the Timişoara municipality (Fig.3.44) is the heat production plant CET South, since it is one of the main heat sources of Timişoara city.
In 1986, the first CET South facility was put into operation - a hot water boiler of 100Gcal/h. The boiler, located on an area of 573 363 m^2, has been designed to work with solid fuel (lignite), support for natural gas, being set to develop in two stages: thermal and energetic. The thermal part includes the following facilities:

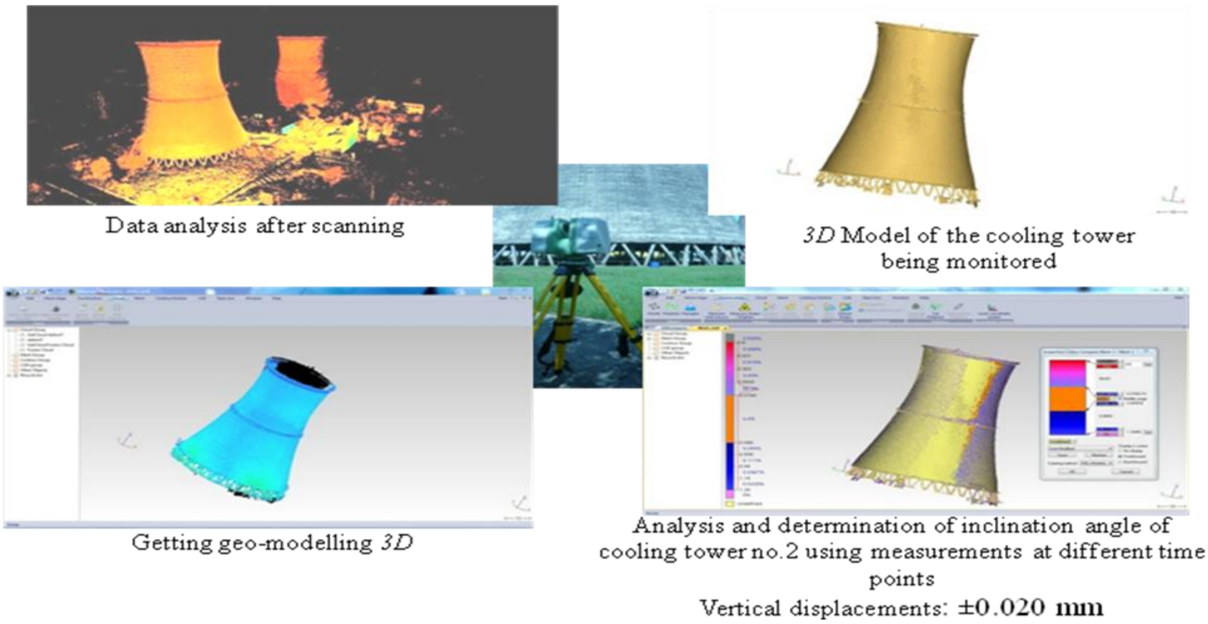
- two hot water boilers of 100 Gcal/h using solid fuel with natural gas,
- three industrial steam boilers of 100 t/h, 15 bars, 250° C using solid fuel with natural gas.

Electricity is provided by setting up a back pressure turbine with installed power of 19.7 MW, fuelled by industrial boilers.
Currently, the company that owns the heat production plant supplies heat for about 230.000 inhabitants of Timişoara, meaning it can cover around 70% of the city's total demand.
Heat is produced in hot water boilers and in steam boilers. The plant has low global energy efficiency with direct implications on generation costs, mainly because of the technical solution chosen and it is not equipped for co-generation.
This is why several rehabilitation projects for this objective have been developed. Engineering surveying has played an important role in an ample work, namely a technical examination for re-engineering the heat pumps from CET South Timişoara, which also includes vibration measurement, mild experiments on heat pump foundations in order to determine the concrete class and geotechnical studies.
The technical examination aims to evaluate the foundations of heat pumps within the studied perimeter in order to decide upon required structural interventions and consolidation measures, taking into consideration scheduled changes within the project: at heat pumps Step 1: EPT 1/I, EPT 2/I, and Step 2: EPT 2/II, the engines are to be replaced.
Determination of cooling tower tilt no.2 due to subsidence in the foundation soil involves setting up a system that performs mechanical and geometrical parameters acquisition, creation of databases, as well as the analysis and prediction of phenomena for a long period of time.
To confirm the possibility of monitoring high buildings and to obtain the necessary information useful for the research, it was performed an analysis of subsidence in the cooling tower with the help of Laser scanning technology.

Fig. 3.44 Heat production plant CET South Timișoara



Scans were made at a resolution of 5cm to 50m, with fine scanning targets that are placed on the pole with tripod attachment to 2mm at 50m resolution. Scan mode was chosen ”target all” entails 360 both horizontally and vertically. The scan was obtained as a file with a cloud of points in local coordinate system. This file contains the 3D position of points, the name of the scanning station, the name of the points that have set targets and the position of the coordinate system.
Based on geo-3D modelling of the cooling tower no. 2 and a reference plane, there have been performed analysis of the displacements of this objective and determinations of the inclination angle at different time points.
Post processing data from measurements with ScanStation C10 was made with Cyclone software v6.0. The next operation is in the process of filtering the resulting data post processing, which requires the removal of items not covered by the area scanned, removing items that contain noise generated by the influence of weak reflection of the scanned surface, obstacles or people in the scan, the scanning resolution, etc.
After filtering and setting these operations, we will pass to data modelling for the colling tower.
The results obtained after a 2-year study confirm the need to:
o Implement this new technology to monitor the strategic constructions;
o Using topo-geodetic measurements as well as 3D modeling, as a system which can provide a permanent control, and which will be able to monitor the behavior in time of the construction movement phenomenon. A system able to signal efficiently, in real time any modification that can lead to potential damages to the environment.



Based on research carried out and the results obtained it was proposed to:

- the creation of a special tracking program of reaction time of structures observed on the basis of the measurement cycles
- research programmes and monitoring data from civil engineers in conjunction with topographical study tracking
- analysing the possibilities of special constructions stability tracking using laser technologies and sensors for monitoring and concrete proposals of applicability in special situations
- knowledge of environmental characteristics of the site in order to optimize the design solutions and studying behavioural patterns provided by banks of data arising from geodetic research

CONCLUSIONS

The measurement, the processing, the calculation and the representation of the settlements, horizontal movements or inclinations of strategic constructions can be done today with modern topo-geodetic technologies, automated, which associated with the correct application of some specific methods, give the guarantee of a fair highlights of the phenomenon of the buildings instability. With the help of the new geodetic methods and technologies with high degree of automation, the field of construction observation behavior submitted to different disturbance factors becomes a branch of topical with applicability to various types of civil engineering, in close connection with the requirements of urban development and environmental protection.
The knowledge offered by surveying engineering in modelling of dynamic systems like special constructions is needed for the evaluation and optimization of these dynamic models describing the behaviour of the monitored objects.
In particular, for this study case, the need for continuous monitoring is also explained by the fact that in Romania, there are laws that stipulate monitoring of special constructions, such as hydro-technical ones in order to determine both horizontal displacements and settlings.

(Doctoral Advisor UPT,
Phd Thesis, Timișoara 2011- Floarea Maria Brebu)

Natural and social factors that influence the interaction with the close ecological balance determines living conditions for humans and for economic and social development of the society.
Advance towards the information society, knowledge-based, it is considered as necessary evolution to ensure sustainable development founded primarily on products and intellectual - intensive activities as well as achieving socio-advanced human civilization.
Geomatic techniques prove to be useful tools for:

- Research in the field of global environmental changes show interactions between the biophysical and social systems, both in terms of the effects caused by anthropogenic factor over the physical and biogeochemical processes and the quality of the environment, as well as within the meaning of the effects of environmental changes on society
- Finding optimal solutions to sustainable development of society, in the context of interdependent processes of transformations, such as globalization, urbanization, environmental changes, demographic dynamics, political and economic changes and technological advancements

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******The dissemination of the personal research work regarding the geodetic applications in relation with natural and social environment management is subject of several research projects and contracts and also research papers presented in different scientific events.***
<u>Here are some relevant examples:</u>

RESEARCH GRANTS - ex: 5 projects

- *Research Project PN II,* – Monitoring crustal deformation field in seismic area of Banat County using satellite positioning techniques in Geodetic micro networks for realistic modelling of the local sources and evaluation of their seismic potential.
  <u>Research theme</u>: Observing the parameters of natural fields in order to ensure safety threshold in the management of the territory, 2007. (Centrul Național de Management Programme – CNMP, Programul 4, Parteneriate în domeniile prioritare, domeniul de cercetare 8 –Spațiu și Securitate, direcția de cercetare 8.2 –Aplicații spațiale)
- Național Research Project PN II Modul I, Capacities, 90 CP/ I/ 14.09.2007 (2007-2008-2009), INSTRUCT – Laboratory development for large scale tests
- *Research contract nr. 174/30.12.2010,* Investigations and experiments on growth performance of FRANCIS turbines (FVM DE 57.5 – 128.5) from CHE BRĂDIȘOR – III-stage, Hidroelectrica SA Râmnicu Vîlcea;
- *Research contract nr. 135/20.12.2011*, Studies and surveys for the Foundation monitoring of pumps *CET Centru* and *CET Sud* Timișoara, SC Colterm SA
- *Project no.10/0242-E/4005/2011*, Application of the terrestrial laser scanning for environmental processes and changes -ATLAS, 2011/2013

SCIENTIFIC PAPERS - ex: 15 papers

- **Grecea Carmen** - Geodetic engineering - important tool for Romanian seismicity study- SSE '09: PROCEEDINGS OF THE CONFERENCE ON SUSTAINABILITY IN SCIENCE ENGINEERING (WSEAS), Timișoara, Romania 2009, **(ISI Proceedings)**;
- **Grecea Carmen -** Geoinformation support - impact on urban planning, environment and society, Latest Trends On Urban Planning And Transportation (WSEAS), Greece, ISSN 978-960-474-204-2, 2010 **(ISI Proceedings)**;
- **Grecea Carmen**, Ienciu I, Dimen L, Bălă A, Oprea L - Impact of Surveying Engineering on The Environmental Protection Problems - JOURNAL OF ENVIRONMENTAL PROTECTION AND ECOLOGY (JEPE) – 2009 **(ISI Journal)**;
- Roberta Maria Gridan, Alina Corina Bălă, **Carmen Grecea -** DAM Monitoring, a modern method in environmental engineering, Research of Agricultural Sciences (RJAS), 2011, **(BDI, Copernicus, CABI)**;
- **Grecea Carmen**, Gridan Maria Roberta, Bălă Alina Corina - Model of Ecological and Economic Spatial Analysis of Multifunctional Resources Exploitation, BENA Conference **Proceedings**, ISBN 978-606-554-210-5, 2011;
- Vilceanu CB., **GRECEA Carmen** Herban S. - Engineering Surveying Used for Monitoring the behaviour of Hydro-Technical construction, INDIS 2012 International Scientific Conference **INDIS 2012** Novi Sad, Serbia, ISBN 978-86-7892-451-4, 2012
- **Carmen Grecea,** Vîlceanu Clara – Beatrice Geomatics – possible solution for an efficient management of environmental problems, RESEARCH JOURNAL OF AGRICULTURAL SCIENCE (RJAS), Agroprint Editorial, ISSN 2066-1843, vol. 44 (3) 1 – 306 (2012), **(BDI, Copernicus)**;

- Gridan, MR, Jianu, SF, **Carmen Grecea -** Implication of Forestry Cadastre in the National Strategy of Environmental Protection, JOURNAL OF ENVIRONMENTAL PROTECTION AND ECOLOGY (JEPE) – 2012 **(ISI Journal)**;
- Bala, AC; **Carmen Grecea**; Brebu, FM; David, V; Bota, CI - Monitoring Mining Dumps in Relation with Environmental Protection, JOURNAL OF ENVIRONMENTAL PROTECTION AND ECOLOGY (JEPE) – 2012 **(ISI Journal)**;
- R.Gridan, **Carmen Grecea -** SURFER Solution, tool for terrain modelling, Journal of Geodesy And Cadastre, 2012, **(BDI, Copernicus)**;
- **Grecea Carmen,** Herban S, Bălă AC, Băbuca IN, - Application of Laser Scan Technology to Landslide Monitoring, Volumetric Calculus and DEM - 13th INTERNATIONAL MULTIDISCIPLINARY SCIENTIFIC GEOCONFERENCE SGEM 2013 - Geodesy and Mine Surveying, Albena, Bulgaria, **(SCOPUS, Engineering Village)**;
- **Carmen Grecea,** Clara Beatrice Vilceanu - Possibilities of monitoring the areas affected by natural calamities using Intergraph technology, Research Of Agricultural Sciences Journal (RJAS), Vol 43(3) 1 - 529, 2012 **(BDI, Copernicus, CABI)**;
- **Grecea Carmen,** Herban S, Vîlceanu CB, - Creating 3D Models of Heritage Objects using Photogrammetric Image Processing - ICNAAM 2013: 11TH INTERNATIONAL CONFERENCE ON NUMERICAL ANALYSIS AND APPLIED MATHEMATICS, Greece, **(ISI Proceedings)**;
- Beatrice Vîlceanu, **Carmen Grecea** - Using Geographic Information system analysis in the management of flood risk areas, 13th International Multidisciplinarity Scientific Geoconference - SGEM 2013, Vol I- ISBN 978-954-91818-9-0, **DOI:** 10.5593/, 2013 **(BDI, Scopus, Engineering Village)**;
- **Carmen Grecea**, Anca-Maria Moscovici - Phonic pollution and strategic acoustic mapping with GIS, **ICEEM'07**, 2013, Austria, ISBN 978-973-621, 2013.

PhD THESIS – Doctoral Advisor, ex: 3 thesis

- C.B. Vîlceanu – Modern geodetic methods for monitoring landslides, PhD Thesis, Timişoara, 2014
- Maria-Roberta Gridan – Monitoring special constructions behaviour, using topographical modern methods, PhD Thesis, Timişoara, 2012
- F.M. Brebu – Contribution to geodetic monitoring of special construction, PhD Thesis, Timişoara, 2010

C. Proposal for the future academic, scientific and professional career development

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Department of Overland Communication Ways, Foundation and Cadastre,
Politehnica University of Timişoara

A career plan mainly aims to establish a target, an objective, a specific destination. That is why in the stages developed within my career plan, I intend to envisage and establish the target, the purpose and the destination of my future professional activity. The present plan is based on a thorough analysis and evaluation of several factors, in a successive order, starting with self-knowledge and continuing with a SWOT analysis, main guiding principles, efficiency skills, personal mission, establishing strategic plans and, especially ways of putting them into practice in the envisaged fields.

It is a fact that self-knowledge and expectations are age related and they develop along the years, function to the experience of the individual, and at the same time, being different function to the professional motivations of each individual. Therefore, it is important to know who we are and where we want to get. It is imperative to analyse our professional experience, studies, emotional intelligence, as well as the general and the specific ones, the abilities we have developed, our technical knowledge and our personal characteristics.

For that reason, my personal development plan for a university career is a sort of synthesis of my professional and didactic activity, as well as my scientific research activity, in the time interval: 1990-2013. This document presents my preoccupations, my activities and the results obtained, as well as, my future developments perspectives. The material has the following organisation:

1. *Studies and professional stages*– which consists of a short presentation of the studies made and the didactic and professional degrees obtained in the above mentioned period;
2. *Activities and professional achievements* – where the activities and the professional accomplishments are illustrated, both from educational (teaching) and scientific research point of view;
3. *Proposals for the development of the academic career from the didactic point of view* consists of several future ideas and initiatives for the development of the didactic university career;
4. *Proposals for the development of the academic career from the scientific research point of view* – where several objectives and solutions for the development of the university career as far as the scientific research are presented.

1. Studies and professional stages

From 1977 until 1981, I studied at ***Liceul de matematică - fizică Dimitrie Cantemir*** from Bucharest (*Dimitrie Cantemir - Mathematics and Physics High School)* and I obtained my *Baccalaureate Diploma.*

In 1981, I became a student at *Facultatea de Căi Ferate, Drumuri, Poduri şi Geodezie –Geodesy specialization* (Faculty of Railroads, Roads and Geodesy) within *Institutul de Construcţii Bucureşti* (Institute of Constructions –Bucharest) - in the present day Universitatea Tehnică de Construcţii Bucureşti (Technical University of Civil Engineering -UTCB).

I attended the courses of this faculty from 1981 till 1985, obtaining *Diplomă de inginer*- profile GEODEZIE (Engineer Diploma – major GEODESY), the graduation mark 10; year average mark: 9.45; multiyear average mark: 9.72).

After graduation I worked as a geodetic engineer within several institutes, such as: Trustul Antrepriză Generală Construcţii Hidrotehnice (TAGCH) where I developed field activities, at the working point ACH Olt Superior, and designing activities, at a specialized institute in Bucharest. I also worked for *Institutul de Studii şi Proiectări Hidroenergetice (ISPH).* Here, I was involved in cadastre measurements, design and execution of geodetic networks, processing the geodesic measurements, mapping and drawing plans at various scales for important engineering works. Thus, I had the chance to enhance the theoretical knowledge acquired during the faculty.

In 1990 I won the competition for the position of *assistant lecturer* at *Facultatea de Hidrotehnică (Faculty of Hydrotechnics) from Universitatea Tehnică of Timişoara.* In this position I conducted the laboratory works for the discipline *Topography* for the students who were specializing in the field of *construction*.

In 1991, a new section was founded, i.e.: Secţia de Cadastru, (the Cadastre Section) within the frame on the Faculty of Constructions; thus I could teach various disciplines specific for this domain, such as: Topography, Errors and Measurement Theory, Geodesy and Surveying for the speciality Civil Engineering – English Medium –founded in the same year. During that period I also coordinated the practical training of the Cadaster students.

In 1995, I took part at the competition for the position of *Şef lucrări universitar* (assistant lecturer) and I obtained this position at Catedra de Inginerie Geotehnică şi Căi de Comunicaţie Terestre (Chair of Geotechnical Engineering and Terrestrial Communication Roads) at the Faculty of Constructions. The main didactic activities consisted in giving lectures, and being in charge with seminar and laboratory activities for the following subjects: *Topography, Theory of Processing the Geodetic Measurements, Geodesy, Spatial Geodetic Technologies*; coordinating diploma projects; responsible for the student annual training period. Since 1996 up to present, I have been a member of the Commission for Diploma Examination for this specialization.

In 1992 I was admitted for the doctoral studies at the Faculty of Geodesy –Bucharest within the Universitatea Tehnică de Construcţii Bucureşti (UTCB) (Technical University of Civil Engineering) with the following research theme: **Topographic technologies using the Global Positioning System for cadaster support networks.** The thesis was finalized in 1999, and I was awarded the scientific title of *Doctor of Technical Science*, branch Science and Technology, for **the doctorate field: Geodesy, Photogrammetry, Cartography and Remote Sensing.**

In 2000, I took part at the competition for the position of *Conferenţiar Universitar* (associate professor) and I obtained this position at *Catedra de Inginerie Geotehnică şi Căi de Comunicaţie Terestre,* nowadays Departamentul de Căi de Comunicaţie Terestre, Fundaţii şi Cadastru (Department of Overland Communication Ways, Foundation and Cadastre) of the University Politehnica of Timişoara; this is also my current position.

Since then I have continued my didactic activity for the following subjects: *Topography*, *Theory of Processing the Geodetic Measurements, Geodesy* within the speciality Terrestrial Measurements and Cadaster. Besides this, I introduced a new subject *Algorithms for processing geodetic networks* for the master's study program *Cadastre and Real Estate evaluation,* accredited in 2009. Being also the teacher in charge of the subject *Surveying,* from the curriculum of the speciality International Politehnica, I have continuously coordinated bachelor theses and the practical training of the students.

The teaching activity, irrespective of the degree held, was backed up the scientific research, and by my participation at various events and scientific manifestations, national and international. I have also been a member in various teams for the elaboration/implementation/ execution of several projects/contracts/grants in the field of geodesy or in related fields.

2. Activities and professional achievements

2.1 Activity in education

In 1991 I was a member of the team who founded the new Cadastre section at the Faculty of Civil Engineering in Timișoara. At that time the geodetic higher education was only in Bucharest, within the Faculty of Geodesy of the Construction Institute.
Nowadays, there are at Timişoara, within the Faculty of Civil Engineering, a bachelor's study program, *Terrestrial Measurements and Cadastre* and a master's study program, *Cadastre and Real Estate evaluation*, for which the undersigned played an important part in their academic accreditation and reevaluation.
As teacher in charge of the courses: *General Topography, Theory of geodetic Measurements and Geodesy*, fundamental subjects in the training program of a geodetic engineer, I have always tried to promote this field of activity through pertinent and attractive lectures for students, to open as many perspectives as possible for individual study, develop interest for self-evaluation and self-improvement.
I supported the introduction of the academic subject *Algorithms for Processing Geodetic Networks*, at the master's study program, to better understand and expand the fundamental notions introduced during the specialty courses in the bachelor cycle. I have been coordinating, for many years, bachelor and dissertation theses.
Since 1991 I was the teacher in charge for the course and laboratory activities for the speciality Civil Engineering- English medium, for *Surveying;* the students feed-back was encouraging even from the first lectures.
My whole didactic activity was influenced by several training stages at prestigious European universities which gave me the opportunity to assimilate new techniques and new teaching/learning styles which, later, I was given the chance to put into practice in the academic environment I worked in.
I have always been attentive to permanently update the syllabus of the lectures I gave, as well as seminars and the laboratory activities. All the activities and information were updated, restructured and tailored according to the requirements of a qualitative education, which had to meet the current standards and norms, but also correspond to the needs of the labour market force.
During my didactic evolution I published as a single author or in collaboration 8 speciality books, manuals or laboratory works, and 3 E-learning type course modules, on the online platform within the university.

Other important didactic contributions:

- Contribution to the implementation of the online platform for the modernization of the educational process of the geodetic field (geodesy-instruct);
- Contribution to the development of digital courses (Geodesy, Compensation measures and Statistics) to help students in the learning and self-evaluation processes through the tests included in the courses;
- participation at various professional trainings and specializations in the educational field;
- Develop students' skills of working in teams by using the platform collaboration means, assuring an enhanced transparency to the evaluation process (results of colloquiums, projects, continuous assessments);
- Encourage students to take part in student symposiums and to strive to get prizes;

Showed constant availability for all the didactic activities or collaborations that can help enhance the visibility of the faculty and of the speciality, at national and international levels. The most recent example is the involvement in the organisation of The International Conference ISI

- GENG 2013- - 1st European Conference of Geodesy & Geomatics Engineering (GENG '13), in Antalya – Turkey, where I was both a member of the scientific committee and chairman;
- coordinator of the didactic activity for the specialty *Terrestrial Measurements and Cadastre* and the master's study *Cadastre and Real Estate evaluation* (curricula, syllabuses, analytical programs, title lists, from 1999, and 2007 respectively);
- responsible for the topography-cadastre laboratory licensed by *The National Agency for Cadastre and Land Registration - ANCPI*;
- coordinator of the team that drew the documentation for the ARACIS evaluation and accreditation of the bachelor's study 2008 (Terrestrial Measurements and Cadastre – MTC)) and of the master's study program 2009 (Cadastre and Real Estate evaluation - CEBI).

Managerial activities in the educational process:

- general secretary of the UPT Senate;
- scientific secretary of the Faculty of Civil Engineering;
- member of the council of the Faculty of Civil Engineering;
- dean of the first year students (study program Terrestrial Measurements and Cadastre);
- member in the bachelor thesis commission for the specialization Cadastre ;
- chair of the commission for dissertations CEBI;
- member of the selection commissions of the teaching staff;
- member of commissions for admission and examinations of the PhD students;
- member of the PhD evaluation commissions as scientific referent;
- member of the research team, department CCTFC;
- member of the academic board of the department;
- member of the quality evaluation commission within the faculty;
- member of the faculty didactic commission ;
- member of the faculty commission in charge with students' problems;
- president of the specialization board for Terrestrial Measurements and Cadaster;
- expert evaluator ARACIS – field Geodetic Engineering;
- member ACPART – field Geodetic Engineering;
- member of the quality evaluation commission of the Faculty of Civil Engineering.

Development of material resources

I have always been interested in the development of the specific material resources in accordance with specific standards. Therefore, these are the activities I took part in:
-setting and equipping a **MEDIA Laboratory with a virtual educational platform,** for the students of the speciality MTC within the Faculty of Constructions, for online didactic activities in Geodesy (www.geodesy-instruct.ro);
-responsible for the *MEC* Project for infrastructure development: Laboratories for bachelor degree, UPT 2008 with the following outcome: equipping the Laboratory for Terrestrial Measurements and Cadaster with modern equipment (294.600 RON); setting up and equipping the Laboratory for Automation in Cadaster (36.000 RON); Total project: 100.181 EUR;
- setting up a new laboratory in partnership UPT / INTERGRAPH (2009): RRL (Registered Research Laboratory);
- obtaining the institutional authorization from *The National Agency for Cadastre and Land Registration (ANCPI) for* the Laboratory of Terrestrial Measurements and Cadastre for research projects and works in the field;

-acquisition of specific software licenses for geodetic and cadastre works (Leica GeoOffice Tools, Civil 3D, ERDAS Imagine, Intergraph GeoMedia);
-development of the book resources of the UPT library with specialty books;

2.2 The scientific research activity

The results of my scientific research are materialized mainly in speciality scientific articles and books. Therefore, I have always focused on this aspect, considering that not only the quantitative aspect of the work is important, but also the quality and the value of the material published. It can be seen in the list of the scientific papers attached that I collaborated with colleagues from other Romanian universities at writing articles in my specialty.
A main priority in the last years was the publication of scientific articles in magazines and journals of different scientific events, indexed in Web of Knowledge (ISI), or magazines and volumes of different scientific events also indexed in other relevant BDI.
The evaluation of my own research-development activity can be made by comparing it with similar activities, national and international. An important component of the management of my own research activity was the dissemination of the results obtained in the scientific community and the feedback obtained. Thus, I have taken part at various conferences, symposiums where I had the chance of getting a direct feedback on my research activity. Another challenge was the decision of choosing the correct research directions in correlation with the existent financial, materials and mainly human resources. At the present time, my research activity tends to be multidisciplinary, involving specialists in civil engineering, environment, architects, experts in information technology, researchers in the field of geo science, etc. This multidisciplinary cooperation, the contact with specialists from different research fields within the research teams I was a member of, have represented for me an important qualitative improvement. The collaboration has contributed to my training and my development from the professional and scientific point of view. Another important component of my personal research activity consisted in the research documentation work on the subject of the international scientific activity in the geodetic engineering field. Lately I have become more involved in taking part at different scientific committees of various manifestations or international publications, as well as in the activity of scientific referent of these publications. This is an intense activity from the scientific point of view, a voluntary one, but with the satisfaction of being useful in my professional field, on the national and international level. During 2010-2011 and 2012-2013 I was a member of various management and implementation teams for projects financed by structural funds, national scientific competitions organized by UEFISCDI, SEE; I played an active part in submitting projects, in the activities of elaboration and logistics, and in getting the projects ready to take part at the competitions, respectively. As far as the collaboration with other institutions with the same profile from abroad, I initiated bilateral agreement and partnerships for educational and research projects (Agreement for scientific partnership Leica Geosystems AG Switzerland; Collaboration program - West University of Hungary, Faculty of Geoinformatics Szekesfehervar; Intergraph Corporation Education Program; ERASMUS Intensive Programmes: *Application of the terrestrial laser scanning for environmental processes and changes(* ATLAS) – coordinator UPT, RO, etc.).
The recognition of my activity is also marked by the being a member of various professional organisations in the fields such as: Uniunea Geodezilor din România (the Union of Romanian Geodesy), Ordinul Geodezilor din România, (The Order of Romanian Geodesy) Asociația Generală a Inginerilor din România (The General Association of Romanian Engeneers), Agenția Națională de Cadastru și Publicitate Imobiliară (The National Agency for Cadastre and Land Registration), Ministerul Dezvoltării și Administrației Publice (Ministry of Development and Public Administration), EUROLIS, Balkan Environmental Association, Federation International des Geometres.

2.3 Scientific visibility

The scientific papers, classified in the list of publications annexed in the file, can also be considered as a personal publishing activity:
9 – books in the field of Geodesic Engineering as author/coauthor;
28 – articles in international publications indexed ISI/BDI;
27 – papers in international Proceedings ;
27 – papers in national journals;
39 – papers at national conferences

Total number of papers - 121

Research Projects
-3 international projects – 1- director, 2 – member;
-14 national grants;
-3 contracts over 10.000EUR;
-30 contracts under 10.000EUR;

Director of grant and projects (**excerpt**):

- **O**nline network for university collaboration; objective: to develop the capacity to supply superior competences in the geodetic field, contract POSDRU/86/1.2/S/63140, 2010-2012, 1.225.685RON (300.000EUR)
- **E**xperimental research for improving the turbine performances FRANCIS FVM CHE Brădisor, contract no. 174/2010, 57.571EUR – UPT theme responsible;
- **E**laboration of a data base for the use of geospatial information in managing cemeteries of Timişoara Municipality; data collecting and data introduction, contract no. 182/2008, 14.000EUR;
- **N**ational Program for infrastructure modernization- - Interdisciplinary Laboratories (laboratory component for the bachelor cycle), contract no. 2575/2007, 100.181EUR;
- **C**adastral Index Plan for Romania, contract no. 674/2007, 6.000EUR;
- **A**pplication of the terrestrial laser scanning for environmental processes and changes -ATLAS-, project no.10/0242-E/4005/2011, 31.802EUR;
- **E**xcellence in Photogrammetry for Open Cultural Landscape & Heritage -EPOCHE- IP, project 2012-1-GR1-ERA10-10609.

Citations of my papers in BDI- **30**.

Coordinator or member of the research team in 50 research projects/grants

Member in editorial committees of national/international journals; scientific referent

- Referent – Scientific Bulletin of UPT – Constructions;
- Scientific referent of the Journal of Surveying and Cadastre;
- Editor in chief of the Scientific Year Book UPT– Constructions;
- Editor, Monography, 70 years of higher education in Constructions in Timişoara, Orizonturi Universitare Publishing House, 2011;
- Editor for the volume: *Recent Advances in Geodesy and Geomatics Engineering*, ISBN 978-960-474-335-3, Turkey 2013.

The self-evaluation of my current professional situation represents another motivation for the day to day challenges, and at the same time, the urge to reach a superior hierarchical professional stage.

3. The development of the university career from the didactic and professional point of view

The development of the academic career will be made mainly on the disciplines found in the Function Chart of the CCTFC Department within the Faculty of Cicil Engineering of the University Politehnica Timişoara, i.e.: T*opography, Theory of processing the geodetic measurements, Geodesy, Algorithms for the processing of geodetic networks, Surveying*.
The above mentioned disciplines are taught at the following years of study: I, II and III, bachelor study program *Terrestrial measurements and Cadastre*, and the first year master's study program, *Cadastre and Real Estate evaluation* respectively, as well as the first year *Civil Engineering, English medium*.
Along my university career, I have been preoccupied to provide didactic materials, such as courses, books, and support materials for the disciplines taught. In the future, I intend to continue to publish new didactic materials and also to update and revise the previous courses from the disciplines Geodesy and the Theory of processing the geodetic measurements, which will ensure a better compatibility with the similar courses taught at other institutions.
For the master's study program, I intend to recommend the publication of didactic materials for the discipline: *Algorithms for the processing of the geodetic networks* based on the electronic support already existing on the current university virtual campus.
At the present time I am working at a course entitled *Surveying*, based on the material used for the discipline Topography – in Romanian language, where there already is a course support material.
The practical assignments will be continuously updated, and correlated with the lectures, so that they allow both the first cycle students and the master's students to familiarize themselves with the specificity of the discipline.

- As far as the improvement of the teaching activity is concerned, I plan to give as many interesting lectures in the field as possible, and to upload them on the virtual platform. Thus, the students will be able to visualize them before the actual lecture is held. In my opinion if the students can have access to the didactic material before the lecture, we can change the traditional course into an interactive one, and replace the monologue with the dialogue. The advantages of this way of teaching are very important, in my opinion, since the students can focus their attention on the information and to the corresponding explanations, as they already are in the possession of the material which can be permanently updated.
- Regarding the activity of coordinating bachelor's theses or dissertation theses, I plan to revise and to renew the themes, to propose new research subjects to students, themes of actuality, able to make them more involved in the documentation and research activity. In this way, we can avoid the overlapping of the themes with those of the previous yeas and will ensure a continuity of the research in conformity with today's current scientific research in the filed and with the latest trends.
- As far as the practical training is concerned I will be involved along with my colleagues in the activity to organise field study trips, at various companies and institutions in our field, to enable the students connect directly with the real production flux.
- By helping the PhD students in elaborating and writing their PhD theses with interdisciplinary character, I will try to draw to the educational system new assistant lecturers for our specialty, i.e. Terrestrial Measurements and Cadastre, people interested in having a career in higher education.
- From a professional point of view, I will continue my activity to design projects, along with activities of execution and verification in the field of geodetic engineering, to monitor several objectives still in the execution or exploitation stage. I will monitor the impact of the topo-

geodetic works on the environment and on the society as well. I think that these requirements for a geodetic engineer are needed in the teaching activity, the didactic one and the research one as well, since the exemplification of the theoretical concepts with images from real situations, together with such field activities and visits to various institutions with the same profile make easier the understanding of the theoretical principles.

- More than this, on the didactic plan, in the capacity of a candidate, I intend to make a detailed general analysis of the content of the courses taught to harmonize the syllabuses and to eliminate overlapping or omissions.
- Next, together with my colleagues from the Cadastre Section I intend be more involved in promoting/ organizing a post university course on geomatics.

4. Development of the university career from the scientific point of view

In what concerns the future research and development plans of the candidate, related to the fields of research presented above, the following research topics will continue or will be developed:

- **E**laboration of a data base for the use of geospatial information in managing Municipality projects; data collecting and data introduction
- **N**ational/local Program for infrastructure modernization
- **E**xperimental research for improving geodetic technologies performances
- **A**pplication of the terrestrial laser scanning for environmental processes and changes
- Geodetic applications for Open Cultural Landscape & Heritage

The development plan for the scientific development consists of two phases, namely: short and medium term development plan and long term research plan, respectively.
In order to improve and develop the research activity, on a short and medium term I plan to do the following:

➢ Considering that the research activity is essential for a university teacher, the only objective measure to evaluate this activity is represented by the number of articles published and by the prestige of the publications. Therefore, I intend to involve myself more intensely in promoting the findings of the scientific research I have been involved in, either as author or coauthor, in articles to be published in publications with impact factors;

➢ constant publication of articles in scientific journals indexed ISI and/ or BDI;

➢ have a sustained activity by taking part at scientific competitions, national and international **by:**

▪ closer collaboration with accredited institutions and other profile faculties in Romania on subjects specific to our field. So far, I have had collaborations with colleagues from our country for the elaboration of scientific articles, in various authors groups from several faculties with the same profile (București, Alba Iulia, Iași, Petroșani). However, not all the scientific collaboration ways have been used and we are considering taking part in consortiums at national and international competitions or research projects that can maximize the success rate.

▪ Set up a multidisciplinary research team, with various specialists (construction, hydrology, geology, geography, etc), from numerous institutions, able to respond more efficiently to the call for scientific competition;

➢ Identify and promote several common research themes with other institutes and faculties, stating from the similar or complementary activities developed. These types of collaboration might be initiated, for example, by mutual participation in consortiums/ partnerships, at call for projects, national or international, that are to be launched;

➢ Identify and promote certain research themes in partnership with private institutions (companies) which have scientific research as main activity object, especially in the current situation when it has become almost a rule in the national research competitions that part of the financing has to be assured by co-financing;

- Identify and continuous initiate partnerships at institutional level, to take part at competitions financed by FSE such as POSDRU (Operational Sectorial Program for the development of Human Resources) or POSCCE (Operational Sectorial Program for Increasing Economic Competivity);
- Involve students in the research activity. As, this represents an important objective, I have tried to involve my students in taking part at various conferences and symposiums in the field, but we have to do better in this activity in the future.

Considering all the above, I think that my personal mission implies the fact that:

- I wish to evaluate, correct and optimize constantly the didactic tools and the performance standards used;
- I will help my students learn and guide them how to learn, to make them able to know where to find information. I will help them form their own way of thinking in the technical field, develop their personality by using at the maximum their potential and their creativity;
- I will always treat and evaluate my students impartially, manage my own emotions, put into value and periodically adapt my own abilities and competences to meet the quality standards as far as the teaching-learning-evaluation activity in the technical field is concerned;
- The knowledge and the experience acquired along the years will help me support my students, my university colleagues, but also those from other universities and profile companies with plans and quality projects, with reports and efficient solutions; making thus successful collaborations in our field and with other fields as well.

From the professional point of view, I will continue my activity of designing projects, along with activities of execution and verification in the field of geodetic engineering; monitoring several objectives still in the execution or exploitation stage. I will monitor the impact of the topo-geodetic works on the environment and on the society as well.
Finally, it have to be underlined that the active role of the candidate will continuously increase by participation with new research topics to international conferences and papers published in specialized journals. Also, as member in different associations and comities, I will continue the collaborative work with other researchers in the field.

<u>Synthesis of the personal development strategies – career objectives</u>

- **Short term objectives (next 2 years)**

I plan to:

- ✓ draw up a financial request for at least one project as a project director;
- ✓ continue writing didactic materials – at least one specialty book to be published and also online support materials;
- ✓ continue my activity of writing articles for journals ISI indexed, to communicate my research findings at various scientific events, national and international conferences; minimum two articles per year;
- ✓ continue to take part in various international scientific committees, by reviewing specialist articles;
- ✓ continue to organize various internal and international scientific events;
- ✓ organize an ISI conference in UPT, with international participation, in collaboration with other universities.

- **Medium term objectives (between 3 and 5 years)**

✓ be the author or coauthor of at least 5 papers published in specialty journals, respectively journals indexed in international data base;

✓ be the director of at least one national contract and a team member at an international one;

✓ be the co-author, with my specialty colleagues, of one specialty book, in English, published at a foreign publishing house.

- **Long term objectives (over 5 years)**

✓ get involved in as many research projects as possible;

✓ be the author or co-author of 3 specialty treaties, out of which one in English;

✓ be the director of at least 2 projects;

✓ accede to a managing position.

By making this plan I have tried to analyze certain elements related to my personality, and at the same time, to identify the areas that can be improved in order to reach a higher level in my own life and my own career.
I will always make efforts to develop my career, considering my short/medium/long term objectives presented in my career development plan.

I think that reaching the position of **habilitated professo**r, the professional target of any teacher in higher education, represents the recognition of all the efforts made for the accomplishment of the objectives proposed – the seniority of one's career.

The wish to develop my academic career and consolidate my professional reputation is not for personal success and accomplishment only, but also for a better visibility of the Department, Faculty and University I am a part of.

CONCLUDING REMARKS

All research activities and studies, expertises and scientific achievements in the last period, proved me once more the necessity for promoting interdisciplinar collaboration, interdisciplinary engineering projects, for team work results dissemination where the role of geodetic engineering represents an important support as a technical tool and also as an operational decision making factor