GIS Applications in the Field of Nord Vest of Romanian Mining

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Abstract

This paper analyses the opportunity and usefulness of building GIS systems in the case of mining exploitations, sketching its configuration, the composing informational levels, the methods of management, updating and access of this very up-to-the-minute information management technique in a unitary system and present the conjuncture in which a GIS type informational system is desired to be implemented, the difficulties, the strengths and weaknesses.

Analyzing the informational levels that MINING SURVEYING offers, we can see that practically, starting from the support layer, which would be the general plan of the mine, for the underground, and the topographic site plan for the surface, all the information is geographically labeled, so that everything mentioned below corresponds to the same condition.

A case study is presented concerning the Maramures mining industry , exploitation for extracting non-ferrous metallic minerals and for the subsidence study Was performed at Iara, Cluj County. Iara is a closed iron mine and preserved now, due to current global unfavoured conditions and the fact that support of mines by state had become unprofitable.

Keywords: mining activity, competent authority, extractive cadastre, mining book, topographic base, mine, GIS, subsidence.

1. The North-West Region

The North-West Region (Northern Transylvania) was created based on the Law 151/1998 (modified by the law 315/2004) by voluntary association of the local public administrations, but it is not yet considered an administrative-territorial unit and it does not have a legal status. The Romanian North-West Region is one of the 8 development regions in Romania and it is composed by 6 counties: Bihor, Bistrita-Nasaud, Cluj, Maramures, Satu-Mare, Salaj. The surface of the region is of 34.159 square km, which represent 14.32% of the country's surface, with a total population of 2.744.914 inhabitants. The region includes 421

administrative-territorial units: 6 counties, 42 towns, of which 15 municipalities, 398 communes and 1.823 villages. The region has a strategic geographical position, being situated at the borders with Hungary and Ukraine, but also with the Center, West and North-East development regions in Romania. The region is one of the most picturesque in Romania, starting from the Apuseni mountains that have a particular charm, to the special cultural-popular patrimony in the ethnographic regions unique in this part of Europe. Northern Transylvania is a cosmopolite region, where, together with the Romanians, live half (52.8%) of the total number of the Hungarian inhabitants in Romania, which has brought about the creation of a single cultural identity.

In 2003, the North-West Region will have a GIP/inhabitant of 2.338 Euro, close to the national average, but still far from the European Union average of 27. The contribution of the economic sectors to the creation of the regional GIP indicates a percentage of 16.3% for agriculture, 35% for the second sector and 46.7% for the third one. From the point of view of the evolution, there is a growth of the services and a reduction of the agricultural activities. Considerable growths were registered in the housing and industrial construction sector – dwellings, shopping centers. A series of differences between the counties have been noticed: some are more industrialized, while others are based on the primary activities, especially agriculture and animal breeding**.**

The most important cities are Cluj-Napoca, Baia-Mare, Oradea, Zalau, Satu-Mare and Bistrita – these are considered both regional poles for economic development and cities with a special cultural and historical patrimony. In the Region exist or are proposed as projects 2 metropolitan areas, respectively Cluj metropolitan area and Oradea metropolitan area, these cities being also regional poles for economic development. After analyzing the strategic development options, the Region has chosen a polycentric development model (a development policy sustained by a network of localities that play the role of development poles), with focus on the economic growth through the functional specialization of the territory. Regarding the polycentric development, it has become necessary to strengthen the involvement potential of the municipalities that are county capitals (Baia Mare, Bistrita, Cluj, Oradea, Satu Mare, Zalau), and also to strengthen and/or grow the involvement potential of a minimum of other cities, which at the end of the programming period (2007-2013) can be classified on a superior level than the present one.

2. Main Historical Mining Milestones

The existence of a human community in the area is attested since the superior Palaeolithic. The first written information about the settlement point to the existence of a powerful mining centre, with all the features of a medieval town, self-governing and administrating, subject to central state authority. Thus, a privilege granting document issued by the Royal Chancellery of Louis the Great D'Anjou on 20 September 1347 provides us with extensive information concerning the administrative structure, the eligibility of the governing bodies and their competencies. In 1748 the Austrian authorities founded the Superior Mining Inspectorate (Obermat Inspector) in Baia Mare to be housed in a newly built building and a mint.

3. Regional Planning Process

Given the importance of the programming process for the period 2007-2013 and also the significant changes that occur in the context of Romania's accesion to the European Union, an important process of reflection upon the purpose of the Regional Development Plan, upon the entire planning process, took place at a regional level. The entire planning process was meant to guarantee an element that enforces a strategy: a common vision, as a basis both for the programming and for all the following actions of implementation of the strategy, knowing that these are in fact "individual" actions; in this effect, a major aim is that of increasing the specific ability to "manage" development, and also the structural funds absorption capacity. We have decided to ensure a stronger involvement of the private sector in the process and also to better reflect this problem in the public debate, that is to strengthen the real social dialogue and to prepare the transition to a truly civic dialogue by stimulating the involvement in the process of the sub-county levels, of the local communities.

A project was also initiated in the field of institutional development, meant to result in an Action Plan for the improvement of the administrative capacity in the local public administrations in the region. The project was carried out in parallel with the planning process, also coordinated by the North-West RDA, called *Partnership for Development.*

The planning process is still in process of development at this moment. The main stages of the process are:

· The mobilization and involvement at a regional level stage (arousing the interest, mobilization of the regional partnership networks, revision of the existent documentation):

- The mobilization and involvement at the sub-regional planning levels stage (county, sub-county, stimulation of the "local groups of initiative", of the local communities),
- The regional consent stage (revision of the regional approach according to the reactions in the previous stage),
- The final formal approvals stage.

This strategic option will direct all the interventions within the regional strategy, being an objective to be reached by all the identified TPUs – e.g. the priority environmental investments will be a support for the development of the business infrastructure in the area, the human resources will be the ones oriented towards the training of the workforce etc.

The county councils were asked to identify in each TPU the priority economic sectors based on three criteria:

- the existence in the area of natural resources able to sustain the development of the sector ,
- the sector structure of the local economy ,
- the existence of a well trained workforce in the area of in the adjacent areas (or at least of a necessary education infrastructure – especially professional and technical and/or university education) to: the importance of the sector for the development of the county, the competitive, innovative and stimulating potential of the respective sector.

Several counties in Romania are interested in their development, and there are favourable conditions to build specific competencies of the North-West Region (Northern Transylvania) and to guarantee competitive advantages in the national and global competition:

- IT&C,
- Superior education and research,
- Tourism,
- Agriculture,
- Food and consumer industry ,
- Automotive and equipment industry ,
- Maintenance sectors

These sectors have a high degree of occupation in certain TPUs (Territorial Planning Units), ensuring the economic support for the well-being of these areas. However, their development outside these TPUs is not predictable in the lack of the attraction of very important investors. In this case, the option is to guarantee the conditions necessary for maintaining the interest of multinational companies in the respective fields for the investments in the North-West region, avoiding their delocalization:

· Mining and Metallurgic industry
· Rubber industry

Strategic activity area 1. Services for Regional Development

- Elaboration of regional planning documentation
- Monitoring the implementation of development strategies
- Consulting for the development of regional investment projects
- Management of partner structures
- Development and implementation of own projects of the North-West RDA that can sustain the excellence fields
- Carrying out activities and presentations for promoting the region as investment and tourism destination
- Management of cooperation relationships/protocols (inter-institutional, interregional, European networks)
- Management of institutional structures created with the participation of the North-West RDA

The North-West Regional Development Plan is the fundamental document regarding the need of financing from European funds and from other international and national funds at a regional level. It is the instrument through which the region promotes its priorities and its interests in the economic and social field, representing, at the same time, the contribution of the region to the elaboration of the National Development Plan.

The North-West RDP is elaborated by the Development Office – Planning and Technical Assistance Department of the Agency for Regional Development North-West in a vast partnership framework, established according to Government Decision 1115/2004 regarding the elaboration within partnership of the National Development Plan within the Regional Planning Committee, which took place for a significant period starting with year 2004.

The North-West RDP is composed by the socio-economic analysis of the region, the SWOT analysis and the regional strategy. The method of elaboration of the strategy for the period 2007-2013 consisted of a bottom to top process of analysis of the region's potential.

Presented in its main stages, the process of elaboration of the 2007-2013 Regional Development Plan was divided as it follows:

· Elaboration of the socio-economic Profile of the North-West Region;
· Identification of the strategic development options;
· Outline of a spatial approach of the development policy;
· Identification of the development poles;
· Functional specialization;

· SWOT analysis;
· Settling a long term vision of the North-West Region;
· Settling the strategy for the period 2007-2013 (objectives, priorities and measures);
· Elaboration of the regional documentation for sectoral programming;
· Projects portfolio;
· Public consultations/debates;
· Approval of the Regional Development Plan in the Council for Regional Development.

The Regional Programming Document for Environmental Protection in the North-West Region 2007-2013 was elaborated taking into account the following general principles:

- the mission of sustainable development as a growth path, together with the careful usage of the common natural resources, so that the regenerable resources can be preserved, while the non-regenerable resources are used taking into account the needs of future generations.
- The sustainable use of natural resources, a key objective for Romania, which can be reached only by integrating the environmental protection and preservation of nature in the sectoral policies.
- The importance of integrating environmental protection in fields that regard the use of land, rural development, sustainable use of waters, waste management and environmental safety, and also the regional development of human dwellings and territory planning. The workgroup involved in the strategic planning process was composed by representatives of the North-West RDA, of the Regional Environmental Protection Agency (REPA) Cluj, of the county councils, of the Environmental Guard, of the Hydrographic Basins Somes-Tisa, Crisuri, Mures, together with the Forest Office Cluj, the Ecologic Club Transilvania, the Mounting Club Apuseni.

4. Mineralogical aspects in the Maramures area

The Maramures mining region is located in the northwestern part of Romania and it is famous for the ores it has underground. The geological structure of the region consists in two structural sublevels, which belong to the Alpine orogen:

1. The crystalline and sedimentary bed (Jurassic - Aquitanian)
2. The sedimentary and eruptive blanket (Middle Miocene - Pliocene)

The mineralization is represented in the form of veins, situated in the volcanic apparatus or in their neighbourhood. The veins have length between 500-2000 m, width of a few centimetres (2-4 m on the average) and only exceptionally reach 10-15 m at Baia Sprie. On the vertical,

the mineralization is known on an altitude difference of 800 to 1000 m. The veins can be isolated or grouped in parallel systems (Cavnic) and present branches. The deposits formed of one main vein are split at their superior part (Dealul Crucii, Baia Sprie). Depending on the nature of mineralization, the deposits are classified as follows:

1. *The Northwestern group,* with mineralizations of Pb, Cu, Zn, Au and Ag, includes the deposits Ilba, Nistru, Sofia and Băița Nord.
2. *The central group*, with mineralization predominantly of gold-silver with native Au, includes the deposits Băița Sud, Săsar Mine, Valea Roşie and Dealul Crucii. Also, here appear simple copper veins, as well as veins with polymetal sulphurs. The gold mineralization is epithermal; presents colomorph textures (the chalcedony from Săsar), and the geo-thermometric data indicates 130-240°C.
3. *The Eastern group*, has mineralization of Pb, Cu, Zn and subordinated Au and Ag. Here are included the deposits Herja, Baia Sprie, Cavnic, Roata and Băiuț. The mineralization presents a vertical disposition: in the upper parts predominates the gold-silver mineralization; in the middle part predominates the lead and zinc mineralization; in depths predominates the copper mineralization.

In the region there were described over 400 mineral species, some of them being discovered here for the first time.

5. Romanian mining industry and environment protection-short prezentation

The situation of Romania's geological reserves is: 3 billion tones of lignite;1 billion tones of huile;40 million tones of gold-silver ore;90 million tones of polymetalic ore;900 million tones of cooper ore;4 billion tones of salt. In the Romanian mining industry work in present 96 economics agents and the distribution of these is the following:3 national companies for coal which have 40 mining branches;2 national companies for polymetalic, gold and silver ores which have 44 mining branches; National Company for the Uranium ; National Society for Salt which has 7 branches; National Society for the Mineral Waters;7 societies for non-metal ores;10 societies for geological research;5 research institutes;

The production capacity of the mining activity in Romania is the following (Tabel 1):

Tabel 1

Type of substance	Yearly capacity Mil.tones
coal	**52.00**
polymetalic ores	**21.00**
copper	**13.80**
gold and silver	**2.20**
polymetalic	**3.60**
iron and manganese	**0,80**
uranium	**0.60**
non-metal	**8.00**
salt	**4.30**

In the period of 1990-2002 more than 200 mining sites were proposed for closure;
The costs for the closure of these mining sites are over 300 million USD;
This closure operation is financed by the state budget and by the loan from the World Bank;
The World Bank financed the elaboration of a Manual for the closure of the mining sites; The mining industry impact on the environment refers to the following aspects:

- Emission of pollutants in air (NOx ;CO; SiO2 ;SO2);
- Emission of pollutants on surface and ground waters (heavy metals, sulfates, chlorites, carbonates and others);
- Soil pollution;
- Hydrological changes in the area;
- Landscape changes in the area;
- Occupation of a large area of terrain for the exploitation activity, industrial facility, waste deposits and tailing dam;
- Disturbing of natural habitats;
- Affects cultural and historical sites;
- Vibration effects caused by explosions;
- Long term effects over the environment during activity and after the closure of the mining activity;

Conclusions:

- The mining activity has a strong impact on the environment;
- The environmental problems have been accumulated in time;

- The financial efforts for the closure of the mining sites and rehabilitation are high;
- Every year it's necessary to assure the operational costs for the treatment plant for the acid drainage from the budget ;
- The state has to assure the necessary funds for the safety of the tailing dams and waste deposits ;
- It's necessary to monitor the acid drainage and to mitigate this phenomenon.

6. The role of mining surveying in configuring and coordinating mining GIS

6.1. Overview

Mining topography includes the works of measurement and analytical and graphical processing of measurement data accomplished in order to determine and certify the information concerning all the steps for using the mineral resources, beginning with prospecting and exploration to exploitation and usage, by means of subterranean works and surface works

The main activities of mining topography are:

a) Designing, performing, conservation and development of topographic control networks at the surface and under ground;

b) Investigating, collecting, archiving and supplying the necessary information for the extractive cadastre;

c) Forecasting and monitoring the effects of exploitation on the surface and under ground, in the various phases: exploitation, closing and post-closing, as well as approving urbane detail plans from the mining areas;

d) Tracing the mining works from the surface and from the subterrain;

e) Detailed topographic survey and recording the subterranean and/or surface mining works, as well as the geometric elements of the deposit, in the graphical documentation;

f) Reception of surface and subterranean mining works from mining topography perspective;

g) Control and monitoring of the stability of the surface and subterranean mining works;

h) Consultancy and expertise in the area of mining.

6.2. The mining topographic documentation, according to Order nr. 133 of the National Agency for Mineral Resources from July 25, 2003, concerning the approval of the Mining topography regulation

The graphical mining documentation includes all the documents drawn, drafted based on the data obtained by topographic measurements, graphically represented based on well-determined and unitary projection principles.

The graphical mining documentation is composed of:

Group 1: fundamental plans and drawings, including graphical documents concerning the reference system and the surface and subterranean topographic control network

Group 2: the archive of the deposit, including graphical documents that refer to knowing the deposit, with its characteristics concerning the position, shape, size and geophysical and chemical data, as well as those concerning the computation and recording of the reserves of useful mineral substances;

Group 3: exploitation maps, plans and drawings, including graphical documentation used for the current activity;

Group 4: special plans and drawings, including the graphical documentation concerning the protection of the surface and of the deposit, administrative and organizational documents, exploitation perimeters and extractive cadastre;

Group 5: maps, plans and drawings concerning the design and planning of the mining activity, including specific documents that are used for designing mining constructions and for establishing general exploitation programs.

The topographic documentation consists of:

a) Surface maps and plans:

1. the map on the 1:100,000 scale of the area in which that perimeter is located;

2. the map on the 1:25,000 scale, indicating the borders of the perimeter and the coordinates of contour points;

3. the general topographic plan of the perimeter on the 1:5,000 scale, which contains: contours, demarcation of mining properties and locations, prospectings, the detailed geological exploration limits, the location of descents to under ground, the surfaces intended for depositing the attles, water supplies, etc. with elements for connecting to the "Stereografic-1970" projection system;

4. the topographic plan on 1:2.000 or 1:1,000 scale, in the reference system of the mining basin, in which the mining works are, and in the "Stereografic-1970" projection system;

5. the site plan on the 1:1,000 or 1:500 scale of the mining locations, with elements to connect and coordinates in the "Stereografic-1970" projection system.

b) Subterranean plans:

1. Fundamental plans, performed on strong supports an having special depositing regime, represent the basic legal documents for the subterranean mining activity:

- The general plan of the mine, on the 1:5,000 or 1:2,000 scale, correlated with the surface
- The general plan of the mine on the 1:1,000 or 1:500 scale;
- The plan of each layer, vein or stock in elevation, designating the exploited spaces, on the 1:1,000 or 1:500 scale;
- Longitudinal sections and transversal section through the deposit at 100 m at most, on the 1:500 - 1:5,000 scale;
- The plan of each horizon, in the case of deposits with high declivity, where the general plan presents significant overlapping of works at various horizons, on the 1:1,000 or 1:500 scale.

2. Work plans, drafted on heliographic copies or drawing paper applied on textile, for the current usage of the exploitation:

- The general plan of each sector, on the 1:500 scale;
- The plan of each horizon, in the case of deposits with high declivity, on the 1:1,000 or 1:500 scale;
- The plan of abatises on each layer, stock, vein, on the 1:500 or 1:200 scale;
- The site plan of each exploitation section, in the case of thick layers, on the 1:200 scale;
- The longitudinal profile of main transport routes, horizontal and inclined, periodically updated, depending on the needs of the exploitation;
- The longitudinal profile of the holes, with transversal sections, designating the installations from the hole and from the ramp of each horizon, updated after the periodical checking stipulated in the current regulation;
- The plan and sections of water basins, pump installations, subterranean rooms, subterranean deposits;
- The plans and drawings concerning the mechanical-energetic installations.

c) Written documents: records and journals belonging to the plans and the production and stock record.

6.3.The GIS power

The Geographic Information Systems represent a relatively new science (the first steps have been made at the beginning of the ’60), which has begun to be successfully applied, especially in the area of cadastre, in the countries from Western Europe, after ’90, and in

some countries from Eastern Europe (Hungary, Czech Republic, Poland) at the end of the ’90 and the beginning of 2000. In these countries, the implementation, use and development of applications using GIS was completely accomplished by well and continuously trained specialists. The North-western region of Romania, and generally Romania, was behind in what concerns the implementation, use and development of this modern technology, because there were very few specialists in this activity domain. They attended a series of courses abroad, learned by themselves or attended certain courses after which, unfortunately, they did not reached very high standards, such that we can say without being wrong, that the Romanian graduate education does not take into consideration the training of real GIS professionals The ultimate use of GIS lies in its capability for modelling: constructing models of the real world from digital databases, and using these models to simulate the effect of a specific process over time for a given scenario. Modelling is a powerful tool for analysing trends and identifying factors that affect them, or for displaying the possible consequences of planning decisions or projects that affect resource use and management.

Analysing the informational levels that MINING SURVEYING offers, we can see that practically, starting from the support layer, which would be the general plan of the mine, for the underground, and the topographic site plan for the surface, all the information is geographically labelled, so that everything mentioned below corresponds to the same condition.

6.4. Basic Aspects Solved by MINING GIS:

- Mine management
- Production
- Exploitation safety
- Environment protection

6.5. Other data necessary to be incorporated in MINING GIS=MGIS – Geographical Information Systems for Mining

All the surface GIS characteristic data, to which there are added the data specific to subterranean exploitations:

1. Geologic data,
2. Surface topography,
3. Economical, financial

4. Transportation of carriages for personnel and ore,
5. Production, stocks, reserves,
6. Electrical networks, airways,
7. Support, consolidation of mining works,
8. Mining protection areas, water locks, air, blowholes,
9. Exploitation projects
10. Opening or closing projects
11. Impact on the environment,
12. The impact of the subterranean exploitation on the surface terrains,
13. Topographic control networks, from under ground and connections,
14. The connection of the local control system to the national system,
15. The connection of the local control system to the worldwide system, WGS84,
16. Areas in exploitation, the progress of exploitation,
17. Taxes,
18. Mining cadastre,
19. Protection and management of risks and disasters,
20. Radiometric data,
21. etc.

7. THE DOCUMENTATION OF INFORMATIONL SYSTEMS OF MGIS TYPE IN THE MINING INDUSTRY

The documentation of systems, in general, is a process of decomposing a whole into its composing parts, in order to allow their examination; this leads to the understanding of the nature of their functions and correlations. The following steps are involved, which should not be missing in the case of configuration and establishing of a MGIS, too:

1. Activities to collect information for the analysis of the systems

The main activities for collecting information concerning an object system and its informational system are: documenting, observing, interviewing and questioning.

The documentation, observation techniques, the interview and questionnaires are used in various extents during the next steps of analysing the existing system.

1. Reviewing the object system.
2. Analysing the informational-decisional system of the object system.
3. Identifying the drawbacks of the informational system.
4. Documenting the analysis of the exiting informational systems.

These steps of the system analysis will be discussed in more detail in the sequel.

Managers are frequently asked what information would they prefer to know or what copies of the already drafted reports or of the reports that will be drafted for other managers would they like to be offered. This approach tends to encourage managers to ask more information than they need. Research in the field of decision-making and information usage indicates that:

1. Decision-makers tend to ask and feel more comfortable having more detailed information than they actually need. Even more, it seems that they make better decisions having concise information and exceptional reports.
2. The lesser knowledge the decision makers have concerning the necessary decisions for the appropriate administration of a process, the more they will tend to ask for more information.

The informational requirements are based on the decisions that managers have to make. This reduces the tendency of managers to ask for more information than they need. Such surpluses make the process of information processing more difficult and are expensive.

The difficulty of defining the decisional system. Defining the decisional system is an important step in system analysis. In order to define such a system, discipline and considerable effort are necessary from the managers.

Decision centres. The decisions made in an organisation are grouped in decision centres. A decision centre is composed, in general, of a decision-maker, the procedures of decision-making and the activities for which the decisions have to be made. The decisions made in a decisional centre belong to the management of a regular organisational process.

Another advantage of defining decision centres and main decisions is that the decision-making mechanism and the decisional centres often show discrepancies.

Identifying the drawbacks of the existing informational system

After analysing the informational-decisional system of the object system, the next step is to identify the drawbacks of the existing informational system. This prepares the step for reengineering the process. After studying in detail the object system, based on the documentation, interviews or questionnaires, it could seem that the identification of drawbacks is a mere logical extraction of the information needed for making the decision from the information supplied concerning the object system.

Documenting the existing systems

As soon as the information needed for the new system is defined, the next step is to document in detail the existing system and to analyse. In general, there exists a documenting form of the existing informational system, and this is the starting point for the analysis.

8. The impact of the European environment acquis upon the mining industrial sector in Romania, final report

As part of the adhering process, Romania has to explain to the European Union the way in which will be carried out the transposition of the union acquis to the level of national legislation. The union acquis is divided into 30 chapters, Chapter 22 referring to the environment. In Romania, the environmental problems are among the most difficult and sensitive problems that need to be negotiated during the adhering process.

In order to solve the problems concerning the environment in the Mining Industrial Sector, investment in needed:

- Investment costs (million €)533,
- Maintaining and operation costs (million €/year) 5,6,
- Yearly costs (million €/year) 48,2

The benefits resulting from the increase of the air quality and industrial pollution control could be eight times larger than the costs of conforming. From the moment that this sector and the other main polluting industrial sectors will implement the union acquis, the people of Romania could enjoy clean drinking water and the sickness rate will decrease, which will lead to the reduction of premature deaths. A study estimated that the benefits given by the better quality of the air and the control of pollution, as result of implementing the LCP and IPPC directives are between 0.78 and 5.85 billion euro per an. The upper limit of these benefits is approximately eight times larger than the upper limit of conforming costs.

The National Agency for Mineral Resources has prepared an Environment Sector Evaluation between June 2000 and August 2001, as part of the project for closing the mines and for social protection, funded by the World Bank. The main ESE objectives were:

- reviewing the legislative frame for regulating and the institutional frame in the mining sector;
- evaluating the impact of mining upon the environment and local communities;
- estimating the costs of environmental rehabilitation;
- establishing a corresponding priority based on the action plan in the environment area.

The main conclusions of the sector evaluation are:

- State mine management should be improved especially concerning pollution and accidents prevention, which implies adopting a new approach and allocating supplementary funds for environment protection. There should be an environmental action plan in the state mining sector that would evaluate the optimal environment costs for all the phases of mining operations and not only for the final phase (closing the mine). In this phase, establishing a

high quality GIS is indispensable. This will serve for all the next phases, in the case of continuing the production, conserving the mine, monitoring the environment, etc.

- The ability to monitor the polluting emissions of the state mining companies is very weak and the ability to monitor the local inspectorates is quite inefficient because of the lack of equipment and financial resources. In this area, lack of GIS is a major drawback.
- The institutional ability certifying, implementing and environment management in the mining sector should take into consideration the best available technologies (BAT), the environment management systems and the risk management.
- Most mines did not perform impact analysis or environmental audit and not much less mines have conforming programs. The development of some technical directing lines is needed for assessing the environmental impact, the environmental audit, risk analysis and environment management procedures.
- There was proposed an Action Plan in the environmental area for the mining sector, based on two important aspects:

a) The mining sector has a difficult heritage concerning the environmental degradation and is confronted with serious financial and environmental difficulties. Though there exists a high level of awareness concerning environmental problems, there have been taken few steps in order to eliminate and prevent the negative impact of mining activities;

b) The continuing and increase of the environmental problems are not caused by the lack of regulations, standards, institutions and legislation, but by the weak implementation of the existing regulations.

The privatisation and closing on unprofitable mines still remain the main instruments for restructuring and increasing the efficiency of mining industry, but this process should take into consideration the reduction of state aid and the negative social effects that determined not once a resistance reaction on the part of syndicates and workforce involved in this industrial sector. On the other hand, the state was until now the only investor and the only owner of the mines, few mines could be leased in the second half of the ´90. The investments from the sources of the companies were almost negligible, as well as those from the private investors or external credits. Or, in these conditions, the societies from the extractive industry should be transformed into stock companies. But in the new circumstances, the management of the entire activity could not be conceived without a real, correct and complete information system.

9. Land subsidence due to underground coal mining activities

9.1. Generality

The use of GIS was prompted by the fact that the process of understanding and managing coal mine subsidence impacts is largely a spatial one and that many of the factors that are critical to the assessment of subsidence impacts have a strong spatial component, such as proximity to longwalls, terrain attributes (slope, relative height, valley shape and height), and the distribution of sensitive features (BHP Billiton Illawarra, Coal Environment Manager, Gary Brassington).

Land subsidence due to underground coal mining activities has the potential to impact on surface or near surface infrastructure.

Australian Researchers (**GIS technology improves decision making**), found five main roles for GIS in subsidence impact management:

1. The storage and management of spatial data related to mine workings (planned and existing) and the associated environment;
2. Site characterisation and identification and quantification of susceptible features, such as cliff lines and watercourses;
3. The assessment or prediction of the extent and magnitude of subsidence impacts;
4. Researching and understanding subsidence processes; and
5. 2D and 3D visualisation for communication and research purposes.

Gary Brassington said work on an industry subsidence impact database had commenced in the 1970s but it was only in recent years that the industry recognised the critical need for such data. The resulting deformation maps were analysed with the aid of a geographic information system (GIS). Possible horizontal or vertical movements due to underground mining were identified outside the normal angle of draw. Movement of the ground surface due to underground coal mining activities includes vertical subsidence, horizontal displacement, horizontal strains, curvature and tilt. Vertical subsidence is dominant around the centre of the subsidence basin, while the horizontal displacement is more significant at a distance further away from the centre. Generally, mine subsidence is less than the thickness of the coal seam extracted underground. Civil infrastructures and the natural environment may be damaged by land deformation caused by underground mining activities. Besides vertical subsidence and horizontal movement within the subsidence basin, there are some unexpected but significant horizontal displacements far away from the active longwall in the Southern Coalfields of NSW.

The size of the movements and deformations depends primarily on geo-mechanical properties of rocks and general geomechanical situation comprising the geological conditions

of embedded deposit, extracted thickness and depth of deposit under the surface, method of exploitation and other factors (Schenk, J,1999).

Systematic measurements are required to be able to evaluate and interpret the effects of the ground movement at the surface.

9.2. Case Study

Was performed at Iara, Cluj County.Iara is a closed iron mine and preserved now, due to current global unfavoured conditions and the fact that support of mines by state had become unprofitable. The geological studies suggests that iron stocks in the area are the most important in Romania!

The topographic measurements are made for knowing the impact of the underground voids after making operations on the surface. The impact is considered catastrophic, images are showing only part of them. The results interpreted and centralized may be a piece information for the link of the GIS of the area both in the general knowledge of the area or to monitor the environment ; for the most desired database of the mine created which may be a valuable database to re-open of the mine.

A strong base of support was created, initially consisting of 16 points and then reduced to five, after testing the stability of network points in relation to the studied area. GPS measurements were used and by the total topographical station with an accuracy of 2 ". The surveying measurements of the buildings were made with the high precision level and with the invar stade (mira). Four measuring cycles have been done, three of them completed the fourth in processing, subsequent cycles were performed based on the ultimate results. All data are geo-referenced coordinates of the national system, so always can be included in the GIS of the area, not depending on the studies' destination. The measurements and the studies are carried out under a collaboration between CS CONVERSMIN SA Bucharest, CNCAF MINVEST Deva, University of Petrosani and the North University of Baia Mare. The project aims the knowledge of the effects of disasters produced by mine subsidence and their limitation , particularly on the expansion of impacts on constructions and neighboring properties.

Fig. 1. Different time images taken at the diving cone, the last image: 12 mai 2010

CONCLUSIONS

Beyond the symbolism of the mine and the substances that are extracted through this activity, the development of European mining basins has generated problems concerning the flow of people, urbane and regional development, union integration processes, social organization systems, knowledge transmitting in formal and informal systems, appearing of a characteristic of the mining culture. The cultural and social heritage of the mine and mining must be saved from disappearing, when the activity itself ceases, in order to keep the identity of those areas, and the historical values they have produced. The dynamics of the current social, economical, cultural processes can accelerate these losses, irreversibly.

From 37,000 miners that Remin Baia Mare Company had (which the studied mine is part of) in 1990, 125 were left. The budget project for 2006 does not allocate any more many for mining subventions. Without subventions, the mines from Maramureş, Bucovina, Ardeal and all the subterranean exploitations from Oltenia are closed. The European Union does not accept subvention granting.

Subsidence is one of the most important environmental effects of underground mining and depends on many factors. Therefore, prediction of ground movements and deformations caused by underground mining is an important aspect in determination and prevention or minimization of the damage (M. Esenay Haciosmanoglu, 2004).

Depending on the type and condition of structure, monitoring systems may need to be capable of measuring both long-term movement trends and short-term loading deformations. Long-term measurements are far more common and somewhat more complex given their external nature. Long-term monitoring of a structure's movement typically requires observations to monitoring points on the structure from external reference points. These external reference points are established on stable ground well removed from the structure or its construction influence. Traditional geodetic survey instruments and techniques may be employed to establish and monitor the reference network points.

The implementation and use of GIS technology in an organization represents a long process. Being a relatively new area in Europe, too, one of the main obstacles for successfully implementing and using it within the area is the lack of knowledge, the incomplete understanding or misunderstanding of techniques and concepts, which leads to a completely wrong approach of the issues that are to be solved.

This paper tried to present the conjuncture in which a GIS type informational system is desired to be implemented, the difficulties, the strengths and weaknesses. Future papers will present possible solutions.

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