



According to the scheme in figure 1, the information flow contains three subsystems having different roles: - subsystem I – Monitors the negative effects brought to the environment; - subsystem II - Monitoring the economic units (gravel pits); - subsystem III – Exploitation management.

The software (applications) for monitoring and management for the gravel pits were in such a way made that they could meet the imposed requirements and ensure the informational flow according to the scheme in figure 2.

Scheme of the applications (fig. 2), contains the following stages: graphical data acquisition; alphanumeric data projection and acquisition; realization of the 3D model of the location; realization of the applications; realization of the working interface for the beneficiaries.

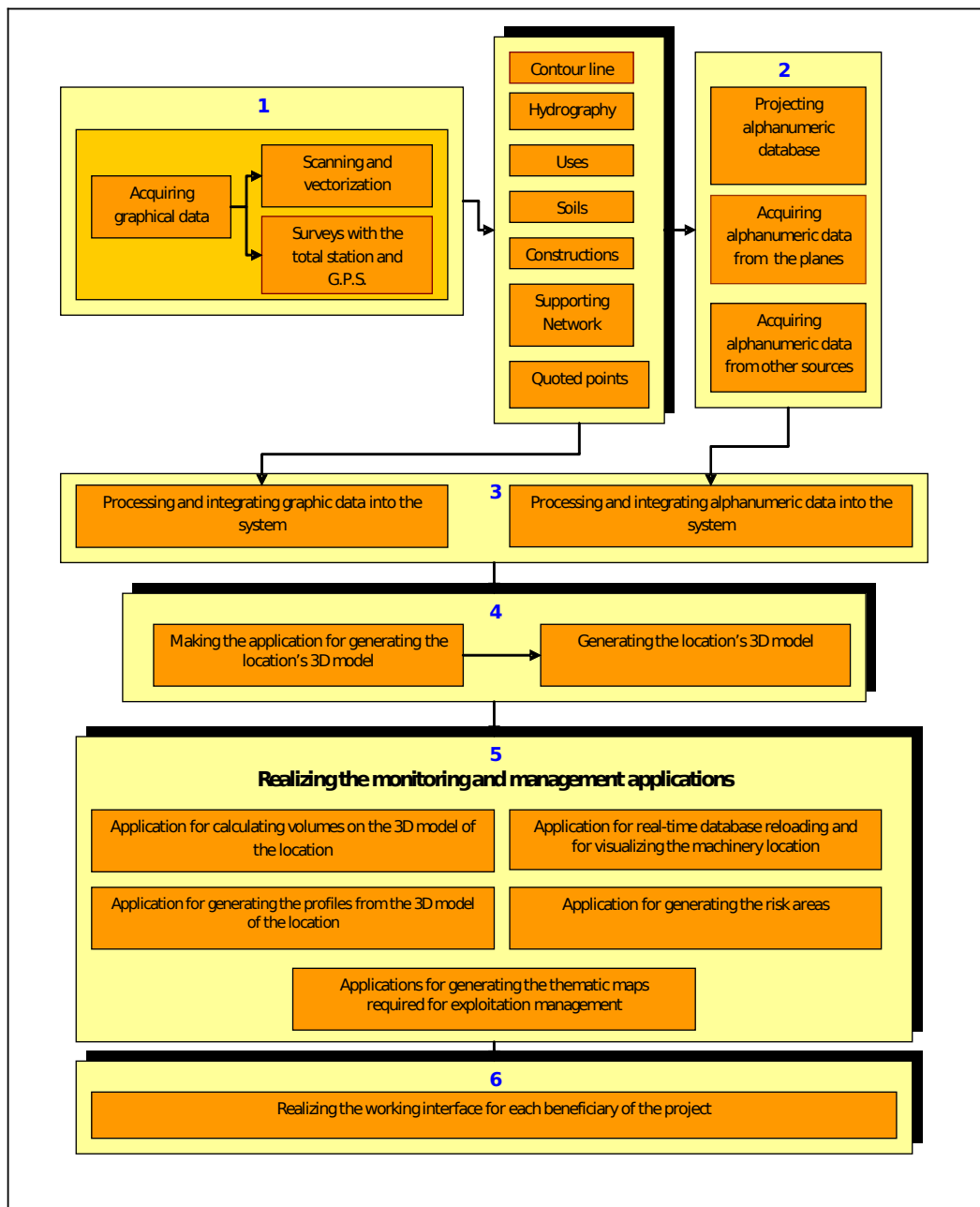


Fig.2: Scheme of the monitoring and management applications

The project's applications are conceived in such a way so that they could ensure the efficient exploitation of the system's data, in order that an efficient management could be made. The functional scheme of the gravel pit's management is shown in figure 3.

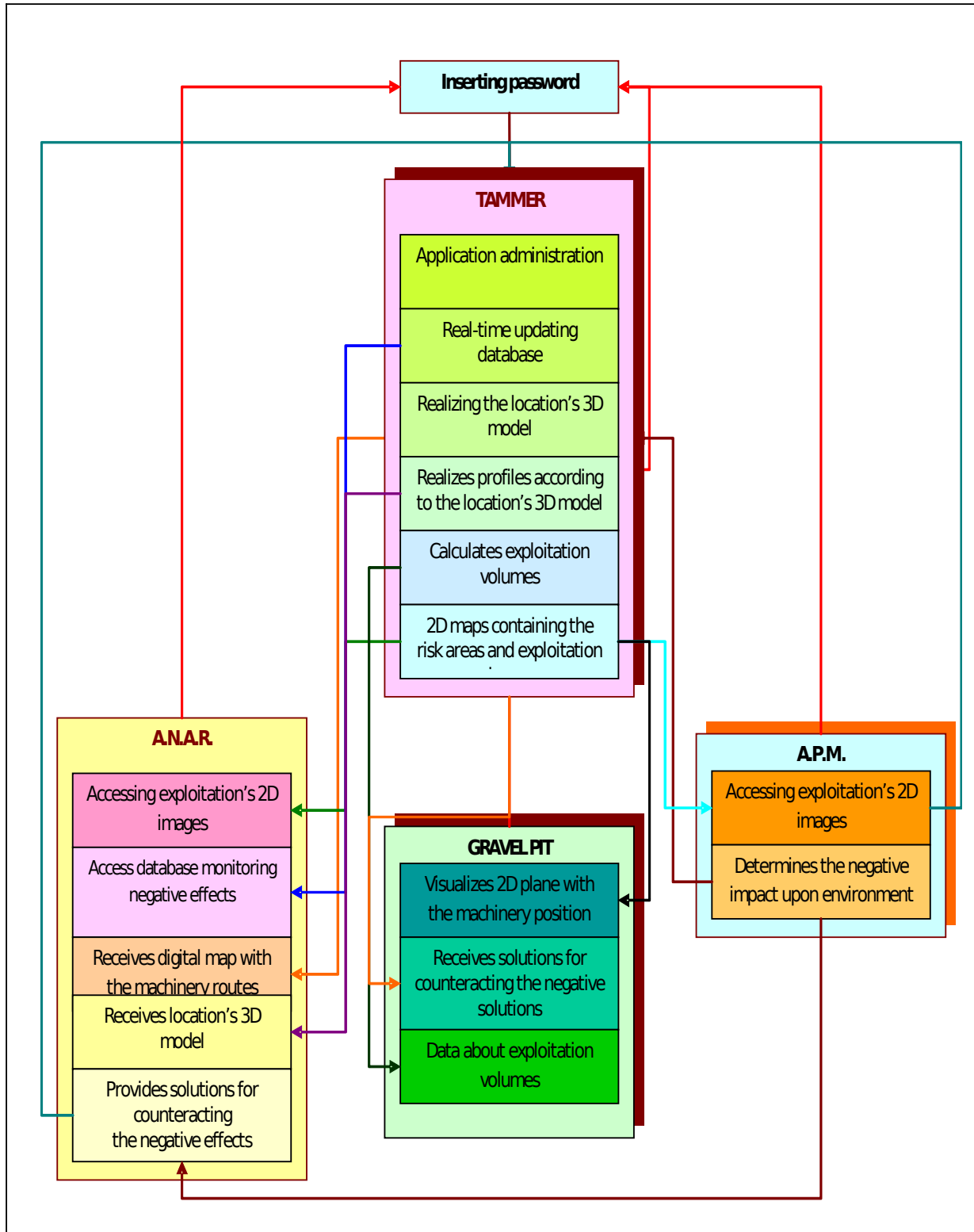


Fig.3. Functional scheme of the gravel pit's management

Function of the entire system requires that each participant to the exploitation's process of monitoring and management to possess a minimum of technological assets, in order that it could ensure the real-time informational flow of the data. In figure 4 it is shown a scheme with hardware able to ensure the system's informational flow.

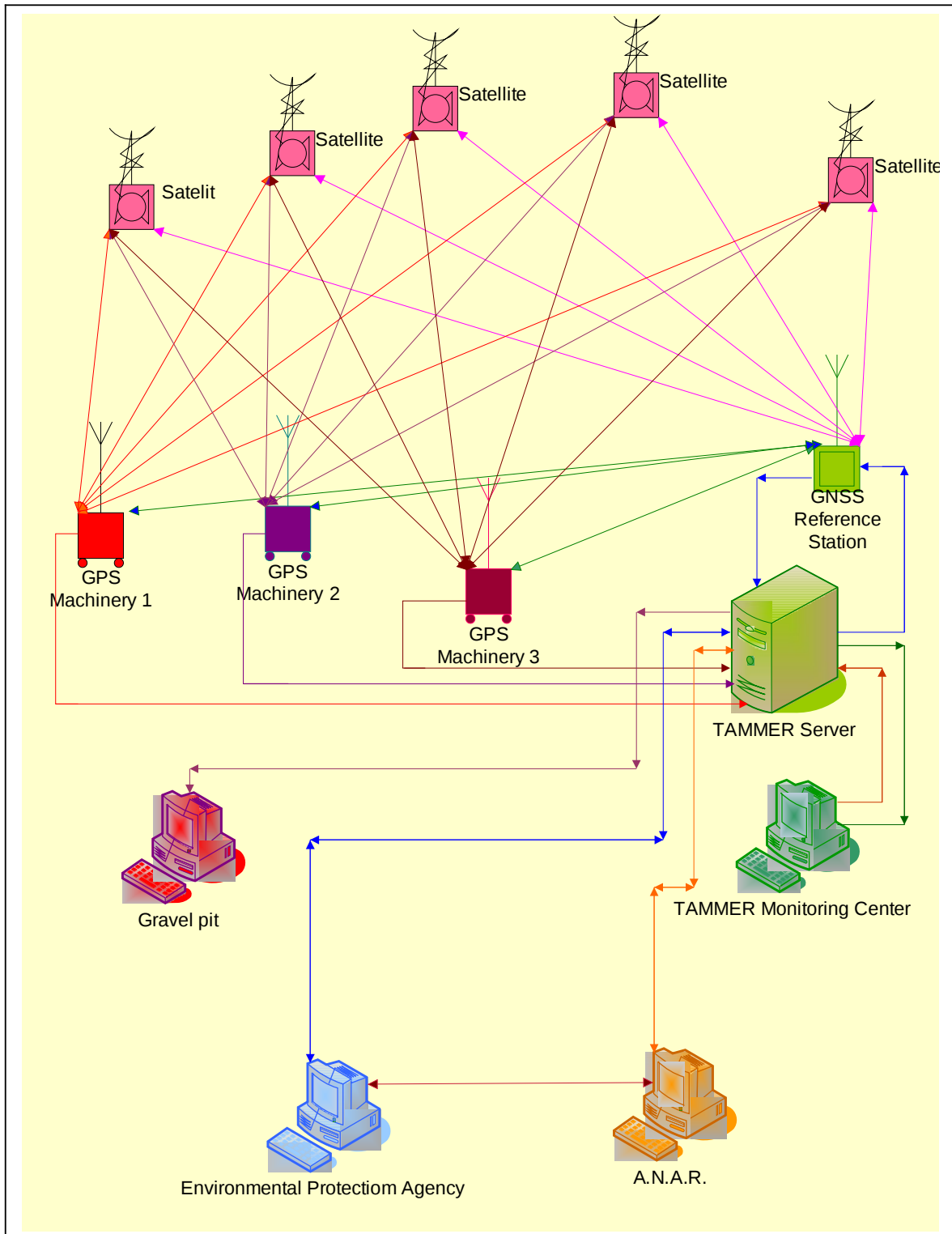


Fig.4. Scheme with the hardware required for monitoring and management of the gravel pits

## 2.1 Description of the application for monitoring-management

The software of the monitoring-management system is created in Visual C++ and includes functions and windows which are available according to the user's access level. The application is launched by a window which allows introduction of the username and his password, in order that they could be validated and allow access to information (fig.5.).



Fig.5. – Windows for accessing the application

Having made these two selections, the program opens directly with the image of the selected gravel pit (fig.6).

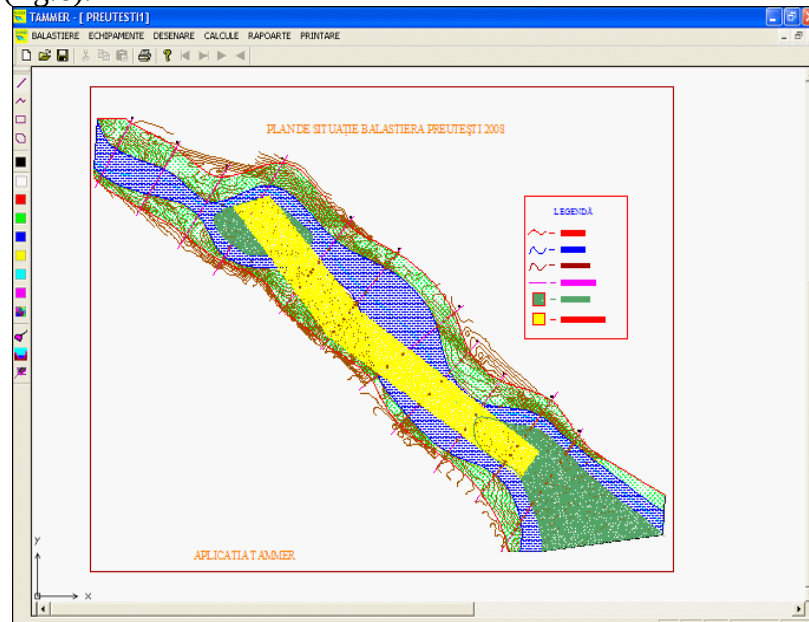


Fig.6. Situation plan of the gravel pit

The main window of the program contains a menu bar consisting in six scrolling windows, from which the application's functions are launched. Only the administrator of the monitoring center has full access to all the program's functions and subfunctions, the other user having limited access according to the established protocol.

From the windows in the menu bar can be launched functions by means of which information regarding the exploitation can be obtained or modified. If *Exploatare/Echipamente* (*Exploitation/Equipment*) procedure is activated, then the windows in figure 7 is launched; it contains four tabs by means of which can be visualized information about the selected gravel pit, the machinery being in action into that gravel pit, GPS equipment mounted on the machinery and information about machinery's location. Consequently, the *Balastieră* (*Gravel pit*) tab offers general information regarding the exploitation localization, owner, concessionaire, exploitation state, volume of rock fields excavated annually, etc., the *Utilaj* (*Machinery*) tab offers the machinery's identification data,

the *Echipament GPS pe utilaj* (GPS equipment on machinery) tab offers information about the G.P.S. equipment mounted on each machinery, for monitoring its moving and the *Localizare utilaj* (Machinery localization) tab offers a number of sixteen pieces of information about the accurate localization of a machinery each moment.

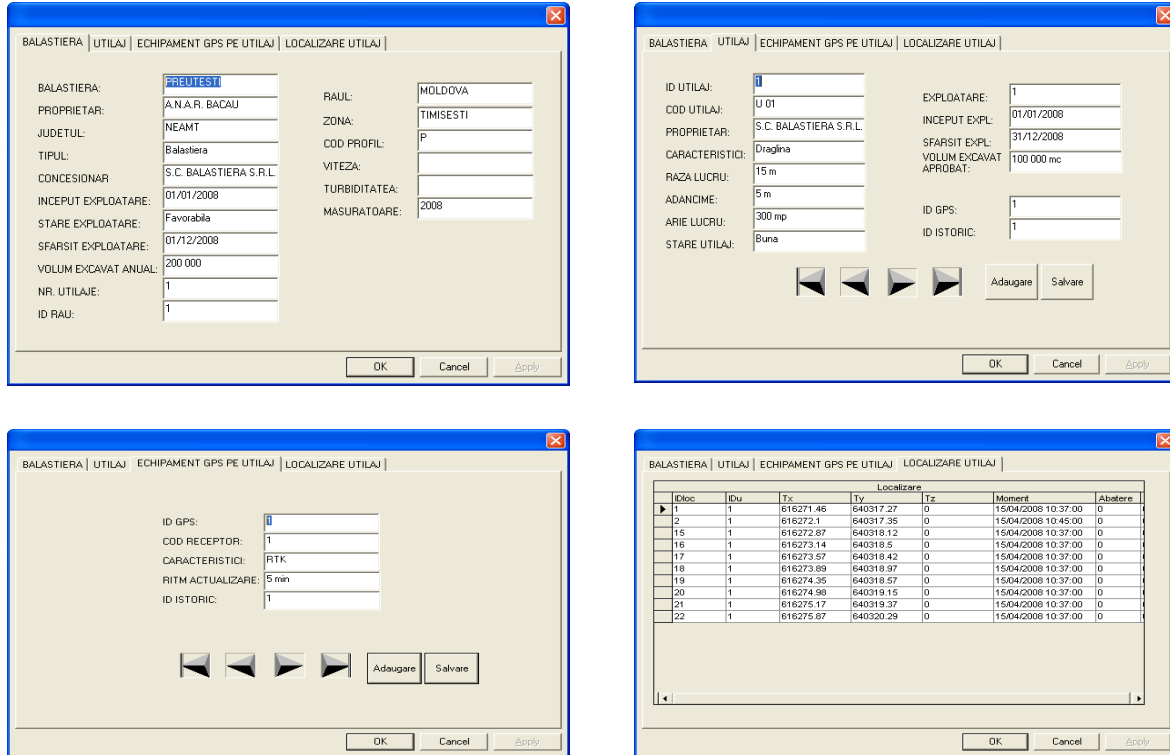


Fig.7. Windows with information by the Exploitation/Equipment procedure

Another set of information which can be obtained by launching the Measurements procedure and it refers to data about locations, marks, exploitations and profiles (fig.8).

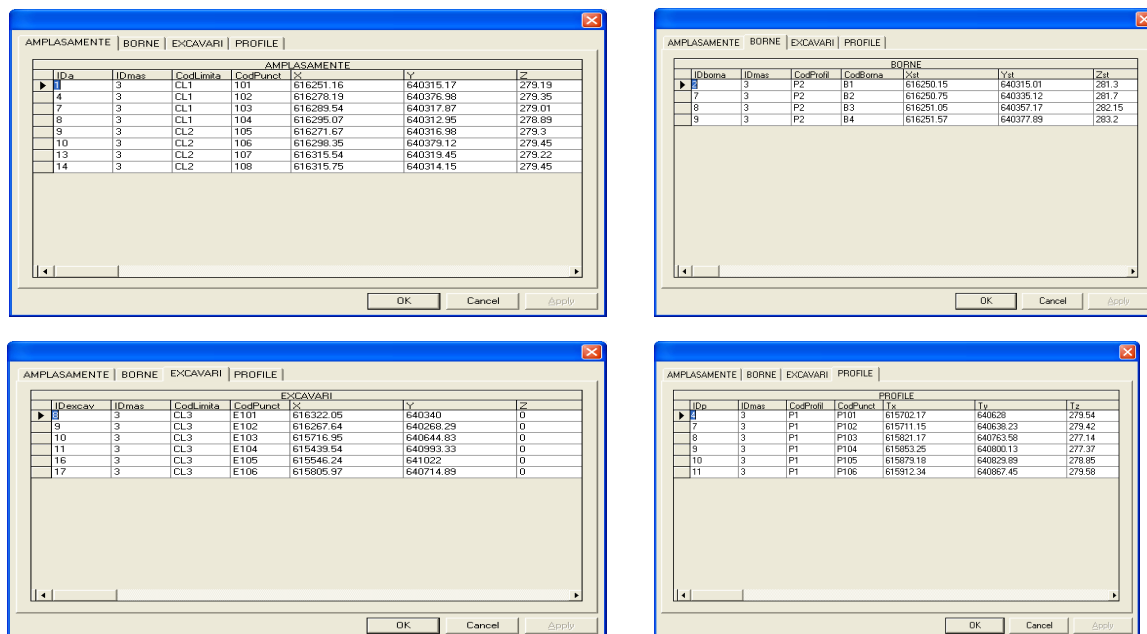


Fig.8. Windows containing data through the Măsurători (Measurements) procedure

They can be accessed by launching the *Măsurători* procedure from *Exploataři* (*Exploitations*) menu. By activating: *Amplasamente* (*Locations*) tab, the data about the coordinates of the excavation limits imposed by the exploitation notification are visualized; *Borne* (*Marks*) tab, data about the marks in the triangulation network are visualized, by means of which all the measurements in the exploitation area are made; *Excavări* (*Excavations*) tab, the coordinates recorded by the GPS equipment on the machinery working are visualized; *Profile* (*Profiles*) tab, the points being on the measured transversal profiles are visualized. They can be visualized by activating the *Profile* tab.

Another menu is *Administrare* (*Administration*) containing 3 procedures: *Import date* (*Data Import*) – the information obtained by the measurements made on the spot are brought into the system’s database; *Utilizatori/Roluri* (*Users/Roles*) – allows introduction of new users and of their roles within the system; *Istoric operații* (*Operations History*) – allows identification of all the operations which were made into the system, date, time and persons who operated.

*Desenare* (*Drawing*) menu allows activation of the four drawing procedures: *Punct* (*Point*), *Linie* (*Line*), *Polilinie* (*Polyline*) and *Poligon* (*Polygon*). They are used for completing the graphical information in the database, with extra data.

The procedures in *Calculare* (*Calculations*) menu: *Distanța* (*Distance*), *Identificare punct* (*Point identification*), *Volum* (*Volume*) and *Suprafață* (*Surface*), are used for operations necessary for the exploitation management.

In *Rapoarte* (*Reports*) menu (fig.9), the application’s visualization and management procedures are visible are accessible : generating transversal and longitudinal profiles through the exploitation area (*Profiles* procedure); generating the 2D model of the location (*2D Model* procedure); generating the 3D model of the location (*3D Model* procedure); generating thematic plans (*Plan thematic -Thematic plan* procedure); rendering evident the machinery activity (*Activitate utilaj - Machinery activity* procedure); rendering evident the machinery deviations compared to the required limits (*Abateri utilaje – Machinery deviations* procedure );

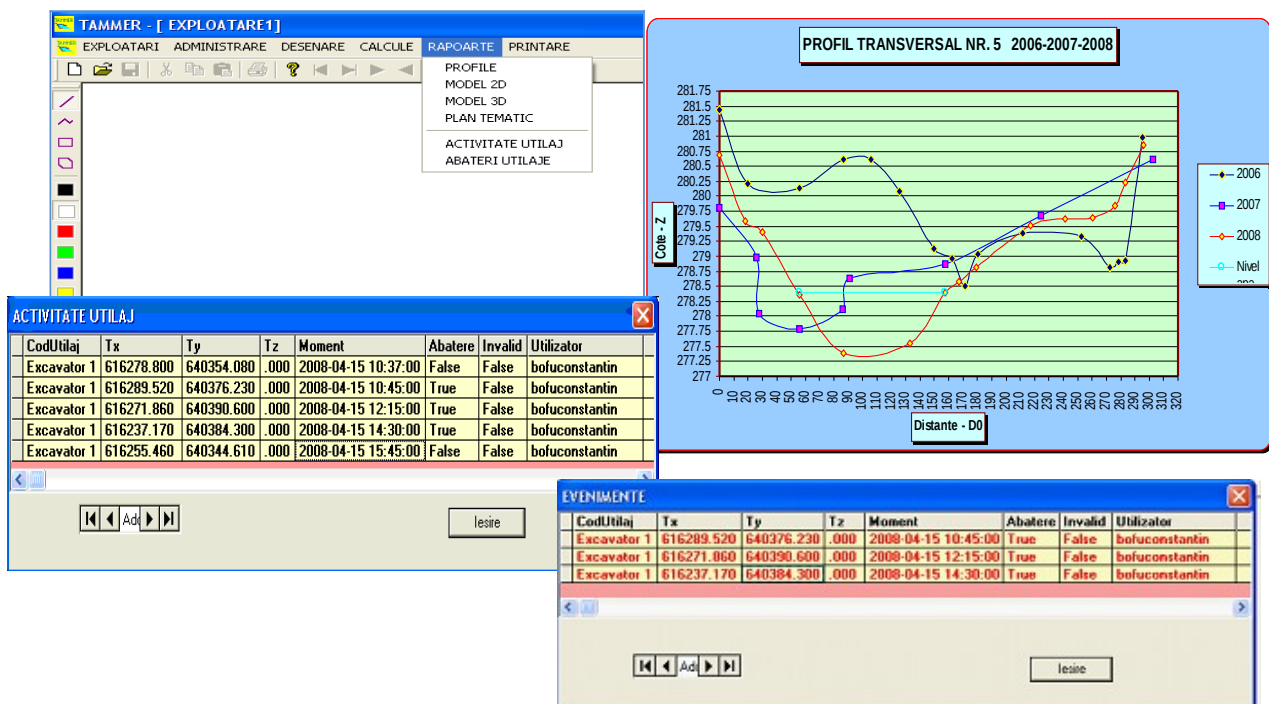


Fig.9. Windows containing information offered by the Rapoarte (Reports) procedure

Exploitation monitoring is made continuously by means of the signals emitted by the GPS mounted on the machinery. The signals are transmitted by using GSM technology to the monitoring center where they are transformed into spatial coordinates X,Y,Z. these coordinates are taken over and then reported into the application. The application analyses the position of the reported point, whether or not it is inside the approved exploitation perimeter. When the point's position is outside the working perimeter, the application displays immediately a window named *Evenimente - Events*, into which information about machinery deviations are presented (fig.10.). The digging Z quota is not presented because it is necessary a special sensor for the dragline backhoe.

The table in the figure 10 is also visible to the exploitation's dispatching unit, where the person in charge with the exploitation can intervene for remedying the existent situation.

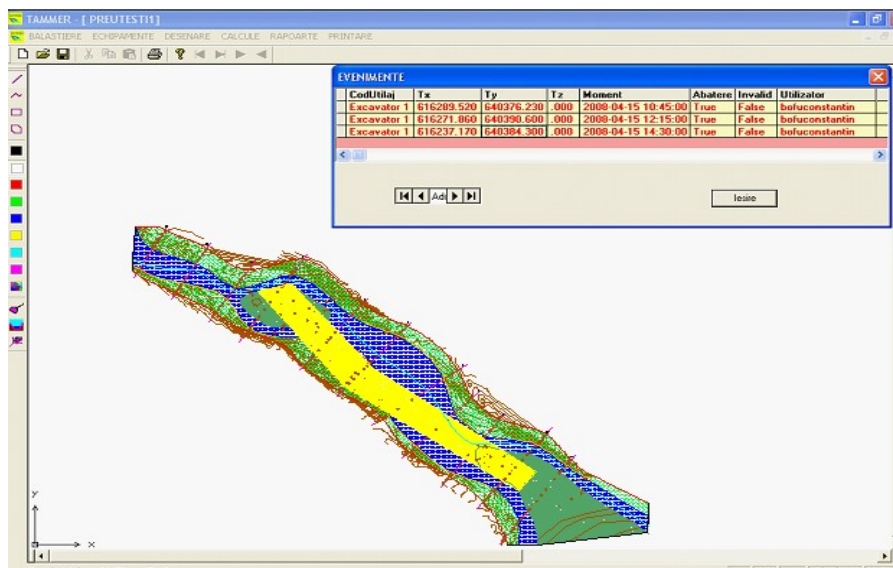


Fig.10. Windows Events containing machinery deviations

We could talk about an efficient management of a gravel pit, when there the possibility of obtaining as accurate as possible real-time data about everything meaning activities and their results.

The monitoring-management system offers sufficient data in order that an image as accurate as possible could be realized upon the specific situations, and, consequently, could be adopted the best solutions. For example, visualization of the data about the route of some machinery during a certain exploitation period can be made by means of *Activitate utilaj (Machinery Activity)* procedure, which allows opening *Selectare utilaj (Machinery Select)* window (fig.11.). It is allowed in this window the machinery and time selection for which the data visualization is desired.

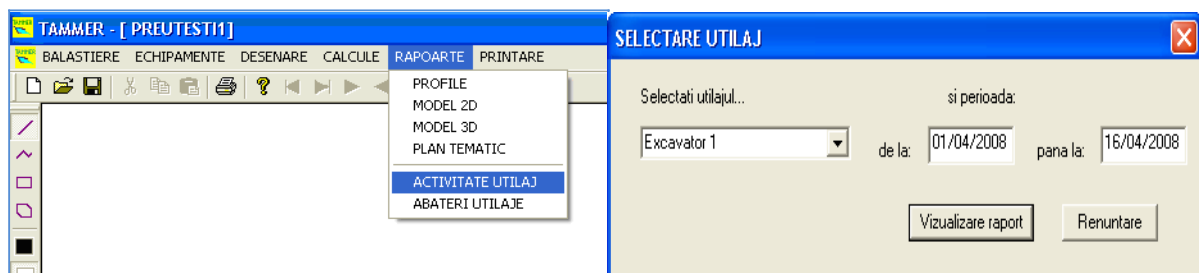


Fig.11. Windows for the Machinery Activity procedure



By filling in with the data in the *Selectare utilaj* (*Selection of machinery*) window and by activating the *Vizualizare raport* (*Report visualisation*) option, the required information are obtained, as we can see in figure 12.

CodUtilaj	Tx	Ty	Tz	Moment	Abatere	Invalid	Utilizator
Excavator 1	616278.800	640354.080	.000	2008-04-15 10:37:00	False	False	bofuconstantin
Excavator 1	616289.520	640376.230	.000	2008-04-15 10:45:00	True	False	bofuconstantin
Excavator 1	616271.860	640390.600	.000	2008-04-15 12:15:00	True	False	bofuconstantin
Excavator 1	616237.170	640384.300	.000	2008-04-15 14:30:00	True	False	bofuconstantin
Excavator 1	616255.460	640344.610	.000	2008-04-15 15:45:00	False	False	bofuconstantin

Fig.12. Table containing the activity of the required machinery

Another example of data accessed by the system is about the evolution of the exploitation bed and, especially, of the riverbed for 2-3 years. The profiles were made by using the exploitation plans for 2006, 2007 and 2008. The profiles are necessary for tracking the effects upon the riverbed configuration as a result of the gravel pit's exploitation into that bed. By activating the *Profile* (*Profiles*) procedure, the system launches Microsoft Office Excel 2007 for creating profiles for eleven sections through the riverbed (fig.13.).

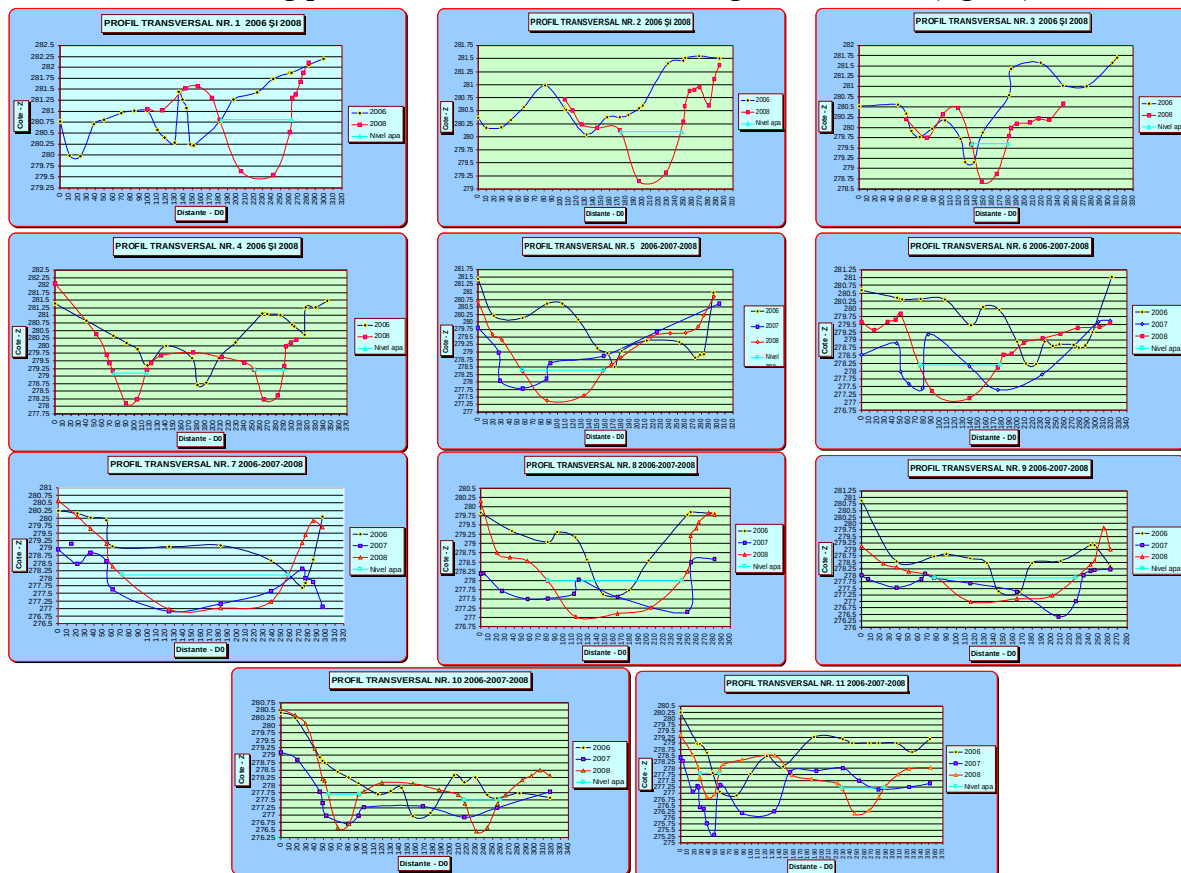


Fig.13. Transversal profiles for a three-year pursuit

### 3. Conclusions

Improper exploitation of the gravel pits into the rivers' bed can result in serious effects upon the environment and their adjacent areas.

Monitoring the great number of gravel pits existent today cannot be made any longer with the actual technical means, being necessary introduction of techniques and technologies adapted to the European legislation's requirements in the waters' field, applied now in Romania, as well.

Elimination of the abuses in exploitation can be made by using a centralized monitoring and management system.

Implementation of this system can be made only by the law, in order that be possible implementation of the monitoring equipment on machinery.

Monitoring system allows both the qualitative monitoring – observation of all the required regulations and restrictions-, and also the quantitative monitoring by a real-time evidence of the quantities of exploited material.

Monitoring software, together with the GPS equipment represent a modern means for efficiently managing the resources and for protecting the environment.

Consequently, the accurate monitoring of the water course shall allow adopting, in due time, the corrective measures to ensure environment preservation and protection and the good functioning condition of the gravel pits.

### 4. Bibliography

1. Bofu, C., Chirilă, C., *Sisteme informațional geografice – Cartografierea și editarea hărților*, Editura Tehnopress, Iași, 2007;
2. Neuner, J., *Sisteme de poziționare globală*, Editura Matrix Rom București, 2000;
3. Biali, G., Pavel, D., Popovici, N., *L'influence de L 'extraction des Agregates Mineraux du Lit de la Riviere Moldova, sur la Dynamique du Thalweg, dans la Zone de la Ballastiere Timișești- Cristești*, Conferința Internațională Monitorizarea Dezastrelor și Poluării, 1– 2 noiembrie, CI.MDP.03, pag.381-388, ISBN: Iași, 2007
4. Nițescu, E., Popescu, Șt., Chiorescu, E.I., Maftai, C., *Sustainable development in the areas where mineral aggregates are exploited*, The 5th International Conference Management of Technological Changes-25-26th August, Alexandroupolis, vol.2, ISN-978-960-8932-2-9, pag. 493-501, Grece, 2007

### 5. Acknowledgements:

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