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Considerations Related to the Architecture of the Environmental Management System Designed in the MEMDUR Project

Dorin CÂRSTOIU[1)], Gabriel GORGHIU[2)], Adriana OLTEANU[1)], Alexandra CERNIAN[1)]

[1)] Faculty of Automatic Control and Computer Science, University Politehnica of Bucharest, 313 Independentei Ave., Sector 6, 060042 Bucharest, Romania;
{dorin.carstoiu},{atolteanu},{alexcernian} @yahoo.com
[2)] Electrical Engineering Faculty, Valahia University Targoviste, 18-24 Unirii Bd., 130082 Targoviste, Romania; ggorghiu@yahoo.com

Abstract. Started in 2007, the PN2 MEMDUR project's main objective is to design, develop, test and implement in Dambovita County an advanced management system which has to assure the evaluation of the environmental risk in order to administrate the crises situations, in accordance with the demands required by the sustainable development on local, regional and national level. This paper tries to emphasize one of the most important parts of the project which manages the recorded data collected from the measuring workstations. Those workstations measure several parameters in fixed or mobile points.

Keywords: monitoring, environment, risk factors, application, XML files, MEMDUR project

INTRODUCTION

Approved in the first part of 2007 and started in autumn 2007, the PN2 project entitled "Sustainable Management System of Resources Used for Monitoring and Evaluating the Environmental Risks in Order to Prevent the Negative Effects and to Manage Crises Situations - MEMDUR" (http://memdur.ssai.valahia.ro) has the main objective to design, develop, test and implement in Dambovita county an advanced management system which has to assure the evaluation of the environmental risk in order to administrate the crises situations, in accordance with the demands required by the sustainable development on local, regional and national level. The system offers methods and technologies for spatial databases development related to the monitoring of the environmental risk factors in order to evaluate their movement and impact and to improve the environmental management quality (Grünfeld, 2005). Five academic and research institutions are involved in the project activities.

Six different phases are designed until the end of the project (September 2010) and particular / measurable sub-objectives are targeted to be reached: (a) increasing the technical and informational level of the knowledge related to the specific conditions of Dambovita county where environmental risk factors are present; (b) defining the spatial conditions of the management system with the view of its adaptation to the knowledge-based information society demands; (c) defining the necessary information tools for the spatial management of the county in order to evaluate the environmental risks, anticipate and prevent the negative effects; (d) creating and developing the management system and demonstrating its utility; (e) developing dedicated applications for evaluating the risks; (f) generalizing the good practices of the sustainable management system through large scale dissemination (Nicolescu *et al.*, 2008).

Conceived to manage atmosphere pollution with dusts, pollution gases and noises, the proposed management system can be adapted for the management of all types of pollution and natural disasters. The topic is an actual one, framing to European and national policy for sustainable environment management which came as a necessity, not only for improving the life quality in Dambovita County, but also as a present request of European Community - life and environment quality, being a governmental and nongovernmental priority of contemporary civilization.

THE ENVIRONMENTAL MANAGEMENT SYSTEM

Environmental atmospheric parameters are monitored (wind speed and direction, air temperature and humidity, atmospheric pressure, solar radiation, precipitation quantity) as well as noxes (CO, NO, NO_2, SO_2, PM10 dusts). Measured data is recorded into the database as time function samples and dispersion analysis can be realized using specific software programs. The software methodology involves the using of a spatial database for increasing the efficiency of the management system.

Finally, the management system consists of two minimal components (Gorghiu *et al.*, 2008):

a. *Spatial databases*: contain the vectorial representation of the real world attached to a coordinates system and the alphanumerical representations which include technical attributes (values) of the objects and also the events appeared in critical industrial points. Three elements (typical to spatial database) will be implemented: *position* - usually in terms of spatial coordinates; *attributes* - characteristics of geographic entities (pollution factors names, admitted limit values, current values and alarming thresholds); *spatial relations* – relative position of the entities;

b. *Applicative software* for creating, maintaining and exploiting of databases and also for data communication. The technology is client-server oriented using the procedures saved into the database management server.

THE SYSTEM ARCHITECTURE

In principle, the management system manages the measured data collected from the measuring workstations. There are a lot of workstations that measure several parameters in fixed or mobile points. The workstations are transmitting hourly the average of the measurements from the last hour. The measured parameters are: SO_2 (ug/m3), NO (ug/m3), NO_X (ug/m3), CO (ug/m3), O_3 (ug/m3), wind direction in degrees from North, wind speed (m/s), temperature (C degrees), relative humidity (%), atmospheric pressure (Pa), ground radiation (W/m3), pluvial water (l/m2), PM10 (ug/m3) powders.

On each measurement of one parameter, a series of information represented by the letters of the alphabet is recorded (status information). Therefore, for each measurement there should be added a state field that will contain a string with the following meaning: A out scanning, B average to calculate, C no element data, D element data not stuff, E delta > threshold, F delta < threshold, G average < threshold, H average > threshold, K average OK, I wind calm, L variable wind, M zero not OK, N span not OK, O zero OK, P not liniarized data, S span OK, T calibration in progress, U data invalidated by user, Z data not acquired. These characters may be combined.

For each workstation, the measured values are introduced by specialized users. Every user who introduces the data will log in into the system with a username and a password. When he is logged in, he may choose specific parameters for which he will introduce the measured value (the average).

The system is in fact a web application that contains two parts: a view part - for visualizing the data and a management part - for the data stored in the database. The system architecture is presented in Fig. 1.

To develop the system the following technologies were used:

- Microsoft SQL Server 2005 – for the database;
- PHP script language;
- IIS web server;
- HTML language.

Finally, the system will allow the user: to automatically export data measured in the points of the workstations, in XML files on the disk, hourly; to export measured data from the application by a specialized user; to introduce a new workstation, a point on a workstation; to introduce a new parameter, and its minimum and maximum values; to introduce the measured values of the parameters, in each workstation, for a point in the workstation; to view the history of the data.

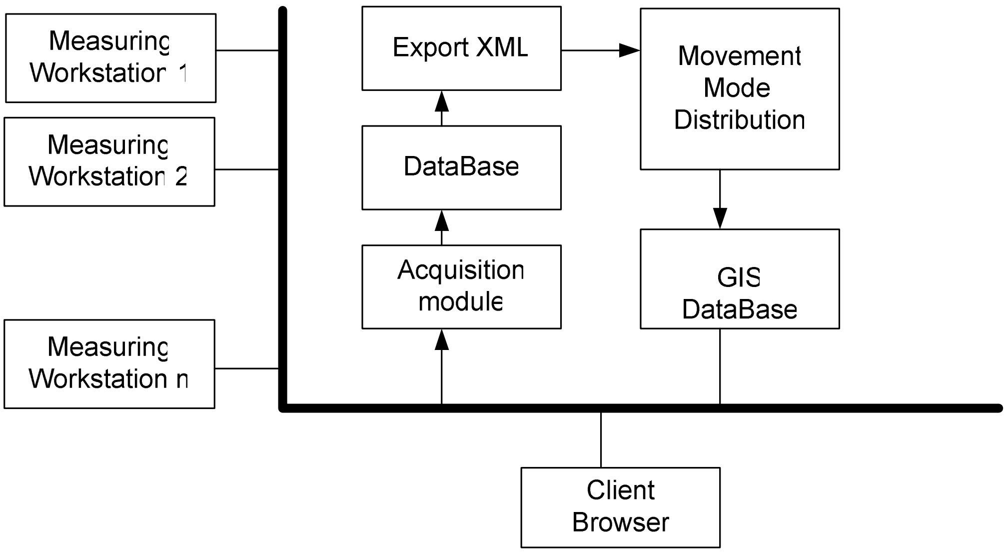

Fig. 1. The system architecture

THE DATABASE STRUCTURE

From the conceptual point of view, the database is divided in the following sections:

- The workstations (*Statii*)
- The parameters (*Parametri*)
- The users (*Utilizatori*)

1. The workstations

This section of the database keeps track of the workstations, of the points from the workstations and the history of the measured data in the same points. For each workstation, the following information are registered (Fig. 2): the workstation name (Denumire statie), locationID (the connection to the location table, Localitati), latitude, longitude, height and the details.

For each workstation points, the following information is registered: stationID (the connection to workstation table), the type of the measurement point (mobile or fixed) and the location of the point within the workstation.

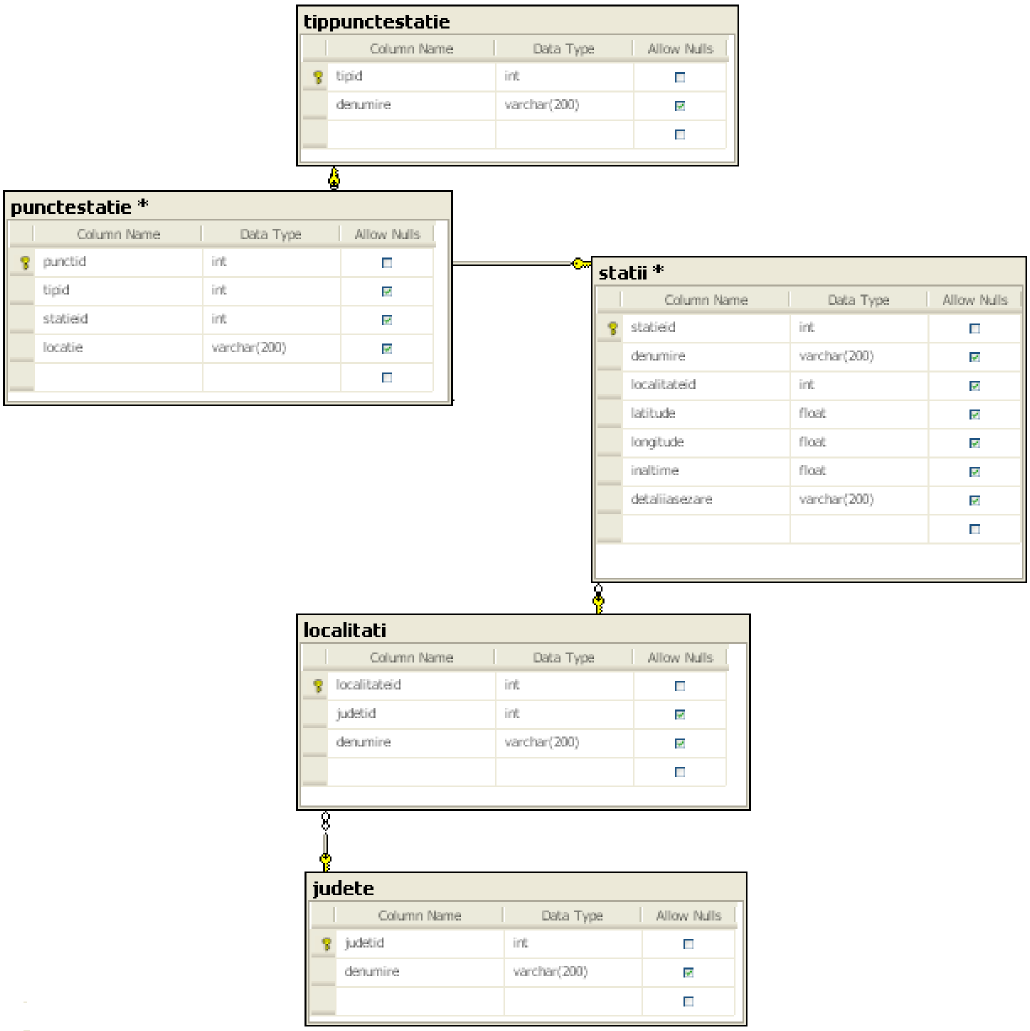

Fig. 2. The database diagram - the workstations

2. The Parameters

This section of the database keeps track of the parameters and their measured values, of the connection between the measurements and the workstations, and the history of the data measured in the workstations points. The workstations measure some parameters in mobile or fixed points. The parameters are described below. For each parameter the following information are registered: the parameter name, the measurement unit, the minimum value, the maximum value, and some details (Fig. 3).

There is a connection table between the parameters sections and the measurement points on the workstations, called Masuratori. In this table, the following information is registered: ParameterID (the connection with parameters section), PointID (the connection with workstations section), Date, Hour, the value of the measured parameter in the same hour of every day and in the same point, and the status.

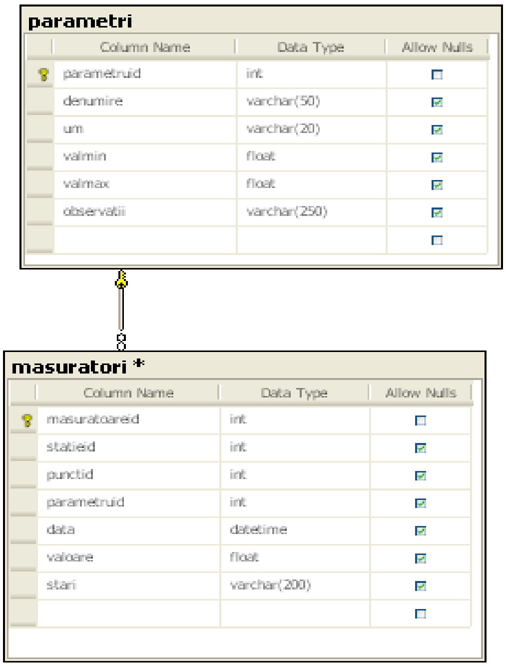

Fig. 3. The database diagram - the parameters

On every measurement of the parameter there is a series of information represented by the letters of the alphabet (status information). The status information is registered in the table: Stari (Fig. 4).

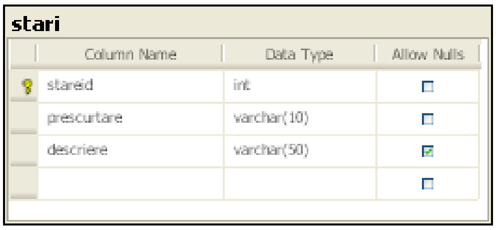

Fig. 4. The database diagram - the Stari table

3. The Users

This section manages the users. The users have associated roles:

- Admin - this user can add another users, can specify new measurement points and new workstations;
- Normal - this user can realize all the processing operations, to introduce and to delete measured data;
- Guest - this user can access the data, only to view the data, not to modify.

Physically, the database consists of 10 tables. These tables are:

1. **Useri**, with the fileds: **userid,** usertypeid, username, password, fullname.

The uniqueness of each record entered into the Users table is provided with the primary key **userid**. This field has *identity* type. The database management system will generate the value of this type, automatically. The **usertypeid** field is a foreign key of the table coming from the *tipuri_utilizator* table. It is used to know the associated role of the user.

2. **Tipuriuseri**, with the fields: **usertypeid,** usertypename.

The uniqueness of each record entered into the *Tipuriuseri* table is provided with the primary key **usertypeid.** This field has *identity* type. The database management system will generate the value of this type, automatically.

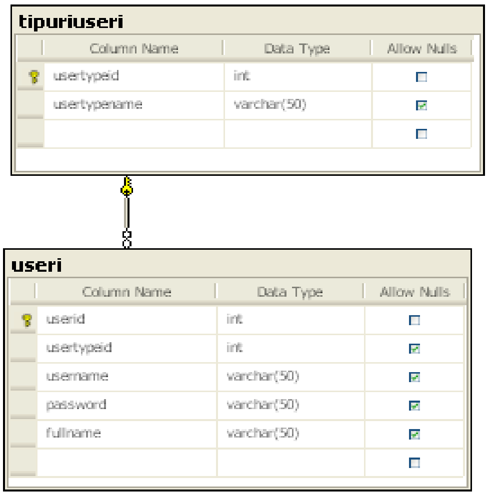

Fig. 5. The database diagram - the users

3. **Judete**, with the fields: **judetid,** denumire.

The uniqueness of each record entered into the *Judete* table is provided with the primary key **judetid.** This field has *identity* type. The database management system will generate the value of this type, automatically.

4. **Localitati**, with the fields: **locid,** judetid, denumire.

The uniqueness of each record entered into the *Localitati* table is provided with the primary key **locid.** This field has *identity* type. The database management system will generate the value of this type, automatically. The **judetid** field is a foreign key of the table coming from the *Judete* table.

5. **Statii**, with the fields: **statieid,** denumire, localitateid, latitudine, longitudine, inaltime, detaliiasezare.

The uniqueness of each record entered into the *Statii* table is provided with the primary key **statieid.** This field has *identity* type. The database management system will generate the value of this type, automatically. The **locid** field is a foreign key of the table coming from the *localitati* table. It is used to know the right location of each workstation.

6. **Punctestatie**, with the fields: **punctid,** statieid, tipid, locatie.

The uniqueness of each record entered into the *Punctestatie* table is provided with the primary key **punctid.** This field has *identity* type. The database management system will generate the value of this type, automatically. The **statieid** field is a foreign key of the table coming from the *statii* table. It is used to know the workstation of each point. The **tipid** field is a foreign key of the table coming from the *tipuripunctestatie* table. It is used to know the type of each point.

7. **Tipuripunctestatie**, with the fields: **tipid,** denumire.

The uniqueness of each record entered into the *Tipuripunctestatie* table is provided with the primary key **tipid.** This field has *identity* type. The database management system will generate the value of this type, automatically.

8. **Parametri**, with the fields: **parametruid,** denumire, um, valmin, valmax, observatii.

The uniqueness of each record entered into the *Parametri* table is provided with the primary key **parametruid.** This field has *identity* type. The database management system will generate the value of this type, automatically.

9. **Stari**, with the fields: **stareid,** prescurtare, descriere.

The uniqueness of each record entered into the *Stari* table is provided with the primary key **stareid.** This field has *identity* type. The database management system will generate the value of this type, automatically.

10. **Masuratori**, with the fields: **legid,** statieid, punctid, paramid, data, ora, valoare, stari.

The uniqueness of each record entered into the *Masuratori* table is provided with the primary key **legid.** This field has *identity* type. The database management system will generate the value of this type, automatically. This table is the connection between the *punctestatie* table and the *parametrii* table. The fields **punctid** and **paramid** are foreign keys and they will connect the *punctestatie* table and the *parametrii* table. The **stari** field will contain a string of status abbreviations from the *Stari* table. The diagram of the above mentioned tables is presented in Fig. 6.

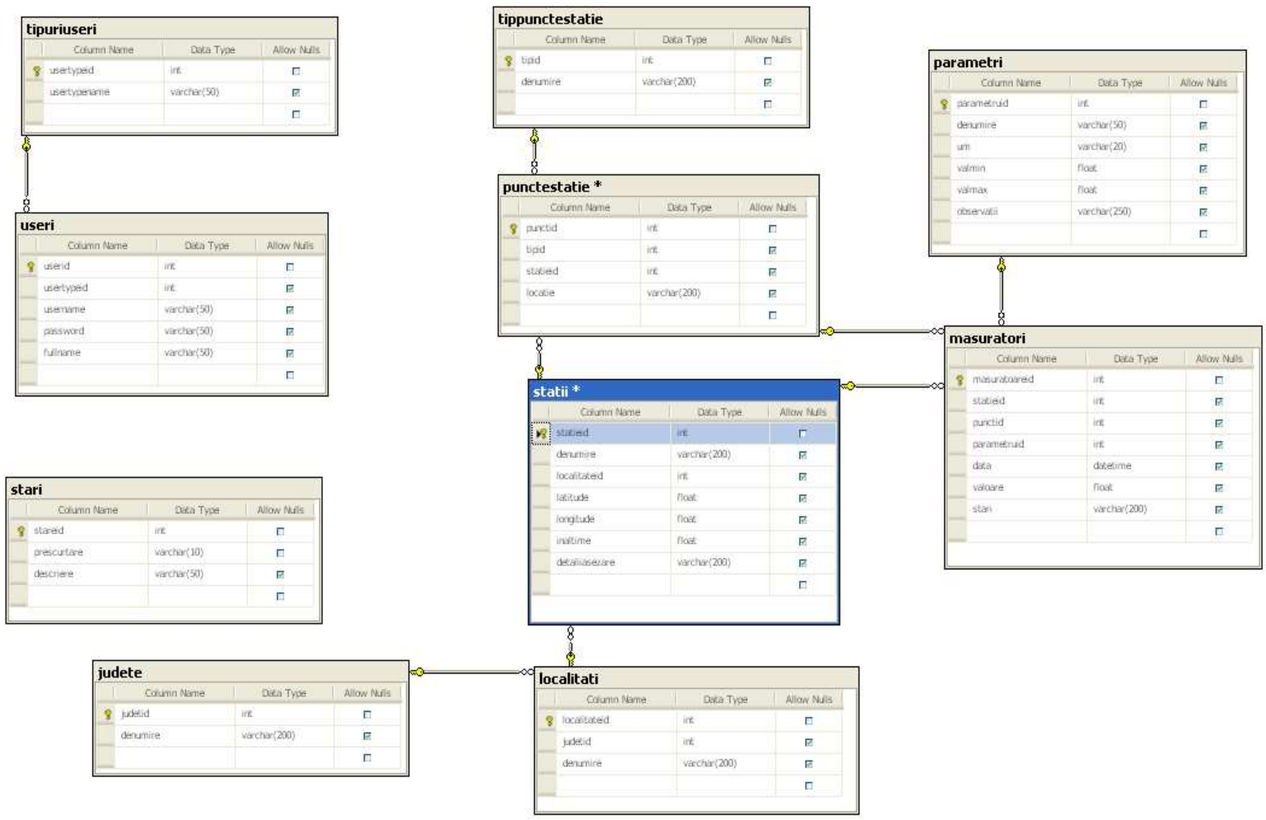

Fig. 6. The 10 tables database diagram

THE EXPORT OF THE DATA IN XML FORMAT

An important feature of this system is to automatically export the measurements of data in XML format hourly. The data is saved in *xml files* on disk. Each XML file is associated with a specific workstation. Inside the file, there are data associated to each fixed or mobile point of the workstation. XML files have been very used lately because of the transportability between applications and the ease of their writing. XML structures data. XML is functioning on every platform, is well supported and has no need of license.

These XML files, generated by the application, are used by another application from the project. That application uses spatial database. *GIS* is the main technology used for the applications designed in the frame of this research Project.

To be able to export the date in XML format at regular intervals of time will create a job in *MS SQL SERVER 2005*. The intervals of time at which measured data is exported will be defined in the related job.

An interrogation is defined, which must be run to extract the desired data using the *bcp* utility, which is incorporated in the *SQL Server*. It allows the execution of a *TSQL* phrase and permits saving the results in one file on disc. This utility, being a Windows application, can be run from *SQL Server* with the help of the system stored procedure *xp_cmdshell*. The same method is being used for the export of data within the web application, in case in which the user has introduced the measurement results subsequent to the moment in which the job has been defined to run. To define a job, the *SQLServer Agent* must be started. This is the job defined in the system.

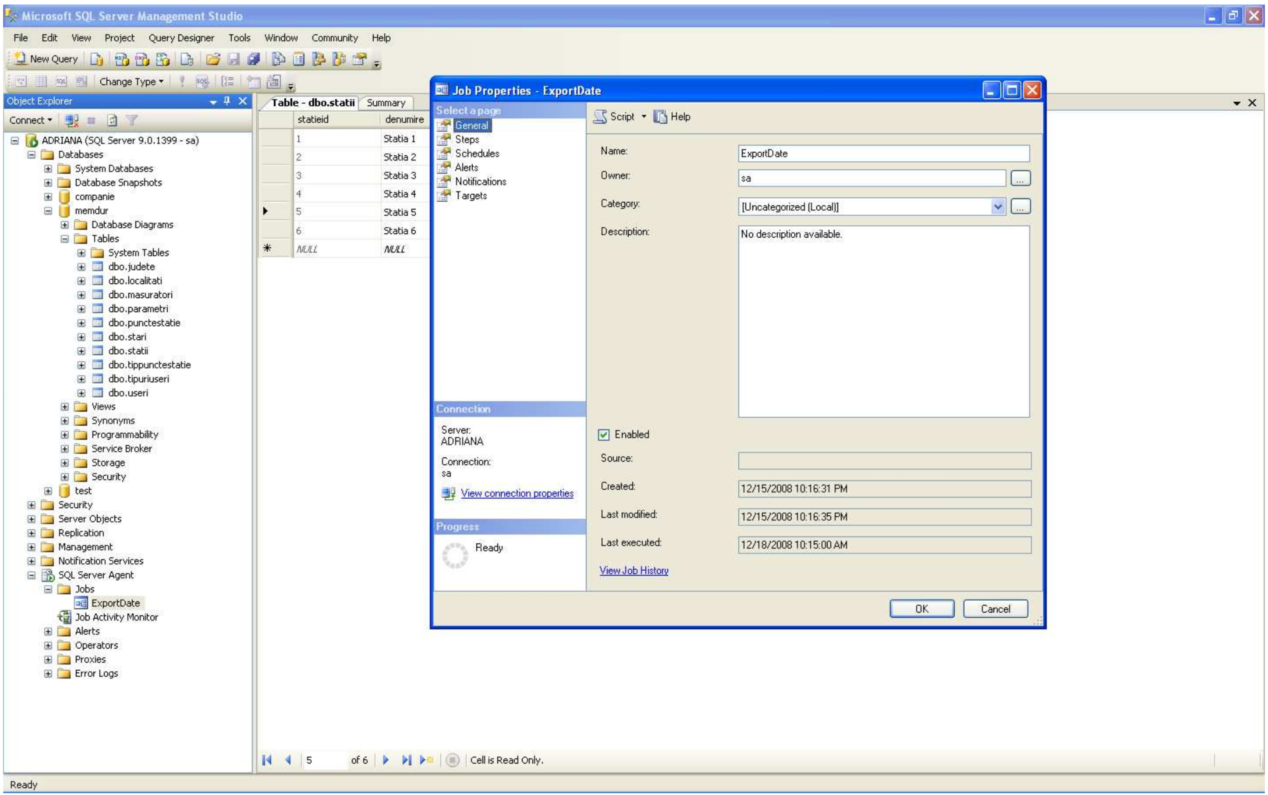

Fig. 6. The Job Properties - ExportDate interface

A body of the job defined in the system to export the data is presented below. The exported XML files are saved on disk (c:\XML). The filenames are found with the form as *20081218_1015.xml*. The content of one file is looking as following:

```
<Root>
<Punct PunctId="1" StatieId="1">
<Masuratori  ParametruId="1"  Valoare="1.000000000000000e+002"
Data="2008-12-15T06:19:45.170"/>
<Masuratori  ParametruId="2"  Valoare="1.000000000000000e+002"
Data="2008-12-15T06:19:45.170"/>
<Masuratori  ParametruId="3"  Valoare="1.000000000000000e+002"
Data="2008-12-15T06:19:45.170"/>
```

Afterwards, the XML files are passed to a spatial database, another essential part of the system application.

CONCLUSIONS

The proper selection of the environmental factors and air pollution sources allows a good estimation of risk situations. In this sense, choosing the best monitoring points and making the air pollutants analysis (noxes, powders) using both classical and modern methods will conduct to an efficient way for environment data processing through the on-line monitoring. A resource management system which can assure the evaluation of the environmental risk in order to administrate the crises situations, in accordance with the demands required by the sustainable development on local, regional and national level, can be designed through the integration of the GIS technologies.

An essential part of this system is the management of the workstations, of the users and of the parameters. This data is used by the spatial database later. All the data from the workstations are kept and passes to spatial databases via XML files. These files are simple text files compatible with any technology and are widely used lately.

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