# INTEGRATED ENVIRONMENTAL MONITORING SYSTEM

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**Abstract:** The accurate measures of pollution control and environmental restoration are useful environmental monitoring systems in mining areas. These are surveillance, forecasting, warning (alarm) and intervention that consider the dynamics of the systematic quality of the environmental factors, the purpose of ascertaining the quality status and their ecological significance, evolution and social implications of the changes occurred, followed by measures to be taken. In this paper, several aspects of environmental monitoring in the county that the air quality results, results that are in databases for the integrated computer system.

**Key words**: information system, monitoring, environmental

## 1. INTRODUCTION

Environmental Monitoring System is an integrated system that performed continuous monitoring of environmental status and provide data on all structural components of the environment (air, water, soil, biocoenosis). The data acquired are processed by statistical methods and the final information obtained is used for environmental impact assessment, warning and alarm, and environmental quality control.

To measure the effects of global pollution have been put in place procedures for environmental impact assessment are to quantify the effects of human activity and natural processes on the environment, health and human safety and property of any kind.

After verifying the correctness of data can proceed to step input into the computer system and database creation.

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## 2. OBJECTIF

In terms of information, an integrated environmental monitoring system includes: data sources, data server and application server, and generation / distribution of reports to makers (Fig. 1).

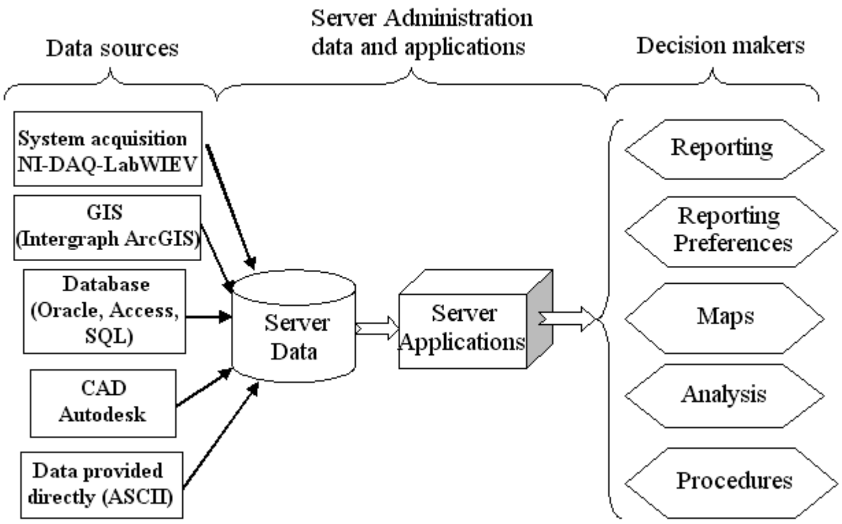


**Fig. 1.** Block diagram of the integrated information system for environmental monitoring.

System data sources can be grouped into several categories: direct data from information providers (monitored variable values entered as ASCII), data from GIS systems, data transmitted to the database system monitoring data from CAD systems (CAD - Computer Aided Design), data acquisition systems through software application. Among the direct providers of information can be listed Autonomous Romanian Waters, Municipalities, County Councils, Civil Protection Inspectorate, Prefects, Police, Fire, and healthcare units. Makers (the prefect technical specialties management committees) have available a range of reports as graphs, maps, etc. intervention procedures.

Data obtained after the application of various processing procedures are stored in databases. For the analysis of environmental quality and prompt and correct decisions, the data are compared with specific standards for water quality, air and soil.

Environmental monitoring system, proposed (Fig. 2.) is an integrated system that performed continuous monitoring of environmental status and provide data on all structural components of the environment (air, water, soil, biocoenosis). The data acquired will be processed by statistical methods, and the final information obtained will be used for environmental impact assessment, warning and alarm, and environmental quality control.

The proposed monitoring system will be structured at the local, national and international (global) on environmental factors and pollution. Carry out monitoring subsystems for air, water, soil and the structure and functions biocenosis.

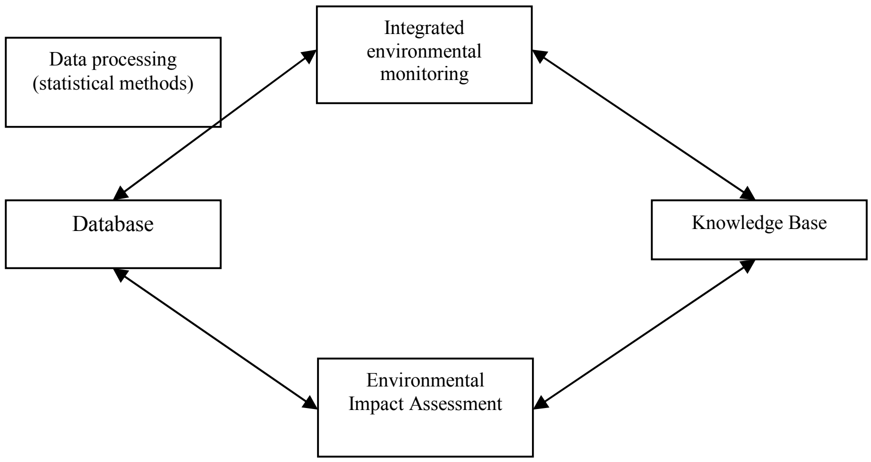


**Fig. 2.** Environmental monitoring system proposed

Monitoring system structure is shown in Figure 3. After setting the variables to be monitored, depending on monitoring objectives, the procedure of sampling and measurement of attachment points (methods, sensors, appliances). Monitored variables will be analyzed off-line (with some frequency) will be measured automatically or on-line, using modern data acquisition systems.

The data obtained by automatic sampling and measurement of variables must be processed to assess overall water quality, air or land, evaluation of any pollutant spreading and warning decision-making, alarm and control.

The monitoring systems will be the statistical analysis, presentation graphics and generate reports for decision makers, so that management can develop a long-term monitoring and control.

The first step to be covered by obtaining monitoring data is data verification. Perform a primary verification of data quality by detecting errors that occur in particular off-line data analysis. Errors can be random (transcription errors, confusion of evidence, errors of calculation, etc.) or systematic (due to calibration errors, etc.).

After verifying the correctness of data can proceed to step input into the computer system and database creation.

The modern monitoring systems, data obtained from samples or automatic measurements (here comes the data acquisition systems) are introduced in numerical

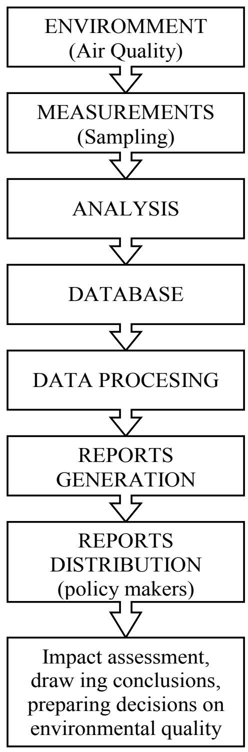


**Fig. 3.** Monitoring system structure.

computation systems. Logistics support data transmission for computer network systems will be provided either by conventional (analog telephone, radio communications) or by modern (and GSM digital phone, Internet, ISDN, etc.). Data processing. Will be done using software packages that can be grouped into several categories:

- Purchasing software that's toolbox contains data processing: statistical analysis, spectral analysis, report generation (examples: Matlab, LabVIEW, LabWindows, etc.);
- Software for statistical analysis (Mathematica, etc.);
- Database software (Oracle, Access, SQL etc.);
- CAD software (Autodesk);
- Integrated systems GIS - Geographical Information Systems (Intergraph GeoMedia, ArcGIS / ESRI, etc.).

GIS packages are booming and are systems for transmitting data from remote geographical locations. These systems produce an overview of the data combined with geographical coordinates and translates them into operational maps superimposed. Thus to obtain maps showing the pollution of a river network overlaid on maps of roads and railways in the area, etc. Policymakers have a number of predefined reports, remote access, and a series of stored procedures for emergency situations.

## 3. AIR QUALITY MONITORING

Air quality monitoring will be a subsystem of the general environmental monitoring. Air quality monitoring involves a series of actions to observation and measurement of quantitative and qualitative indicators of air (such as concentrations of components in the air). The monitoring system allows to obtain useful data to quickly identify contaminated areas and for making strategic and tactical combat pollution and its prevention.

For the good functioning of an air quality monitoring system is essential to establish the correct number and location of measuring stations, or points, and the appropriate choice of variables monitored.

The number of measurement points is determined by the type variable monitored and the type of source of pollution.

Figure 4 is a schematic diagram of a system for monitoring local air quality near a power plant. Stations and measuring points are located according to the influence of point source pollution and pollutant dispersion.

The monitoring system of Figure 4 are measured at the source by means of automatic flue gas analyzers, and measurement of combustible and toxic gas in the area of influence (points placed according to the dispersion model) by means of electrochemical type sensors. To assess the impact of power plant pollution in residential areas near the urban center of the mobile stations are used for measuring.

The results of all measurements are sent to the local network and then monitoring the monitoring center where they completed processing data, generating reports, etc. The connectivity provided by various means of communication monitoring system is connected to other local systems and national monitoring system.

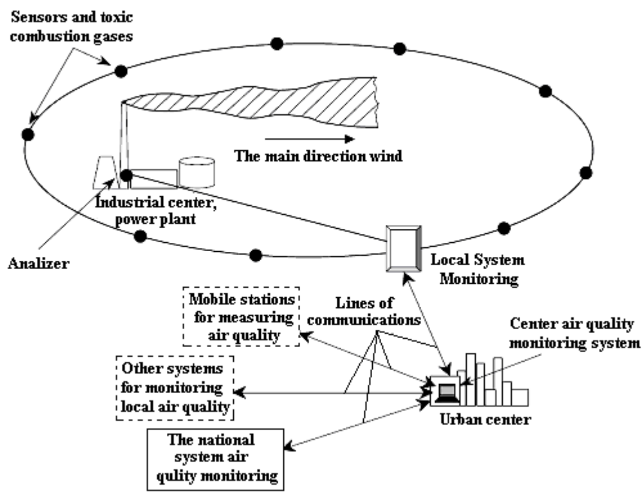


**Fig. 4.** Schematic diagram of a system for monitoring local air quality near a power plant.

## 4. AIR QUALITY MONITORING IN DISTRICT GORJ

### 4.1. Greenhouse gas emissions acidifying

Acidification is the process of changing the chemical nature of a component of natural environment, due to the presence of compounds that cause a series of chemical reactions in the atmosphere, leading to changes in pH of rain and even soil. Atmospheric emissions of acidifying substances as $SO_2$, $NO_X$ results mainly from burning fossil fuels, can persist in the atmosphere for several days and can be transported thousands of kilometers, until the conversion takes place in acid (sulfuric, nitric respectively). Primary pollutants $SO_2$, $NO_X$ and $NH_3$ together with their products of reaction after deposition leads to chemical changes in soil composition and surface water. This process affects ecosystems, leading to the acidification process.

### 4.2. Annual emissions of sulfur dioxide

Emissions of sulfur dioxide measured in 2009, by groups of sources (generating activities) are presented in Table 1. The most significant contribution to greenhouse emissions acidifying pollutants is the combustion processes for power generation and processing industries (Fig. 5), and the evolution of these emissions is closely linked to changes in the consumption of fossil fuels in power plants and increasing production industrial.

Most significant weight (over 99%) in total emissions of $SO_2$ in the Gorj county hold emissions from fossil fuel combustion in energy and transformation industry, other sources are generating production processes, non-industrial combustion plants, road transport and combustion in manufacturing industries. Table 2 is shown on the annual evolution of the quantities of sulfur dioxide in Gorj County 1999-2009.

*Table 1.* **$SO_2$ emissions measured in 2009, by groups of sources**

| Groups | Group Name | $SO_2$ (t) |
|---|---|---|
| 01 | Combustion in energy and transformation industries | 168973,41 |
| 02 | Non-industrial combustion plants | 2,82 |
| 03 | Combustion in manufacturing | 1,14 |
| 04 | Production Processes | 4,68 |
| 05 | Fossil fuel extraction and distribution | - |
| 06 | Solvent and other product | - |
| 07 | Road | 2,81 |
| 08 | Other mobile sources and machinery | 0,12 |
| 09 | Treatment and disposal | 0,11 |
| 10 | Agriculture | 0,01 |
| | **TOTAL** | **168985,10** |

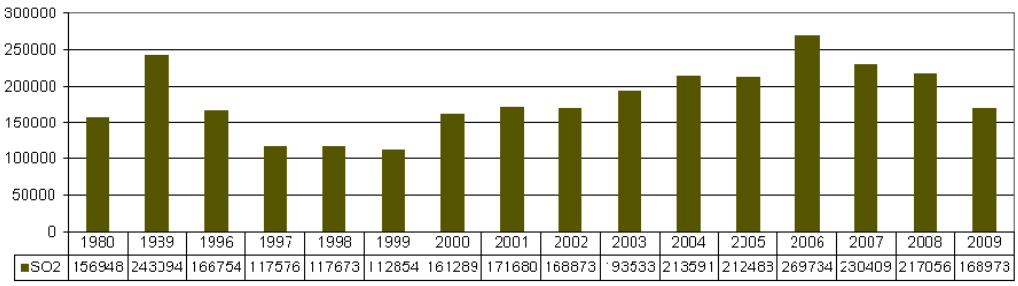


**Fig. 5.** Annual sulphur dioxide emissions in energy industry (t/year)

*Table 2.* **Annual emissions of sulfur dioxide in the period 1999-2009**

| **Year** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
|---|---|---|---|---|---|---|
| **$SO_2$ (t)** | 115423 | 163259 | 174074 | 169434 | 207009 | 215997 |
| **Year** | **2005** | **2006** | **2007** | **2008** | **2009** | - |
| **$SO_2$ (t)** | 214873 | 271951 | 231418 | 218028 | 168985 | - |

Compared with 2008, emissions of $SO_2$ recorded in 2009 decreased due primarily to reduced energy demand and reduce the sulfur content, containing fossil fuels in power plants (Fig. 5).

### 4.3. Annual emissions of carbon monoxide, nitrogen dioxide

Emissions of nitrogen oxides by groups of sources (generating activities) as the air pollutant emission inventory for 2009, are presented in Table 3.

Most of these emissions result from combustion in energy and transformation industries (approx. 92%).

*Table 3.* **Emissions of nitrogen oxides by groups of sources for 2009**

| Groups | Group Name | $NO_X$ (t) |
|---|---|---|
| 01 | Combustion in energy and transformation industries | 27326,33 |
| 02 | Non-industrial combustion plants | 83,50 |
| 03 | Combustion in manufacturing | 65,33 |
| 04 | Production Processes | 7,19 |
| 05 | Fossil fuel extraction and distribution | - |
| 06 | Solvent and other product | - |
| 07 | Road | 1925,48 |
| 08 | Other mobile sources and machinery | 251,50 |
| 09 | Treatment and disposal | 4,55 |
| 10 | Agriculture | 0,06 |
| | **TOTAL** | **29663,95** |

Annual evolution of oxides of nitrogen emissions in the county, during 1999-2009, is presented in Table 4.

*Table 4.* **Emissions of nitrogen oxides in the county, 1999-2009**

| **Year** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
|---|---|---|---|---|---|---|
| **$NO_x$ (t)** | 18593 | 27236 | 28658 | 31931 | 35860 | 32480 |
| **Year** | **2005** | **2006** | **2007** | **2008** | **2009** | - |
| **$NO_x$ (t)** | 31876 | 38803 | 32311 | 36585 | 29664 | - |

Compared with 2008 can be seen, for 2009, a decrease in nitrogen oxide emissions by approx. 18.9%, following reductions in emissions from the energy industry recorded (Fig. 6). Emissions of nitrogen oxides from road transport were estimated using emission factors Corinvent application updated as the latest guide for developing emission inventory (EMEP, EEA Air Pollutant Emission Inventory Guidebook 2009).

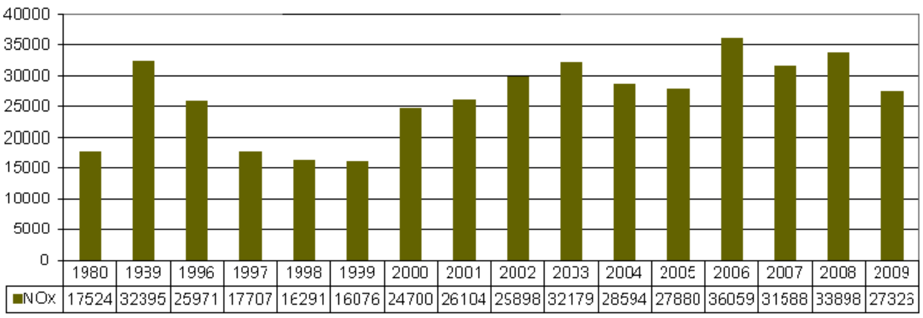


**Fig. 6.** Annual emissions of nitrogen dioxide in energy industry (t/year).

### 4.4. Annual emissions of ammonia

In terms of emissions of $NH_3$, the most important sources in the county are agricultural, that manure from livestock and use of nitrogenous fertilizers (Table 5).

Table 6 illustrates the quantity of ammonia released annually in the period 1999-2009.

*Table 5.* **Ammonia emissions by groups of sources, for 2009**.

| Groups | Group Name | $NH_3$ (t) |
|---|---|---|
| 01 | Combustion in energy and transformation industries | - |
| 02 | Non-industrial combustion plants | 0,027 |
| 03 | Combustion in manufacturing | 0,112 |
| 04 | Production Processes | - |
| 05 | Fossil fuel extraction and distribution | - |
| 06 | Solvent and other product | - |
| 07 | Road | 5,489 |
| 08 | Other mobile sources and machinery | 0,061 |
| 09 | Treatment and disposal | - |
| 10 | Agriculture | 356,091 |
| | **TOTAL** | **361,779** |

*Table 6.* **Emissions of ammonia in the Gorj county, 1999-2009**

| **Year** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
|---|---|---|---|---|---|---|
| **$NH_3$ (t)** | 2665 | 2671 | 3056 | 3689 | 5326 | 4606 |
| **Year** | **2005** | **2006** | **2007** | **2008** | **2009** | - |
| **$NH_3$ (t)** | 4610 | 4879 | 970,15 | 370 | 362 | - |

The emission of $NH_3$ is lower in 1999-2002 and 2007-2009 due to the fact that for these years were estimated emissions from all source categories (use of nitrogenous fertilizers, latrines, waste treatment and storage etc.).

### 4.5. Methane volatile organic compounds emissions

Methane volatile organic compound emissions were estimated for several groups of activities, using emission factors updated as the latest guide for developing emission inventory (EMEP, EEA Air Pollutant Emission Inventory Guidebook 2009).

Activities to share the most important are:

- road transport - approx. 33.6%;
- solvent and other products - approx. 28.5%;
- fossil fuel extraction and distribution - approx. 22%;
- combustion in energy and transformation industries - approx. 7.7%;
- production processes - approx. 3%.

Table 7 is presented the situation. NMVOC emission trends between 1999 - 2009 the level of the county is as follows (Table 8):

*Table 7.* **Methane volatile organic compounds emissions for 2009**

| Groups | Group Name | NMVOC (t) |
|---|---|---|
| 01 | Combustion in energy and transformation industries | 107,43 |
| 02 | Non-industrial combustion plants | 15,62 |
| 03 | Combustion in manufacturing | 30,50 |
| 04 | Production Processes | 43,34 |
| 05 | Fossil fuel extraction and distribution | 307,53 |
| 06 | Solvent and other product | 399,07 |
| 07 | Transport (estimate Cover III) | 469,43 |
| 08 | Other mobile sources and machinery | 26,10 |
| 09 | Treatment and disposal | 0,02 |
| 10 | Agriculture | 0,01 |
| | **TOTAL** | **1399,06** |

*Table 8.* **NMVOC emissions in the period 1999-2009 in Gorj county**

| **Year** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
|---|---|---|---|---|---|---|
| **NMVOC (t)** | 15944 | 15839 | 16165 | 13856 | 18052 | 19048 |
| **Year** | **2005** | **2006** | **2007** | **2008** | **2009** | - |
| **NMVOC (t)** | 18804 | 16988 | 11078 | 9646 | 1399 | - |

### 4.6. Emissions of heavy metals

This category of pollutants is the main source of various industrial processes for lead and adding to pollution caused by exhaust gases from internal combustion engines with spark ignition. Heavy metals, mainly in the form of aerosols resulting from combustion, industry and transport.

Estimated heavy metal emissions into the atmosphere for 2009 (Table 9) based on emission factors updated as the latest guide for developing emission inventory (EMEP, EEA Air Pollutant Emission Inventory Guidebook 2009) and the Application Cover III vehicles, the following results for county.

*Table 9.* **Emissions of heavy metals into the atmosphere, for 2009**

| Groups | Group Name | Cd (kg) | Ni (kg) | Cr (kg) | Zn (kg) | Hg (kg) | Cu (kg) |
|---|---|---|---|---|---|---|---|
| 01 | Combustion in energy and transformation industries | 29,238 | 308,422 | 44,497 | 61,846 | 244,909 | 58,689 |
| 02 | Non-industrial combustion plants | - | - | - | - | - | - |
| 03 | Combustion in manufacturing | 0,008 | 0,002 | 0,0004 | 0,246 | 0,001 | 0,029 |
| 04 | Production Processes | 0,053 | 0,187 | | 0,961 | 0,013 | 0,005 |
| 05 | Fossil fuel extraction and distribution | - | - | - | - | - | - |
| 06 | Solvent and other product | - | - | - | - | - | - |
| 07 | Transport (estimate Cover III) | 1 | 4 | 3 | 58 | - | 98 |
| 08 | Other mobile sources and machinery | 0,070 | 0,532 | 0,361 | 7,607 | - | 12,888 |
| 09 | Treatment and disposal | - | - | - | - | - | - |
| 10 | Agriculture | - | - | - | - | - | - |
| | **TOTAL** | **30,36** | **313,14** | **47,85** | **128,66** | **244,92** | **169,61** |

### 4.7. Lead Emissions

At European level there was a decrease compared with the heavy metal concentrations recorded in the 70 years. The decrease is more pronounced in the case of lead due to the reduction of lead content in fuels (Table 10).

*Table 10.* **Lead emissions in the atmosphere, for 2009**.

| Groups | Group Name | Pb (kg) |
|---|---|---|
| 01 | Combustion in energy and transformation industries | 44,639 |
| 02 | Non-industrial combustion plants | - |
| 03 | Combustion in manufacturing | 0,025 |
| 04 | Production Processes | 0,694 |
| 05 | Fossil fuel extraction and distribution | - |
| 06 | Solvent and other product | - |
| 07 | Transport (estimate Cover III) | 126 |
| 08 | Other mobile sources and machinery | - |
| 09 | Treatment and disposal | - |
| 10 | Agriculture | - |
| | **TOTAL** | **171,36** |

### 4.8. Emissions of persistent organic pollutants (POPs)

Persistent organic pollutants are very stable chemicals that can accumulate in biological trophic chains with a high degree of risk to human health and the environment. POP emissions are a mixture of organic compounds of natural or anthropogenic origin with the following characteristics:

- are resistant to environmental degradation;
- have low solubility in water but high in fat media;
- can be transported long distances, depositing it far from home;
- accumulate in terrestrial and aquatic
- have acute and chronic effects on human health and animal species.

In order to reduce environmental impact, the United Nations Environment Programme adopted by the Stockholm Convention (May 2001) a program designed to control and elimination of 12 POPs (*pesticides*: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex Toxaphene; *industry*: hexachlorobenzene HCB, PCB diphenyl chlorides; *products*: dioxins, furans).

Of these, Aldrin, Chlordane, DDT, dieldrin, endrin, heptachlor and HCB are forbidden to produce and use across the country.

The main source of emissions that contribute to persistent toxic substances is agriculture, particularly through existing deposits prohibited substances, unidentified and/or expired. Another source is the chemical pesticide manufacturing and import of commercial substance.

Since the county was not identified obsolete pesticide warehouse/unknown whether resulting from the use of pesticides in agriculture in previous years and there is pesticide-producing chemical industry (the most important sources of POPs emissions), emissions in the county are very low (Table 11).

*Table 11.* **Emissions of persistent organic pollutants (POPs) for the year 2009**.

| Groups | Group Name | DIOX (g) | Flouranthe (kg) | Benzo (b) (kg) | Benzo (a) (kg) |
|---|---|---|---|---|---|
| 01 | Combustion in energy and transformation industries | - | - | - | - |
| 02 | Non-industrial combustion plants | - | - | - | - |
| 03 | Combustion in manufacturing | - | - | - | - |
| 04 | Production Processes | 0,0002 | - | - | - |
| 05 | Fossil fuel extraction and distribution | - | - | - | - |
| 06 | Solvent and other product | - | - | - | - |
| 07 | Transport (estimate Cover III) | - | - | - | - |
| 08 | Other mobile sources and machinery | - | 3,29 | 0,365 | 0,219 |
| 09 | Treatment and disposal | - | - | - | - |
| 10 | Agriculture | - | - | - | - |
| | **TOTAL** | **0,0002** | **3,29** | **0,365** | **0,219** |

According to estimates made for the county, in 2009, resulted POP emissions from other sources mobile functioning of the equipment (all waste incinerators have stopped work in the county hospital incineration of dioxin emissions as a result sharply).

The emission of dioxins in the period 1999 - 2009, the level of the county is as follows (Table 12):

*Table 12.* **Dioxin emissions in the county, 1999-2009**

| **Year** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
|---|---|---|---|---|---|---|
| **Diox (g)** | 8,152 | 8,063 | 7,941 | 8,863 | 8,914 | 9,8028 |
| **Year** | **2005** | **2006** | **2007** | **2008** | **2009** | |
| **Diox (g)** | 4,806 | 3,83 | 6,223 | 2,646 | 0,0002 | |

## 5. CONCLUSIONS

Figures 5 and 6 are presented the evolution of annual averages of the pollutants monitored automatic stations for the years 2008 and 2009. It is noted, in general, a decreasing trend for all pollutants except $NO_2$ and CO pollutants GJ-2 station.

Evolution of annual average concentrations (emissions) monitoring as specified within the hand (wet chemistry method) is shown in Figures 7-9.

For the Rovinari, annual averages for the years 2001-2007 for gaseous pollutants are calculated from daily averages per 24 h, unlike previous years and the years 2008-2009, when annual average values were calculated from the average value of short-term (30 min). Turceni area, the annual averages are calculated from short (30 min).

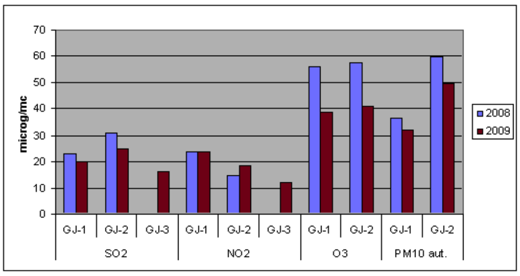


**Fig. 5.** Annual average change polluters automatic stations monitored in 2008-2009.

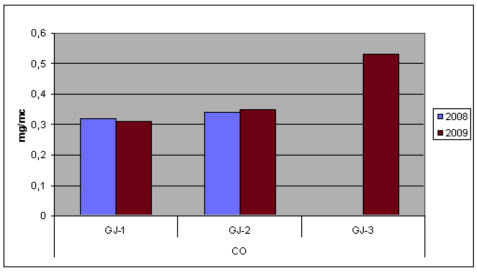


**Fig. 6.** CO annual average change in auto plants during 2008-2009.

From Figures 7-9 it is noted that the trend is decreasing for all areas pollutant $SO_2$, $NO_2$ has slightly increased in all areas, namely increasing the $NH_3$, Tg. Jiu area compared with previous years.

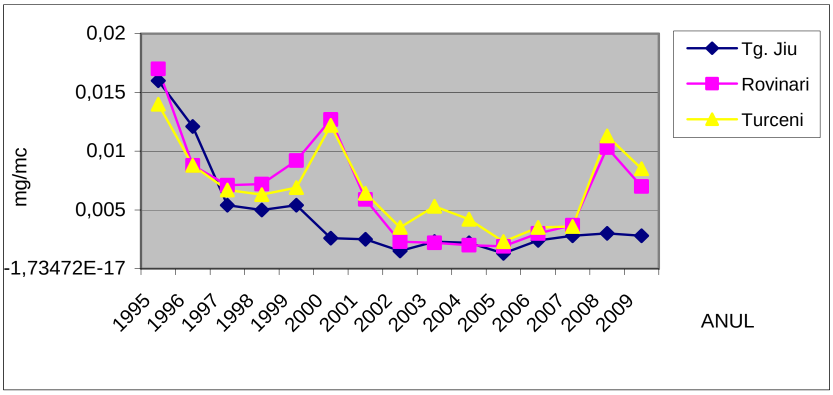


**Fig. 7.** Evolution of annual mean concentration of $SO_2$ indicator

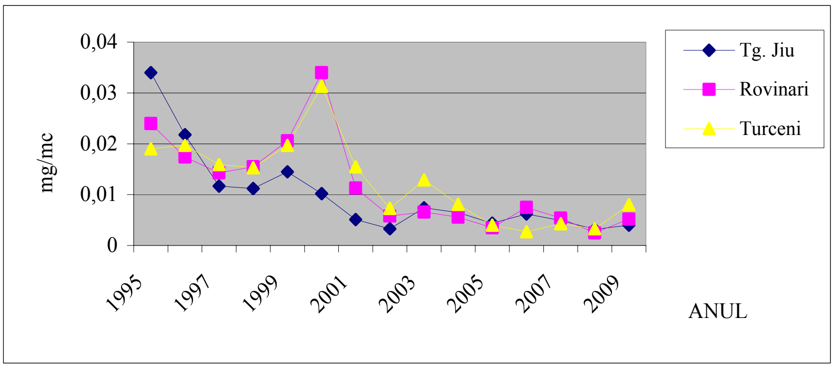


**Fig. 8.** Evolution of annual mean concentration of $NO_2$ indicator

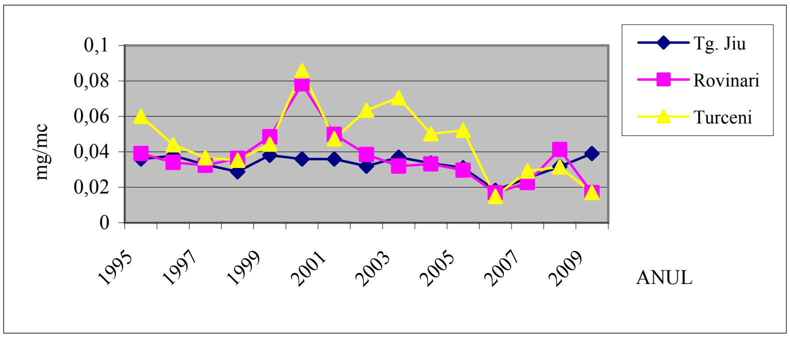


**Fig. 9.** Evolution of annual mean concentration of $NH_3$ indicator

Powders that pollute the atmosphere in the county have a different character depending on the sources that generate them, namely: fossil fuel-fired power plants, quarrying, landfill of slag and ash dumps, traffic, building materials manufacturers, and for residential heating during the cold.

In the county, the most important sources of particulate pollution are:

- Rovinari area: Rovinari Energy Complex, mining quarry, traffic;
- Turceni area: Turceni complex;
- Areas Motru Matasari, Seciuri, Pinoasa, stall, Timiseni: mining quarries, roadside;
- Barseşti area: About SIMCOR VAR SA Oradea – workstation Targu Jiu MACOFIL SC, SC LAFARGE CEMENT ROMANIA SA - Plant Targu Jiu traffic;
- Meri area Career Meri.

Situation settled dust (Fig. 10) is as follows:

- areas: Rovinari Motru (Rosiuta), Jilt Barsesti, Turceni trend is decreasing;
- slightly increasing trend is recorded for the Targu Jiu.

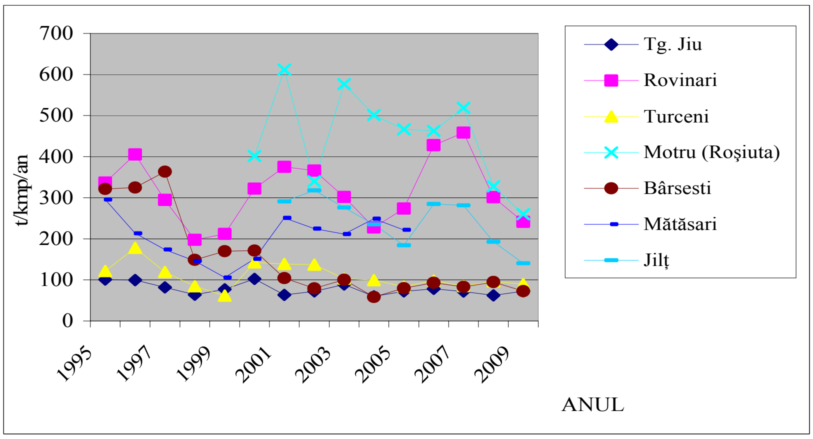


**Fig. 10.** Evolution of average annual amounts POINTER SEDIMENTARY

Mining exercise great influence on the environment, which manifests itself in all phases of production processes. The influence of environmental factors begins with the work of prospecting and exploration of deposits and continues and intensifies with the development of productive activities.

Impact on air the mining perimeters generated by stationary sources and mobile sources participating in the activities of mining and thermal power stations on the air transport. Impact has a local character and a slight intensity.

Impact on air production processes, sources of pollution from the analysis reveal the following: mobile sources, represented by conveyor belts, machinery and vehicles, have an impact with a degree of regional expansion and its average intensity, mid-term deposits of coal, is a source of coal dust, which generates a strong impact intensity and degree of expansion in territory area, the tailings dumps are a source of indoor dust particles, which generates a low-impact intensity and degree of extending the area code, outside the sterile dumps, and dumps inland, are sources of dust particles, especially fine sand and sandy clay, which generates a low-impact intensity and degree of expansion in the area code.

In some cases, the negative influence manifests a very long time, even after total cessation of productive activity in the area. The seriousness of the influence industry issues, including the mining on the environment requires both the designers and those who will lead productive activities in the field to anticipate negative effects and to take all possible measures for prevention, protection and restoration.

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