Environment for Access to the Inventory of Stationary Point Sources of Emissions of Air Pollutants in Armenia

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ABSTRACT

Environment for access to the inventory of stationary sources of emissions of atmospheric pollutants was established to facilitate the work on creating and editing the data about the location and characteristics of these sources. It is a specialized website (http://armei.grid.am), which unites the online GIS and emissions inventory. As GIS the integrated platform with the open source OpenGeo Suite 3 Community Edition is used.

Additional functionality (processing, data input and output) is implemented with programs in Python. This environment is the service application for a system of numerical modeling of atmospheric pollutants CMAS, adapted to national needs, to monitoring the emissions of polluting substances and the process of their distribution.

Keywords

Emission inventory, stationary point sources, air pollutants, air quality modeling.

1. INTRODUCTION

One of the main objectives of the environmental protection is the ecological safety. It can be achieved by effective management by developing methods in order to avoid negative impacts on the environment, in particular, by monitoring, assessment and estimation of air quality.

The air monitoring data received from the Ministry of Nature Protection of the Republic of Armenia [1, 2, 3] and the data from the National Statistical Service of the Republic of Armenia [4] on air pollutants emitted by point sources and transports in 2011 indicate that the concentration of contaminants in the area of industrial facilities dramatically exceeds the legally allowed level. According to the official data of the Ministry of Nature Protection of RA [1] the amount of airborne particulates suspended in the atmosphere in 2011 was as high as 269.3 thousand tons, of which 57.5% was produced by traffic, while the remaining other 42.5% was caused by 3437 point sources located at the manufacturing enterprises.

Along with traffic and manufacturing enterprises, unfavorable climate conditions also expand air pollution causing the spread of waste products in the air. Therefore, assessment and estimation of air quality should be made together with accurate weather forecast. It is a challenge, since mathematical modeling of such processes requires a huge amount of computational resources, as well as automatic collection and processing of quite a large amount of information on processes in the atmosphere.

The computational resources of the Armenian National GRID Initiative [5] helped to overcome the above mentioned problem. This infrastructure consists of relevant computational resources, which make possible to implement state-of-the-art models for weather forecast, as well as for air quality assessment and estimation of the air pollution level in Armenia.

2. SYSTEM OF AIR POLLUTION DISSEMINATION MODELING

Air pollution dispersion is reproduced by the Community Modeling and Analysis System (CMAS) [6]. The key module of this system is the Model of Community Multiscale Air Quality (CMAQ) [7]. The general structure of the system is illustrated in Fig. 1.

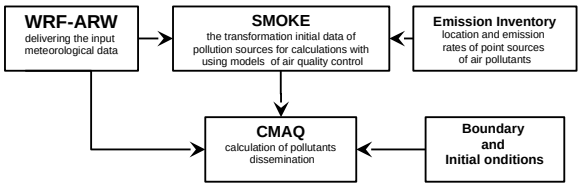

Fig.1. The general structure of the system of air pollution dissemination modeling.

The mesoscale new generation model for Weather Research and Forecasting (WRF) [8] delivers input meteorological data for CMAQ. Calculations are made using NCEP GFS [9] data collected every 3 hours with aspect dimensions of 0.5×0.5 degree longitude and magnitude.

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Transformation of the initial data for the application of the air quality control models is done by means of Sparse Matrix Operator Kernel Emissions (SMOKE) [10].

CMAQ is a third generation model applied for control and estimation of the air quality, as well as scientific investigations of the scheme of intricate chemical and physical processes in the atmosphere. This model works at different distances (either local 1km – or global) and allows to estimate areas of concentration of a variety of chemically active substances – CO, NO2, NO, O3, float organic chemicals, etc., aerosols (PM2.5 – up to 2.5 micrometres, PM10 – up to 10 micrometres) – predict their composition and decomposition in the troposphere, as well as oxide precipitations and visibility reduction.

Inventory of particulates is comprised of numerous formatted ASCII files named ARINV, MBINV, PTINV for area, mobile and point sources, respectively. These files contain either genuine information (characteristics of the source, data on emission, etc.) or a list of names of the files with full description of destinations. In input SMOKE reads all the files in the list and incorporates their information into a single summary inventory.

3. INPUT DATA

To create an emission the inventories used data on standards of pollutant emissions obtained from the Ministry of Nature Protection RA (marginal permitted emission (MPE) data of about 1200 enterprises [2]), as well as data on emissions of pollutants obtained from the National Statistical Service of Armenia (data on actual emissions, based on statistical reports of enterprises from over 3600 point sources) [3] (the data include geographical coordinates, height of the source, as well as type and volume of waste materials). The division is based on current standardization mode and structure of national accounts of pollutant emissions in Armenia.

Subject to accounting are the enterprises with annual air usage for emission ranging from 2 mln to 2 bln m^3 [11]. The enterprises, whose annual air usage for emission exceeds 2 bln or 2 ths m^3/s are subject to rationing.

All these data were transformed into the format required by SMOKE. Although this format allows viewing and editing data with any text editor it is not convenient for regular modifications. For this purpose, a database for storage of the inventory of pollutants was developed.

As a topobase for constructing maps the data from the database of vector records of Armenia established by Acopian Center for the Environment were used (ACE) [12].

4. ENVIRONMENT FOR ACCESS TO THE INVENTORY OF POLLUTANTS

The environment for access is developed on the basis of OpenGeo Suite 3 Community Edition [13]. It is a specialized website (http://armei.grid.am), which unites the online GIS and emissions inventory. The environment contains OpenGeo Suite components (GeoServer, GeoWebCache, Styler, GeoExplorer, OpenLayers, GeoExt, Dashboard) and special software, realized on Python programming language with using PyNGL/PyNIO, NumPy, SciPy packages, GNU Data Language (GDL) , NCAR Command Language (NCL) codes and CDO (Climate Data Operator) software, and NetCDF Operators (NCO). To accelerate calculations, F2Py tool is used, which is a part of NumPy package. This tool also allows the use of FORTRAN software as modules for Python software. The data are statistically processed with software R. All the information is stored in PostgreSQL/PostGIS spatial database.

This website provides easy internet browser access to the inventory of point source emission of pollutants (for reading, modification and expansion of the inventory).

Data are presented as text reports, tables, as well as maps. They are divided by industries, objects, chemical substances and substance groups. This website helps to determine the source of pollutant emission, the emitted pollutants, their volume and spread in atmosphere.

The basic functionality of this environment is shown in Fig. 2 – 4.

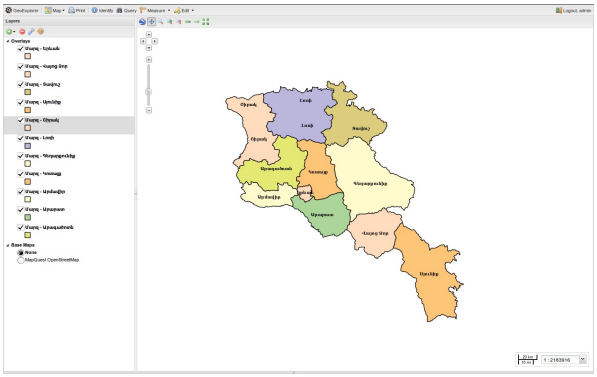

Fig. 2. GeoExplorer - Administrative map of Armenia

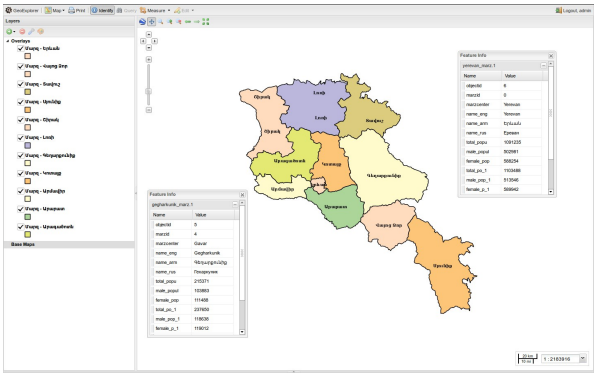

Fig. 3. GeoExplorer - Administrative map of Armenia. Using the “Identify” tool.

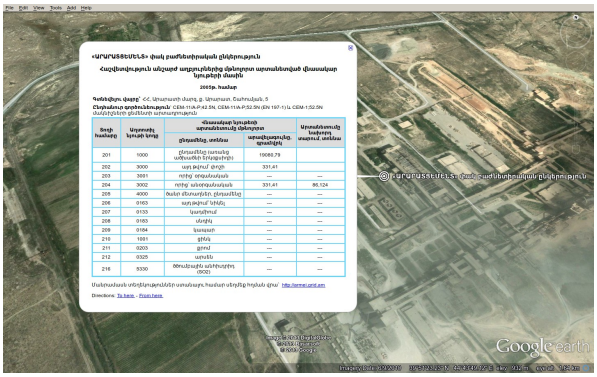

Fig. 4. Sample report on emission in Google Earth, generated from emission inventory (exported to KML).

4. CONCLUSION

Thus, there has been developed an environment for access to the inventory of pollutants, adapted to national inquiries, that allows observing the emission of pollutants and their dissemination.

5. ACKNOWLEDGEMENT

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