IMPACT ASSESSMENT OF THE FUTURE DEVELOPMENT OF OPEN-CAST COAL MINES "TRAYANOVO" ON THE AIR QUALITY

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INTRODUCTION

"Maritza"open-cast coal mines are the biggest open-cast mines in Bulgaria. They are the major source of brown coal fuel for the three thermo-electric power plants "Maritza-Iztok 1, 2, and 3". Mining operations lead to emitting of various pollutants in the atmosphere, dust being the essential one. There are two kinds of main dust sources:
- area sources - such as mines "Trayanovo 1, 2, and 3", as well as pit dumps "Staroseletz", "Gledachevo" and "Mednikarovo";
- linear sources – belt conveyors for each mine.

The present work aims at assessing the impact of mining operations on the dust pollution rate of the atmosphere, taking into account area and linear sources based on planned dimensions of mining works for 2010, 2015 and 2025, compared to dust pollution in 2000. The future development of "Maritza" mines generally involves changing of area and location of mines and dumps (inside and outside), work capacity, and thence dust emissions from the mines and dumps.

METHODS

Surface dust concentration fields from area and linear sources of mines "Trayanovo" are calculated with AER_R model [*Syrakov D.and A. Tzenkova,* 1998]. This model is intended for estimating the distribution of aerosols and includes specific parameterization of aerosol processes (sedimentation, dry and wet deposition), suggested by Galperin [*Syrakov D. and M. Galperin*, 1997]. The model is PC-oriented and implements a particular version of the so-called Gaussean PLUME-model.

The atmospheric stability is determined after the Pasquill-Turner classification. Briggs formulae for sigma's are used. The wind velocity at source height is determined from surface wind applying the US-EPA recommended power law, exponent depending on the stability class. With calm weather, plumes, formed at wind speed of 0.5 m/s, are averaged by all directions.

All calculations are made on uniform grid 25x30км (with 500м step). Data from climatic station Stara Zagora (assumed as representative for this region according to previous authors' studies) is used as input meteorological information. Data for area and linear sources emissions is prepared by I.Ivanov. [*Ivanov I. at all*, 2001]. Modeling results give mean annual dust concentration fields and its deposition on the earth surface.

RESULTS

Year 2000

The impact of the mines in the year 2000 is biggest compared to all prognostic models due to the fact that both the mines and outside dumps still emit dust. Mean annual dust concentrations in the atmosphere near and over annual maximum admissible concentration (MACma - 0,15mg/m^3) are formed over the region (shown in Fig. 1), which spreads to the village Pet mogili and the outskirts of "Ovcharitza" reservoir to the north, eastward of village Polski gradetz, partly encloses village Madretz and "Madretz" reservoir, westward of villages Trayanevo, Obruchishte, Ljubenovo, and Gipsovo. Villages Kovachevo, Ovcharitza, Iskritza, and Trayanevo are in the zone of double MACma.

The highest levels of dust load of the atmosphere are over the mining fields and the dumps. The maximum model value is formed at the boundary between mines "Trayanovo" 1 and 3 and is 1,4 mg/m^3 - about ten times above MACma. This value should be compared to working environment standards since it is in the site and not in the dwelling area.

The verification is made on the data from stationary points for air quality monitoring in the region. Results are shown in Table 1.

Table 1. Comparison between model concentrations and observed mean annual values for the year 2000

Station	Observed mean annual dust concentration for 2000	Model mean annual dust concentration for 2000
Galabovo	0,25 mg/m^3	0.12 mg/m^3
Mednikarovo	0,10 mg/m^3	0,25 mg/m^3
Polski gradetz	0,12 mg/m^3	0,17 mg/m^3

Obtained results show the adequacy of the model fields and, on the other hand, the necessity to develop proper system for monitoring of atmospheric conditions in order to better specify meteorological conditions over the mine fields.

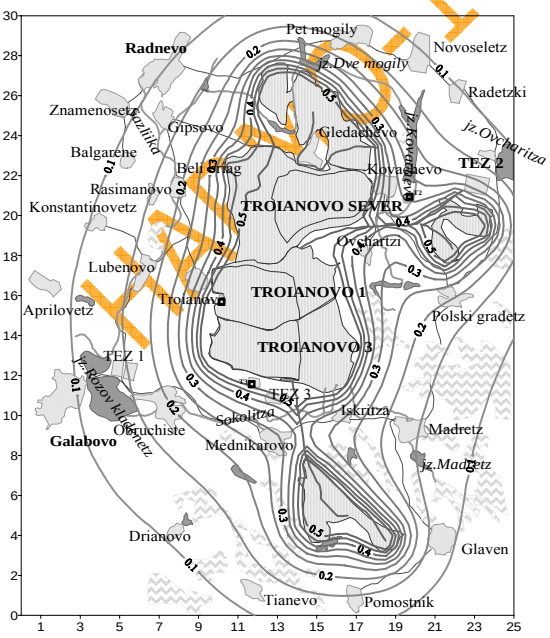

Fig.1. Field of mean ground level dust concentration for Year 2000

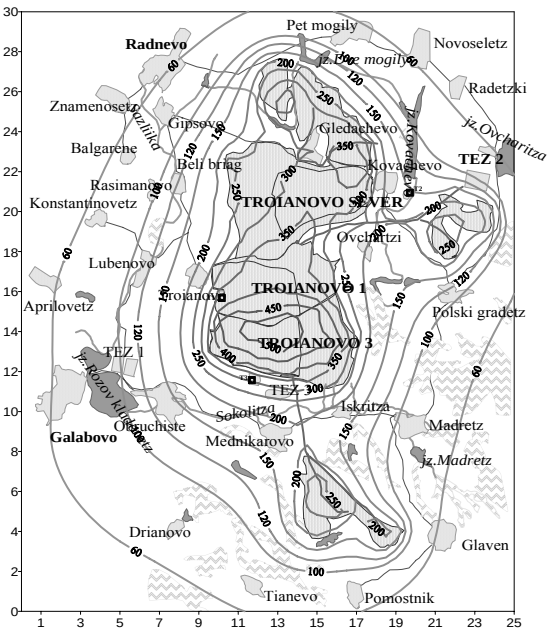

Fig.2 Field of mean daily dust deposition for Year 2000..

Figure 2 shows the field of the mean diurnal deposition for the specific year calculated with 2000 data. Geometrically the deposition field resembles the concentration field. We should emphasize the essential role of dust particle sizes as well as the precipitation regime as determining factors for the quantity of dust deposited on the ground. As revealed by Figure 2, dust deposition exceedance (MAC mean diurnal deposition - 350 mg/m^2) is observed inside the mines, particularly in "Trayanovo" 3 and partly in "Trayanovo" 1, and also in part of "Gledachevo" dump.

Year 2010

According to the surface dust concentration field shown in Figure 3 the character of dust concentration is expected to change as compared to the year 2000. The dust concentration in the region of mine "Trayanovo Sever" decrease twice without forming a zone of maximum dust pollution. Both the level and the spatial range of high pollution of the atmosphere in the region of "Staroseletz" dump decrease in contrast to the central part of "Mednikarovo", where the high levels of increased dust content and the range of concentration exceedances remain unchanged. In accordance with the raise of coal output from mines "Trayanovo" 1 and 3, the spatial range of impact of their activity expands.

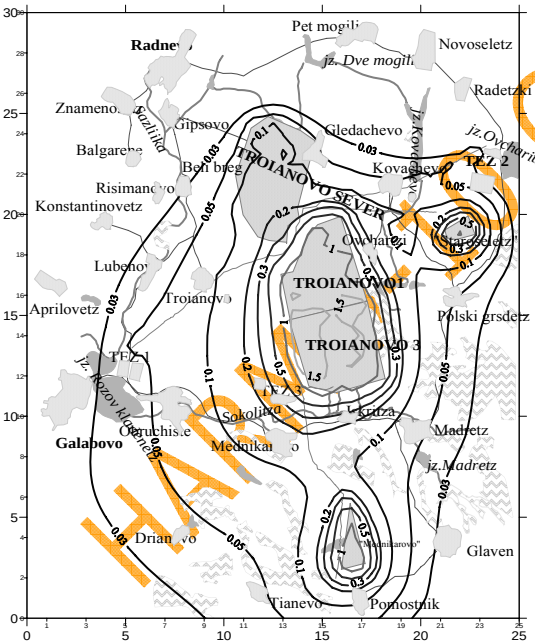

Fig.3. Field of mean ground level dust concentration for Year 2010

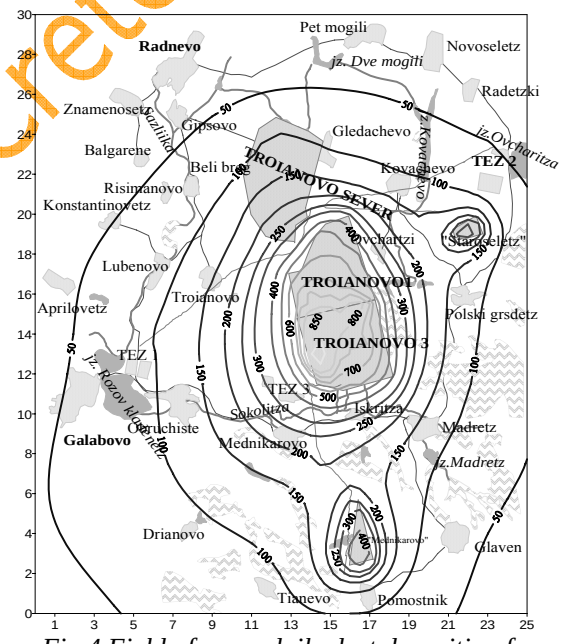

Fig.4 Field of mean daily dust deposition for Year 2010..

The deposition field resembles the concentration field (Figure 4). There is dust precipitation exceedance over mines "Trayanovo" 1 and 3 as well as in the south-southwestern sector. Dust pollution exceedance is also obtained over the outside dumps, and in the region of "Mednicarovo" dump. The maximum model mean annual dust concentration is formed in the region of "Trayanovo" 3 and is 950 mg/m^2 – three times above MACma.

Year 2015

The forecast for the year 2015 does not differ essentially from that for the year 2010. Figure 5 shows that the zones of impact are similar, while the trend of impact shift to northeast continues. The maximum model concentration (2,1 mg/m^3) is again obtained in the region of "Trayanovo" 1 and 3.

The trends in the deposition field are same as in the concentration field (Figure 6). Village Iskritza and the site of TPP 3 are almost outside of the region of dust precipitation exceedance. In the northeast direction the opposite trend is obtained. The maximum model value is almost identical with this for the year 2010 - 900 mg/m^2.

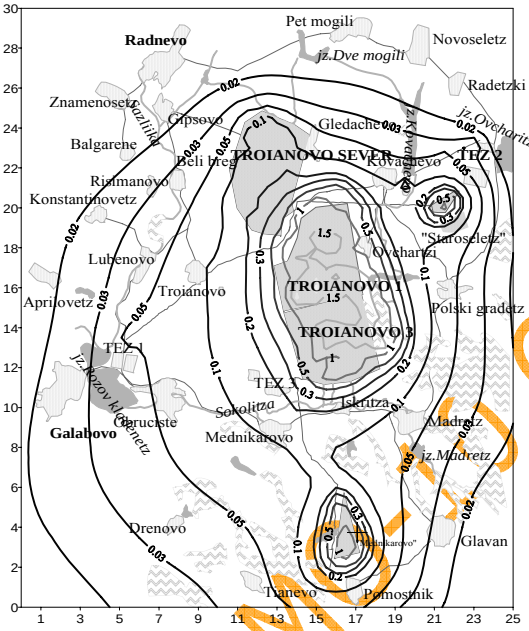

Fig.5. Field of mean ground level dust concentration for Year 2015

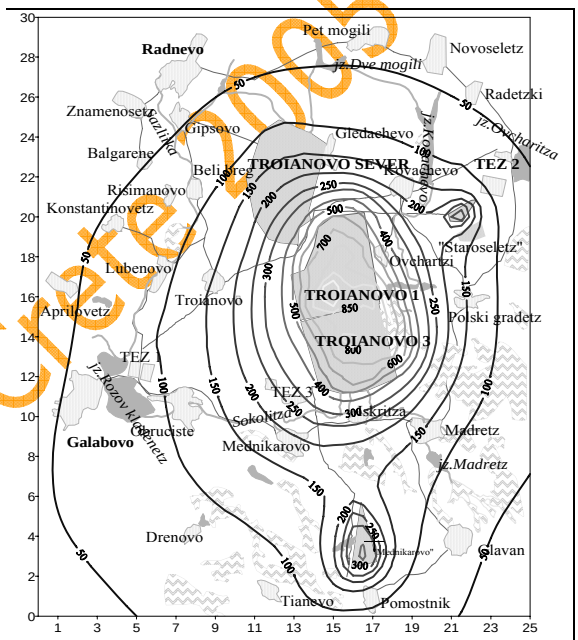

Fig.6 Field of mean daily dust deposition for Year 2015..

Year 2020

According to the forecast for the year 2020 dust pollution exceedances are expected to form only above mines "Trayanovo" 1 and 3, and "Mednikarovo" dump. The range of impact in the northeast direction remains the same, as a result of slightly decreased emissions from mine "Trayanovo" 1. Formation of new zone of dust pollution exceedances over "Staroseletz" dump is not expected because of its closing. The maximum model value is as might be expected in mine "Trayanovo" 3 - 1,6 mg/m^3 (about ten times above MACma).

As far as the deposition is concerned (Figure 8) increased impact zones are nearly identical with those for the year 2015; only over "Staroseletz" there is no such zone. The maximum model deposition appears over the region of "Trayanovo" 3 - 700 mg/m^2.

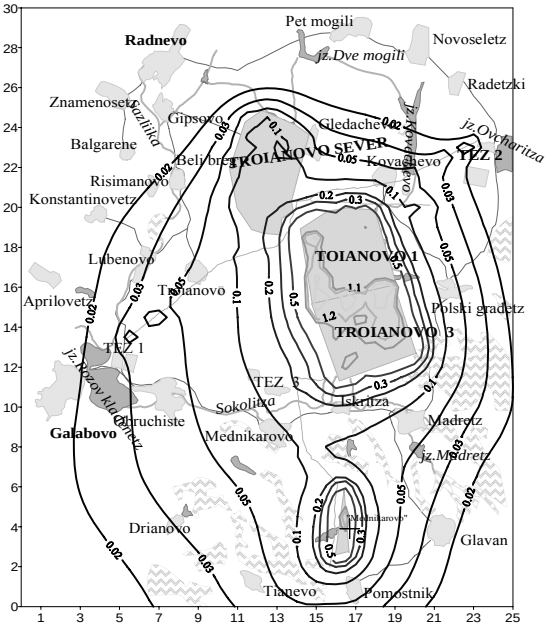

Fig.7. Field of mean ground level dust concentration for Year 2020

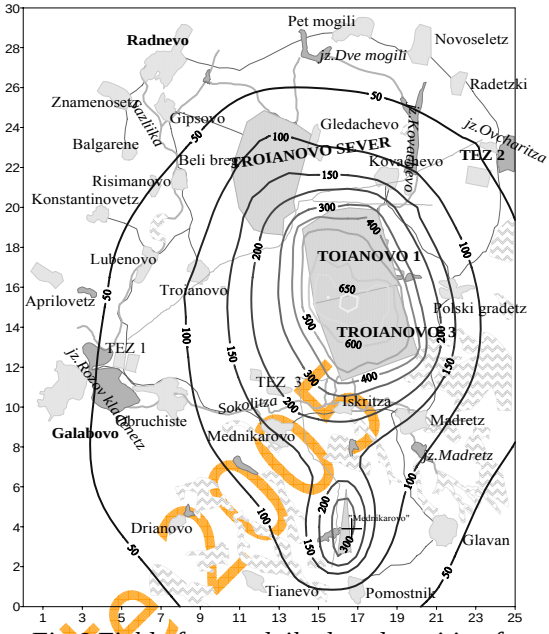

Fig.6 Field of mean daily dust deposition for Year 2020

CONCLUSION

The performed modelling study of air pollution sources impact in the area of mines "Trayanovo" on air quality allows to draw the following conclusions:

The used model AER_R describes adequately the dust pollution level of the atmosphere. More precise results could be obtained if meteorological information on mines region was available.

Mining activities in the region of "Trayanovo" and adjacent dumps leads to violation of sanitary standard requirements related to dust pollution of the atmosphere, and also to dust deposition on the ground in some places.

The prospect development of mining operations will have more restricted spatial and more limited quantitative impact in comparison with the year 2000; the range of the spatial impact is shifted gradually toward east-northeast and its rate is conditioned by the design indices of emissions and source area.

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