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ANALISIS OF AIR TRANSFER MODELS

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The article presents the analysis of the air transfer models and air pollution monitoring which is held in the European countries. It also reveals the opportunities for these models' application in the conditions of Ukraine and produces the analysis of the existing air monitoring system in Ukraine for improving the economic block LRTAP.

Keywords: *atmospheric air, monitoring, model, pollution, emissions, pollutants, air transmission (transfer), forecasting.*

INTRODUCTION

The adoption of European Convention on the Long Range Transboundary Air Pollution (LRTAP) in 1979 allowed to coordinate the efforts of the European states aimed at the air pollution abatement. In recent years there is a process of active formation of new legislation. Its constitutional framework was changed both at the state level and in subjects. Many legislative acts were adopted in the field of natural resource management and environmental protection.

However, the economic bloc LRTAP has not been systematically developed.

The scientific basis of air quality management at the state level has been shaped in works of foreign economists: M. Amann, S. Atkinson, S. Ya. Kofal, K. Conrad, G. Klassen, S. Kruitwagen, A. Krupnik, G. Stingler, D. Simpson, T. Selden, D. Song, T. Tietenberg, N. Shafik et al.

At the same time the very model of emission certificates trade, the critical indicators are still discussed.

In our opinion, the model LRTAP can be improved.

TASK SETTING

Despite the fact that nowadays the scientific research of economic problems of air quality management has achieved a high level and a great experience has been obtained in this field, in our opinion, further studies should be deepened due to the modern trends of international social and economic development, global nature of environmental problems and objective need to adjust the trends of the Ukrainian economy development to the LRTAP requirements.

Today there are the basis and tools for the improvement of economic bloc LRTAP, i.e. for the transition from the indicator of the total emission of pollutants to the indicator of the load reduced to the complex (set) of recipients [1].

It allows to determine the balance of emissions in the EMEP grid cell accurately and with regard to many factors that are not taken into account while calculating the indicator of the total emission of pollutants.

The aim of the article is the analysis of some existing air transfer models, air pollution monitoring in European countries as well as identifying opportunities and the degree of these models application in terms of Ukraine and the analysis of the existing air pollution monitoring system in Ukraine in order to improve the economic block LRTAP.

RESULTS

The EMEP makes a significant contribution to the implementation of the Convention Protocols on heavy metals and persistent organic pollutants. Particularly, it provides the Parties to the Convention with the necessary guidelines for national emission inventory. In addition, the EMEP develops models on air quality assessment and supports the monitoring network for the regular provision of the Parties to the Convention with information on the level of air load and fallout of HMs and POPs [2].

Pollution levels assessment is carried out on the basis of model calculations:

– concentration fields in the environments with a spatial resolution 50x50 km (in the graphical and numerical form);

– fields of the fallout on the territory of own country and other countries from national sources with spatial resolution 50x50 km (in graphical and numerical form);

– maps of external anthropogenic sources contributions to the fallout on the territory of the country;

– diagrams of the European countries' contribution to the fallout on the territory of the country;

– diagrams of the country sources' contribution to the fallout on theEuropean countries;

– fallout on the ecosystems.

Let us consider some of the models of the atmosphere pollution assessment and the possibilities of applying these models.

Nowadays, the activity of EMEP, European Commission, HELCOM, OSPAR, WHO and various national programs is aimed at gradual reduction and prevention of air pollution, including transboundary transfer of heavy metals over long distances.

Concern about the harmful effects of heavy metals on human health and the environment, in turn, has led to vigorous activity in the field of monitoring, assessment, regulation, control and also cooperation both the international and national levels [8].

Table 1 - Models of air pollution assessment

Model	Main point	Model use
1	2	3
1. Regional model MSCE-HM	Regional model MSCE-HM of air transfer was developed for the time efficient modeling of heavy metals (HM) transboundary pollution within the EMEP region in order to provide participating countries of the Convention on Long-range Transboundary Air Pollution with information on atmospheric heavy metal pollution [3]	MSCE-HM model is used for the purposes as follows: – assessment of air transfer and fallout of heavy metals within regional and national scale; – fallout modeling on ecosystems for further assessment of the excess critical loads; – assessment of transboundary transfer of heavy metals; – assessment of temporal and spatial trends; – forecasting of future levels of heavy metals pollution under various emission scenarios
Further development of MSCE-HM regional model	Now, the development of single approach to the modeling of models of heavy metal transfer is running within different scales such as global, regional and local. The Global Multi-media Modeling System (GLEMOS) is being developed. It is supposed that GLEMOS model will substitute the MSCE-HM model in near future [3]	
2. MSCE-POP model	The EMEP POP model (MSCE-POP) has been designed for the assessment of the transfer and accumulation of persistent organic pollutants (POPs) within the development of air quality policy in Europe by the Convention on Long-range Transboundary Air Pollution [4]	MSCE-POP model is used for the purposes as follows: – assessment of atmospheric transfer and fallout of POPs on regional scale; – assessment of distribution POPs between main environmental elements; – assessment of transboundary transport of POPs; – assessment of temporal and spatial trends; – forecasting of future levels of pollution with POPs and trends under various emission scenarios of POPs emission; – assessment of the possibility of further transfer and overall stability of new potential POPs

Continuation of the Table 1

1	2	3
Further development of MSCE-POP model	Along with this, the development of the global multi-scale modeling approach to POPs is ongoing. The Global EMEP Multi-media Modeling System (GLEMOS) is being developed to assess POPs pollution at different scales The GLEMOS model is supposed to substitute the MSCE-POP model in near future [4]	
3. GLEMOS (Global Multi-media Modeling System)	Multi-scale model platform for assessment of environment pollution with various toxicants is developed within the EMEP program. GLEMOS is used for designing of cycling models of different classes of pollutants (e.g. heavy metals and persistent organic pollutants) in the environment. The possibility of choice of the model domain as well as spatial resolution is a specific feature. There is a capability for a flexible configuration of the model for pollutant properties and particular research task [5]	– GLEMOS is used for: – Multi-environment modeling of the environment pollution with various contaminants within different scales: from global to local; – assessment of long-range circulation and accumulation of contaminants in the environment; – assessment of intercontinental transfer of the contaminants and its impact on pollution levels in different regions; – designing of future scenarios of toxic substances pollution and correlation between possible climate changes and environmental pollution
Further development of the GLEMOS modeling system	– The development and update of the GLEMOS is a continuous process aimed at the improvement of the model capacity and support of its approaches and parameterization. The further model changes will include: – adaptation and testing of the modeling procedure with in various scales and improvement of computational efficiency; – including of data on atmospheric aerosol and chemical agents based for more precise assessment of HMs and POPs pollution levels on the basis of simplified chemical modulus or external data; – preparation of the modeling system for distribution and support as open source software [6]	
4. Model of the interaction and cumulative effect of greenhouse gases and air pollution - GAINS	GAINS model is the principal instrumental means for carrying out complex assessment of ecological consequences of various scenarios of social and economic development and also efficiency of different strategies onreduction of pollutants emission and greenhouse gases that are used within the Convention on Long-range Transboundary Air Pollution for carrying out works in the field of appropriate air quality providing and principal	GAINS allows to carry out the analysis of synergistic effects and mutual impact between air pollution control on different levels (local and regional) and greenhouse gases emission control. With help of GAINS it is possible to conduct the assessment of the emissions, ways of their reductions and related expenses on the six pollutants (SO2, NOx, NH3, VOC) and also six greenhouse gasses that are regulated within Kyoto Protocol. GAINS features:

Continuation of the Table 1

1	2	3
	pollutant emission control (SO2, NOX, VOC, NH3) and greenhouse gases (CO2, CH4, N2O and F-gases) on the territory of European Union. GAINSis used for advantages assessment of air pollution reduction and greenhouse gases emission and also for assessment of technical and market strategies	– it allows to calculate quantitatively the economic and technical interactions between the control means of greenhouse gases and substances emissions that pollute the atmospheric air; – it assesses the simultaneous effect of air pollution emission reductions [7]
Further development of GAINS model	The modelers of GAINS decided not to take into account some aspects of the model as they had less importance in comparison with other aspects. It can be explained by that fact that the proper treatment of these parameters would increase the overall complexity of the model and, as a result, would put at hazard its functional capability. Nevertheless, at present moment, the experts admit that many GAINS aspects, that were not taken into account, are of great importance. First of all it concerns the assessment of additional benefits, assessment of the benefits in terms of money, funds intended for the control of emissions, which require significant structural changes in the economy and the macroeconomic impacts of emissions control strategies. As with time, the tightening of control strategies of toxicants emission will take place, the conduction of appropriate analysis of these problems come into great significance. All this is necessary ,first of all, to get a better vision of the expenses and benefits of policy decisions in the field of air pollution reduction [7]	

According to Article 7 of the Protocol on Heavy Metals Parties annually inform the EMEP on the heavy metals levels, using the methodologies and the temporal and spatial resolution determined by the Executive Board of EMEP.

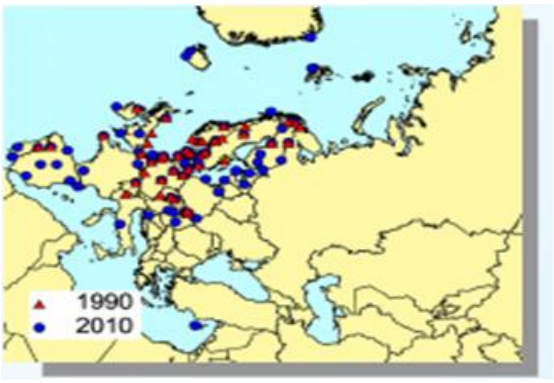

Figure 1- EMEP monitoringnetwork (heavymetals)

The protocol was signed or ratified by 41 countries (May, 2012). Upon signature, the number of parties, that have provided the data on emissions,

have increased from 30 to 46. Only 28 parties provided the data on spatial emission.

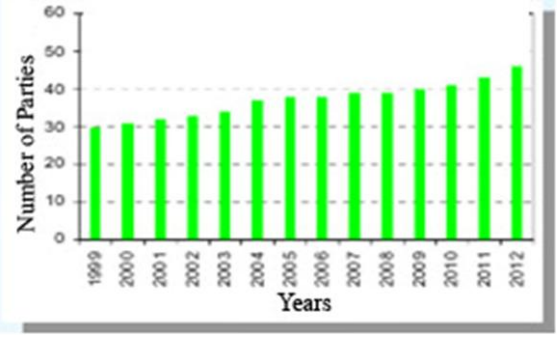

Figure 2 –Number of Parties providing the data on the fallout of heavy metals

Reduction of heavy metals fallout in the EECCA (Eastern Europe, Caucasus and Central Asia) countries is somewhat lower than in other EMEP countries. At the same time, the analysis of the pollution levels is limited by the lack of data on emissions and monitoring.

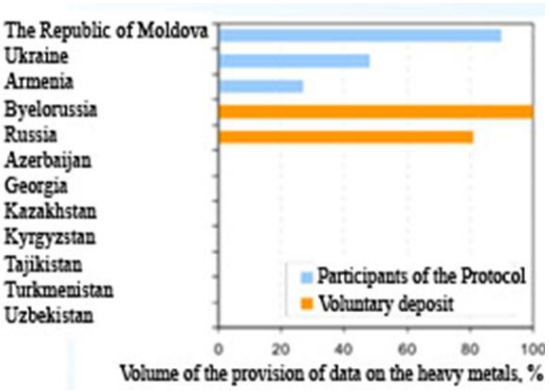

Figure 3 – Volume of the provision of data on the heavy metals

National data on the anthropogenic emission in the countries are the source information for the pollution levels assessment. Only 5 of 12 EECCA countries present the data on heavy metals emission. Two of them present the information on the spatial distribution of emission.

Measurement data on the concentrations of HMs in the air and the fallout in the EECCA countries are not provided by the EMEP. In the result it reduces the quality of the assessments of the HMs pollution levels in this part of the EMEP region [8].

Air Pollution Monitoring in Ukraine

Important role in the system of monitoring of air quality belongs to the information on the transboundary pollutants transfer. These observations are carried out in the network of National Hydrometeorological Service.

Figure 4 - Network of the Ministry of Emergencies of Ukraine hydrometeorological organizations' observations on environmental pollution

Observations of transboundary pollutants transfer by atmospheric air and precipitations, as well as in previous years, were carried out at the two meteorological stations of the National Hydrometeorological Service, i.e. Svityaz (Volyn region) and Rava-Russkaya (Lviv region).

Observations of the chemical composition of atmospheric precipitation were carried out at 33 meteorological stations of the network of the National Hydrometeorological Service; observations of precipitation acidity (pH) – at 50 meteorological stations. Observation of air quality and pollutants content including radionuclides is carried out by three subjects of national environmental monitoring system: the Ministry of Emergencies of Ukraine (the National Hydrometeorological Service), the Ministry of Ecology and Natural Resources (the National Environmental Inspectorate) and the Sanitary and epidemiological service (the SES). The National Hydrometeorological Service of the Ministry of Emergencies of Ukraine carries out the assessment of air pollution in the cities of Ukraine on the basis of the observational data in 53 cities, 162 stations and two route sites. Air quality monitoring program includes eight pollutants: dust, nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide, formaldehyde (H2CO), lead, benzpyrene and radioactive substances. Some stations carry out the monitoring on the identification of additional pollutants [9].

According to the decision of the 29th Session of the Steering body of the EMEP program, the Ministry of Ecology and Natural Resources plans to set up and start running the first in Ukraine international background monitoring station EMEP. The station location at the territory of Karadag Nature Reserve of the NAS of Ukraine is agreed with EMEP Chemical Coordinating Centre (Norway). In 2012, new equipment for air quality monitoring was purchased for the background monitoring station. It was gas analyzer manufactured by Horiba (Japan), that are capable of measuring the concentration of ground-

level ozone, nitrogen oxide and carbon dioxide, sulfur dioxide, carbon monoxide and volatile hydrocarbons. The entire complex of devices must operate continuously and transmit the information in real time [10].

CONCLUSIONS

Therefore it should be noted that currently the activities and coordinated efforts of international organizations on the environmental protection are directed toward the prevention and progressive reduction of air pollution. It is supported by the development and implementation of environmental pollution models, as well as the systems for monitoring and forecasting of air pollution.

Ukraine as a Party of the LRTAP also makes maximal efforts for holding measures on environmental monitoring and air pollution in particular. For this purpose the international background monitoring station EMEP is set up. The regulation of legislation is carried out in accordance with international standards for the improvement of the economic bloc LRTAP.

РЕЗЮМЕ

АНАЛІЗ МОДЕЛЕЙ АТМОСФЕРНОГО ПЕРЕНОСУ

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У статті проведений аналіз моделей атмосферного переносу, моніторингу забруднення атмосферного повітря, який проводиться в країнах Європи, а також виявлені можливості застосування цих моделей в умовах України і аналіз існуючої системи моніторингу атмосферного повітря в Україні для удосконалення економічного блоку LRTAP.

***Ключові слова**: атмосферне повітря, моніторинг, модель, забруднення, викиди, забруднююча речовина, атмосферний перенос, прогноз.*

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