

TO THE QUESTION OF STATIONARY AIR SAMPLING STATIONS LOCATION AND NUMBER DETERMINATION IN URBAN AGGLOMERATIONS ECOLOGICAL MONITORING SYSTEM

V. Bakharev, A. Marenych, M. Zhuravska

Kremenchuk Mykhailo Ostrohradskyi National University

vul. Pershotravneva, 20, Kremenchuk, 39600, Ukraine. E-mail: v.s.baharev@yandex.ua

Purpose. A brief analysis of the basic requirements for choosing the location of stationary air sampling stations for air quality assessment has been carried out and some suggestions on schematic approximate location of stationary positions and the required number have been established. **Methodology.** The method of critical analysis has been used carrying out theoretical studies in order to establish the lacks of the existing requirements for the placement and the number of monitoring stations; and the theoretical elementary method of synthesis has been used to develop proposals for the schematic location of the sampling points and the algorithm for their number determining. **Originality.** For the first time the procedure for determining the number and schematic location of monitoring posts within urban industrial agglomerations has been grounded scientifically by using critical analysis of existing requirements to the determination of air sampling stations for assessing air quality. **Practical value.** The algorithm proposed for determining the number of stationary air sampling stations of air monitoring and fundamental layouts of sampling stations location for terms of practical application in real urban agglomerations will let to lay the basis for the development of an adequate system of air ecological monitoring. *References 3, no tables, figures 4.*

Key words: environmental monitoring, urban agglomerations or industrial sites, stationary sampling station, assessment of air quality, urban background monitoring point.

ДО ПИТАННЯ ВИЗНАЧЕННЯ МІСЦЬ РОЗТАШУВАННЯ ТА КІЛЬКОСТІ СТАЦІОНАРНИХ ПУНКТІВ ВІДБОРУ ПРОБ АТМОСФЕРНОГО ПОВІТРЯ В СИСТЕМІ ЕКОЛОГІЧНОГО МОНІТОРИНГУ МІСЬКИХ АГЛОМЕРАЦІЙ

В. С. Бахарев, А. В. Маренич, М. К. Журавська

Кременчуцький національний університет імені Михайла Остроградського

вул. Першотравнева, 20, Кременчук, 39600, Україна. E-mail: v.s.baharev@yandex.ua

Проведено стислий аналіз базових вимог щодо вибору місць розташування стаціонарних постів відбору проб для оцінки якості атмосферного повітря та розроблено пропозиції щодо принципових схем орієнтовного розташування стаціонарних постів і встановлення їх необхідної кількості. При виконанні теоретичних досліджень для встановлення недоліків існуючих вимог до місць розташування та кількості постів моніторингу застосовано метод критичного аналізу, а також метод елементарно-теоретичного синтезу для розробки пропозицій щодо принципових схем розташування пунктів відбору проб та алгоритму визначення їх кількості. Запропонований алгоритм визначення кількості стаціонарних постів моніторингу атмосферного повітря та принципові схеми розміщення пунктів відбору проб за умов практичного застосування в реальних міських агломераціях дозволяють закласти базис для розробки адекватної системи екологічного моніторингу атмосферного повітря.

Ключові слова: екологічний моніторинг, міська агломерація, стаціонарний пункт відбору проб, оцінка якості атмосферного повітря, міський фоновий пункт моніторингу

PROBLEM STATEMENT. The question of the environmental monitoring efficiency is relevant to all settlements without any exception, but the most relevant is the availability of adequate air quality environmental monitoring system in industrial cities and towns with a significant number of inhabitants and concentration of various industrial enterprises. The existing systems of air environmental monitoring is a part of the state system of environmental monitoring. The procedure of organizing and monitoring in the field of air protection is established by the Cabinet of Ministers of Ukraine. The main drawback of the existing system, in our opinion, is the lack of opportunity to make grounded recommendations and decisions in the field of air protection as an integral functions of environmental monitoring. This conclusion is based on the fact that de facto, under the existing system of selection and

analysis of air samples, industrial facilities can not have legal consequences for their own activities in violation the norms of environmental legislation. Thus, today, in terms of power decentralization in Ukraine, solving the task of air quality monitoring within the administrative boundaries of urban agglomerations the question of effective integrated system of air environmental monitoring is vitally important. In coping with issue mentioned above the imperative prerequisite is adequate and scientifically grounded definition of locations and stationary air sampling stations number for the air quality assessment of cities.

Purpose of the paper. The research work is aimed to conduct a brief analysis of the basic requirements for choosing stationary air sampling stations locations and develop proposals for schematic approximate location of monitoring posts and their placement of the required

number.

EXPERIMENTAL PART AND RESULTS OBTAINED. Today in Ukraine the requirements of air observations and particularly the choice of stationary air sampling stations are regulated by a number of regulations. We have made a brief analysis of these requirements:

1. RD 52.04.186-89 "Guide to atmosphere pollution control" Guidance Document [1] defines the principles of the observation system organization that have been implemented in the existing state system of air quality monitoring. In particular, 2.2 point of this document regulates the location organization and determines the number of sampling stations. The basic principles are as follows. When choosing a post location there should be determined the kind of information expected to be obtained: air pollution level typical of the district, or the impurities concentration in particular point that is influenced by emissions of some particular industrial enterprises or busy motorway. In the first case, the post should be located at the site, which is not affected by detached emission sources. In the second case, the post is located in the zone of maximum impurities concentration associated with emissions of the reporting sources. There the recurrence of wind direction over the city should be taken into account. The number of stationary air sampling stations is determined by the population in the city, the area of the settlement, the terrain and the industrialization degree, recreation destinations concentration.

2. "Guidelines on the establishment of environmental monitoring at the regional level" [2]. The document mentions only the basic requirements for observations that should be developed during the planning the issues of observation program and actually they duplicate the 52.04.186-89 RD requirements.

3. 2008/50/EC Directive of the European Parliament [3]. The document mentioned is the result of integration processes in Ukraine and is mandatory for the implementation of the action plan, it is the experience of the European system of human settlements air quality monitoring. The document sets sufficiently clear requirements for the placement of stationary sampling stations, including:

(a) Sampling points directed at the protection of human health shall be sited in such a way as to provide data on the following: the areas within zones and agglomerations where the highest concentrations occur to which the population is likely to be directly or indirectly exposed for a period which is significant in relation to the averaging period of the limit value(s); levels in other areas within the zones and agglomerations which are representative of the exposure of the general population,

(b) Sampling points shall in general be sited in such a way as to avoid measuring very small micro-environments in their immediate vicinity, which means that a sampling point must be sited in such a way that the air sampled is representative of air quality for a street segment no less than 100 m length at traffic-orientated sites and at least 250 m × 250 m at industrial sites, where feasible;

(c) Urban background locations shall be located so that their pollution level is influenced by the integrated contribution from all sources upwind of the station. The pollution level should not be dominated by a single source unless such a situation is typical for a larger urban area. Those sampling points shall, as a general rule, be representative for several square kilometres;

(d) Where the objective is to assess rural background levels, the sampling point shall not be influenced by agglomerations or industrial sites in its vicinity, i.e. sites closer than five kilometres;

(e) Where contributions from industrial sources are to be assessed, at least one sampling point shall be installed downwind of the source in the nearest residential area. Where the background concentration is not known, an additional sampling point shall be situated within the main wind direction;

(f) Sampling points shall, where possible, also be representative of similar locations not in their immediate vicinity.

For setting the number of observation posts the directive gives recommendations on the minimum number depending on the population number, observation land area and pollutants concentration level.

Summing up, there should be noted that outdated but current guidance document does not include changes in the requirements of time, the individual characteristics of each urban area for management decisions, and which is the most important it is aimed to control emissions, but not the human health. The guidance for the development of regional systems do not provide answers to the question of adequate monitoring system organization at the metropolitan area level. The EU Directive is the basic document, the main advantage of which is to focus on the human health protection. However, taking into consideration the base of the requirements given there should be considered that the directive is an adjusting instrument for the organization of supervision with all local features included. Moreover, the directive does not define requirements for the physical factors of influence on the environment. Based on detailed analysis of the above mentioned documents we have proposed a universal algorithm for determining the number of stationary sampling points and some principles layouts of observation posts within urban agglomerations have been developed.

Thus it is determined that an urban background monitoring point should be defined in the monitoring system that will provide representative information on the general level of air pollution outside the zones of active industrial pollution. Taking into account the presence of highways in the system, it is advisable to determine the monitoring point which will provide reliable information on contributions of the road transport into the overall level of air pollution. The matter is that European standards establish only requirement for a minimum number of posts, the sufficient number of stationary sampling points based on the number of places of compact population residence within the zone of active industrial pollution of groups is proposed to determine. According to p.

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3.4.3 [1] particularly high emersion of peak concentrations is observed at distances from 10 to 40 average height of emission sources of the company. For our research tasks, taking into account the necessity to establish approximate maximum dimensions of possible pollutant dispersion zones with high concentration, it has been accepted that the zone of active pollution (ZAP) from industrial facilities that has high-rise emission sources spread in the territory up to the 40 height sources output highest elevation.

Thus the total number of stationary sampling points for the assessment of air quality within the urban area is defined as:

$$m = n + 2 ,$$

where: *m* is the total number of stationary sampling stations of air pollution observations (sampling points) pcs.; *n* is the number of stationary observation stations depending on the number of residential areas that reach the large industrial facilities ZAP boundaries (where the highest levels of air pollution may occur) pcs *; 2 is the number of the observation posts required: urban background monitoring point, vehicles fee monitoring point.

Note. * – Number n can be increased if it is

necessary to take into account the prevailing wind direction in the area, and in order to obtain additional data at different distances from the powerful industrial sites or their mutual influence (overlapping ZAP), but only if only one additional sampling point is installed.

To design the principal schemes of observation posts location within metropolitan areas it has been examined a number of possible spatial scenarios of urban agglomerations allocation:

1. Several industrial metropolitan areas form a certain conglomerate due to a small distance from one another and due to ZAP limits spread by the way of the interpenetration to the territory of the nearby cities;

2. Outside the administrative borders of a metropolitan area where the impact of other industrial agglomerations is not spread a powerful industrial facilities complex is situated which ZAP covers the territory of urban area;

3. Air pollution is formed only by administrative facilities within the metropolitan area. In the metropolitan area other industrial agglomerations complexes or industrial facilities ZAPs are not spread.

Schematic display of proposed scenarios are presented in figures 1, 2, 3 respectively.

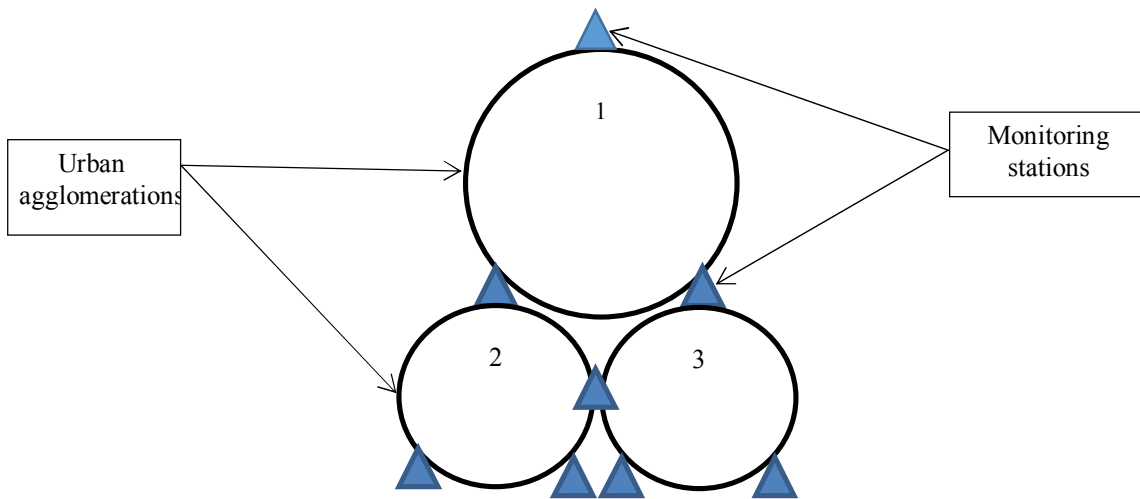


Figure 1 – Schematic diagram of the air quality monitoring stations location in conditions of mutual influence of several industrialized urban agglomerations

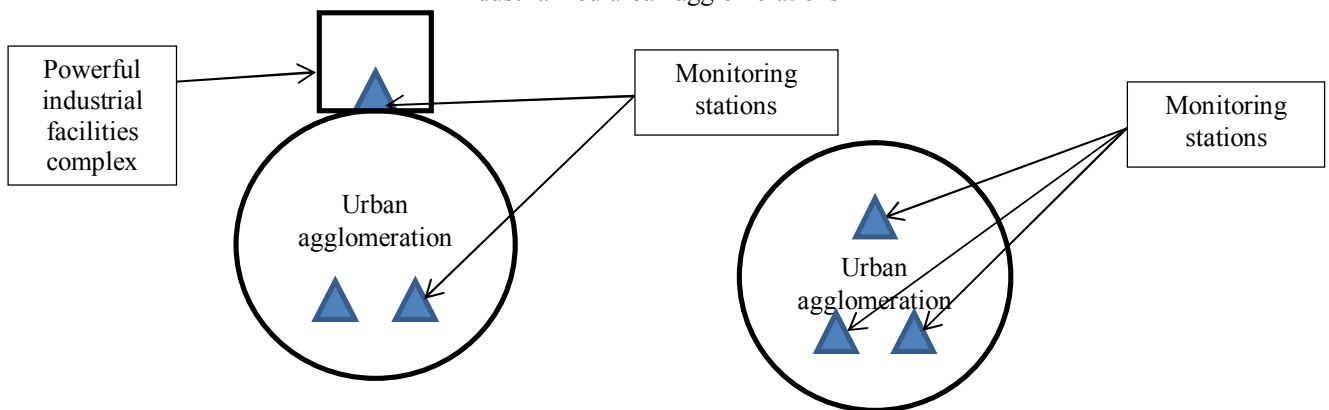


Figure 2 – Schematic diagram of the air quality monitoring stations location in conditions of complex influence of industrial facilities in urban area

Figure 3 – Schematic diagram of the air quality monitoring stations location in the conditions of external influences absence on the industrial urban area territory

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Schematic implementation of the principles proposed for the sampling points location within the

urban area that is not under the external influence is shown in Figure 4.

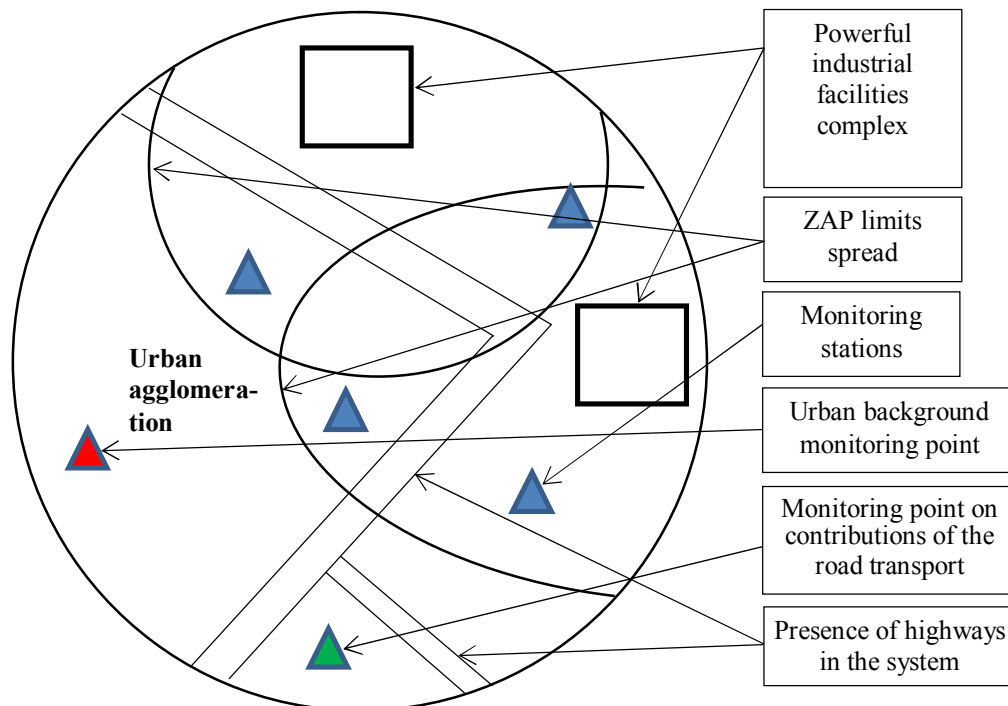


Figure 4 – Schematic diagram of the air quality monitoring stations location in the industrial urban area territory

CONCLUSIONS. According to the results of theoretical researches the universal algorithm for the determination of the number of air quality monitoring stations in the air environmental monitoring system of metropolitan area is proposed. The proposed algorithm takes into account the requirements of Directive 2008/50/EC and allows to determine the "background" concentrations of road transport and contribute to overall pollution. Principle layouts of air quality monitoring stations location taking into account scenarios with presence or absence of external influence on the metropolitan area territory have been developed. In further researches it is planned to detail

the requirements for the observation posts placement in micro scale.

REFERENCES

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3. 2008/50/EC Directive of the European Parliament, available at: http://zakon5.rada.gov.ua/laws/show/994_950

К ВОПРОСУ ОПРЕДЕЛЕНИЯ МЕСТ РАЗМЕЩЕНИЯ И КОЛИЧЕСТВА СТАЦИОНАРНЫХ ПУНКТОВ ОТБОРА ПРОБ АТМОСФЕРНОГО ВОЗДУХА В СИСТЕМЕ ЭКОЛОГИЧЕСКОГО МОНИТОРИНГА ГОРОДСКИХ АГЛОМЕРАЦИЙ

В. С. Бахарев, А. В. Маренич, Н. К. Журавская
 Кременчугский национальный университет имени Михаила Остроградского
 ул. Первомайская, 20, Кременчуг, 39600, Украина. E-mail: v.s.baharev@yandex.ua

Проведено краткий анализ базовых требований по выбору мест расположения стационарных постов отбора проб для оценки качества атмосферного воздуха и разработаны предложения по принципиальных схем ориентировочного расположения стационарных постов и установления их необходимого количества. При выполнении теоретических исследований для установления недостатков существующих требований к местам расположения и количества постов мониторинга применен метод критического анализа, а также метод элементарно-теоретического синтеза для разработки предложений по принципиальных схем расположения пунктов отбора проб и алгоритма определения их количества. Предложенный алгоритм определения количества стационарных постов мониторинга атмосферного воздуха и принципиальные схемы размещения пунктов отбора проб в условиях практического применения в реальных городских агломерациях позволяют заложить базис для разработки адекватной системы экологического мониторинга атмосферного воздуха.

Ключевые слова: экологический мониторинг, городская агломерация, стационарный пункт отбора проб, оценка качества атмосферного воздуха, городской фоновый пункт мониторинга.