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THE WIND ROSE AND ITS HYGIENIC SIGNIFICANCE

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Abstract. This article describes the concept of the wind rose, the methods of its construction and its hygienic significance. The wind rose shows how often winds blow from different directions over a certain period of time. These data are used to assess the risk of atmospheric air pollution, to plan residential areas and medical institutions and to protect public health. The article explains the stages of construction of a wind rose, its main results and its practical applications, and emphasizes that it does not by itself determine the level of air pollution and must be used together with laboratory measurements and other meteorological data. The work is based on a theoretical analysis; no original measurements are presented.
Keywords: wind rose; wind direction; hygiene; atmospheric air; air pollution; sanitary protection zone; ecology; human health.

Introduction

Human health is closely connected with the state of the environment [2]. Clean air is necessary for breathing, gas exchange in the body and normal life activity. Contamination of atmospheric air with dust, smoke, harmful gases and other pollutants may have a negative effect on the respiratory and cardiovascular systems [1].

Air pollution may be caused by industrial enterprises [5], motor transport, fuel combustion, construction work and waste. Substances released from these sources are carried by the wind to other areas. Therefore, studying the direction and frequency of winds is important for hygiene and ecology.

The wind rose is a simple and convenient graphic method that serves exactly this purpose. It shows from which direction the wind blows most often in an area and provides additional information for environmental assessment.

The aim of this article is to explain the concept of the wind rose, the procedure for constructing it and its hygienic significance.

Materials and Methods

Study design

This work is a descriptive analytical review of the wind rose as a method of hygienic assessment. No original meteorological observations were made, and the numerical values used in the example below are conditional and given only for explanation.

Procedure for constructing a wind rose

To construct a wind rose, meteorological observations made in the area are first collected. In each observation, the direction from which the wind blew is recorded. Then the number of observations for each direction is counted. Observations with no wind (calm) are usually recorded separately.
The construction proceeds in four stages:
1. Lines are drawn from the center of the sheet in eight main directions: north, northeast, east, southeast, south, southwest, west and northwest.
2. The same scale is chosen for each direction; for example, one centimeter is taken to equal a certain number of observations.
3. Each line is marked with a length corresponding to the number (or percentage) of observations in that direction.
4. The ends of the lines are connected, and the diagram is completed.
The period of observation must be clearly stated. One month of observations reflects a short-term situation, whereas one year or many years of observations better represent the general wind regime of the area. Therefore, when planning an area, long-term and reliable data are used whenever possible.

Interpretation of the diagram

When analyzing a wind rose, attention is paid to the direction of the longest line, from which the wind has blown most often. Wind direction is named by the side from which the wind comes: for example, a north wind blows from north to south.

Results

General characteristics of the wind rose

The wind rose is a diagram that depicts the frequency of winds from different directions in a certain area over a certain period of time. It is used in meteorology, ecology, urban planning and hygiene. The wind rose does not directly show wind speed; it mainly expresses wind directions and their frequency. Wind speed is measured by special meteorological instruments, for example an anemometer.
As an illustrative example, suppose that in a conditional area, north winds were recorded in 30% of observations, west winds in 25%, south winds in 20%, east winds in 15% and winds from other directions in 10%. In this example, the north wind is the most frequently observed direction. These numbers are given only for explanation; a real diagram is constructed on the basis of meteorological observations.
It is not possible to conclude that the air is polluted or clean by looking at the wind rose alone. For this, the amounts of pollutants in the air must also be measured.

Hygienic significance of the wind rose

One of the main goals of hygiene is to identify environmental factors that may harm human health and to reduce their effect. The wind rose helps to understand the probable direction of influence between pollution sources and residential areas. Its main applications are summarized in Table 1.

Assessment of atmospheric air pollution

Gases, smoke and fine particles emitted by industrial enterprises and vehicles may be spread by the wind. The wind rose makes it possible to determine toward which side the wind usually blows. On

the basis of this information, additional observations are planned in areas close to the pollution source. For example, if the wind in the area where an enterprise is located often blows toward a residential area, regular control of air quality becomes important. However, the real level of pollution depends not only on wind direction but also on the amount of emissions, weather, relief and other factors.

Siting of industrial enterprises and waste facilities

The wind regime of the area is taken into account when planning new industrial enterprises, waste storage sites and other potential sources of pollution. The goal is to reduce the effect of harmful odors, gases and dust on residential areas. The wind rose is one of the data sources that help in planning sanitary protection zones. In making the final decision, the sanitary norms in force, the type of the facility, and the composition, amount and dispersion characteristics of the emissions are also taken into account.

Hygiene of residential areas, schools and hospitals

Residential buildings, schools, kindergartens and hospitals are places where people spend a long time. Therefore, the quality of outdoor air and the surrounding pollution sources must be taken into account in planning them. The wind rose shows in which direction the wind blows more often from pollution sources. This information helps in placing buildings, planning green areas and choosing places for air-quality monitoring. However, the wind rose is not the only criterion for the placement of buildings.

Spread of dust and biological particles

The wind can carry soil dust, plant pollen and other particles suspended in the air. Plant pollen causes allergic symptoms in some people, and dusty air may cause discomfort in the eyes and respiratory tract. The wind may also spread some biological particles, but wind direction itself does not prove the presence of disease-causing microorganisms in the air. Special laboratory and microbiological tests are required to determine this.

Table 1. Hygienic applications of the wind rose and the additional information required

Area of use	What the wind rose shows	What must also be considered
Assessment of air pollution	Direction in which emissions are most often carried	Amount of emissions, weather, relief and measured pollutant concentrations
Siting of industrial and waste facilities	Prevailing wind direction relative to settlements	Sanitary norms, type of facility, composition, amount and dispersion of emissions
Housing, schools, kindergartens, hospitals	Direction of possible influence of pollution sources	Other planning criteria; the wind rose is not the only criterion

Area of use	What the wind rose shows	What must also be considered
Dust and biological particles	Direction in which dust and pollen may be carried	Laboratory and microbiological tests to confirm the presence of pathogens

Effect of wind on human health

Wind affects the human body differently depending on its speed, air temperature and humidity. Cold and strong wind speeds up heat loss from the body, so in cold weather a person may feel even colder. In hot weather, wind increases the evaporation of sweat and helps to cool the body. However, in hot and dry conditions it may increase the spread of dust and some particles. Thus, the effect of wind depends on environmental conditions.

In a polluted area, wind may carry pollutants to another place. In some conditions, mixing of the air reduces the accumulation of substances in one place. This process depends on wind speed, the state of the atmosphere, the source of pollution and local relief.

Practical use of the wind rose

The wind rose is used in sanitary and hygienic inspections, environmental monitoring, urban planning and agriculture. It helps to determine toward which side the wind blows from pollution sources and to organize observations correctly. In practice, with its help it is possible to choose air-quality measurement points around industrial areas, to assess the directions in which dust or odor may spread and to draw preliminary conclusions on area planning. In agriculture, it is useful for understanding the spread of dust and pollen.

Discussion

It is not correct to evaluate wind as always useful or harmful. In hygienic assessment, data about wind are studied together with air quality, temperature, humidity and other meteorological indicators.

The main advantage of the wind rose is that it is a simple, clear and low-cost graphic method that allows the prevailing direction of possible pollutant transport to be seen quickly. At the same time, it has clear limitations. It does not show wind speed, it does not measure the amount of pollutants, and it cannot prove the presence of pathogenic microorganisms. Its reliability depends on the quality and length of the observation period.

For effective use of the wind rose, observations must be reliable, regular and carried out for a sufficient period. Its results are analyzed together with laboratory tests, wind speed, air temperature, humidity and the sanitary norms in force, in line with the general principle of hygienic evaluation [6, 7]. The training of specialists in hygiene is also important for the competent use of such methods [4]. Further studies with real observation data from specific areas would allow the practical value of the method to be demonstrated.

Conclusion

The wind rose is an important graphic tool that shows the frequency of wind directions over a certain period. It helps to assess the risk of atmospheric air pollution, to plan industrial facilities, to determine sanitary protection zones and to protect public health.

The main hygienic significance of the wind rose is that it helps to understand in which direction pollutants in the air may spread. However, it does not independently determine the level of air pollution. Therefore, the wind rose should be used together with laboratory measurements and other meteorological data.

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