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PROBLEMS OF ATMOSPHERIC AIR DUSTINESS IN SAMARKAND

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Abstract. This article reveals the problems of the dustiness of Samarkand, and the need to take into account local climatic features in urban planning. It shows the factors of dust formation and the features of the relief of the city. In order to study the dustiness of Samarkand, theoretical and field observations were carried out on the coastal territories of the Zerfshan River. The results demonstrate that the dustiness in residential buildings located on the coast depends on its density and the nature of the relief. The current domestic regulatory materials are of little use for assessing the dustiness of atmospheric air for the conditions of Samarkand. As the aerodynamic modeling shows, the conditions of dust dispersion can vary significantly within Samarkand.

Keywords: wind, modeling, urban planning, dustiness, residential development, coastal strip, Samarkand, field observations

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ПРОБЛЕМЫ ЗАПЫЛЕННОСТИ АТМОСФЕРНОГО ВОЗДУХА САМАРКАНДА

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Аннотация. В данной статье раскрываются проблемы запыленности Самарканда, необходимости учета местных природно-климатических особенностей в градостроительстве. Показываются факторы формирования запыленности и особенности рельефа города. В статье указывается, что для изучения запыленности Самарканда были проведены теоретические и натурные наблюдения на прибрежных территориях реки Зарафшан, результаты которых показывают, что запыленность в жилой застройке, расположенной на побережье, зависит от ее плотности и характера рельефа. Полученные результаты свидетельствуют о том, что действующие отечественные нормативные материалы малопригодны для оценки запыленности атмосферного воздуха для условий Самарканда. Как показывает аэродинамическое моделирование, в пределах Самарканда условия рассеяния запыленности могут значительно различаться.

Ключевые слова: ветер, моделирование, градостроительство, запыленность, жилая застройка, прибрежная полоса, Самарканд, натурные наблюдения

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Introduction. Samarkand is located on the left bank of the Zeravshan River, in the south-west the flat relief passes into the Chupan-ata Upland. The climate in the city is subtropical, with mild winters and very hot summers. Summer (the period with daily temperatures above +20 °C and average daily temperatures above +15 °C) lasts from the 2nd decade of April to the 2nd decade of October. In June and July, daytime temperatures usually exceed the 40-degree mark (on average, 20–40 days per summer season).

As Samarkand is 700 meters above sea level, it is a bit cooler than other cities in the country.

The territory of the city and neighbourhood of Samarkand in physical and geographical terms does not appear to be unified and whole, but is located at the junction of three landscapes, which divide the city and neighbourhood into three sharply distinguishable parts [1]:

1. Sloping foothill-plain proluvial landscape.
2. A hilly-ridgy Palaeozoic landscape.
3. Terraced alluvial-plain landscape.

1. Foothill Plain Landscape. The main part of the city and the southern suburbs of Samarkand are located on a vast proluvial plain, adjacent to the south and north sloping foothill plains of the Karatepin Mountains. Absolute altitudes of the plains vary from 760–790 m in the south-east to 670 m in the north-west. Genetically, the landscape is a foothill trough filled with a thick thickness of predominantly clay-sand sediments of the Neogene age. The geological structure of the landscape is characterised by the development of a thick thickness (from 20 to 120 m) of Quaternary sediments, represented mainly by proluvial loess-like loams of light grey colour, in their lower part interlaced with sandy loam and gravel deposits, represented by an uneven eroded surface of reddish-brown Tertiary clays.

The landscape has a general slope, directed to the north and north-west, and is a slightly undulating plain, cut by many canals and ditches. The ancient canals and aryks (Dargom, Shaudar, Siob, etc.) cut deeply into loess-like loams, formed their own valleys with terraces and acquired the appearance of natural rivers. The aryks branching from them by deep ravines cut the city in meridional direction and make it extremely uneven.

On the territory of Samarkand and its suburbs ravines are quite strongly developed, which accommodate compact development, construction of urban transport, water supply, sewerage and create territorial gaps between separate parts of the city. The left bank of the Dargom canal is characterized by ravines of the greatest depth and density of dissection. Meridionally orientated gullies up to 30 metres deep are strongly developed here. The main reasons for the development of gullies at Dargom are as follows: 1) wide spreading of loose Quaternary sediments, in the composition of the latter are observed loams, granitic sand, etc., characterized by macroporosity, low coefficient, high multiplicity, weak connectivity. They are easily submitted to erosion by surfaces and groundwater; 2) in spring, snow melt water and heavy rainfall in the mountains collect in the soils and come out in large streams into the landscape; 3) the general slope of the Pridargomie from south to north increases the erosive activity of water streams passing here, where the base of erosion is the canal.

2. The hilly-ridgy Palaeozoic landscape occupies the north-eastern edge of the city under the name of Chupanata Upland, is still completely undeveloped and has retained a more or less natural appearance**.**

The genetic landscape is a protrusion of the Palaeozoic folded basement, the Zerafshan intermountain depression, where Palaeozoic rocks come to the day surface and are expressed in relief by low hilly ridges with a maximum absolute height of 826 m and rising above the surrounding area by about 140 m. Ancient Palaeozoic rocks on the surface of the Chupanata Upland are represented by crystalline shales and red sandstones. In relief, the landscape is expressed by hilly ridges, strongly dissected by saiys running in different directions. The north-eastern slopes of the Chupanata steeply steepen to the Zerafshan River, where rocks in the form of small cliffs are exposed. The southern and southeastern slopes are gentle, characterised by relatively weak dissection, overlain by loess-like loams of considerable thickness at the foot of the slopes.

Here the most pronounced tracts are: a) steep, precipitous, northern and north-eastern slopes with outcrops of Paleozoic rocks; b) gentle slopes of hilly ridges with sedge, bluegrass associations on eroded low-moisture rubbly loamy sierozems; c) sai with uplifted slopes, with grass-ephemeral vegetation on fine-grained typical sierozems.

In the future, this landscape is suitable for single-storey development with the allocation of sites for the construction of individual public buildings.

3. Terraced alluvial-levelled landscape covers the north and north-eastern parts of the city and its neighbourhood. Genetically, the territory of the landscape corresponds to the Samarkand trough, formed in the Tertiary time on the sites of plunging troughs.

The day surface of the geological structure of the landscape is characterized by the development of thick alluvial deposits. At the base the alluvium consists of gravels, which are everywhere overlapped by a cover of fine-siliceous formations of varying thickness. Absolute heights of the landscape vary from 650 m in the west to 720 m in the east.

The landscape consists of a floodplain and three floodplain terraces with a general slope from east to west. This landscape is characterized by peculiar favorable features of microclimatic conditions caused by the influence of irrigation, construction of canals, etc., which significantly reduce the temperature and increase the absolute and relative humidity of the lower layer of the atmosphere. The landscape is characterized by the abundance of groundwater.

The landscape structure is composed of the following complexes:

1. Lower terrace complex with close occurrence of gravels and groundwater on loamy-sandy cover covers the first and second terraces of the Zerafshan River. The first terrace is formed by a thickness of gravels; overlapped from the surface by fine-grained deposits – clay with sandy loam with a thickness of 0.5–2 meters. The second terrace is the most developed, it is elevated by a ledge of 2–3 m above the surface of the first terrace and is an alluvial plain composed of clayey layered sediments 2–3.5 m thick. Groundwater within the lower terraced complexes is confined to alluvial pebble deposits and enters at a depth of 0.5 to 3 m, along the lowered areas of gentle terraces and ditch beds they wedge out, forming powerful springs that feed spring systems of the “Karasu” type.

2. The complex of true terraces with deep bedding of gravel and groundwater occupies the third terrace of the Zerafshan River. The third terrace is separated from the second terrace by a scarp of 2–3 m and higher. In some places the scarp is smoothed. The surface of the third terrace is a weakly undulating and clear plain, in the southern part it merges with the proluvial foothill plain. The complex is composed of ancient alluvial-proluvial gravels overlain by a cover of thick (5–7 m and more) grey-yellow slightly porous and loess-like loams alternating with interlayers of grey silty fine-grained sands and sandy loam. Ground waters occur at the depth of 8–10 m. The prevailing part of the territory of this complex has been used for irrigation since ancient times. There is a sparse linear development here, which can be ordered and compacted. The architectural complex is represented by gardens and dacha and village buildings. The complex is rich in natural preconditions for urban planning solutions.

Samarkand often experiences samun, simun (from Arab, samma – fire, poisonous, poisoned, fiery wind, breath of death hot, dry), a sudden-onset dust storm in the deserts of the southern coast of the Aral Sea (in contrast to dust storms of the sirocco type blowing from the deserts). Usually accompanied by westerly or south-westerly squalls. Lasts up to 20 min. [2].

Discussion. The issue of wind transfer of dust from natural and anthropogenic sources and, as a consequence, dustiness of the urban environment is relevant for Samarkand, but is insufficiently studied. Even in areas with active dust transfer activity due to natural and climatic conditions, the dust factor is not sufficiently taken into account when making urban planning decisions [3].

Ground or urban dust, contains a mixture of particles of soil, road surfaces, smoke, soot, plant and animal organisms (spores, bacteria, moulds and others) raised into the air. The highest dust content is observed in the lower layers of the atmosphere immediately adjacent to the ground surface.

Constant growth of the car fleet, increase in traffic intensity and area of the street and road network significantly complicates the removal of pollution accumulated on the surface of the carriageway, which is an additional source of air dustiness of urban areas, as well as worsen the appearance of buildings (Fig. 1).

Significant dustiness of the air negatively affects the intensity of solar insolation, prevents the city from greening with greenery. First of all, urban dust has a negative impact on the human respiratory system. High dustiness of the air contributes to the aggravation and progression of chronic diseases of the bronchi and lungs. Penetrating into the home, dust can contribute to the spread of some contagious diseases (so-called droplet infections: tuberculosis, polio, diphtheria, influenza and many others). In this regard, one of the most important problems is the protection of atmospheric air from various types of its dustiness. When the air is dusty, human breathing becomes superficial, and superficial breathing affects health and performance. A large amount of dust in the inhaled air causes runny nose in some people and choking attacks in people suffering from bronchial asthma [4].

Over the central and industrial areas of the city under certain meteorological conditions “heat islands” (peculiar air domes – bubbles of warm air) are often

Fig. 1. Dustiness of an urban motorway

formed. All this seriously complicates the mathematical modelling of dust transport-diffusion processes in the atmosphere, at the same time a number of these problems can be solved by using aerodynamic modelling.

Methods. An important method of studying processes in the study of air dustiness in residential buildings is modelling in wind tunnels. Compared to field experiments, each of which requires the participation of hundreds of people with hundreds of devices and appropriate transport support, experiments in laboratory conditions are incomparably cheaper. Therefore, this method is widespread.

The principle of similarity allows to simulate real objects with sizes from hundreds of metres to tens of kilometres. For this purpose, models of a group of buildings or terrain are made to an appropriate scale. A map of horizons of the given terrain is also used, and the type of surface determines the roughness of the modelling surface. Special attention is paid to rivers, as the water temperature often differs significantly from the temperature of the active surface of residential buildings. This is achieved by special heating of the river model. Air velocity at an arbitrary point in the pipe is measured using a thermoanemometer, dust concentration is measured using several methods. Depending on what state the dust particles are in when determining their weight or number (suspended or precipitated from the air).

Existing methods of air dustiness determination are divided into two main groups: a) with separation of dispersed phase from aerosol and b) without separation of dispersed phase from aerosol. The first group includes weight (gravimetric) and counting (conometric) methods. The second group includes photoelectric, electrometric, optical and radiation methods [5].

The main problem in wind tunnel modelling is the observance of similarity criteria. Full similarity is possible and the values of the main parameters are kept equal to the natural values. In particular, when modelling the temperature inhomogeneity of the surface "land – river", the temperature of the model "river" is set from the preservation of the natural Richardson number [6]:

$$R = \frac{gT}{(\Delta T / \Delta z)^2}\left(\Delta u / \Delta z\right), \qquad (1)$$

where g is the free fall acceleration; T is the air temperature; $(\Delta T/\Delta z)$ is the average temperature gradient between the ground surface and the boundary of the surface layer; $(\Delta u/\Delta z)$ is the average wind speed gradient between the ground surface and the boundary of the surface layer.

Depending on the distribution of atmospheric pressure, air is constantly moving in the horizontal direction. Vertical components also join the horizontal air transport. They are usually small compared to the horizontal transport, on the order of centimeters or tenths of a centimeter per second. Only under special conditions, i.e. convection, in small parts of the atmosphere can the vertical components of the air velocity reach several meters per second.

In order to assess the influence of orography and river on dust fields, in-situ and aerodynamic studies of dust distribution over a model of residential buildings in Samarkand were carried out. The influence of characteristic features of air currents over the city of Samarkand due to the features of the surrounding terrain, the presence of the river and the peculiarities of the city building was studied.

Results. In order to analyze the results obtained, field similar measurements were carried out in coastal built-up and undeveloped (free) areas. Measurement points were located along streets directed perpendicular to the river shoreline. Stationary points were located at the beginning and end of the route. Route points were located in groups of 8 within the width of each residential building along the streets.

Observation points were located along the river stem at 150–230 m intervals. The measurement regime is similar to the procedure for taking measurements at stations in the built-up area. Open ground surfaces prevail in the study area.

All measurements in both built-up and free areas were made at a height of 1.5 m from the ground surface (human breathing zone). During gradient measurements microclimatic parameters were also recorded at heights of 0.5, 2.0 and 3.5 meters.

The obtained material was processed using the methods of variation statistics and correlation analysis. In the processing we used the relationship between heat and humidity indices, their differences and meteorological elements. For relatively stable in time and space meteorological elements, such as air temperature and humidity, the method of differences was used, based on the stability of differences of these elements at observation points remote from the river and reference control points. The results of observations made it possible to study the regularities of changes in the parameters near the river and in the built-up area and to plot their correlations.

Winds with diurnal change of direction are observed in the area under consideration. They develop not only on the right bank of the Zerafshan, located on the south-western slope of the upland, where winds with daily periodicity can have the nature of mountain-valley winds, but also on the flat left bank, where the relief does not allow assuming the occurrence of intense mountain-valley winds. The average breeziness coefficient is practically the same on both shores: for the control points on the left bank it averages 38%, for the right bank 34 %.

The change in air temperature (at a height of 1.5 meters) in residential buildings with increasing distance from the Zerafshan River in the hot dry period is expressed as follows [7]:

$$\Delta t = k\left(T_g - T_w\right)\ln\left(1 + \frac{L}{100}\right), \qquad (2)$$

where T_g – temperature of air in residential buildings at a height of 1.5 m from the ground surface, °C, outside the zone of influence of the river; T_w – air temperature at the water's edge at the same height, °C; k – coefficient taking into account the height of the building, equal to 0.65; L – distance from the river's edge to the control point of the study in the zone of influence of the Zerafshan River.

In the study of coastal slope models with different angles of inclination to the horizontal plane, it was found that the initial flow velocity decreases in the zone at the bottom of the slope and behind the slope edge. In the zone between the bottom and the berm there is an increase in wind speed relative to the initial value. The degree of transformation of the initial velocity is determined by the slope steepness. Figure 2 shows the flow of the "conditional" building with the air flow under turbulence [8].

In wind observations, the properties of the underlying surface affect the diurnal course, vertical gradient of wind speed. Therefore, no correlation of sufficient accuracy is observed at the same time.

For relative humidity data, the co-correlation coefficients are of approximately the same order of magnitude as for wind speed.

At a height of 2.0 m with a slope steepness of 8°, a decrease in velocity is observed between the river edge and the bottom of the slope and is 11–14 % of the initial value. From the bottom to the middle of the slope there is an increase in velocity exceeding the initial value by 19–35 %. From the middle of the slope to the edge of the slope there is a sharp decrease in velocity, which continues on the upper terrace at a distance of about 150–200 m (Fig. 3).

Conclusion. Thus, Samarkand city and its surroundings consist of non-rock genetically sharply different landscape conditions and many small natural complexes, which require separate urban-planning solutions [9–12].

According to the degree of influence of the Zerafshan River on the heat and humidity regime of residential buildings, four zones of the city territory are defined:

a) the lower terrace of the bank slope;

b) the zone between the bank slope edge and the front of the building;

c) built-up areas experiencing constant heat and moisture influence of the river;

d) built-up areas experiencing episodic (non-sustainable) influence of the river.

The analysis of available works and design experience of Samarkand allows to conclude that at present there is no unified scientifically grounded approach to assessment and consideration of wind regime and dustiness of residential buildings.

Here are the main conclusions of these studies important for practical applications:

– depending on the wind direction, turbulent diffusion coefficients can differ several times;

– the influence of the river is manifested not only on the streets perpendicular and parallel to the shoreline, but also directly on the territories of residential zones. The wind regime of residential buildings is determined mainly by air flows coming through the gaps between buildings from the Zerafshan River;

– consideration of the river is important and depends on the wind direction;

River valley **Stepped slope**

Fig. 2. Wind turbulence caused by a mechanical obstacle

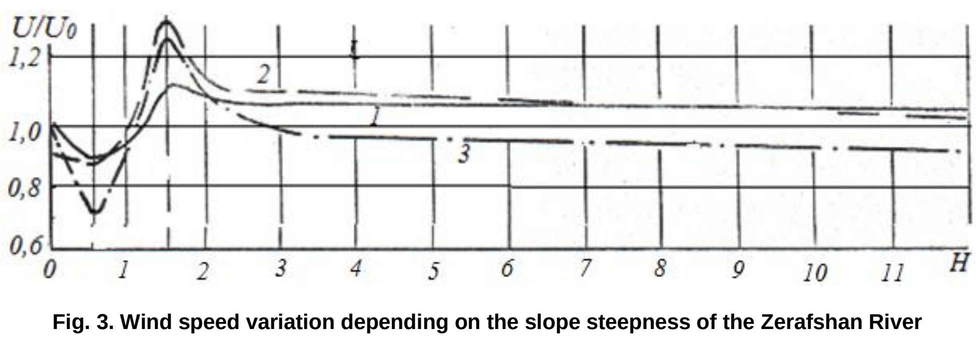

Fig. 3. Wind speed variation depending on the slope steepness of the Zerafshan River at the height: 1 – 1.5; 2 – 2.0 and 3 – 3.5 m

– there is no differentiated approach to the layout and development of individual residential developments located in complex physiographic conditions and characterized by different wind regimes.

The results obtained indicate that normative materials, such as OND-86, are of little use for assessing atmospheric air dustiness for the conditions of Samarkand. As aerodynamic modelling shows that dust dispersion conditions can vary significantly within Samarkand.

References

1. Shukurov I.S. [Formation of microclimate in conditions of mountain-hollow relief of cities]. *Problems of architecture and construction (Scientific and technical journal) 27.04.2023 № Special issue.* Samarkand: Samarkand state architecture and construction university named after Mirzo Ulugbek; 2023. P. 226–229. (In Russ.)

2. Shukurov I.S. [Heat and wind regime of residential development]. *Zhilishchnoe Stroitel'stvo* [Housing Construction]. 2005;2:20–21. (In Russ.)

3. Shukurov I.S. [Formation of the microclimate of mountain-hollow cities]. In: *Materialy I Mezhdunarodnoy nauchno-prakticheskoy konferentsii* "*Ustoychivoe razvitie territoriy"* [Materials: I-th International scientific and practical conference "Sustainable development of territories"]. Moscow: MGSU; 2018. (In Russ.)

4. Revich B.A., Saet Yu.E., Smirnova P.C., Sorokina E.P. *Metodicheskie rekomendatsii po geokhimicheskoy otsenke zagryazneniya territoriy gorodov khimicheskimi elementami* [Methodological recommendations on the geochemical assessment of urban pollution with chemical elements]. Moscow: IMGRE; 1982. 112 p. (In Russ.)

5. *Rukovodstvo po otsenke i regulirovaniyu vetrovogo rezhima zhiloy zastroyki* [Guidelines for Assessing and Regulating the Wind Regime of Residential Buildings]. *TsNIIP gradostroitel'stva* [Central Research and Design Institute for Urban Development]. Moscow: Stroyizdat Publ.; 1986. 59 p. (in Russ.)

6. Jacobson M.J. *Atmospheric Pollution: history, science and regulation.* New York: Cambrige University Press; 2002. 399 p.

7. Shukurov I.S., Ahmed Elamin M.A. Influence of the Blue and White Nile on the urban-ecology of coastal urbanized territories of Khartoum. *Industrial and Civil Engineering.* 2016;3:15–19.

8. Shukurov I.S., Alireza M. Dustiness and Aerodynamics of Air in Central Asian Cities. *IOP Conf. Series: Materials Science and Engineering.* 2019;753:042013. DOI: 10.1088/1757-899X/753/4/042013

9. Mel'nikova L.N. [Aeration of cities in the arid zone of Central Asia]. *Obzornaya informatsiya "Ekologicheskie voprosy arkhitektury i gradostroitel'stva"* [Overview information "Environmental issues of architecture and urban planning"]. 1992;1:23 (In Russ.)

10. Shukurov I.S., Bilal A. [Problems of the heat and wind regime of housing in Iraq]. In: *Sbornik materialov Mezhdunarodnoy mezhvuzovskoy nauchno-prakticheskoy konferentsii studentov, magistrantov, aspirantov i molodykh uchenykh "Stroitel'stvo – formirovanie sredy zhiznedeyatel'nosti"* [Collection of materials of the International interuniversity scientific and practical conference of students, undergraduates, postgraduates and young scientists "Construction- formation of the living environment"]. Moscow: MGSU; 2008 (In Russ.)

11. Karamyshev V.A. *Gorod stroitsya v pustyne* [The city is being built in the desert]. Alma-Ata, 1975. 128 p. (In Russ.)

12. Lyons T.J., Kenworthy J.R., Newman P.W.G. Urban structure and air pollution. *Atmosphere. Environ.* 1990;24B:43-48.

Список литературы

1. Шукуров И.С. Формирование микроклимата в условиях горно-котловинного рельефа городов // Проблемы архитектуры и строительства (научно-технический журнал) 27.04.2023 № специальный выпуск. Самарканд: Самаркандский государственный архитектурно-строительный Институт им. М.Улугбека, 2023. С. 226–229.

2. Шукуров И.С. Тепло-ветровой режим жилой застройки // Жилищное строительство. 2005. № 2. С. 20–21.

3. Шукуров И.С Формирование микроклимата горно-котловинных городов // Материалы I Международной научно-практической конференции «Устойчивое развитие территорий». М.: МГСУ, 2018.

4. Методические рекомендации по геохимической оценке загрязнения территорий городов химическими элементами / Б.А. Ревич, Ю.Е. Сает, Р.С. Смирнова, Е.П. Сорокина. М.: ИМГРЭ, 1982. 112 с.

5. Руководство по оценке и регулированию ветрового режима жилой застройки/ ЦНИИП градостроительства. М.: Стройиздат, 1986. 59 с.

6. Jacobson M.J. Atmospheric Pollution: history, science and regulation. New York: Cambrige University Press, 2002. 399 p.

7. Шукуров И.С., Ахмед Эламин М. А. Влияние Голубого и Белого Нила на градоэкологию прибрежных урбанизированных территорий Хартума // Промышленное и гражданское строительство. 2016. № 3. С. 15-19.

8. Shukurov I.S., Alireza M. Dustiness and Aerodynamics of Air in Central Asian Cities // IOP Conf. Series: Materials Science and Engineering. 2019. Vol. 753. 042013. DOI: 10.1088/1757-899X/753/4/042013

9. Мельникова Л.Н. Аэрация городов аридной зоны Средней Азии // Обзорная информация «Экологические вопросы архитектуры и градостроительства». 1992. Вып. 1. 23 с.

10. Шукуров И.С., Билал А. Проблемы тепло-ветрового режима жилища Ирака // Сборник материалов Международной межвузовской научно-практической конференции студентов, магистрантов, аспирантов и молодых учёных «Строительство– формирование среды жизнедеятельности». М.: МГСУ, 2008.

11. Карамышев В.А. Город строится в пустыне. Алма-Ата, 1975. 128 с.

12. Lyons T.J., Kenworthy J.R., Newman P.W.G. Urban structure and air pollution // Atmosphere. Environ. 1990. Vol. 24B. P. 43–48.

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