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ECOLOGICAL FACTORS' IMPACT ON THE CONDITION OF MAUSOLEUM OF KHOJA AHMED YASAWI

Abstract. The article gives the results of experimental and estimated researches on ascertainment of ecological factors' impact on the condition of mausoleum of Khoja Ahmed Yasawi. Main types of anthropogenic sources, existing near historical monument area were detected. Chemically polluted precipitation was determined as the main source of air pollution, generated due to burning of fossil fuel, tires and various waste, accumulation of domestic, construction and other production wastes, transport emissions. It was ascertained that black dust, greenhouse and ozone depleting gas, aerosols of acid, salt, hydrocarbon and its derivatives, heavy metals constitute a special hazard for conservation of mausoleum and its facilities. Vegetation, especially a locust tree was selected for creation of barrier on the spread of corrosive dust and gas mixtures as absorbents. It is planted along conservation zone border. We developed the understratum of new composition to plant the locust tree due to absence of fertile layer in the nekrozem. It represents a mixture of mass. %: vermitea (20), sawdust (20), grey perlite containing waste (5), wood ash (1), the rest is sierozem (nekrozem).

Key words: mausoleum of Khoja Ahmed Yasawi, monitoring, grey perlite containing waste.

Introduction. As known that the environment, created by culture of ancestors and by human itself is also important for human life apart from conservation of surrounding natural environment. If the nature is needed for human for his biological life, but the cultural environment is also necessary for its spiritual, ethical life, ethical self-discipline and social life. In connection with this the conservation of the monument of history and culture, namely a mausoleum of Khoja Ahmed Yasawi – an object of world heritage is an important goal of social political nature [1-3].

The Mausoleum of Khoja Ahmed Yasawi is an irreplaceable monument of architecture of the end XIV and beginning of XV centuries, the mausoleum has been included in the UNESCO list since 2000 and is under protection of international organizations. Inclusion of the object in the list of World heritage – it is not just honourable international status, but high responsibility to world community. Conservation of this unique monument of architecture of the whole religious Islamic world, which is considered to be the second Mecca, is one of the main goals in the field of the world heritage safeguard and protection.

This object, being located in the territory, where active economic activity is maintained like other historical and cultural heritage objects including Kultobe, is under negative impact of factors. Most of frequent problems are nonobservance of temperature and humidity regime inside of the building, presence of rodents, insects, birds, growth of fungic and mold as well as pollution of air basin. In total different factors both of natural (natural-climatic, biological physical etc.) and man-made origin (pollutant emissions, vibration, new construction, disturbance of geologic medium, salinity of ground water etc.) influence the object under study.

From year to year evolutionary transformation of historical territories of Turkistan town accelerates acceleration of processes connected with impact of anthropogenic factors. And anthropogenic factors rise by geometric progression, which can result in violation of integrity of this unique architectural complex.

We earlier showed that emissions of production facilities from heating systems of housing complex of the residential area, surrounding the Mausoleum of Khoja Ahmed Yasawi as well as release from cars promote quick pollution of frontispieces and they form chemically corrosive environment coupled with atmospheric precipitation causing destruction of frontal materials (brickwork, plasterwork, modeling, painted coats, decor) [4-6]. Ecologically corrosive environment accelerates natural destruction of the monument because of aging process. Thus any ecological damage — first of all, which damages the monument has to be recorded and conservation measures have to be taken on the facto of damage. Averse anthropogenic factors affecting the integrity of an immovable historical and cultural monument are reactive substances in the form of gases and dust, which contribute to the development of corrosion processes in their building structures especially in the urban environment. [7-8].

In Turkistan, after obtaining the status of an oblast center, the works on demolition of old and construction of new houses, structures began in the neighboring territories to the monument. In this regard, while conducting large-scale construction works in large quantities, the emissions come from vehicles, from furnaces of residential and industrial facilities, from processing plants for various purposes used in construction as well as from waste generated.

We can note the greenhouse (CO_2, CH_4, NO_x, H_2S etc.) and ozone depleting gas (nitrogen oxides, halogen-containing hydrocarbons, carbon tetrachloride, organic solvents, freon gas, mercapatan, dioxin, furan etc.) as harmful emissions, concentrated in the air.

There is a need to develop scientifically feasible measures to protect historical and architectural monuments from negative factors to ensure environmental safety for the Khoja Ahmed Yasawi mausoleum, including the restored socially significant object Kultobe (old Turkestan). At the same time, green spaces play a large role in the localization of pollution created by anthropogenic sources. They serve as a natural barrier to the dispersion of pollutants. As known, the pollution is reduced by 1,5-2,0 or more times due to screen planting [9-11]. The work objective is to conduct monitoring of the air and searching the ways to protect the mausoleum complex of Khoja Ahmed Yasawi.

Methods and objects of research. Studies on monitoring of atmospheric air were carried out in different seasons of the year in years of 2018-2020. Analysis of atmospheric air samples was done for dust, methane, hydrogen sulfide, sulfur dioxide, ammonia, carbon dioxide, carbon monoxide, nitrogen oxides, hydrocarbons, dioxin, mercaptans content, from metals - lead, iron, mercury, copper, zinc content.

Gas analyzer ГАНК-4 was used to determine gaseous products, volt amperometrical method using Ta-lab instrument for metals, gravimetric analysis (sulfates, chlorides), photometry (humic acids) and other classical methods for other components were used [12-14].

We began the work on formation of a green strip from locust tree along the protected area border for improving the atmospheric air around the mausoleum of Khoja Ahmed Yasawi. The selection of this plant is related to its functional ability to absorb gases and adsorb dusty substances on leaf surfaces [15].

The locust tree was grown from seeds, as they are covered with a very thick dense peel, impervious to moisture; we carried out their preliminary preparation by hydrothermal method. The seeds were put in the vessel and hot water with temperature 70-80 °C was poured and kept approximately for 12 hours. Swollen seeds were mixed with sand and kept in humid condition in the vermitea solution of 0,01% at 20-25 °C during 4-5 days. Planting of seeds initially was initially in open ground through each 25 cm. Then the seedlings were transferred to permanent place in the early spring of next year.

In connection with absence of a fertile layer in the soils of the territory designated for planting, an artificial substrate was used, which has a fertilizing, reclamation and nutritional property. Namely, it is a mixture of agricultural waste utilization products in the form of worm wee (vermitea), sulfur-perlite-containing waste from sulfuric acid production, sawdust and wood ash.

For preparation of artificial substrate the sawdust was soaked during 2-3 days with vermitea at mass ratio 1:1, and it was mixed with sulfur-perlite-containing waste (SPCO), ash and soil, taken from pit for planting. Correlation of components in a mass %: vermitea: sawdust: SPCO: ash: sierozem soil = 20:20:5:1:40.

Vermitea is an intermediate product, which is generated when vermicomposting in the production site of SRI «Ecology» of IKTU K.A. Yasawi [16]. It is rich with digestive micro Californian worm, ferments, vitamins, biological active and other substances. Antibiotic features, are characteristic to vermitea due to

its composition, which prevent from development of disease-producing microflora, keeping under the saprogenic processes.

Apart from that the vermitea contains complex mixture of humus substance maromolucules (humic acid, fulvic acid, humins) of changeable composition and irregular structure. As shown by the results of our previous experimental studies, vermitea has a growth-promoting effect on plants and increases the fertility of the soil system [17]. When it is used combined with sulfur-perlite-containing waste, a synergistic effect arises, as a result of which biological activity is enhanced and the mixture already serves as both fertilizer and ameliorant [18].

Results and discussion. The feature of atmospheric air state in the environment of Turkistan town was determined by comparing the actual pollution level with values of the following background concentrations of pollutants, presented by Republican State Enterprise "Kazhydromet".

Background concentration for Turkistan town:
Dust (suspended substance) - 0,3 mg/m^3
Carbon oxide - 0,8 mg/m^3
Nitrogen dioxide - 0,015 mg/m^3
Sulphur dioxide - 0,05 mg/m^3.

As follows from the results of experimental studies in determination of a number of harmful substances in the atmospheric air at different periods of the year their greatest number is observed in winter during heating season, which indicates mainly on contribution of electric power plants. According to the calculated emission data, more than 30 thousand tons of harmful substances are formed annually only from them. The deterioration of the Khoja Ahmed Yasavi mausoleum state, a historical monument, to a certain extent, evidently, is associated with pollution of town air basin of not only by sources of local origin, but also by salts, coming from atmospheric air movement from Aral Sea [19]. This contributes to the rapid contamination of facades and, in combination with precipitation, they form a chemically aggressive acidic and saline environment, causing the destruction of building materials (brickwork, plaster work, modeling, painting layers, etc.).

Very often, due to the frequent wind in the town, dust storms are observed with duration of 1,5 to 5,5 hours, consisting mainly of solid particles of natural or man-made origin with a radius of 10^{-6} to 10^{-2} cm.

As known, dust in the atmosphere is not only chemically neutral, but depending on its composition, it can display acidic or alkaline reactions in contact with a water-containing system [20-21]. Many types of dust are distinguished that differ in both qualitative and quantitative composition. For example, fine soot dusts, formed at combustion of solid, liquid and gaseous fuels, consist of soot on which harmful substances of an organic and mineral nature are in an adsorbed state. Such types of atmospheric air dust can act as an active damaging agent for the monument [22].

Dust samples were collected, which are formed in the surface layer of air during windy weather (15-20 m/s) as well as in the smoke emissions of a boiler house and individual heating furnaces houses to characterize the impact of stored waste and other sources near the mausoleum (distance of 150-500 m). A content of gases, heavy metals (HM) was determined in them. Significant amounts of HM enter the atmosphere with solid smoke particles from the furnaces (table 1).

The average metal content in dusty smoke particles from a centralized boiler house in micro-districts

Smoke dust composition	Concentration of HM, mg/m^3	Smoke dust composition	Concentration of HM, mg/m^3
Zinc	2,679	Cadmium	0,056
Lead	1,875	Mercury	0,001
Copper	0,354	Chrome	0,033
Arsenic	0,120	Nickel	0,098
Iron	3,043	Manganese	0,768

HMs themselves do not directly affect the condition of monument's materials; their danger lies in acting as catalysts in many secondary reactions occurring between pollutants in the air [23]. An example can be oxidation of sulfur oxides to a higher valence form, i.e. SO_2 to SO_3 in the presence of iron, manganese, etc. Heavy metals can also stimulate the photooxidation of many organic compounds adsorbed on the surface of solid particles, such as soot [24].

According to figures from our experimental studies, the amount of dust settling on 1 m^2 of surface per week is 1,7-3,8 g at weak wind (up to 2 m/s), at strong wind (25 m/s or more) this content increases in dozens, hundreds of times. Particles from historical ash and other wastes are included in the air at strong winds. Atmospheric factors have a significant effect on the chemical properties of dust components and on the nature of its subsidence.

Dust rising from the surface of long-term cluttered ash dump, solid domestic waste (SDW) and other industrial waste from the protected area consists on average of 30-40% silicic acid, 5-10% lime and gypsum, up to 5% sulfur, up to 0,3% HM and other harmful substances of inorganic and organic nature. Considering the chemical composition of soot and other types of dust, we can conclude doubtless that these dust particles of atmospheric air have a significant aggressive action on the state of a monument under consideration. In this regard, studies on regular monitoring are necessary both to determine the quantitative and qualitative composition of dust and its effect on the stability and conservation of historical and restoration building materials.

As per a number of indicators, primarily in terms of mass and distribution of harmful effects, *sulfur dioxide* is considered to be a number one atmospheric pollutant. It is generated during oxidation of sulfur contained in fuel and as part of various kinds of waste. Emissions of *nitrogen oxides* generated during the oxidation of atmospheric nitrogen increase in connection with the increase of solar energy flow every year to the earth surface, with the growth of car fleet and number of heat supply systems. The entry of large amounts of sulfur and nitrogen oxides into the atmosphere leads to a noticeable decrease in the pH of atmospheric precipitation. It happens owing to entry of gaseous products above with atmospheric moisture forming the strong acids - sulfuric and nitric.

Dust particles containing HM play the role of catalysts in formation of corrosive acids. Below are reactions to the formation of secondary pollutants in the atmosphere:

$$2SO_2 + O_2 + 2H_2O \longrightarrow 2H_2SO_4;$$

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3.$$

Apart from these basic reactions, intermediate ones also occur in an atmospheric air with formation of a number of other products. Formation of acids in atmospheric air leads to precipitation of “acid rains”, i.e. pH changes [25]. Air acidification also affects the state of soils and water, making many components into a soluble active state, which activates the degradation of structures and decorative ornaments of the architectural complex of the Khoja Ahmed Yasawi Mausoleum.

Presence of the solid domestic waste (SDW) landfill of historical, i.e. long-term nature, leads to the creation of conditions for generation and emission of greenhouse gases - CO_2, CO, CH_4, NO_x, aerosols of halogen-containing hydrocarbons and other compounds, which also play a significant role in destruction of the monument’s materials.

MPC excesses of some substances were observed in the surface layer of atmosphere, where the factors polluting the environment are aerogenic emissions and precipitation containing toxicants. In accordance with our estimates, annually about 15-20 thousand tons of harmful chemicals are delivered to the surface layer of the atmosphere of Turkistan from stationary sources, of which at least 4873 tons are nitrogen oxides, 4623 tons of sulfur dioxide, about 36 tons of heavy metals, including iron, cadmium, cobalt, copper, manganese, lead, chromium, nickel, zinc. Iron compounds –21,233 t/year (84,7% of the total heavy metal emissions) are prevailing. 1,1 t/year (4,5%) of manganese and zinc enters the atmosphere, 0,380 t/year (1,5%) - copper, 0,185 t/year (0,7%) - lead, 0,211 t/year (0,8%) –chrome.

Aerotechnogenic emissions of heavy metals by volume prevail in the eastern part of the town (the area where the mausoleum is located), they are about 35,2% of all emissions in the town altogether. The main contributors to atmospheric air pollution by heavy metals are ash waste from a former precast concrete factory, accumulated in the mausoleum’s protected area, power boilers and furnaces of heating systems, vehicles (45,6% of emissions); construction organizations (28,2%) and other households (2,8%).

Based on of experimental and estimated data using «Era-vozduh» program, the nature of pollutants’ dispersion in the surface layer of atmospheric air is established. According to the estimated data, there is an excess of MPC (maximum permissible concentration) of nitrogen oxides by 1,5 -2,7 times, carbon oxides by 6,5 – 25,0 times and sulfur oxides from 5,0 to 6,5 times in the air of the Turkistan town. These data refer to the summer months. On basis of experimental measurements in winter during thick smog, an

excess of harmful substances (nitrogen, sulfur, carbon oxides) was to be 20-30 times higher than in summer period. In addition to these pollutants, carbon monoxide, mercaptans, dioxins, hydrocarbons, hydrogen sulfide, soot particles were detected in the atmospheric air during winter.

For purification the atmospheric air around the Yasawi Mausoleum, there was a need to build up green areas along the protection zone borders using the locust tree. Formation of a green protecting strip of locust tree, which acts not only as a sorbent of harmful emissions and a protective fence with its spiny branches, but also its flowering properties improve the aesthetic and visual perception of the architectural complex. Conservation of this monument of history, culture and architecture is the main objective to contribute to development of tourism and international cooperation.

Conclusions

1. Monitoring studies of the atmospheric air of Turkistan town were conducted in different seasons of the years 2018-2019. Based on experimental studies, the following excess concentrations of dust, including soot, were to be 15–20 times, sulfur oxides 10–12 times or more, nitrogen oxides 18–24 times, hydrogen sulfide 2–3 times, and hydrocarbons 4–6 times each in comparison with a permissible norm.

2. In order to reduce the impact of anthropogenic factors on the facilities of the mausoleum of Khoja Ahmed Yasawi complex, it is proposed to build up a green strip of locust tree along conservation zone.

3. Conditions for the phased cultivation of locust tree from seeds are selected.The hydrothermal method was selected for seed treatment and as a growth-promoting agent, a 0,01% vermitea solution obtained as a by-product of vermicomposting was selected.

4. A new composition of soil material was developed for planting of locust tree from a mixture of vermitea, sulfur-perlite-containing waste of sulfuric acid production, sawdust, wood ash and local gray earth soil. The proposed composition contains components that are characterized by loosening, nutritious, growth-promoting, fertilizing and a number of other useful properties.

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ҚОЖА АХМЕТ ЯСАУИ КЕСЕНЕСІНІҢ ЖАҒДАЙЫНА ЭКОЛОГИЯЛЫҚ ФАКТОРЛАРДЫҢ ӘСЕРІ

Аннотация. Мақалада Қожа Ахмет Ясауи кесенесінің жағдайына әсер ететін экологиялық факторлардың әсерін анықтау бойынша тәжірибелік және есептеу жұмыстарының нәтижелері келтірілген. Тарихи ескерткіш орналасқан аймаққа жақын орналасқан антропогендік көздердің негізгі түрлері анықталды. Ауаның ластануының негізгі көздері ретінде жанармайдың, автокөлік доңғалақтарының және әртүрлі қоқыстардың жануы, тұрмыстық, құрылыс және басқа өндірістік қалдықтардың жиналуы, көлік құралдарының шығарылуы нәтижесінде пайда болатын химиялық ластанған жауын-шашындар анықталды. Кесененің және оның объектілерінің сақталуына күйе шаңдары, парниктік және озон бұзатын ғаздар, қышқылдар, тұздар аэрозолдары, көмірсутектер және олардың туындылары, ауыр металдар ерекше қауіп төндіретіні анықталды.

Қожа Ахмет Ясауи кесенесі кешенінің нысандарына антропогендік факторлардың әсерін азайту үшін қауіпсіздік аймағының бойында ақ қарағанның жасыл жолағын жасау ұсынылады.

Тұқымдардан ақ қарағанды кезең-кезеңмен өсіру шарттары таңдалды. Тұқымдарды өңдеу үшін ғидротермиялық әдіс таңдап алынды, вермикомпостау кезінде қосалқы өнім ретінде алынған 0,01 % вермичай өсімді ынталандырушы ағент ретінде алынды.

Агрессивті шаң мен ғаз қоспаларының таралу жолында кедергі жасау үшін оларды сорбциялаушы ретінде біз ағаш өсімдіктерін, атап айтқанда ақ қарағанды таңдап алдық. Ол қауіпсіздік аймағының шекарасы бойымен отырғызылған. Сұр топырақтың құнарлы қабаттының болмауына байланысты біз ақ акацияны көшеттерін отырғызу үшін жаңа құрамды субстрат әзірледік. Ол келесі компоненттерінің массалық қоспасы болып табылады. %: вермичай (20), ағаш қалдығы (20), күкірт перлит құрамды қалдық (5), ағаш күлі (1), қалған сұр топырақ.

2018-2019 жылдың әртүрлі мезгілдерінде Түркістан қаласының атмосфералық ауасына мониторингтік зерттеулер жүргізілді. Тәжірибелік зерттеулер негізінде шаң концентрациясының, оның ішінде күйе 15-20 есе, күкірт оксидінің 10-12 есе және одан да көп, азот оксидінің 18-24 есе, күкіртсутегінің 2-3 есе, көмірсутектердің 4-6 есе артуы анықталған.

Түйін сөздер: Қожа Ахмет Ясауи кесенесі, мониторинг, вермичай, күкірт перлит құрамды қалдық.

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ВОЗДЕЙСТВИЕ ЭКОЛОГИЧЕСКИХ ФАКТОРОВ НА СОСТОЯНИЕ МАВЗОЛЕЯ ХОДЖИ АХМЕДА ЯСАВИ

Аннотация. В статье приведены результаты экспериментальных и расчетных исследований по установлению воздействий экологических факторов, влияющих на состояние мавзолея Ходжи Ахмеда Ясави. Выявлены основные виды антропогенных источников, существующих вблизи зоны нахождения исторического памятника. В качестве основных источников загрязнения атмосферного воздуха выделены химически загрязненные осадки, образуемые вследствие сжигания ископаемого топлива, шин и различных мусоров, скопление бытовых, строительных и других производственных отходов, эмиссии транспортных средств. Установлено, что особую опасность для сохранности мавзолея и его объектов представляют сажевые пыли, парниковые и озоноразрушающие газы, аэрозоли кислот, солей, углеводороды и их производные, тяжелые металлы.

С целью снижения воздействий антропогенных факторов на объекты комплекса мавзолея Ходжи Ахмеда Ясави предложено создание зеленой полосы из белой акации вдоль охранной зоны.

Подобраны условия для поэтапного выращивания белой акации из семян. Для обработки семян выбран гидротермический способ, в качестве ростостимулирующего агента – 0,01% раствор вермичая, получаемого как побочный продукт при вермикомпостировании.

Для создания барьера на пути распространения агрессивной пыли и газовых примесей в качестве сорбирующих их поглотителя нами выбрана древесная растительность, а именно белая акация. Она высажена вдоль границы охранной зоны. В связи с отсутствием в некроземе плодородного слоя нами разработан для посадки саженцев белой акации субстрат нового состава. Он представляет собой смесь следующих компонентов в масс. %: вермичай (20), опилка (20), сероперлитсодержащий отход (5), древесная зола (1), остальное серозем (некрозем).

В разные сезоны года 2018-2019 гг. проведены мониторинговые исследования атмосферного воздуха города Туркестан. На основе экспериментальных исследований установлены следующие превышения концентрации пыли, включая сажу, на 15-20 раз, оксидов серы в 10-12 раз и более, оксидов азота – в 18-24 раза, сероводорода – в 2-3 раза, углеводородов – 4-6 раз по сравнению с допустимой нормой.

Ключевые слова: мавзолей Ходжи Ахмеда Ясави, мониторинг, вермичай, сероперлитсодержащий отход.

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REFERENCES

[1] Medved A. N., Razmustova T. O. (2000) Problemy sokhraneniya arkheologicheskogo naslediya v sovremennoy Rossii [Problems of preserving the archaeological heritage in modern Russia]. Ekologiya kul'tury. M., 198 p (in Russ).

[2] Robert Boyd., Peter J. Richerson. (2009) Culture and the evolution of human cooperation. *Philos Trans R Soc Lond B Biol Sci*. vol. 364(1533), pp. 3281–3288. https://doi.org/10.1098/rstb.2009.0134.

[3] Shin Maekawa, Franciza Toledo. (2001) Sustainable Climate Control For Historic Buildings In Hot And Humid Regions. *The 18th Conference On Passive And Low Energy Architecture*, Florianópolis - Brazil, 7-9 November 2001 Paper Code PL01-386, PLEA 2001.

[4] Akbasova A.D., Sainova G.A., Dzhumanova G. (2014) Otsenka sostoyaniya mavzoleya H.A.Yasavi [Evaluation of the state of the mausoleum of H.A. Yasavi]. *Materialy Mezhd. nauchno-prakt. konf. «Nauka i obrazovaniye v XXI veke»* - Rostov, pp. 14-16 (in Russ).

[5] Akbasova A.D., Sainova G.A., Beisembaeva L.S., Toychibekova G.B., Sunakbaeva D.K. (2016) Impact Assessment of Environmental Natural-Climatic and Anthropogenic Factors on State Of H.A.Yasawi Mausoleum. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. vol. 7(1), pp. 2068-2074.

[6] Abasova A.Zh., Sainova G.A. Toychibekova G.B. (2014) Ingibirovaniye protsessa razrusheniya arkhitekturno-istoricheskogo pamyatnika mavzoleya H.A.Yasavi [Inhibition of the destruction of the architectural and historical monument of the mausoleum of H.A. Yasavi]. Vol. 5 (2), pp. 77-78 (in Russ).

[7] Akbasova A.Zh. (2012) Vliyaniye faktorov ekologicheskikh riskov na sokhraneniye kul'turnogo naslediya [The influence of environmental risk factors on the preservation of cultural heritage]. *Vestnik MKTU im. KH.A. Yasavi. Seriya yestestvennykh nauk*. vol.3(78). pp. 105-110 (in Russ).

[8] Kuzmicheva A.A., Loboykob V.F. (2016) Impact of the Polluted Air on the Appearance of Buildings and Architectural Monuments in the Area of Town Planning. *Procedia Engineering*. vol. 150. pp. 2095 – 2101.

[9] Rakhimov T.U. (2016) Vliyaniye sernistogo angidrida na listovuyu plastinku nekotorykh porod derev'yev [The effect of sulfur dioxide on the leaf blade of some tree species]. Zhivyye i biokosnyye sistemy. vol 15.pp.10-11 (in Russ).

[10]Hamada, S., Ohta T. (2010) Seasonal variations in the cooling effect of urban green areas on surrounding urban areas. *Urban Forestry Urban Greening*. vol. 9. pp. 15-24.

[11]Chirkova A.I., Litvinov P.V. (2017) Zelonyye nasazhdeniya kak metod zashchity ot shuma i vrednykh vybrosov dvigateley vnutrennego sgoraniya v sel'skoy mestnosti [Green spaces as a method of protection against noise and harmful emissions of internal combustion engines in rural areas]. Molodoy uchenyy. Vol. 11. pp. 173-176 (in Russ).

[12]PND F 16.1:2:2.2:2.3.46-06. (2008) Metodika vypolneniya izmereniy massovoy doli kislotorastvorimykh form tyazhelykh metallov i toksichnykh elementov (Cd, Pb, Cu, Zn, Bi, Tl, Ag, Fe, Se, Co, Ni, As, Sb, Hg, Mn) v pochvakh, gruntakh, donnykh otlozheniyakh [The method of measuring the mass fraction of acid-soluble forms of heavy metals and toxic elements (Cd, Pb, Cu, Zn, Bi, Tl, Ag, Fe, Se, Co, Ni, As, Sb, Hg, Mn) in soils, soils, bottom sediments , sewage sludge by inversion voltammetry] - ZAO AKVILON. 9p.

[13]Gromovik A.I., Yonko O.A. (2010) Sovremennyye instrumental'nyye metody v pochvovedenii. Teoriya i praktika [Modern instrumental methods in soil science. Theory and practice]. *Voronezh* – 60 p (in Russ).

[14]Reff, A., P.V. Bhave, H. Simon, T.G. Pace, G.A. Pouliot, J.D. Mobley., M. Houyoux. (2009) Emissions Inventory of $PM_{2.5}$ Trace Elements across the United States. *Environmental Science & Technology*. vol. 43, pp. 5790-5796.

[15]Wei-Kang Zhang, Bing Wang, Xiang Niu. (2015) Study on the Adsorption Capacities for Airborne Particulates of Landscape Plants in Different Polluted Regions in Beijing (China). *Int J EnvironRes Public Health*. vol. 12(8). pp. 9623–9638.

[16]Baihamurova M.O., Akbasova A.D., Sainova G.A.(2017) Vliyaniye preparata «S-vermichay» na kachestvennyy sostav kartofelya [The effect of the drug "S-vermicay" on the qualitative composition of potatoes.] *Vestnik nauchnykh konferentsiy «Perspektivy razvitiya nauki i obrazovaniya»,* vol. 12-1 (28), pp. 26-27 (in Russ).

[17]Musa S.I., Njoku K.L., Ndiribe C.C., Oke F.M. (2017). The Effect of vermi tea on the growth parameters of Spinaciaoleracea L. (spinach). *J. Environ. Sci. Pollut. Res.* vol.3 (4). pp. 236–238. https://doi.org/10.13140/RG.2.2.25268.71041.

[18]Akbasova A.D., Isakov O.A., Sainova G. (2015). Ekologizatsiya sel'skogo khozyaystva putem ratsional'nogo ispol'zovaniya vermiproduktsiy i biopreparatov na ikh osnove. monografiya. – Almaty: Izdatel'stvo «Nurly Alem»,176 p (in Russ).

[19]Akbasova A.D., Aubakirov N.P., Nursultan A.N. (2017) Korrozionnyye yavleniya na stroitel'nykh konstruktsiyakh mavzoleya Khodzhi Akhmeda Yasavi [Corrosion phenomena on the building structures of the mausoleum of Khoja Ahmed Yasawi]. *Mezhdunarodnyy zhurnal prikladnykh i fundamental'nykh issledovaniy*. vol 3 (2), pp. 1260-1263 (in Russ).

[20]Peng Zhang, Tianzeng Chen, Jun Liu, Changgeng Liu, Jinzhu Ma, Qingxin Ma, Biwu Chu, Hong He. (2019) Impacts of SO2, Relative Humidity, and Seed Acidity on Secondary Organic Aerosol Formation in the Ozonolysis of Butyl Vinyl Ether. *Environmental Science & Technology*. vol. 53 (15).pp. 8845-8853. https://doi.org/10.1021/acs.est.9b02702.

[21]Zhirnova O. V., Suleimenov B. A., Toigozhinova A.Zh., Wojcik W. T. Construction of mathematical model the combustion of biogas to reduce greenhouse gas emissions // News of the national academy of sciences of the republic of Kazakhstan series of geology and technical sciences. – 2017.- Vol. 1. (421). -P. 177 – 185.

[22] Inchik V.V. (2000) Solevaya korroziya kirpichnoy kladki [Salt corrosion of masonry]. Stroitel'nyye materialy, vol. 8(548). pp.55-67 (in Russ).

[23]Dultseva G.G., Dubtsov S.N., Skubnevskaya G.I. (2008) Vklad fotookisleniya al'degidov v obrazovaniye atmosfernogo organicheskogo aerozolya [The contribution of aldehyde photooxidation to the formation of atmospheric organic aerosol], *Khimiya v interesakh ustoychivogo razvitiya.* vol. 6. pp. 303-309 (in Russ).

[24]Toichibekova G.B., Koyshieva G. (2011) Vozdeystviye vzveshennykh pylevykh chastits na sostoyaniye mavzoleya KH.A.Yasavi [Impact of suspended dust particles on the state of the H.A. Yasavi mausoleum]. *Vestnik MKTU im.KH.A.Yasavi*. vol. 3. pp.143-147 (in Russ).

[25] Sainova G.A., Akbasova A.D., Abdikarim G.G., Kalieva N.A., Ali Ozler Mehmet. Environmental monitoring on the landfill of solid domestic wastes of the town Kentau // News of the National Academy of Sciences of the Republic of Kazakhstan Series of Geology and Technical Sciences. Vol. 1. №433. - 2019- P. 57-62. https://doi.org/10.32014/2019.2518-170X.6