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Impact Assessment of Environmental Natural-Climatic and Anthropogenic Factors on State Of KH.A. Yasawi Mausoleum

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ABSTRACT

Real state of world heritage monument "Khawaja Ahmed Yasawi Mausoleum" was described. Complex theoretical and experimental investigations, based on different physical, physicochemical, chemical and visual (photofixaton) methods revealed types of different factors impact and their contribution to the state of architectural ensemble. For the first time the modern state of the monument was assessed from the ecological point of view; complexity and synergism of different natural and anthropogenic factors, that impact on the object under study, were predetermined.

Keywords: heritage monument, Khawaja Ahmed Yasawi, anthropogenic factors.

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INTRODUCTION

Numerous historical and cultural monuments of our country, as well as other immovable cultural heritage resourses, have important social functions [1-4]. They belong to one of the principal objects of science, education and culture development, formation of patriotism, ideological, moral and aesthetic education [5-7].

The applicable Law of the Kazakhstan Republic "About Protection and Usage of Objects of Historical and Cultural Heritage" mentions that Kazakhstan historical and cultural monuments "make an integral part of world Islamic cultural heritage and give evidence of great contribution of people from our country to the development of world Moslem civilization". This law [8], based on the Constitution of the Kazakhstan Republic [9], says that the protection of historical and cultural monuments in general is an important task of state authorities and social bodies.

"Khawaja Ahmed Yasawi Mausoleum", situated in South-Kazakhstani district of the Kazakhstan Republic is one of such important monuments with rich historical-cultural and architectural heritage. This irreplaceable architectural monument of the end of XIV and early XV centuries was included to the list of UNESCO world protected monuments in 2000 and it is protected by international organizations [10]. One of the main tasks of world heritage protection [11-13] is to preserve this unique architectural monument of the whole religious Islamic world, considered to be the second Mecca in its importance.

Unfortunately, in the last years this monument has become a victim of "ecological problems" as a result of its low resistance to the impact of external exogenous factors, including contaminated precipitation, ground waters and other factors [14-16].

It is known that year by year the speed of negative processes, due to the impact of anthropogenous factors, increases in geometrical progression as a result of intensified industral activities and growth of transport means. This fact can result in integrity violation of this unique architectural ensemble. Therefore a vital task is to determine main types of impact on its resistance and integrity, that is a complex of natural, climatic and technogenic factors [17-18].

An integrated monitoring of biosphere objects impact on the state of Khawaja Ahmed Yasawi Mausoleum was not carried out up to the present moment. Accordingly there is no real information about its ecological state and possible loss risk.

The purpose of the paper is to reveal a contribution of anthropogenous (industry, transport and other types of economic activities) and natural factors on maintenance of steady state of Khawaja Ahmed Yasawi Mausoleum.

RESEARCH SUBJECTS AND METHODS

Ecological monitoring was carried out on the basis of visual (photofixaton), laboratory, site and calculation research methods.

Visual observation was done by driving round the territories of protected and settlement zones, adjoined to the monument under study. Pollution zones length and topography, dependent on seasonable wind rose, its speed, duration and fallout period were determined during sampling.

Soil and water sampling and the laboratory research methods were carried out using well-known chemical and physical-chemical methods.

The pollutants in the atmospheric air were determined by gas analyzer GANK-4. A fluid analyzer Fluorat–02-2M, a device KHAN–2, based on voltammetry, a photometer KFK-3-01-30MZ and other modern devices and methods were used to determine waste and soil structure.

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RESULTS AND DISCUSSION

Visual inspection showed ecologically crisis situation. Nowadays a protected buffer zone of the mausoleum was turned into an unauthorized field of solid domestic and industrial waste. Figure 1 shows photofixation data as an example.

Monument territory soil pollution by differrent in composition waste (domestic, construction, industrial) is one of the reasons for chemical degradation and biodestruction of building structures, as well as the risk of forced fires due to heating of agglomerated solid domestic waste (SDW), especially in hot summer months [19]. Additional heat and biogas (carbon dioxide, methane, hydrogen, hydrogen sulfide et al.), able to self-ignition, naturally appear as a result of exothermic combustion processes in landfills.

Figure 1 – Territorial pollution of Kh.A.Yasawi monument by different wastes.

Agglomeration of great number of solid domestic waste (SDW), different in composition, characterises non-compliance of the territory under study to the ecological standards; besides, they impact negatively on historcal heritage state. As per our rough estimates, more than half of the Khawaja Ahmed

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Yasawi Mausoleum territory is polluted by ash, industrial and domestic waste. Average composition of ash and content of several components in landfill wastes are shown in tables 1-2.

Table 1 – Average content of main components in landfill ash (calculated as oxides)

Name of the component, contained in the ash	Content, %
Silicon oxide (SiO_2)	60,2
Aluminum oxide (Al2O3)	21
Ferrum trioxide (Fe2O3)	8,3
Ferrum oxide (FeO)	1,1
Calcium oxide (CaO)	3,3
Magnesium oxide (MgO)	1,5
Titanium dioxide (TiO_2)	0,8
Sodium oxide (Na_2O)	0,8
Potassium oxide (K_2O)	2,1
Sulphuric anhydride (SO_3)	0,2
Phosphorus oxide (P_2O_3)	0,4
Manganese oxide (MnO)	0,3

Table 2 – Qualitative and quantitative composition of wastes, located on the protected mausoleum territory

№	Ingredient name	Elements, contained in waste, including ash, slag waste and other materials, mg/kg
1.	Aluminium	10394± 22,8
2.	Ferrum	32825±8,7
3.	Cadmium	0,3±0,1
4.	Calcium	15582±2,8
5.	Silicon dioxide, %	70,7±0,4
6.	Magnesium	5258±8,9
7.	Manganese	353±3,8
8.	Copper	61,2±5,4
9.	Arsenic	9,0±0,8
10.	Nickel	48,9±1,2
11.	Plumbum	36,0±7,6
12.	Sulphates	5157±4,13
13.	Chrome	25,9±4,4
14.	Zink	40,5±6,9
15.	Water extract pH	10,6±0,1

In some places ash and waste height exceeds 1,5 m, that is why soil sampling has become practically unreal. These wastes on extensive areas displaced natural ecosystems. Table 3 shows discovered average qualitative and quantitative morphological waste composition.

Table 3 – Landfill morphological composition

№	Name of landfill components	Quantitative composition, %
1.	Ash	46±2,5
2.	Manure and bed straw	20±1,3
3.	Woodwaste	3,7±1,7
4.	Plastic masses (Bottles, packaging materials etc.)	5±0,8
5.	Bones of domestic animals	11±0,5
6.	Broken glass	5,4±0,3
7.	Metal	0,5±0,2
8.	Leather, rubber	1,5±0,1
9.	Paper and textiles	6,0±0,4
10.	Stones	0,9±0,1

Waste density is up to 0,2 t/m^3. Waste humidity equals to around 43%, organic content is not above 30-31%.

Taking into consideration landfill historical character, biogas formation was investigated. The results of experimental investigations showed that decomposition of organic matters proceeds with formation of gaseous products that can contribute significantly to atmospheric air pollution and therefore impact on mausoleum state. It is required to carry out further thorough investigations to reveal the role of biogas and secondary products in disruption of ecological balance, resulting in destruction of construction materials of the protected object.

Unauthorized landfills can be named “a delayed-time bomb”. It is known that the secondary physical-chemical and biochemical processes proceed in stored landfills of different wastes, including the rests of construction materials (cement et al.); as a result there are numerous chemicals, toxic and aggressive in their nature. Therefore the environment is polluted not only by familiar contaminants, but also by absolutely new substances, unpredictable in their impact on ecosystems. They pollute not only atmospheric air and soil system, but also ground waters. Besides, a landfill is a habitat for birds, rats, insects and other animals, which can become one of the reasons for destruction of the object under study.

The results of our preliminary investigation show that more than 50% of soil of the protected zone is destructed, covered by ash and wastes (higher than 1 m in some areas); chemical, biochemical and other processes in landfill layers result in the following way: 1) biogas results in “acid rain” and fire risk; numerous substances of acid and salt character, transported as dust by wind over the considerable distance, cover and destruct the external surface of the mausoleum, changing the composition and properties of its construction materials; 2) unauthorized landfills, SDW landfills, ash hills and other wastes prevent from formation of full historical view and deform the relief.

Sampling from different sites of the existing historical landfill on the monument protected territory showed the following concentrations of heavy metals (HM), mg/kg: zinc (5760,5), copper (314,8), plumbum (4609,3), cadmium (112,9), arsenic (56,7). We see that gross content of some HM in waste materials exceeds many times their maximum permissible concentrations (MPC) in soil, for example zink exceeds in 57,6 times, copper – in 89,9 times, plumbum – in 131,7 times, arsenic – in 28,3 times.

Long-term character of SDW landfill testifies to conditions for formation and emission of greenhouse gases - CO_2, CO, CH_4, NO_x, aerosols of galogenous hydrocarbons and other compounds, than contribute significantly to destruction process of monument civil structures.

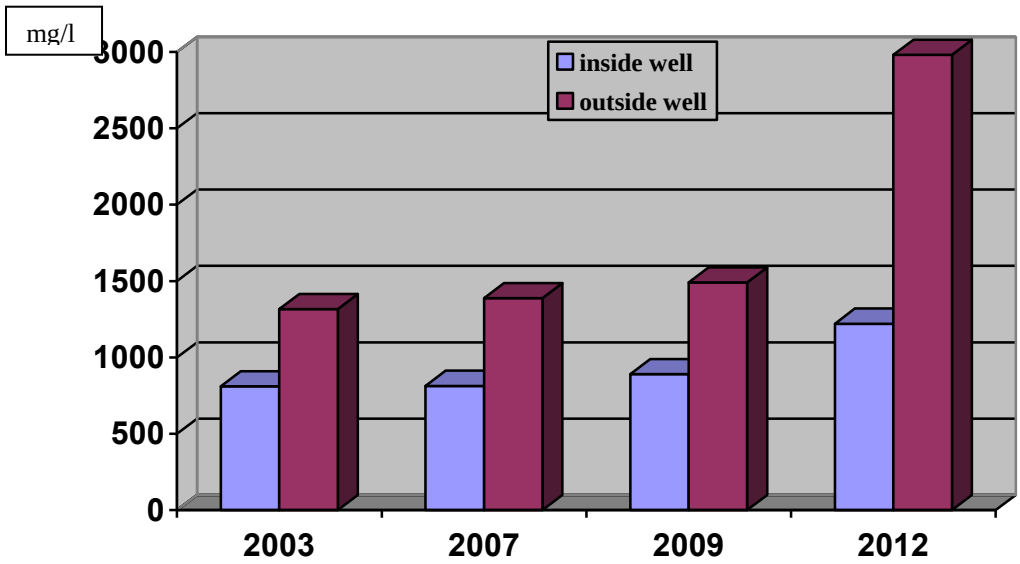

Figure 2 – The results of water analysis from inside and outside wells of “ Khawaja Ahmed Yasawi ” mausoleum
Figure 2 shows that water salt content increases year by year.

Statistic data and our calculations reveal the volume of harmful chemical substances, equal to 15 thous. tons, coming into the ground layer from the stationary sources. There are 3731 tons of nitrogen oxide,

4331 tons of sulphur dioxide and 25 tons of heavy metals among them. The direct measurement of contaminant concentration in open air near the monument testifies to multiple excess of maximum permissible concentration values (MPC).

The stability of mausoleum civil structures can considerably depend not only on atmospheric pool, but also on the groundwater level and composition. That is why we also carried out the analytical investigations of water composition from wells, located both inside and outside the main building.

Figure 2 shows experimental data, obtained durng the analysis of water from wells of " Khawaja Ahmed Yasawi" complex.

Observable increase of ground water salt concentration can impact signficantly on the monument state, as the saline moisture due to capillary ascent and evaporaton saturates the civil structure pores, destroys the structure by cristallization, i.e. results in foundation destructon and wall structure deformaton.

CONCLUSION

Thus, short preliminary monitoring reveals the necessity in coordination measures for whole environmental improvement.

The development of environmental protection measures to decrease the antropogenic impact and to transform aesthetic and visual perception of invaluable globally important complex are recommended.
To preserve this immovable historical and cultural monument, it is necessary to carry out a regular extended monitoring of object state, peform a complex approach to its problem, executing all round observations wth assistance of experts from architectural monument restoration sphere.

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