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Satbayev University

ХАБАРЛАРЫ

ИЗВЕСТИЯ

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НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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MONITORING OF ACCUMULATION OF POLYCHLORINATED BIPHENYLS IN THE SNOW COVER IN THE ALMATY AGGLOMERATION

Abstract. There are presented results of the accumulation of polychlorinated biphenyls (PCBs) – the most toxic compounds among persistent organic pollutants (POPS) in the snow cover (SC) study (2018 and 2020) in the Almaty agglomeration (AA).

Protection of the natural environment and the population from the effects of POPs, including PCBs, is one of the most acute problems for Kazakhstan. The territory of AA is experiencing a serious technogenic load, the concentration of a number of pollutants in its natural objects exceeds the permissible standards. Snow cover among natural objects, is one of the informative indicators of pollution of the natural environment, including the air basin, and reflects the main trends in the spread of pollutants in the region.

For the first time, studies of the level of PCBs contamination of the SC of the vast AA, by taking snow samples at a large number of points, using modern chromatographic methods and instruments, established the contamination of its territory with these dangerous toxicants. Up to 22 individual PCBs congeners were identified in the SC of the agglomeration. Strictly controlled «marker» (indicator) and highly toxic dioxin-like congeners were registered in snow samples with a wide range of PCBs congener composition. The analysis of analytical data and the container composition of PCBs allows us to note that the SC of the agglomeration is polluted by regional sources.

The results of the study can be used by government agencies and scientific

institutions in assessing the level of pollution of the SC territory of Kazakhstan, including urban agglomerations.

Key words: snow water, concentration, toxicants, congeners, pollution.

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АЛМАТЫ АГЛОМЕРАЦИЯСЫ АУМАҒЫНЫҢ ҚАР ЖАМЫЛҒЫСЫНДАҒЫ ПОЛИХЛОРЛЫ БИФЕНИЛДЕРДІҢ ЖИНАҚТАЛУ ДЕҢГЕЙІНІҢ МОНИТОРИНГІ

Аннотация. Алматы агломерациясында (АА) қар жамылғысын зерттеуде (SC) (2018 және 2020 жылдар) тұрақты органикалық ластағыштар (ЖҚОЛ) арасындағы неғұрлым уытты қосылыстар – полихлорланған дифенилдердің (ПХД) жинақталу нәтижелері ұсынылған.

Табиғи орта мен халықты ПХД әсерінен қорғау Қазақстан үшін ең өткір проблемалардың бірі болып табылады. АА аумағы Елеулі техногендік ауыртпалықты бастан кешуде, оның табиғи объектілерінде бірқатар ластаушы заттардың шоғырлануы рұқсат етілген нормалардан асып түседі. Табиғи объектілер арасындағы қар жамылғысы табиғи ортаның, оның ішінде ауа бассейнінің ластануының ақпараттық көрсеткіштерінің бірі және өңірдегі ластаушы заттардың таралуының негізгі үрдістерін көрсетеді.

Қазіргі заманғы хроматографиялық әдістер мен құралдарды қолдана отырып, көптеген нүктелерде қар сынамаларын алу арқылы ПХД КА-ның кең АА ластану деңгейін алғаш рет зерттеу оның аумағын осы қауіпті токсиканттармен ластауды анықтады. СК-да 22-ге дейін жеке ПХД конгенерлері анықталды. Қатаң бақыланатын «маркер» (индикатор) және жоғары уытты диоксин тәрізді конгенерлер ПХД конгенерлік құрамының кең спектрімен қар үлгілерінде тіркелді. ПХД аналитикалық деректері мен контейнерлік құрамын талдау агломерация аумағы өңірлік көздермен ластанғанын атап өтуге мүмкіндік береді.

Зерттеу нәтижелерін мемлекеттік органдар мен ғылыми мекемелер қалалық агломерацияларды қоса алғанда, Қазақстанның бүкіл аумағының ластану деңгейін бағалау кезінде пайдалана алады.

Түйін сөздер: қар суы, концентрация, токсиканттар, конгенерлер, ластану.

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МОНИТОРИНГ УРОВНЯ КУМУЛЯЦИИ ПОЛИХЛОРИРОВАННЫХ БИФЕНИЛОВ В СНЕЖНОМ ПОКРОВЕ ТЕРРИТОРИИ АЛМАТИНСКОЙ АГЛОМЕРАЦИИ

Аннотация. Представлены результаты исследования (2018-2020гг.) уровня аккумулирования полихлорированных бифенилов (ПХБ) – наиболее токсичных соединений из числа стойких органических загрязнителей (СОЗ) в снежном покрове (СП) территории Алматинской агломерации (АА).

Охрана природной среды и населения от воздействия СОЗ, в том числе ПХБ, относится к числу острейших проблем и для Казахстана. Территория АА испытывает серьезную техногенную нагрузку, в ее природных объектах концентрация целого ряда поллютантов превышает допустимые нормативы. Снежный покров из числа природных объектов является одним из информативных индикаторов загрязнения природной среды, в том числе воздушного бассейна, и отражает основные тенденции распространения загрязняющих веществ в регионе.

Впервые проведенные исследования уровня загрязнения ПХБ СП обширной по площади АА путем отбора образцов снега на большом количестве точек, с использованием современных хроматографических методов и приборов, установили загрязненность ее территории этими весьма опасными токсикантами. В СП агломерации идентифицированы до 22 индивидуальных конгенеров ПХБ. В пробах снега с широким спектром конгенерного состава ПХБ зарегистрированы строго контролируемые «маркерные» (индикаторные) и высокотоксичные диоксиноподобные конгенеры. Анализ аналитических данных и конгенерного состава ПХБ позволяет отметить, что СП агломерации загрязняется региональными источниками.

Результаты исследования могут быть использованы государственными органами и научными учреждениями при оценке уровня загрязненности СП территории РК, в т.ч. городских агломерации.

Ключевые слова: снеговая вода, концентрация, токсиканты, конгенеры, загрязнение.

Introduction. The research of the chemical composition of the snow cover is one of the ways to assess changes in the level and spatial scale of local pollution of large areas, including the agglomeration of large cities. The use of snow cover (SC) as an indicator of environmental pollution will serve as the basis for the development of a forecast of the state of pollution of environmental objects.

During the study of the snow cover of the object under consideration, special attention was paid to the study of polychlorinated biphenyls (PCBs) included in the list of persistent organic pollutants (POPs). It is known that POPs are recognized by the international community as substances that pose a great danger to humans and the environment. To take measures to protect human health and nature, a global international agreement has been in force since 2001 – the Stockholm Convention on POPs (Stockholm Convention on Persistent …, 2011), which was ratified by the Republic of Kazakhstan in 2007. In relation to PCBs, the Stockholm Convention sets three main goals: the immediate cessation of their production; the cessation of operation of equipment containing PCBs by 2025; and the earliest, no later than 2028, destruction of PCBs. PCBs are one of the most toxic and widespread representatives of POPs on a global scale. Their global distribution in nature is facilitated by high stability, resistance to biodegradation, activity in accumulation in biological objects and a significant amount of use (Amed et al., 1992:173).

According to the HELCOM Convention on the Protection of the Baltic Sea from Pollution, three main criteria are used to assess the hazard of substances: persistence, toxicity and bioaccumulation. According to these characteristics, priority groups of harmful substances are formulated in (Safonova et al., 2014:78), which include dangerous organic compounds such as POPs and others. Consequently, the dangerous xenobiotics (PCBs) studied by us are quite consistent in their properties to the 3 specified criteria.

In the field of problems of atmospheric precipitation research, the authors of the review article (Barenboim et al., 2010:13) claim that there are few works on the study of organic xenobiotics in the snow cover, including especially dangerous ones, and the need to expand research in this area deserves attention.

The high toxicity of POPs and their ability to bioaccumulate make this problem especially urgent. The determining factors in the global distribution of PCBs are long-term existence in the atmosphere and the ability to be transported over long distances: there is data about the presence of POPs compounds in the Arctic and Antarctica in relatively high concentrations (Arctic Assessment …, 1998, 2002; Konoplev et al., 2005:38; Laletin et al., 2013:109-114; Herbert et al., 2005:2998; Riseprough et al., 1976:738).

The issue of ecology has become one of the priorities for large megacities and the Almaty agglomeration is no exception. Megacities are centers of concentration

of population, industry, transport, communications and the resulting degradation of landscapes and intense environmental pollution.

The purpose of this work was, on the basis of a detailed study using modern methods and physical devices, to assess the level and spatial distribution of PCBs in the snow cover of various agglomeration areas experiencing different types of man-made pollution. It is recommended to develop monitoring networks for monitoring and scientific research of the state of contamination of the natural environment of the Republic of Kazakhstan with a dangerous PCB toxicant.

The object and relevance of the study. As part of the implementation of the President's Address to the People of Kazakhstan dated December 14, 2012 «Strategy «Kazakhstan – 2050»» and the Decree of the Government of the Republic of Kazakhstan dated May 24, 2016, No. 302, the Interregional Scheme of Territorial Development of the Almaty Agglomeration (AA) was approved. The area of influence of the AA includes (the core) of the agglomeration – the city of Almaty, parts of five administrative districts of the Almaty region: Karasai, Talgar, Ili, Enbekshikazakh and Zhambyl, as well as the territory of the Kapshagai city administration. Its zone includes satellite cities: Kapchagai, Kaskelen, Talgar, Esik, the village of Uzynagash, recreation areas on the northern coast of the Kapshagai reservoir. The total land area of the agglomeration is 939.5 thousand hectares. There are 188 settlements of the Almaty region located in the agglomeration zone.

A natural feature of the AA is location which covers the northern slope of the Ili Alatau up to an altitude of 2755 m above sea level and a foothill plain with a minimum elevation of 487 m above sea level. There are many mountain rivers of different water content like tributaries of the river Ili, which is one of the main transboundary rivers of Kazakhstan, feeding the unique lake Balkhash. The AA includes the dam part of the water area of the Kapshagay reservoir located on Ili river with area 1280 km^2 and water volume 16.5 km^3. Also, there are large crop and livestock agricultural facilities, summer cottages, recreational facilities for the population, etc.

At the same time, it should be noted that within the South-Eastern Kazakhstan, which includes part of territory AA, it is planned to introduce (adapt) an integrated approach to the analysis of agricultural systems (express assessment of agricultural innovation systems [RAAIS]) (Barrett et al., 2017:106; Barrett et al., 2017:747). According to the authors, the use of RAAIS in the countries of Africa, Southeast Asia and Central America has proven itself well in the field of studying and predicting the effects of climate change on water resources, crop production and food security.

Therefore, the importance of studying the AA snow cover is not only in the general assessment of its impact on the environment, but also in a significant

impact on the ecological and toxicological state of important water bodies, on the quality of food products and on other spheres of life of the population.

These aspects of the conducted research distinguish them from a number of scientific works devoted to the study of snow cover only in urban areas. At the same time, it is appropriate to refer to the well-known work (Barenboim et al., 2010:13), the authors of which, based on a statistical analysis of publications related to the study of snow cover, drew attention to the predominance of urban areas as objects of research.

One of the most acute problems for Kazakhstan is the protection of the natural environment and population from the effects of POPs, including PCBs. Kazakhstan ranks second among the countries of Central and Eastern Europe and the Commonwealth of Independent States (CIS) after Russia in terms of stocks of POPs waste. According to the results of the preliminary inventory (2004), eight "hot spots" were identified in the republic – territories contaminated with PCBs, there is PCB-containing equipment in the amount of 116 transformers and about 50 thousand capacitors, which contain about 800 tons of PCBs.

However, there is practically no purposeful monitoring of PCBs in natural objects to implement the national tasks adopted under the Stockholm Convention on POPs in Kazakhstan. Consequently, operational data on the spread of these dangerous toxic compounds in the natural environment of the republic are essentially absent; scientific publications are also extremely insufficient. In literary sources, including Kazakhstan, it is not possible to find publications on the study of PCBs in atmospheric precipitation. Single snow samples were taken in 1985 around the Ust-Kamenogorsk condenser plant, which is one of the eight "hot spots". The PCB content in the SC ranged from 0.28 to 4.56 μg/dm^3 (Kabdrahmanova et al., 2014:128).

For the determination of PCBs, sampling was carried out in the central part of Almaty and Talgar located 25 km from each other during the winter of 2014 and 2015. The highest concentrations of the toxicant were recorded at 0.8 μg/dm^3 in Talgar city and 3.79 μg/dm^3 in Almaty (Amirgaliev, 2016). Among the found congeners there are "marker" congeners (PCBs 52, 101 and 138), as well as the most dangerous and highly toxic to living organism's dioxin-like congeners – PCBs 105 and 118.

Thus, the assessment of the pollution of the natural environment by these pollutants, not only of atmospheric precipitation, but also of all natural objects, the adoption of urgent measures to eliminate their sources, is an extremely acute environmental problem for Kazakhstan. According to research (Amirgaliev, 2014; 2016; Amirgaliyev et al., 2019:541; Kajiwara et al., 2003:741), highly toxic PCBs pollute the water and biological resources of large internal and transboundary water basins of the country. The solution of this problem requires joint efforts of state bodies for nature protection and the scientific community.

Research Material and methods. Sampling was carried out at 22 and 30 points in January-February of each year, respectively, in 2018 and 2019, and 2020. Snow samples were taken at 41 points with the established coordinates of their location for more detailed ranking of AA according to the distribution of PCBs. The sampling points of the SC were established considering the degree of anthropogenic load and sources of anthropogenic pollution of the agglomeration (in accordance with the recommendations (Methodological recommendations …, 1990:16). Location of sampling points of snow samples are shown in Fig. 1.

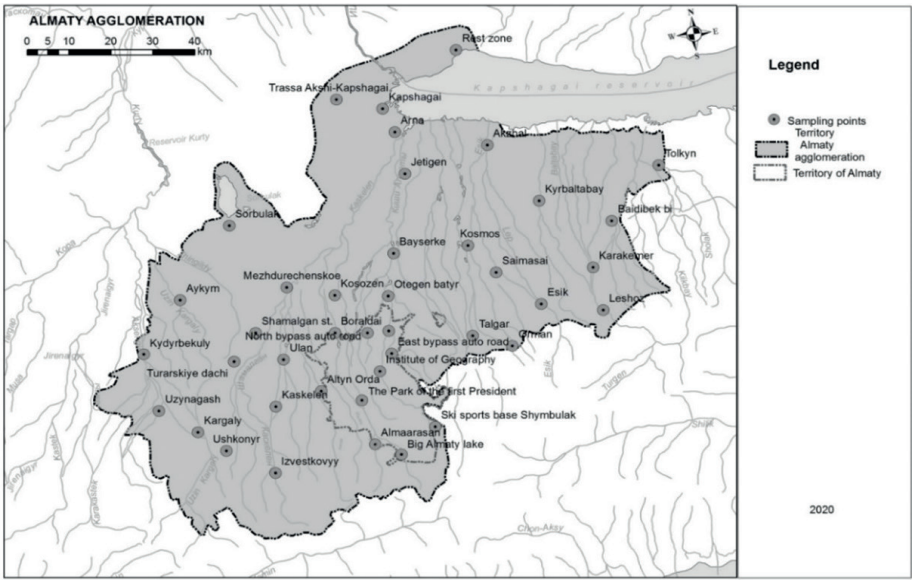

Figure 1. Location of snow sampling points in 2020

Snow sampling was conducted during two surveys in 2018 and 2019. In 2020, it was during one trip before the start of the massive melting of snow. Snow cover was sampled from the whole thickness from pits, measuring of the sides and depth of the pit (except for a 5 cm layer above the soil). Before processing, the samples delivered to the laboratory were stored at a temperature of –5.... –15°C. The samples were placed in pre-prepared containers for snow melting. The sedimented sample was filtered through a white ribbon filter paper for further chemical and toxicological analysis of snow. The determination of PCBs in the SC was carried out according to MU 1792-77 on a gas chromatograph "Chromos GKh-1000" with software, an electron capture detector (ECD) and using a capillary column 30 m × 0.32 mm long. Chromatographic conditions: column temperature 220°C, evaporator temperature 240°C, detector temperature 300°C, carrier gas flow rate (high purity nitrogen) - 38 ml/min. As a standard was used the State standard samples of the composition of the Sovol solution in

hexane, which is a mixture of PCB-52, PCB-101, PCB-138, PCB-153 and the sum of tetra-, -penta-, and hexachlorobiphenyls.

The territory of AA was conditionally divided into 4 zones according to the degree of technogenic load: mountain (1236-2755 m above sea level); the Almaty city (674-993 m); Small towns and urban-type villages (STUV) (489-1002 m); small villages (SV) (487-981 m). This approach seems to be justified based on the distinct inhomogeneity of the spatial distribution of the studied parameters.

Result and discussion. The main results obtained presented in table 1, which includes the averaged data on the PCB content in the SC of individual zones and the detected congeners for 2018-2020. First of all, the obtained results show the spread of PCBs in the SC throughout the AA, with the exception of cases of their temporary absence at certain sampling points.

The highest concentrations of the toxicant in the SC of the AA (exceeding 0.1 μg/dm^3, i.e. 100 pg/dm^3) were marked at 9 points during the first survey in 2018, and during the second - at 4 points out of 22 examined. The maximum level of PCB accumulation was recorded during the second survey in the snow water of a mountain point – the Shymbulak Mountain Resort 2755 m above sea level (1.942 μg/dm^3) and in the area of station Shamalgan in the amount of 1.283 μg/dm^3. A total of 22 individual PCB congeners were recorded in the snow samples. The dominant position is possessed by "light" congeners: during the first survey, PCB 44, 49 belonging to the homologous group of tetrachlorobiphenyls, as well as PCB 151, which is part of the homologous group of hexa CB, and during the second survey, PCBs 49 and 151.

Table 1 – Average content and congener composition of PCBs in the AA snow cover in 2018-2020

Zones	PCB congeners			PCB concentration, μg/dm^3				
	2018	2019	2020	2018		2019		2020
				1*	2*	1*	2*	
1. Mountainous territory	40, 42, 44, 49, 151	40, 42, 48, 86	44, 49	0,031	1,942	0,026	0,0	0,005 (0,038)
2. The Almaty city	41, 44, 49, 52, 66/95, 87/115, 101, 110, 118, 119, 138, 151	40, 41, 44, 64, 71, 86, 101, 114	44, 74, 114, 137	0,066	0,058	0,044	0,009	0,071
3. Small towns and urban-type villages	40, 44, 49, 52, 85, 97, 110, 118, 119, 128, 138, 151, 155	42, 44, 74, 86	44, 66/95, 74, 97	0,129	0,225	0,039	0,016	0,207
4. Small villages	40, 44, 49, 97, 118, 121, 151	42, 44, 86	44, 48, 49, 74, 97	0,093	0,028	0,016	0,007	0,068
Note: *–serial number of sampling								

A great number of congeners in the SC samples is an indicator of the presence of various sources of PCB atmospheric pollution. The author of the work (Kannan, 2000) came to same conclusion by studying the soil cover of urbanized cities. Such conclusions are confirmed by our research. Sampled snow of indicated points with a wide spectrum of PCB congener composition are registered strictly controlled "marker" (indicator) PCB congeners 101 and 138, as well as PCB congener 118 (highly toxic dioxin-like congeners). "Marker" PCB congener 52 and dioxin-like PCB congener 118 were also found in the SC in the Almaty city. Highly toxic congeners were not found in the SC of the mountainous zone.

The content of PCBs was found from 0.003 to 0.164 μg/dm^3 in all 5 samples in the SC of the AA. The highest concentrations of the toxicant were found in the SC of the city center and in major highways. The average PCB content in the area during the two surveys was characterized by similar values (Table 1).

A relative predominance was recorded for PCB congeners 49 (92%), 52 (90 and 77%), 151 (up to 88 and 100%). The "marker" congeners of PCBs 101 and 138, found in the SC of North bypass (accounted for 11 and 10%, respectively). Only here was registered the dioxin-like congener PCB 118 in the amount of 23%. The concentration of PCBs in the SC of STUV (zone 3) varied in a wide range from zero values to 1.283 μg/dm^3, which was noted in the SC of a large railway station Shamalgan. The highest values of the average PCB content (0.129 and 0.225 μg/dm^3) were recorded in the SC of this zone.

The maximum values of the relative content of PCB congeners were noted for PCBs 44 and 155 during the first survey up to 79 and 74%, respectively (Fig. 2). "Marker" congeners of PCBs 52 and 138 were registered in the amount of 100 and 15%, respectively, as well as dioxin-like PCBs 118 (39%) during the second survey. Moreover, these isomers were present in the SC of the cities of Talgar and Kapshagay.

The PCB content reached 0.192 and 0.205 μg/dm^3 in the snowmelt water of SV (zone 4). Light congeners dominated in relative concentration (PCB 44 to 97 (100%) and PCB 49 up to 77%, also PCB 151 from 64 to 100%). There was a single case of the presence of a dioxin-like congener PCB 118 at a point near the Almaty city.

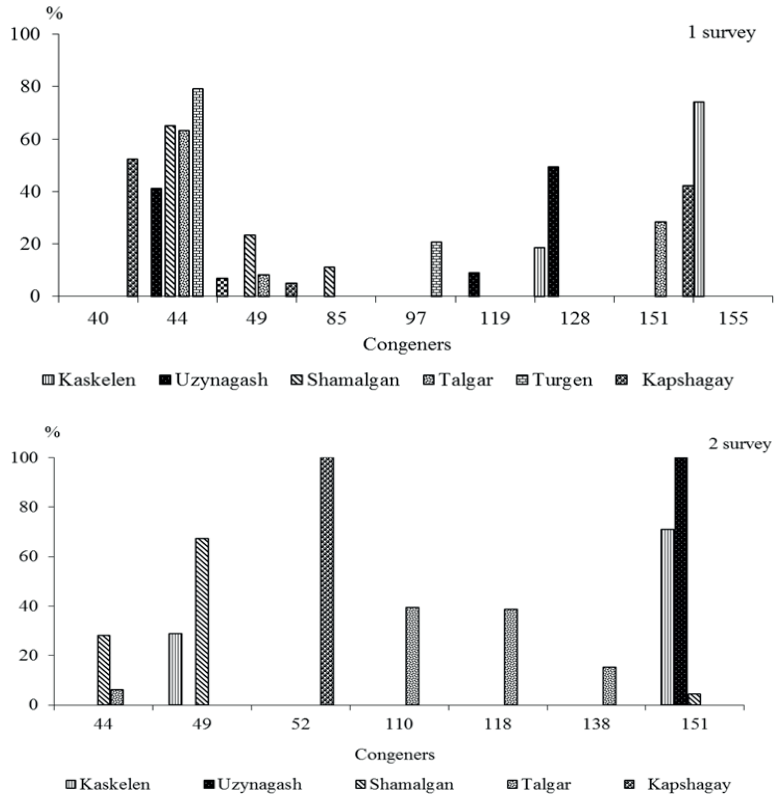

Figure 2. The relative content of PCB congeners in the SC of small towns and urban-type settlements (STUV)

According to the results of studies in 2019, it can be noted about a relatively low level of pollution of the SC of agglomeration by the pollutants. The maximum values of the PCB concentration were 0.140 and 0.148 μg/dm^3 and 0.039 and 0.044 μg/dm^3 during the first and second surveys respectively (at individual points of the Almaty city and STUV). PCB were not found in most permanent points in the SC. The average content of the toxicant in all areas was significantly lower than in 2018 (Table 1).

The decrease of PCB contamination in the SC in comparison with the data of 2018, can presumably be explained by the fact that the winter of 2019 was characterized by little snow and frequent thaws. As a result, mainly freshly fallen precipitation were sampled for analysis, which did not sufficiently affect local sources of pollution. “Light” congeners had the dominant position in SC of agglomeration, which belong mainly to the homologous group of tetra- and hexachlorobiphenyls. The indicator PCB congener 101 (0.017 μg/dm^3) and the dioxin-like congener PCB 114 (0.038 μg/dm^3) were registered in the SC of two points of the urban zone.

PCB congener 86 (75.2%) prevailed in the snowmelt water of zone 1. The highly toxic dioxin-like isomer of PCB 114 (53%) had a predominant position in the Almaty (Fig. 3).

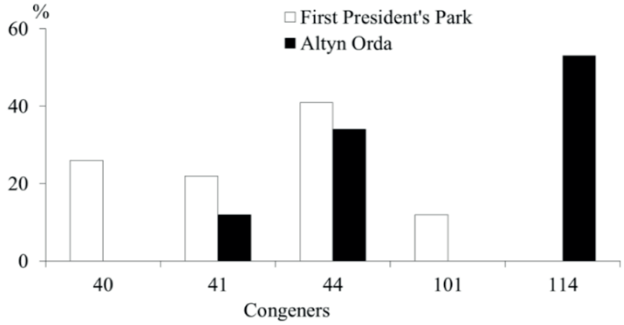

Figure 3. The relative content of PCB congeners in the SC of the Almaty city

The nature of the distribution of the concentration in the SC throughout the AA is shown in Fig. 4. Also, the elevation marks are plotted for all sampling points. PCBs are registered in the SC at 27 points out of 41 sampling points. PCBs were found in the amount of 0.038 μg/dm^3 only in the snow of the Shymbulak Mountain Resort from the 7 points established this year in the mountainous area. PCBs was registered in the SC only at this point in 2018-2020 except for the second survey in 2019.

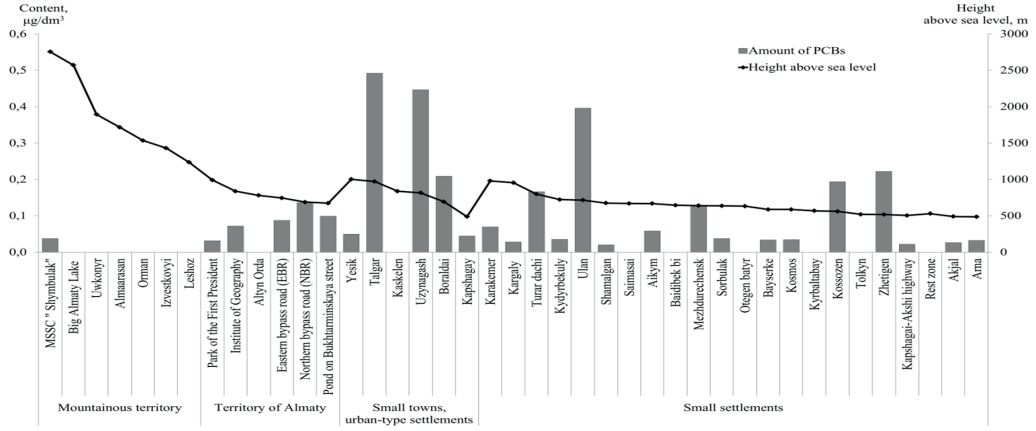

Figure 4. The content of PCBs in the SC of the AA and the altitude characteristics of its territory

It is rather difficult to explain the reason for this phenomenon. At the same time, presumably, it needs to pay attention to the following circumstances. Shymbulak Mountain Resort is located closer to the Almaty city in comparison

with other sampling points, which are located at a considerable distance in the east and south-west direction from the resort. Consequently, it can be assumed that the Shymbulak is located on the transfer strip depending on the speed and direction of the wind, air mass and aerosols polluted over the industrial city into higher layers of the atmosphere. Solid precipitation can accumulate a certain part of the carried pollutants including PCBs.

In addition, a rather vast territory of the long-functioning Shymbulak resort is economically developed. Objects of communal housing and other sectors have been built. Therefore, these local sources are not excluded as a possible influence on the composition of the SC in winter.

The average PCB content in the SC was 0.071 μg/dm^3 in the Almaty city in 2020, which is approximately equivalent to the average data for 2018 and 2019 (Table 1). The maximum value reached 0.137 μg/dm^3 in the large highways.

The highest average concentration of PCBs (0.207 μg/dm^3) turned out to be characteristic of the SC of STUV zone in 2020. Their highest content reached 0.447 and 0.492 μg/dm^3 in the SC of Talgar and the Uzynagash village, respectively. It also amounted to 0.209 μg/dm^3 in the Boralday village. Sources of pollution of the SC can be emissions from industrial facilities and from combined heat and power CHP-2, located near the Boralday village.

PCBs were registered in the SC of 16 small settlements out of 22 surveyed. Their highest concentrations were noted in SC in Ulan village (0.396 μg/dm^3), as well as four other settlements. The average content of the toxicant (0.068 μg/dm^3) is approximately equal to the content in the Almaty city in 2020 and closer to the maximum value of the average content of PCBs noted here in 2018 (Table 1). Sources of pollution of the SC can be production facilities of small and medium-sized businesses, autonomous utilities operating on coal, often high-ash (up to 40%), railway and coal facilities. It is not excluded Air transport of pollutants from the territory of closer located cities such as Almaty.

The congener composition of PCBs did not significantly differ in the Almaty in 2020 from that observed in 2019 (Table 1). Total of 7 individual PCB congeners were recorded in the snow samples. The dominant position is possessed by "light" congeners 44, 49 belonging to the homologous group tetrachlorobiphenyls. Dioxin-like congener PCB 114 (0.045 μg/dm^3) from the pentaCB group was registered only in one snow sample in the Almaty.

The relative share of the congener PCB 44 area was in the range of 35-53% in the SC of the urban (Fig. 5).

100% presence of PCB 74 congener was noted at one point. The share of this congener ranged from 32 to 63% at other points. The most toxic congener PCB 114 was present in an amount of 33% in the SC of North bypass.

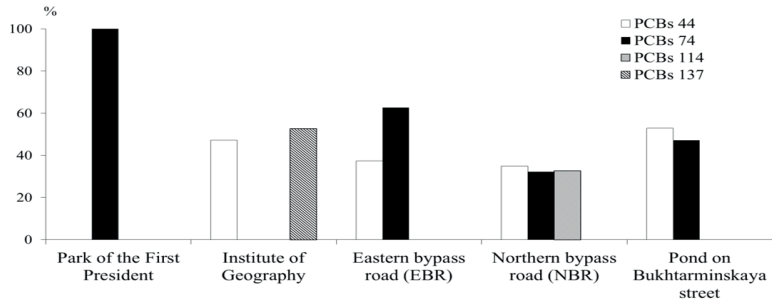

Figure 5. The relative content of PCB congeners in the snow cover of the Almaty city in 2020

100% of the PCB congeners 44 and 74 were found in the territory of two cities of zone 3 (Fig. 6). The relative content of other congeners is low.

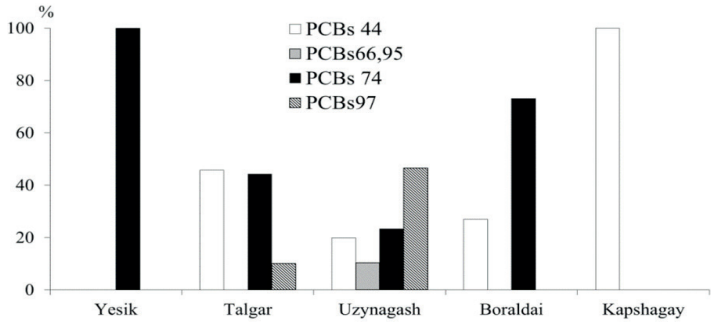

Figure 6. The relative content of PCB congeners in the snow cover of the STUV in 2020

A total of 5 PCB congeners were found in the STUV (Fig. 7). PCB congeners 44, 49, and 74 had 100% content. The relative proportion of congeners varies in a wide range from 3 to 100% in the SC of zone 3.

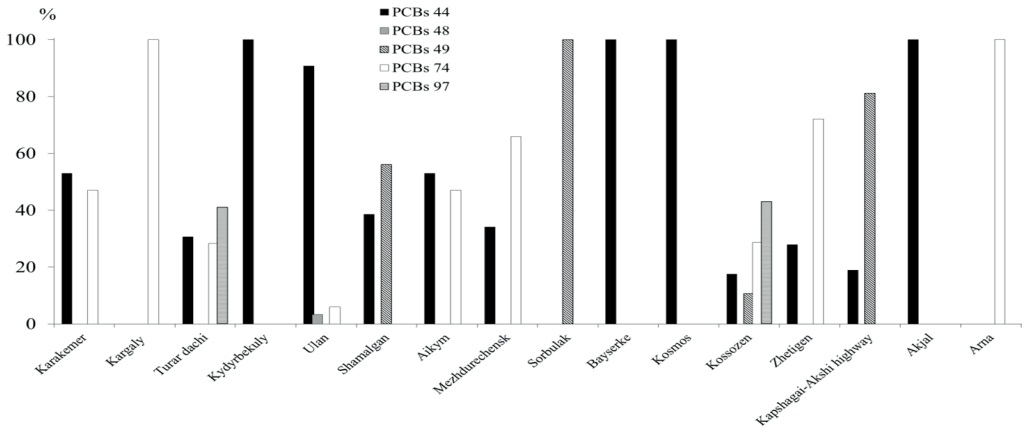

Figure 7. The relative content of PCB congeners in the snow cover of the SV in 2020

According to research by leading scientists in this field (Barenboim et al., 2010:13), the content of POPs compounds of atmospheric precipitation is influenced by two main types of pollution sources: local sources and global transport. The predominance of low-chlorinated congeners (dichlorobiphenyls and trichlorobiphenyls) of PCBs indicates a long-distance transfer of toxicants to the sampling area. The dominance in the total concentration of PCBs congeners belonging to the homologous group of tetra-, penta- and hexachlorobiphenyls is an indicator of the similarity of the composition of the detected PCBs with the composition of the main Sovol mixture, which was used in the USSR. Thus, this indicates the participation in the formation of the PCB composition mainly of local or regional sources of pollution in the sampling site.

The composition of the identified toxicants is mainly represented by congeners belonging to the homologous groups of tetra-, penta- and hexachlorobiphenyls (Table 1). Consequently, this may be a reason to believe that the SC of the AA is polluted mainly by sources located in this region.

Conclusion. The level of PCB contamination was investigated the first time in the SC of the vast Almaty agglomeration. The coverage of the territory with many snow sampling points allowed studying in more detail the distribution of the toxicant over the characteristic zones, which are urban, mountainous, and lowland territories with the different man-made load. Analytical data and analysis of the congener composition of PCBs registered in the SC of various zones shown that the main sources of pollution are local industrial enterprises, energy and other objects of various profiles. It is extremely expedient to develop scientific research on the level of PCB pollution of natural resources of the Republic of Kazakhstan.

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REFERENCES

Amed L.J., Lederman P.B. (1992) Critical evaluation of PBC remediation technologies, Environmental Progress, 11(3):173-177 (in Eng.).

Amirgaliev N.A. (2016) Polychlorinated biphenyls in the water ecosystem of the Ile-Balkhash basin, Nuray Print Service LLP, Almaty. ISBN: 978-601-7150-79-2 (in Russ.).

Amirgaliev N.A. (2014) Polychlorinated biphenyls in lake water. Balkhash and influent rivers, Water: chemistry and ecology, 9:102-106 (in Russ.).

Amirgaliyev N., Madibekov A., Mussakulkyzy A., Ismukhanova L., Kulbekova R. Polychlorinated biphenyls in the snow cover of Almaty agglomeration of the republic of Kazakhstan. 19th International Multidisciplinary Scientific GeoConference SGEM 2019. Conference proceedings. Volume 19. Ecology, economics, education and legislation. Ecology and Environmental protection (30 June – 6 July, 2019). Albena, Bulgaria, 2019, 541-549. https://doi.org/10.5593/sgem2019/5.1/S20.068

Arctic Assessment Report (1998) / In: Arctic Monitoring and Assessment Programme (AMAP). Chapter 6. Persistent Organic Pollutants, Oslo, Norway, pp 183-371 (in Eng.).

Arctic Pollution 2002 (2002) // In: Arctic Monitoring and Assessment Programme (AMAP). Oslo, Norway (in Eng.).

Barrett T., Feola G., Krylova V., Khusnitdinova M. (2017) The application of Rapid Appraisal of Agricultural Innovation Systems (RAAIS) to agricultural adaptation to climate change in Kazakhstan: A critical evaluation. Agricultural Systems, 151:106-113. DOI: 10.1016/j.agsy.2016.11.014 (in Eng.).

Barrett T., Feola G., Khusnitdinova M., Krylova V. (2017) Adapting Agricultural Water Use to Climate Change in a Post-Soviet Context: Challenges and Opportunities in Southeast Kazakhstan, Hum Ecol 45,747-762. DOI: 10.1007/s10745-017-9947-9 (in Eng.).

Barenboim G.M., Chiganova M.A., Avandeeva O.P. (2010) Methodological aspects of analysis of snow cover pollution in connection with their influence on the quality of natural waters, Water: chemistry and ecology, 11:13-23 (in Russ.).

Herbert B.M.S., Halsall C.S., Villa S., Jones C., Kallenborn R. (2005) Rapid changes in PCB and OC pesticide concentration in Arctic snow, Environmental Science and Technology, 39(9), 2998-3005 (in Eng.).

Kabdrahmanova S., Kabdysalym K., Shaymardan E., Kudaibergenov S. (2014) Inventory of PCB equipments in Kazahstan. The international workshop «Sustainable management of toxic pollutanats in Central Asia: towards a regional ecosystem model for environmental security», Proceedings Nato SFP–983931 Project. P.128-136 (in Eng.).

Kajiwara N., Ueno D., Monirith I., Tanabe S., Pourkazemi M., Aubrey D.G. (2003) Contamination by organochlorine compounds in sturgeons from Caspian Sea during 2001 and 2002, Marine Pollut. Bul., 46(6):741-747 (in Eng.).

Kannan N. (2000) The Handbook of Environmental Chemistry Part K New Types of Persistent Halogenated Compounds, ISBN 3-540-65838-6 (in Eng.).

Konoplev A.V., Nikitin V.A., Samsonov D.P., Chernik G.V., Rychkov A.M. (2005) Polychlorinated biphenyls and organochlorine pesticides in the atmosphere of the far Eastern Russian Arctic, Meteorology and hydrology,7:38-44 (in Russ.).

Laletin N.A. (2013) Migration of persistent organic pollutants in freshwater objects. Spitsbergen (oz. Mandatemi and manual. Wastac), Water: chemistry and ecology, 2:109-114 (in Russ.).

Methodological recommendations for assessing the degree of atmospheric air pollution in localities with metals based on their content in snow cover and soil (1990), p. 16 (in Russ.).

Riseprough R.U., Walker W., Schmidt T.T., de Lappe B.W., Conners C.W. (1976) Transfer of Chlorinated biphenyls to Antarctica, Nature, 264(5588):738-739 (in Eng.).

Safonova A.S., Chiganova M.A., Barenboim G.M. (2014) Application of information technologies for the analysis of toxicity of organic xenobiotics included in the International List of substances polluting the Baltic Sea, Water: chemistry and ecology, 9:78-85 (in Russ.).

Stockholm Convention on Persistent Organic Pollutants (2011), Stockholm. p. 53 (in Russ.).

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