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PRESENCE OF CONTAMINANTS IN THE ENVIRONMENT AND THE FOOD CHAIN OVER THE LAST 25 YEARS IN KAZAKHSTAN

In recent years, increasing attention is paid to the ecological and global issues related to environmental pollution by heavy metals and persistent organic pollutants. Pollution by metals is very noticeable in mining areas, as well as around foundries and metallurgical plants. Persistent organic pollutants are found everywhere, which can be explained by long-distance transport by wind and water, they remain for a long period of time in the environment, have the capacity for cumulation and can pass from one species to another through the food chain. The problems associated with the presence of heavy metals and POPs in the environment is relevant for the country. In this regard, the purpose of this work was to determine the points of contamination with contaminants for further studies the effect of these compounds on the food chain. This article aimed to summarize data reporting concentrations of environmental contaminants in various regions of Kazakhstan. In the course of the work, was made an analysis of scientific articles measured concentrations of contaminants in Kazakhstan, primarily in environmental matrices (soil, water, plants) and in livestock products.Thus, territories containing elevated concentrations of heavy metals, organic pollutants and pesticides in various environmental components were identified. The obtained data have an important theoretical value and contain useful information for further research.

Key words: environmental pollution,heavy metals, organic pollutants, pesticides.

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Қазақстандағы соңғы 25 жылдағы қоршаған ортада және азық-түлік тізбегіндегі ластаушы заттардың болуын анықтау

Соңғы жылдары қоршаған ортаның ауыр металдармен және тұрақты органикалық ластағыштармен ластануына байланысты экологиялық және жаһандық мәселелерге көп көңіл бөлінуде. Ауыр металдармен ластануы тау-кен өнеркәсіптердің, сондай-ақ құйма және металлургиялық зауыттардың айналасында байқалады. Тұрақты органикалық ластағыштар жел мен су арқылы алыс қашықтықта тасымалдануына байланысты барлық жерлерде кездеседі, олар кумуляция қабілетіне ие, және де ұзақ уақыт бойы қоршаған ортада сақталып, азық-түлік тізбегі арқылы бір түрден екіншісіне ауыса алады. Қоршаған ортада ауыр металдар мен тұрақты органикалық ластаушылардың, соның ішінде пестицидтердің болуына байланысты туындайтын мәселелер мемлекет үшін маңызды болып табылады. Осыған байланысты жұмыстың мақсаты аталған қосылыстардың тамақ тізбегіне әсерін одан әрі зерттеу үшін түрлі ластаушы заттармен ластанған аймақтарды анықтауға бағытталған. Мақалада Қазақстанның түрлі аймақтарында ластаушы заттардың концентрациясы туралы мәліметтер жинақталып қарастырылған. Жұмыс барысында Қазақстанда өндірілетін мал шаруашылық өнімдерінде және экологиялық матрицаларда (топырақ, су, өсімдіктер) ластаушылардың концентрациясын (ауыр металдар, органикалық ластағыштар, пестицидтер) анықтауға жүргізілген ғылыми зерттеулерге талдау жасалынды. Осылайша, әртүрлі экологиялық компоненттерде ауыр металдардың, органикалық ластағыштардың және пестицидтердің жоғары концентрациясы бар аумақтар анықталды. Алынған нәтижелер алдағы уақытта зерттеу жұмыстарын жүргізуге қажетті ақпарат пен маңызды теориялық құндылыққа ие.

Түйін сөздер: ауыр металдар, қоршаған орта ластануы, органикалық ластағыштар, пестицидтер.

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Присутствие загрязнителей в окружающей среде и пищевой цепи в Казахстане за последние 25 лет

В последние годы все большее внимание уделяется экологическим и глобальным проблемам загрязнения окружающей среды тяжелыми металлами и стойкими органическими загрязнителями. Загрязнение металлами очень заметно в горнодобывающих районах, а также вокруг литейных и металлургических заводов. Стойкие органические загрязнители встречаются повсюду, что можно объяснить переносом на большие расстояния ветром и водой, они остаются в течение длительного периода времени в окружающей среде, обладают способностью к кумуляции и могут переходить от одного вида к другому через пищевую цепь. Проблемы, связанные с наличием тяжелых металлов и стойких органических загрязнителей, в том числе и пестицидов в окружающей среде, являются актуальными для страны. В связи с этим, целью настоящей работы является определение точек загрязнения различными контаминантами для дальнейшего исследования влияния этих соединений на пищевую цепь. В этой статье обобщены данные о концентрации загрязнителей в окружающей среде различных регионов Казахстана. В ходе работы был выполнен анализ результатов научных исследований, посвященных измерению концентраций загрязняющих веществ (тяжелых металлов, органических загрязнителей, пестицидов) на территории Казахстана в первую очередь в экологических матрицах (почве, воде, растениях) и в продуктах животноводства. Таким образом, были выявлены территории, содержащие повышенные концентрации тяжелых металлов, органических загрязнителей и пестицидов в различных компонентах окружающей среды. Полученные данные имеют важное теоретическое значение и содержат полезную информацию для дальнейших исследований.

Ключевые слова: загрязнение окружающей среды, органические загрязнители, пестициды, тяжелые металлы.

Kazakhstan is the largest economy in Central Asia and holds vast reserves of oil, gas and other mining products. Shipments of oil, ferrous metals, copper, aluminum, zinc and uranium have been the engine of economic growth, accounting for more than 90 percent of total exports and for around 40 percent of GDP (https://tradingeconomics.com/kazakhstan/gdp-growth). The exploration of these resources is on the one hand necessary to allow the economic development of the country, but on the other hand can provoke consequent contaminations around mining sites or processing plants.

Pollution of environment with heavy metals, especially near large cities and large industrial plants, has become one of the environmental problems for Kazakhstan. In the industrial regions of the country, significant centers of anthropogenic disturbances and contamination of the soil cover are widespread (Shepelev, 2017: 135).

Agriculture plays also a central place in the development of Kazakhstan. Indeed, intensive crop culture is a warranty for food self-sufficiency, especially in grain, but also to produce feed for livestock. The improvement of agricultural yields passes by an increased use of fertilizers and pesticides, which can be recovered in the environment. However, certain efficient organochlorinated pesticides have unfortunately been shown to be very persistent with toxic effects on Human health after a chronic exposure. Although these pesticides are forbidden today, their half-life time make that we have to cope with their presence in the environment for a long time. The DDT is one example of such pesticides used in Kazakhstan but the Stockholm convention was list other pesticides of this group.

Along with the pesticides that belong to POPs, the environment has also be affected by compounds coming from different combustion processes such as dioxins (i.e. PCDDs and PCDFs) and PAHs. They can be produced by road transport (thermic engins), mining and the development of the petroleum industry in Kazakhstan (CAGR 2,0508 % in 2012, www.tradingeconomics.com). Therefore, problems due to the presence of POPs are very relevant for the country and the problem of environmental pollution is topical. By signing the Stockholm Convention on 23 May 2001 and ratifying it on 7 June 2007, the Republic of Kazakhstan announced its intention to follow the course of the world community to at least limit and if possible to eliminate hazardous chemicals in order to improve the environmental contaminations and Human health.

Therefore, this article aimes to summarize published data reporting concentrations of environmental contaminants in various regions of Kazakhstan. This reviewpresents the results of scientific articles treating measured concentrations of contaminants (heavy metals, organic contaminants, pesticides) on the territory of Kazakhstan first in environmental matrixes (soil, water, plants), then in their produced Food (milk, plants destinated to Human consumption). Thus, this overview of published results should allow analyzing the development of the environmental situation during the last 25 years in Kazakhstan and the risks for the contamination of Food and consequently Human health.

1. Concentrations of contaminants in environmental matrixes

1.1 Heavy metals

Heavy metals (HM) are a group of metallic elements with a density greater than 5 g/cm^3 and an atomic mass exceeding that of calcium (MW=40). Most of the HM are extremely toxic.For example, the main consequences of prolonged exposure to low levels of cadmium are chronicobstructive pulmonary disease and emphysema, chronic renal tubular disease. There may also be consequences for the cardiovascular and skeletal systems. The concerns of leadexposure for adultsare peripheral or chronic nephropathy (Goyer, 1996: 812-813).

We revealed 20 scientific articles reporting concentrations of HM in soil, plants or water in Kazakhstan. We focused our literature review on the frequent occurrence of HM regulated in Kazakhstan. Indeed, the Republic of Kazakhstan limited permissibleconcentrations of zinc, copper, cadmium, lead and mercury in soil, water and plants (Joint Order No. 99 of the Minister of Health of the Republic of Kazakhstan of January 30, 2004 and the Minister of Environmental Protection of the Republic of Kazakhstan dated January 27, 2004, No. 21-p; Order of the Minister of National Economy of the Republic of Kazakhstan of June 25, 2015 No. 452). Nowadays, the most common and studied HM in the soil of various regions of Kazakhstan are zinc, copper, lead, cadmium, mercury and nickel.Environmental pollution is very common around emitting sources such as mining areas, foundries and smelters, and other metal-based industrial operations. Therefore, measurements on such sites are on a special interest (Abduazhitova, 2014: 122-125).

1.1.1 Soil

Zinc (Zn) is a vital metal, and a deficit Pbs tosevere health consequences. Nevertheless, an excess can also Pb to health problems. Indeed, a chronic exposureto Zn of 0,5 g/kg body weight and day are reported to enhance toxic effects in laboratory rodents (Goyer, 1996: 812-813). The results of various studies reporting the concentration of Zn in soil in various regions of Kazakhstan were presented in table 1.

Data from 8 articles reporting Zn concentrations in soil of 26 measuring points have been summarized in table 1. In 81% of the reported sampling points the Zn concentration exceeded the maximum allowable concentration (MAC) in the soil of the Republic of Kazakhstan (Joint Order No. 99 of the Minister of Health of the Republic of Kazakhstan of January 30, 2004 and the Minister of Environmental Protection of the Republic of Kazakhstan dated January 27, 2004, No. 21-p). The highest concentrations in soil are reported in the area at the Northern industrial zone of Ust-Kamenogorsk (852,6 mg/kg). Indeed, different smelters and Zn treating factories exist in that zone which can be considered as the main emission source (Boluspaeva, 2012: 803-810).Moreover, even in distant regions as Almaty or the Burlinsky district in West Kazakhstan, the regulatory threshold is overpassed in the majority of measurement points (21 out of 26). In the Burlinsky district (West Kazakhstan), the complex gas-processing unit can be source of Zn emission explaining these high concentrations. By the way, such high concentrations in this area do not concern only Zn but also other HM, as well as some organic compounds. The composition of gas emissions is very complex and depends on the nature of the production and the fuel burnt. The emission in the atmosphere may concern many organic and inorganic compounds, and in the latter can be isolated metal and non-metallic components.

Table 1 – Concentration of different HM (mg/kg dry soil) in soil of different regions of Kazakhstan

Region	Sampling site	Zn[1]	Cu[1]	Cd[1]	Pb[1]	Hg[1]	Ni[1]	Samp-ling date	Ref.
Balkhash	NW of tailing pond	42,0	76,6	0,20	25,1	n.a	28,0	before 2002	16
Balkhash	Zone of influence of tailing pond	40,0	16,4	0,30	20,7	n.a	28,0	before 2002	16
Pavlodar	N of industrial zone	150,2	55,2	1,79	54,1	3,5**	75,9**	2001-2002	19
Pavlodar	E of industrial zone	178,2	73,5	3,40	83,8	0,2	66,1	2001-2002	19
Pavlodar	Central residential zone	89,6	47,1	1,21	46,6	0,1	51,5	2001-2002	19
Pavlodar	Suburbs N	58,9	23,5	0,64	28,7	0,2	47,1	2001-2002	19
Burlinsky district, W-Kazakhstan	12 km SW from complex gas-processing unit (site 1)	33,8	5,4	1,97	7,1	n.a	n.a	before 2008	9
Burlinsky district, W-Kazakhstan	4 km SW from complex gas-processing unit (site 2)	21,3	17,5	0,90	6,9	n.a	n.a	before 2008	9
Burlinsky district, W-Kazakhstan	near complex gas-processing unit (site 3)	33,5	11,6	0,60	2,2	n.a	n.a	before 2008	9
Ust-Kamenogorsk	N- industrial zone	852,6**	139,1**	5,80**	95,5**	n.a	n.a	before 2012	8
Ust-Kamenogorsk	NE industrial zone	143,3	90,9	2,36	63,0	n.a	n.a	before 2012	8
Ust-Kamenogorsk	Central residential zone	159,6	66,9	1,10	43,6	n.a	n.a	before 2012	8
Ust-Kamenogorsk	E suburbs	108,4	45,7	0,90	38,4	n.a	n.a	before 2012	8
Almaty	Near road (site 1) – spring	59,6	36,4	0,51	44,8	n.a	n.a	2007-2010	10
Almaty	Near road (site 2) – spring	59,2	43,7	0,39	42,1	n.a	n.a	2007-2010	10
Almaty	Near road (site 3) –spring	59,7	52,7	0,67	50,5	n.a	n.a	2007-2010	10
Almaty	Heat & power plant (site 4) – spring	60,7	42,8	0,41	63,8	n.a	n.a	2007-2010	10
25 km from Almaty	Rural area (site 5) – spring	41,3	21,5	0,16	19,8	n.a	n.a	2007-2010	10
Almaty	Near road (site 1) -autumn	36,7	22,6	0,11	18,7	n.a	n.a	2007-2010	10
Almaty	Near road (site 2) –autumn	35,7	22,4	0,16	20,4	n.a	n.a	2007-2010	10
Almaty	Near road (site 3) – autumn	57,2	36,2	0,24	61,4	n.a	n.a	2007-2010	10
Almaty	Heat & power plant (site 4) – autumn	49,6	33,5	0,17	41,6	n.a	n.a	2007-2010	10
25 km from Almaty	Rural area (site 5) – autumn	28,4	16,3	0,05	15,8	n.a	n.a	2007-2010	10
Kurday site	near Sheldomak river (site 8)	n.a	62	0,29	24	n.a	41	2006	17
Kurday site	near Sheldomak river (site 9)	n.a	91	0,33	40	n.a	42	2006	17
Kurday site	near Shilozek river (site 10)	n.a	47	0,37	30	n.a	20	2006	17
Kurday site	near Shilozek river (site 11)	n.a	86	0,87	n.a	n.a	54	2006	17
Kurday site	near Pit lake (site 12)	n.a	78	0,36	29	n.a	30	2006	17
Kurday site	near Pit lake (site 17)	n.a	21	0,30	16	n.a	43	2006	17
Kurday site	near Pit lake (site 18)	n.a	58	0,94	70	n.a	48	2006	17
Zhalagash village	72 km from Kyzylorda	0,5	0,3	0,10	0,2	0,03	2,5	2014–2015	11
Zhosaly village	150 km from Kyzylorda	0,3 *	0,2	0,10	0,2	0,03*	2,5	2015	12
Irgiz village	430 km from Aktobe	<0,1	<0,1*	<0,01*	0,2*	0	0,9*	2015	13

Notes: *minimal concentration; **maximal concentration; n.a not analyzed; 1 maximal allowable concentrations (mg/kg of dry soil) according to Joint Order of the Ministry of Health of the Republic of Kazakhstan of January 30, 2004 No. 99, Zn 23,0; Cu 33,0; Cd 0,5; Pb 32,0; Ni 4,0 and according to Order of the Ministry of National Economy of the Republic of Kazakhstan of June 25, 2015 No. 452, Hg 2,1; Grey background: concentration overpassing regulation thresholds

In samples from site 2, which located in 4 km south west from this complex, concentration of Zn was one and a half times less (21,3 mg/kg) in than from site 3, which located in the center of the industrial zone (33,5mg/kg) (Kin, 2008: 269-275).

In Almaty sites 1-3 are located near roads, site 4 located near the combined heat and power plant, and site 5 is situated in a rural area at 25 km from the town. Samples from this sites have higher concentrations in spring, than samples taken at the same place in fall (for example, site 4 60,7versus 49,6 mg/kg, respectively for spring and fall). This can be explained by the fact that the spring samples of the soil contain the concentration of Zn accumulated during the heating period (fall-winter) but not these taken at the end of the summer (Mynbaeva, 2012:284-292). Globally, 81% of the concentrations overpassed the regulation threshold of 23 mg/kg (Joint Order No. 99 of the Minister of Health of the Republic of Kazakhstan of January 30, 2004 and the Minister of Environmental Protection of the Republic of Kazakhstan dated January 27, 2004, No. 21-p) and only samples taken in very remote areas (Zhalagash, Zhosaly, Irgiz) showed very low background concentrations of Zn in the soil (Hanturina, 2015a:83-86;Hanturina, 2015б:87-90; Mahaev, 2016: 62-66).

According to the analysis of the European Commission for the extension of the periodic survey of the land use (LUCAS, 2009) for sampling and analysis of the main properties of the topsoil in 23 EU member states, the excess Zn appears on agricultural land in more than 20% of the regions of Europe (NUTS), showing concentrations over the threshold. However, the threshold level was exceeded in less than 1% of the samples. In accordance to Tóth (2016), Zn pollution in the EU concerns only certain areas with agricultural use and does generally not bear a not able risk to the safety of food in Europe. However, it should be noted that the different types of Zn are absorbed at different degrees, which may modulate the risk of toxicity depending on local conditions.The basis of this European Topsoil Survey, the authors used the standards established in the Finnish legislation on soil contaminated (MEF, 2007). Finnish Standard values represent a good approximation of the mean values of the various national systems in Europe and they are applied in the international context forsoils (Tóth, 2016: 299-309).

The Zn concentration in soil depends on the emitted amounts (emitting intensity) but also on the distance from the potential source of emission into the atmosphere, which explains the increased Zn concentration in the soil around the site. The high proportion of overpassed concentrations of Zn in soil underlines a real concern about the Zn contamination of soil in different zones of Kazakhstan.

Copper (Cu) is widely distributed in nature and is an important element in nutrition of animals and human. Nevertheless, a chronic exposure of 30 mg per kg of body weight and day is considered to enhance toxic effects on Humans (Cuivre et composés, 2013).Exposure of Cu in industryare particles in mines or metal fumes during melting, metal welding and related activities (Goyer, 1996: 812-813). The table 1 summarizes the results of different studies reporting the concentrations of Cuin soil of various regions of Kazakhstan.

According to this data, 19 of the 33 measurement points (i.e. 58%) showed concentrations over the regulation threshold concentration of Cu exceeded the MAC of Cu in the soil (Joint Order No. 99 of the Minister of Health of the Republic of Kazakhstan of January 30, 2004 and the Minister of Environmental Protection of the Republic of Kazakhstan dated January 27, 2004, No.21-p). The highest concentrations of Cu in soil are reported for the area in the northern industrial zone of Ust-Kamenogorsk (139,1 mg Cu/kg of dry soil), where large industrial enterprises are concentrated. Also high concentrations of Cu are noted in soil close to the vicinity of the Balkhash concentrator (91 mg/kg), where copper-molybdenum ores are enriched. The tailings pond is a potential source of soil contamination with HM in this area (Baymakova, 2002: 48-57). In addition, soil sampled around the Kurday district, located in Zhambyl region, and Pavlodar overpass regulation threshold of 33 mg/kg soil by two or three times. Data from soil sampled in the town of Almaty differ again between higher concentrations in spring in comparison to these sampled in fall. Nevertheless, these concentrations stay quite close to the regulatory threshold. However, in remote areas (Zhalagash, Zhosaly, Irgiz, and to a lesser extent, Burlinsky district) without identified emission sources, only background concentrations of <0,4 mg/kg are revealed. It seems that metal smelters as Ust-Kamenogorsk and in a lesser extent large towns present main emission sources enhancing to soil contaminated in Cu even if the proportion of samples, which overpass the regulatory threshold, is not so elevated than for Zn. High concentrations of Cu in Kurdai district, indicated the presence of additional mineral sources in the surroundings of the site (Salbu B, 2013: 14-27).

Agricultural lands in European countries are mainly affected in France, Italy, Portugal and Romania. Although the proportion of samples with a Cu concentration above the indicative value is rather low among all samples, its share exceeding 2% in some regions of France and Italy indicates a potential problem for food production (Tóth, 2016: 299-309).

Concentration of Cu in the soil of different regions also depends on the distance from the potential source of Cu emissions to the atmosphere, which explains the increased Cu concentration in the soil around the areas where large industrial enterprises are concentrated.

Cadmium (Cd) is a widely used metal with non-corrosive properties. This metal is used in galvanization, as a coloring pigment for paints and plastics andas a cathode material for nickel-cadmiumbatteries. Moreover, Cd is a by-product of extraction and smelting of Zn and Pb. Thus, there are numerous sources of environmental contamination with Cd (Goyer, 1996: 812-813). Unfortunately, Cd is also very toxic as a chronic exposure of only 0,05 mg per kg body weight and day showed very toxic effects on kidney and bones (Cadmium et composés minéraux, 2013).

Our literature review is based on the same 9 articles reporting measurements in soil realized between 2001 and 2015 (table 1). The concentration of Cd in soil showed that in 45% of sampling points the concentration of Cd exceeded the MAC, in 15 points out of 33. As for previously treated metals, the most polluted soil is in the area at northern industrial zone of Ust-Kamenogorsk (close proximity to industrial enterprises) reaching 5,8 mg Cd/kg soil, i.e. 11 times over the regulatory threshold (Joint Order No. 99 of the Minister of Health of the Republic of Kazakhstan of January 30, 2004 and the Minister of Environmental Protection of the Republic of Kazakhstan dated January 27, 2004, No. 21-p). Also, elevated concentrations of Cd are observed in eastern industrial zone of Pavlodar (3,4 mg/kg), where function such industrial enterprises like refinery, chemical and tractor factories (Panin, 2006: 171-177). The samples taken in the towns of Almaty and Kurday were quite close to the regulatory threshold including some overpassing points. As noted previously for other HM, the Cd concentration in soil depends on the distance from the emitting source. It is highest in samples taken in the industrial zones (Ust-Kamenogorsk and Pavlodar) with >2 mg/kg, followed by these in the residential zone or suburbs of the same towns (1±0,2 mg/kg), and finally towns with only diffuse emitting sources (Kurday and Almaty) with concentrations of 0,41±0,2 mg/kg on average. Samples of remote areas never overpasses 0,16 mg/kg and averaged only 0,08 mg/kg which can be explained by the remoteness and the absence of emitting sources in these areas.

In most soil samples in Europe (72,6%), were not found detectable Cd concentrations, and only 5,5% of the samples had concentrations above the European threshold. Ireland and Greece are the regions with the highest average concentration of Cd. Nevertheless, agricultural areas in Europe are safe from Cd contamination now. Only special cases in France and Spain revealed soil samples with concentrations above the indicative values established for agricultural lands (Tóth, 2016: 299-309).

The frequency and the revealed concentrations show that the Cd contamination of soil in Kazakhstan is an issue to improve the Food safety by protecting the food chain in certain areas of the country.

Lead (Pb) is a frequent heavy metal and is widely present in small quantities in the earth's crust. Although small concentrations of Pbin the environment are natural, the highest concentrations of Pb are released as a result of anthropogenic activities, such as mining and burning of fuel. At present, Pb is widely used in industrial production, in agriculture and for household purposes, in the manufacture of ammunition, metal pipes, batteries and devices to protect against X-rays (Boluspaeva, 2012: 803-810).

In conformity with the table 1,15 of the 32 measurement points (i.e. 46,8%) showed concentrations over the regulation threshold concentration of Pb exceeded the MAC of Pb in the soil of Kazakhstan (Joint Order No. 99 of the Minister of Health of the Republic of Kazakhstan of January 30, 2004 and the Minister of Environmental Protection of the Republic of Kazakhstan dated January 27, 2004, No. 21-p). As for previously treated metals, the most polluted are the soil in the area at northern industrial zone of Ust-Kamenogorsk (close proximity to industrial enterprises) reaching 95,5 mg/kg, i.e. 3 times over the MAC. Also a high concentrations of Pb in soil is observed in eastern industrial zone of Pavlodar (83,8 mg/kg), where, as noted previously, function large industrial enterprises (Panin, 2006: 171-177). However, in remote areas (Zhalagash, Zhosaly, Irgiz) without identified emission sources, only background concentrations of <0,2 mg / kg dry soil are revealed.

The highest proportion of samples with a relatively high concentration of Pb in soils was observed in Central Italy, France and the United Kingdom. In soil samples of agricultural lands in Finland, Hungary and the Baltic countries, there were not found trace of Pb contamination. However, the concentration of Pb in none of these samples did not exceed the estimated value for agricultural land, except for a few cases among more than twenty thousand samples. Thus, Pb is not a problem for food safety in Europe(Tóth, 2016: 299-309).

Based on this data, it follows that the concentration of Pb in the soil of different regions also depends on the distance from the potential source of Pb emissions to the atmosphere, which explains the increased Pb concentration in the soil around the areas where large industrial enterprises are concentrated.

Mercury (Hg) is a heavy metal that belongs to the transition elements of the periodic table. This element is found in nature in three forms (elementary, inorganic and organic), this is its uniqueness. All forms of Hg are toxic and their effects affect the gastrointestinal tract, the nervous and excretory system of human (Goyer, 1996: 812-813). Hg moves along the food chain as follows: it penetrates into the water as a natural process of depositing gases from the earth's crust, as well as through industrial pollution. Then microorganisms methylate inorganic forms of Hg to methylmercury. Methylmercury makes its way through the food chain to the fish, and finally to the Human consumers. Currently, Hg has many uses in industrial processes, including the production of caustic soda, in nuclear reactors, as antifungal agents for wood processing (Tchounwou, 2012: 133-164).

Anthropogenic activity is the main factor of soil contamination with Hg. For example, the extraction of gold and Hg results in high concentrations of Hg in the mine areas, which may be responsible for high concentrations of Hg in some soil samples from Central Italy, North West England and Eastern Slovakia. In the agricultural lands of France, Germany, Italy and Spain, there were special cases of exceeding the estimated values of Hg, which requires the need for more stringent control of Hg throughout the food chain (Tóth, 2016: 299-309). In Kazakh conditions, only data from 4 articles reporting Hg concentrations in soil of 7 measuring points are available to be summarized in table 1. In the studied soil of various regions of Kazakhstan, there are no elevated Hg concentrations, with the exception of the northern industrial zone of Pavlodar (3,51 mg/kg dry soil), where a large industrial enterprises are concentrate (Panin, 2006: 171-177).The lowest background concentrations (0,03 mg/kg dry soil) are observed in very remote areas Zhalagash and Zhosaly, without identified emission sources (Hanturina, 2015a:83-86; Hanturina, 2015б:87-90).

The very low frequency and identified concentrations show that Hg contamination of soil in Kazakhstan is not a widely studied. Only in several regions with large industrial enterprises identified the concentrations of Hg in soil. It follows, that in future the attention of research should bemore focused on the concentration in soil of elements as Hg in Kazakh soils, especially in areas with probably emitting activities.

Nickel (Ni) is a transition metal, which is now widely used in modern industries, from the production of coins to cars and jewelry (Alloway, 2013: 11-50). But Ni is also ubiquitous in nature and specific of some areas with a specific pedogeologic context. Persons can be chronically exposed to low concentrations through air, cigarette smoke, water and food (Klaassen, 2013:982-983). Ni is a carcinogen of respiratory organs in workers in the Ni processing industry (Goyer, 1996: 812-813). The data of Ni concentration in soil at different regions of Kazakhstan are shown in table 1. According to this data, 16 of the 19 measurement points (i.e. 84,2%) showed concentrations over the MAC (Joint Order No. 99 of the Minister of Health of the Republic of Kazakhstan of January 30, 2004 and the Minister of Environmental Protection of the Republic of Kazakhstan dated January 27, 2004, No. 21-p). The exception is remote rural areas without identified emission sources, where are revealed background concentrations under the regulatory threshold (Zhalagash, Zhosaly, Irgiz). The highest concentrations (75,9 mg/kg dry soil), i.e. 19 times over the regulatory threshold are observed in the northern industrial zone of Pavlodar, where function such industrial enterprises like refinery, chemical and tractor factories (Panin, 2006: 171-177).

One of the consequences of anthropogenic impact on the environment is the increase of HM in the environment. This problem is especially relevant for cities in which large industrial enterprises are located. As a result of the activity of factories, large volumes of dust are emitted in the atmosphere, which may contains HM enter the upper layers of soil. Therefore, metals can reach high concentrations in upper layers of soil around the plants as smelters, often exceeding the permissible concentrations. Concentration of Ni in soil depends as previously other HM on the distance from the potential source of emissions into the atmosphere, which explains the increased concentration in the soil around the sites with industrial enterprises.

1.1.2 Sediments

Water pollution can change rapidly depending on theanthropogenic load and hydrodynamic processes. Then bottom sediments are more inert in their characteristics. Bottom sediments contain long-term pollutants and act as an indicator of human-made pollution. Due to their absorbing capacity, sediments play an exceptional role in the processes of self-purification of reservoirs. However, they can cause secondary contamination of the aquatic environment (Sharipova, 2015: 225–230).

We analyzed several articles have been found reporting measurements in bottom sediments in various reservoirs of Kazakhstan realized between 2000 and 2013 (table 2).

Data on concentrations of Zn, Cu, Cd and Pbin bottom sediments of various water bodies in Kazakhstan are given in table 2. At present, there is no relevant maximum permissible concentrations for HM in bottom sediments. By-this comparative analysis is carried out with background values in the soil of the region.

Proceed from the data in the table 2, the highest Cu concentrations observed in River Shilosek (220 mg/kg sediments) at Kurday, Zhambyl region, which are supposedly reflecting localized mineral springs in the area. Also, high concentrations of Zn (67,2 mg/kg dry sediments in 2003-2007, versus 62,5 mg/kg in 2008-2011), Cu (211 mg/kg dry sediments in 2003-2007 versus 144 mg/kg in 2008-2011) and Pb (124mg/kg dry sediments in 2003-2007, versus 102 mg/kg in 2008-2011) observed in the 4 region of the lake Balkhash, in particular in the vicinity of Bertys Bay and Torangalik Bay, where a contamination with waste from the metallurgical plant can be found.

Table 2 – Concentration of different HM in sediments of water reservoirs in Kazakhstan (mg/kg dry sediments)

Rezervoir	Sampling site	Zn	Cu	Cd	Pb	Sampling date	Ref
Caspian Sea	No data	n.a.	6,4	0,05	-	Before 2004	24
Pit Lake	No data	n.a.	80	2	56	May- June 2006	17
River Ospansu	No data	n.a.	33	<0,02	25	May- June 2006	17
River Sheldomak	No data	n.a.	11	0,12	11	May- June 2006	17
River Shilosek	No data	n.a.	220**	<0,02	27	May- June 2006	17
Balkhash lake	Hydrochemical region 1	20,6	20,3	1,08	22,2	2003-2007	23
Balkhash lake	Hydrochemical region 2	27,7	43,1	1,33	26,5	2003-2007	23
Balkhash lake	Hydrochemical region 3	22,9	42,9	1,42	33,3	2003-2007	23
Balkhash lake	Hydrochemical region 4	67,2**	211	1,76	124**	2003-2007	23
Balkhash lake	Hydrochemical region 5	25,6	27,6	1,09	16,1	2003-2007	23
Balkhash lake	Hydrochemical region 6	20,4	24,0	1,17	14,0	2003-2007	23
Balkhash lake	Hydrochemical region 7	27,4	25,8	1,34	26,7	2003-2007	23
Balkhash lake	Hydrochemical region 8	14,3	25,9	1,05	21,3	2003-2007	23
Balkhash lake	Hydrochemical region 1	24,9	39,1	0,65	32,3	2008-2011	23
Balkhash lake	Hydrochemical region 2	17,7	28,9	0,85	25,6	2008-2011	23
Balkhash lake	Hydrochemical region 3	21,3	30,6	0,94	20,7	2008-2011	23
Balkhash lake	Hydrochemical region 4	62,5	144	1,22	102	2008-2011	23
Balkhash lake	Hydrochemical region 5	18,1	25,9	0,71	11,8	2008-2011	23
Balkhash lake	Hydrochemical region 6	13,4*	16,7	0,73	11,6	2008-2011	23
Balkhash lake	Hydrochemical region 7	22,2	30,1	0,84	20,5	2008-2011	23
Balkhash lake	Hydrochemical region 8	16,5	23,8	0,75	19,3	2008-2011	23

Notes : *- minimal concentration; **- maximal concentration; n.a- not analyzed
The background concentration (mg/kg dry sediments) in the gray-brown soil Zn 45; Cu 30; Cd 2; Pb 20 according to Sharipova 2015; Grey background: concentration overpassing regulation thresholds

When comparing the concentrations in the samples of the bottom sediments of Balkhash 2003-2007 to these taken 2008-2011, it follows that the concentration of Zn during this period decreased by 7%, the concentration of Cu and Pb by 32% and 18%, respectively.

As for the concentration of Cd, in the bottom sediments of the investigated reservoirs, did not exceed the background concentrations in the soil of the region.

De Mora et al. (2004) and Ullrich et al. (2007) investigated concentration of Hg in sediments in different reservoirs of Kazakhstan in 2000-2002 (de Mora, 2004: 61-77; Ullrich, 2007: 1-16). Due the lack in Kazakhstan MAC for Hg in sediments, we used MAC for Hg in soil equal 2,1 mg Hg/kg of dry soil. The highest concentrations of Hg are observed in sediment samples taken from Lake Balkyldak, Pavlodar region (48,9-151,5 mg Hg/kg sediments). Obviously this is related to the fact that the lake receives sewage from the Pavlodar Chemical plant, which located 2 km north of the lake. Thus, the sediments of this lake should be considered as heavily polluted with Hg in comparison to the regulatory threshold for soil at 2,1 mg/kg (Joint Order No. 99 of the Minister of Health of the Republic of Kazakhstan of January 30, 2004 and the Minister of Environmental Protection of the Republic of Kazakhstan dated January 27, 2004, No. 21-p), which would represent a significant risk for the environment and Human health (de Mora, 2004: 61-77).

We analysed 15 articles, reporting concentrations of HM in soil and sediments of various regions of Kazakhstan. These data revealed a certain number of “hotspots” of contaminations. It follows that industrial objects have a direct effect on the concentration of HM in these matrices, especially when they are close to the places where soil samples were taken. Based on data from our literature synthesis, it can be concluded that HM in bottom sediments of reservoirs distributed unevenly. It depends not only on the structure of the soil and natural processes within the water bodies, but also on the receipt of metals by human-made means. The greatest concentrations of Zn, Cu and Pb are observed in the Lake Balkhash, in particular in the area, where located industrial enterprises.Also, high concentrations of Cu are observed in the Shilosek River in the Zhambyl region, where there are mineral springs. The concentrations of Cd do not exceed the background concentrations of this metal in soil. The most Hg polluted water reservoir is Lake Balkyldak, Pavlodar region, where the wastewater from the Pavlodar chemical plant falls. Pollution of bottom sediments, and hence of the reservoirs themselves with Hg, is a significant threat to human health and the environment.

1.1.3 Water

Data from 7 articles reporting HM concentrations in water of 53 measuring points in the period from 1999 to 2015 have been summarized in table 3. Water of all sampling points respected the MAC of Zn and Cu (Order No. 209 of the Minister of National Economy of the Republic of Kazakhstan of March 16, 2015). The concentration of Cd in water showed that in 56,7% of sampling points the concentration of Cd exceeded theMAC, in 21 points out of 37. This very sensitive regulation threshold of 0,001 mg/L is due to its very high toxicity and would enhance frequent overpassing during control. The highest concentrations of Cd observed in the water atborehole 108 in Ust-Kamenogorsk (0,0277 mg Cd/L of water), which is in 27 times more than the maximum allowed concentration. This sampling site located at 1 km from Ust-Kamenogorsk metallurgical complex – Pb and Zn smelter. This plant is still in operation and represents one of the greatest ecological threats on the environment (Hrkal, 2001: 174-182).

Also elevated concentrations of Cd are observed in Kapshagay reservoir(0,0252 mg Cd/L of water), which is in 25 times more than the maximum allowed concentration (Order No. 209 of the Minister of National Economy of the Republic of Kazakhstan of March 16, 2015). It explained by confluence of polluted waters of the small riversand the transboundary flow of the Ili River (Amirgaliev, 2014: 202-206).

The MAC of Pb in the water of Kazakhstan (Order No. 209 of the Minister of National Economy of the Republic of Kazakhstan of March 16, 2015) were respected in 33 of 37 sampling points (89,2%). The highest concentrations of Pb observed in the water at borehole 156 in Ust-Kamenogorsk (0,055mg Pb/Lof water) and in Kapshagay reservoir (0,054 mg Pb/L of water), which is in 1,8 times more than MAC. Borehole 156 in Ust-Kamenogorsk located at 1,5 km from the titanium and magnesium smelter, which is only occasionally in operation. Therefore, the probability of the origin of these dissolved metals from the industrial complex in Leninogorsk, several tens of kilometers upstream in the upper reaches of the Ulba River, is not excluded (Hrkal, 2001: 174-182). The elevated concentrations of Pb in Kapshagay reservoir, as noted previously, explained by the transboundary flow of the Ile River (Amirgaliev,2017: 109-113). The lowest background concentrations of Cd and Pb (0,0004 mg Cd/l of water and 0,00009 mg Pb/l of water) are observed in the Middle Kolsay lake, which located at high in Alatau mountains and for a long distance from the sources ofanthropogenic impact (Krupa, 2016: 2-10).

Table 3 – Concentration of different HM in water in different reservoirs of Kazakhstan (mg/l water)

Region	Sampling site	Zc[1]	Cu[1]	Cd[1]	Pb[1]	Ni[1]	Samp-ling date	Ref
Ust Kamenogorsk	borehole 156	0,010	0,006	<0,0001	0,055	0,002	1999	27
Ust Kamenogorsk	borehole 30	0,007	0,007	<0,0001	<0,010	<0,004	1999	27
Ust Kamenogorsk	borehole 108	0,0021	0,0086	0,0277	<0,010	0,00104	1999	27
Balkhash	Whole	0,028	0,018	0,0036	0,034	0,039	2004	31
Balkhash	West	0,039	0,022	0,0028	0,021	0,037	2004	31
Balkhash	East	0,017	0,013	0,0044	0,047	0,042	2004	31
Pit Lake	No data	n.a	0,0064	n.a	n.a	0,101	2006	17
Artesian water	No data	n.a	0,0078	n.a	n.a	0,026	2006	17
River Shilosek	No data	n.a	0,0039	n.a	n.a	0,025	2006	17
River Ospansu	No data	n.a	0,0062	n.a	n.a	0,022	2006	17
River Sheldomak	No data	n.a	0,0032	n.a	n.a	<0,001	2006	17
River Shu	No data	n.a	<0,001	n.a	n.a	0,002	2006	17
Kapshagay reservoir	No data	0,069	0,0090	0,0017	0,0042	0,0595	2006*	28
Kapshagay reservoir	No data	0,018	0,0036	0,00004	0,014	0,0254	2007*	28
Kapshagay reservoir	No data	0,031	0,028	0,00009	0,0026	0,0338	2008*	28
Kapshagay reservoir	No data	0,032	0,019	0,0048	0,0033	0,0364	2009*	28
Kapshagay reservoir	No data	0,047	0,033	0,0048	0,0041	0,0092	2010	28
Kapshagay reservoir	No data	0,047	0,045	0,0029	0,0051	0,0096	2011*	28
Kapshagay reservoir	No data	0,047	0,024	0,0013	0,0025	0,0083	2006**	28
Kapshagay reservoir	No data	0,028	0,034	0	0,054	0,0061	2007**	28
Kapshagay reservoir	No data	0,031	0,039	0	0,0014	0,0059	2008**	28
Kapshagay reservoir	No data	0,060	0,0083	0,0036	0,0031	0,0037	2009**	28
Kapshagay reservoir	No data	0,041	0,048	0,0034	0,0061	0,0027	2010**	28
Kapshagay reservoir	No data	0	0	0	0	0,0020	2011**	29
Kapshagay reservoir	No data	0,043	0,0048	0,0008	0,0241	0,0063	2001	29
Kapshagay reservoir	No data	0,0161	0,0472	0,0252	0,0150	0,118	2002	29
Kapshagay reservoir	No data	0,0457	0,0064	0,0011	0,0121	0,0138	2003	29
Kapshagay reservoir	No data	0,0417	0,0065	0,0026	0,0120	0,0005	2004	29
Kapshagay reservoir	No data	0,0436	0,0255	0,0078	0,0034	0,00001	2005	29
Kapshagay reservoir	No data	0,0568	0,0181	0,0013	0,0038	0,0595	2006	29
Kapshagay reservoir	No data	0,0488	0,0530	0,0040	0,0397	0,0254	2007	29
Kapshagay reservoir	No data	0,0683	0,0251	0,0058	0,0027	0,0338	2008	29
Kapshagay reservoir	No data	0,0418	0,0158	0,0042	0,0033	0,0364	2009	29
Kapshagay reservoir	No data	0,0439	0,0331	0,0044	0,0049	0,0092	2010	29
Kapshagay reservoir	No data	0,0384	0,0394	0,0018	0,0035	0,0096	2011	29
Kapshagay reservoir	No data	0,0256	0,0012	0,0004	0,0026	0,0083	2012	29
Kapshagay reservoir	No data	0,0113	0,0029	0,0031	0,0035	0,0061	2013	29
Kapshagay reservoir	No data	0,0224	0,0188	0,0013	0,0408	0,0059	2014	29
Kapshagay reservoir	No data	0,0243	0,0024	0,0015	0,0135	0,0037	2015	29
Almaty oblast	Low Kolsai lake	0,0009	0,0038	0,00045	0,00014	0,0018	2015	30
Almaty oblast	Middle Kolsai lake	0,0010	0,0031	0,0004*	0,00009	0,0017	2015	30
Almaty oblast	Upper Kolsai	0,0002	0,0026	0,0006	0,00010	0,0014	2015	30
Almaty oblast	under the Sarybulak pass	0,0016	0,0055	0,0004	0,00050	0,0027	2015	30

*- spring; **- summer; n.a- not analyzed;
1 maximal allowed concentrations (mg/L of water) according to Order by Minister of National Economy No. 209, dated March 16, 2015,Zn 1; Cu 1; Cd 0,001; Pb 0,03 and Ni 0,1
Grey background: concentration overpassing regulation thresholds cited here above

Only in 2 (4,6%) out of 43 sampling points the concentration of Ni over the regulatory threshold. The highest concentration of Ni is in the water at Kapshagay reservoir (0,118 mg Ni/l of water). Elevated concentrations of Ni in are explained by confluence of polluted waters of the small rivers from urban areas in Kapshagay reservoir (Amirgaliev, 2014: 202-206).

Industrial objects that are in close proximity to the places where water samples were selected have a direct effect on the concentration of HM in water. As a result, is formed an additional source of pollution of surface and groundwater, often used as drinking water,and it can influenced on the Human health.

1.1.4 Plants

We analyzed 2 articles (Kenzheeva, 2014: 162-166; Korolyov, 2017: 74-79), where were determined the concentrations of HM in vegetable crops originated in three regions of Kazakhstan.

The objects of researching was such vegetable crops as carrots (Daucus carota), cabbage (Brassica oleracea var.acephala), tomato (Lycopersicon esculentum), potato (Solanum tuberosum), beet (Beta vulgaris var.altissima) and onion (Allium). Only in 1 out of 16 samples the concentration of Zn exceeded the MAC (10 mg Zn/kg), a potato sample from west industrial zone of Semey (10,1 mg Zn/kg), which is located in the zone of influence of the cement plant. The lowest background concentrations (0,15 mg Zn/kg) are observed in potato at the country sites of the village "Vostochniy" in Semey.

In case of Cu in 3out of 16 analysed samples the concentration exceeded the MAC (5,0 mg Cu/kg). It observed at the same site in potato (10,1 mg Cu/kg), beet (8,7 mg Zn/kg) and tomato (5,6 mg Cu/kg). The lowest background concentrations (0,2 mg Cu/kg) are observed in cabbage at country sites of the village "Vostochniy" in Semey.

The highest concentration of Cd (0,15 mg Cd/kg) is detected in potatoes at country sites of the village "Vostochniy" in Semey (MAC for Cd 0,03 mg Cd/kg). In this site are observed the lowest (0,003mg/kg) background concentrations of Cd, it detected in tomato. Like in case of Zn and Cu the highest concentration of Pb observed in potato from west industrial zone of Semey (0,71 mg Pb/kg), MAC was exceeded in 4 out of 12 samples. The lowest background concentrations (0,07mg Pb/kg) are observed in cabbage at the country sites of the village "Vostochniy" in Semey.

In samples of carrot (Alau sort) and cabbage (Begabatskaya sort) from Almaty region the concentration of HM was not exceed the MAC. The same situation with samples of carrot (Shantene sort) and cabbage (Tashkentskaya sort) from South-Kazakhstan region.

The concentrations of such HM as Zn, Cu, Cd and Pb in plants of three regions of Kazakhstan were determined. Generally, no overpassed concentrations for Zn or Cu were revealed. Nevertheless, some concentrations of Cd and Pb were over the maximum tolerated threshold (Kenzheeva, 2014: 162-166), especially in root vegetables growing on a contaminated area in Semey. It is interesting to note that aerial parts of plants in the same sampling point (i.e. tomatoes) would not overpass these thresholds. Industrial objects that are in close proximity to the places where plants samples were selected have a direct effect on the concentration of HM in plants.

Heavy metals have accumulate in some living organisms in certain conditions. Thus, HM are a significant hazard to human health, getting into the body when eating vegetables grown in a polluted area(Korolyov, 2017: 74-79). We analyzed 20 literature sources where were determined the concentrations of such HM as in soil, sediments, water and plants of various regions of Kazakhstan. Industrial facilities located in close proximity to sampling sites have a direct effect on the concentration of HM in all these matrices. As a result, the quality of soil, surface and groundwater, as well as the plants that people eat, deteriorates and would not be convenient for the production of healthy Food. Therefore, the contamination of the environment in Kazakhstan by HM poses a serious threat in industrial areas with consequences for the quality of Food and Human health.

1.2 Organic pollutants

Persistent organic pollutants (POPs) are organic compounds that can remain in the environment for a very long time due to their properties, due to their resistance to photolytic, chemical and biological decomposition. Therefore, POPs are a major global issue and they can be transported far away from emission sources, are able to bio accumulation, especially in fatty tissues, and are highly toxic even at low concentrations. POPs can travel far away from the source and with high stability. They reach the ground surface through rain ordeposition of the flying ashes. The sources of POPs are mainly anthropogenic activitiesand can be introduced into the environment throughmany pathways. These compounds reach the environment through agricultural runoff, industrialeffluent, urban runoff, drainage system, deposition from the atmosphere and landfill leachate (Pariatamby, 2016: 842-848).

The representatives from 92 countries have agreed to sign the Stockholm Convention (2001) to reduce and/or eliminate the release of 12 original POP substances which are namely the dirty dozen, 10 intentionally produced chemicals: aldrin, eldrin, chlordane, Dichlorodiphenyltrichloroethane (DDT), dieldrin, heptachlor, mirex, toxaphene, hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs) and the two unintentionally produced substances polychlorinated dibenzo-para-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). But by now more than 15 new compounds have been added. POPs can be divided intentionally and unintentionally into two types of POPs, as shown in figure 1 (El-Shahawi, 2010: 1587-1597).

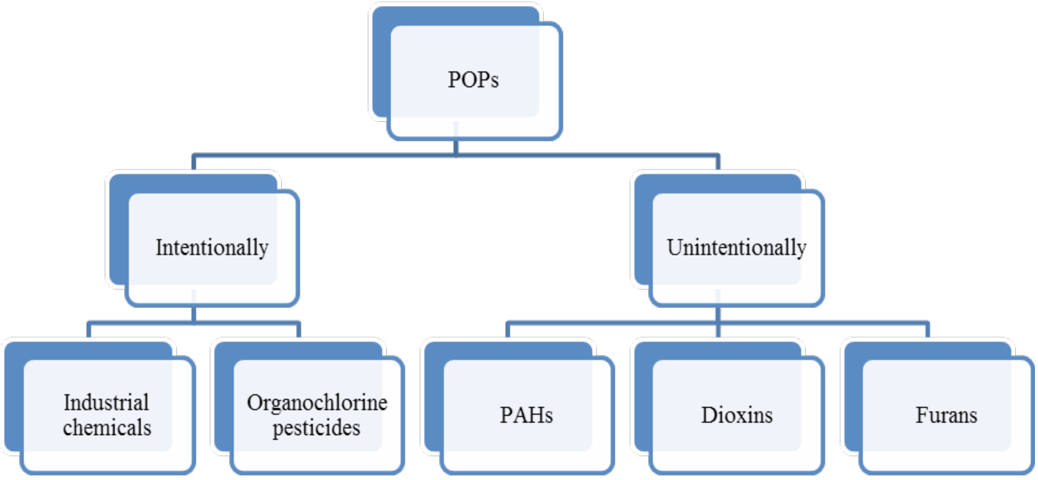

Figure 1 – Classification of POPs

The main sources of POP pollution are industrial waste discharges, sewage system drains and contaminated water that drain from agricultural fields and city streets. In the course of the research it was found that most POPs polluting aquatic ecosystems get there together with precipitation from atmospheric air. In many cases, the main sources of POPs release into the environment were located nearby. However, the scientists were surprised when they found that some POPs were getting to these ecosystems from remote sources after they had traveled thousands or even tens of thousands of kilometers with air currents. While POPs have the ability to move around the world, from warm regions to colder ones, mostly POPs enter the environment in places close to the original source of their formation. When POPs settle from the air, they sometimes get to the surface of water bodies, and sometimes to pastures or agricultural lands. In these places POPs become part of the food chain. When the ecosystem is contaminated by POPs, the organisms of people living in this ecosystem are also will be contaminate.

The most studied is the situation with the contamination of the territory of Kazakhstan with polychlorinated biphenyls (PCBs). They are chemicals that have been widely used in industry since the 1930s until the late 1970s. Although their production was banned in the late 1970s, most of the cumulative world production of PCBs is still in the environment. PCBs have been widely used in many industrial applications, including fire resistant transformers and insulating capacitors. Until 1977, they were used as liquids for heat exchangers, as well as for processing aluminum, copper, iron and steel (Berkinbaev, 2016: 3-8).

Our Republic inherited from the Soviet Union a number of strategic industrial and defense facilities in the territory of which stationary electrical equipment was located, which was often filled with PCBs. During the initial accounting, eight contaminated sites of PCBs in the country were identified. Despite this data, there are little information about contamination of environmental objects, food and producing animals.

1.2.1 Soil

Soil contamination of PCBs has not been adequately studied in Kazakhstan to date, which is probably due to the fact that the analysis of soil connection data is a fairly expensive process that requires special conditions and equipment for research. This problem is covered in the articles of the group of researchers "Scientific and Practical

Center for Sanitary and Epidemiological Examination and Monitoring" under the leadership of A. Sh. Nazhmetdinova (Nazhmetdinova, 2015: 1372-1377; Nazhmetdinova, 2017: 228-233). To analyze the state of contamination of PCBs in soil in various regions of Kazakhstan, the results obtained by scientists from 2015-2017 are presented in a single table 4. Since there is no data in Kazakhstan on Admissible concentrations (AAC) for the content of PCBs in soil, we used Russian Hygienic standards (HS) No.2.1.7.2042-06 (Nazhmetdinova, 2017: 228-233).

Table 4 – Concentration of PCB and dioxins (mg/kg of dry soil) in soil of two regions of Kazakhstan

Region	Sampling site	PCB[1] surface	PCB[1] depth	Dio-xins depth	Samp-ling date	Ref
Aiteke bi, Kyzylorda region	Cemetery	0,0004	0,02	n.d.	2015	38
Aiteke bi, Kyzylorda region	Branching of the railway	0,0009	0,1	0,001	2015	38
Aiteke bi, Kyzylorda region	Asphalt plant	0,004	0,01	0,002	2015	38
Aiteke bi, Kyzylorda region	Railway coal storage	0,004	0,08	0,0003	2015	38
Aiteke bi, Kyzylorda region	Brickworks	0,003	0,04	0,05	2015	38
Aiteke bi, Kyzylorda region	Borkulakov str.	0,0004	0,03	n.d.	2015	38
Aralsk, Kyzylorda region	Samara-Tashkent track	0,000009	0,002	n.d.	2015	38
Aralsk, Kyzylorda region	Airport area	0,0004	0,02	n.d.	2015	38
Aralsk, Kyzylorda region	Zhumash cemetery	0,00005	0,5	0,001	2015	38
Aralsk, Kyzylorda region	Almaty station str.	0,00004	0,05	n.d.	2015	38
Aralsk, Kyzylorda region	Energy grid	0,00005	0,01	0,002	2015	38
Aralsk, Kyzylorda region	Zharbol cemetery	0,0004	0,09	n.d.	2015	38
Aralsk, Kyzylorda region	Old pool	0,00004	0,005	n.d.	2015	38
Aralsk, Kyzylorda region	Arai microdistrict	0,0002	0,02	n.d.	2015	38
Aralsk, Kyzylorda region	Old military town	0,0004	0,7	0,01	2015	38
Zhosaly, Kyzylorda region	Krek substation	0,00002	0,1	0,001	2015	38
Zhosaly, Kyzylorda region	Railway bridge area	0,003	0,5	0,02	2015	38
Zhalagash, Kyzylorda region	Kalybaev str.	0,0001	0,005	n.d.	2015	38
Zhalagash, Kyzylorda region	Myrzalieva str., 71	0,0001	0,02	n.d.	2015	38
Zhalagash, Kyzylorda region	Shamenova str., 78	0,003	0,05	n.d.	2015	38
Zhalagash, Kyzylorda region	Elrai canal	0,003	0,5	0,005	2015	38
Zhalagash, Kyzylorda region	Mametova str.,1	0,001	0,07	0,001	2015	38
Almaty, Turksibsky district	Kaldayakov-Makatayev str.	n.a.	0,09	n.a.	2017	39
Almaty, Turksibsky district	Gas station Raiymbek 78	n.a.	0,13	n.a.	2017	39
Almaty, Turksibsky district	LLP Raiymbek 348	n.a.	0,095	n.a.	2017	39
Almaty, Turksibsky district	Gas station Raiymbek 432a	n.a.	0,53	n.a.	2017	39
Almaty, Turksibsky district	Mailin str., 85	n.a.	0,329	n.a.	2017	39
Almaty, Turksibsky district	Kapalsky str., 12	n.a.	0,277	n.a.	2017	39
Almaty, Turksibsky district	Malaya Almatinka river	n.a.	0,569	n.a.	2017	39
Almaty, Turksibsky district	Bukhtarminskaya str., 2	n.a.	0,56	n.a.	2017	39
Almaty, Turksibsky district	Altai microdistrict, 75	n.a.	0,307	n.a.	2017	39
Almaty, Almalinsky district	Tole bi str., 218	n.a.	0,565	n.a.	2017	39
Almaty, Almalinsky district	Sairan lake	n.a.	0,331	n.a.	2017	39
Almaty, Almalinsky district	Auezov – Gogol str.	n.a.	0,704	n.a.	2017	39
Almaty, Almalinsky district	Gogol str., 47	n.a.	0,248	n.a.	2017	39
Almaty, Zhetysusky district	Tobayakov str., 45	n.a.	0,155	n.a.	2017	39
Almaty, Zhetysusky district	Bulkashev str., 9a	n.a.	0,388	n.a.	2017	39
Almaty, Zhetysusky district	Seifullin str., 43	n.a.	0,113	n.a.	2017	39
Almaty, Zhetysusky district	Zhansugurova str., 176	n.a.	0,51	n.a.	2017	39

Notes: 1 According to Russian Hygienic standards (HS) No.2.1.7.2042-06. Approximate admissible concentrations (AAC) for the content of PCBs in soil is 0,06 mg/kg; n.a. not analyzed; n.d. not detected; Grey background: concentration overpassing AAC

In Kyzylorda region, in 9 of the 22 measurement points (i.e. 41%) showed concentrations over the approximate admissible concentrationsof PCBs in the soil (Nazhmetdinova, 2017: 228-233). Zhetysusky, Turksibsky and Almalinsky districts of Almaty, where soil samples were taken, are industrial areas, where located such industrial facilities as: a combined heat and power plant (CHPP-1), LLP "Casting", JSC "Almaty Heavy Engineering Plant". Sites of soil samplings in this area are located near industrial enterprises, fuel stations.

All 17 measurement points in Almaty (i.e. 100%) showed concentrations exceeding the approximate admissible concentrations (Nazhmetdinova, 2017: 228-233). Thus, contamination of the soil layer by PCBs in all three districts of the areas studied in Almaty has a high level of detection of PCBs. The most significant pollution was observed in the industrial zone on the Auezov and Gogol streets, 0,704 mg/kg, which exceeds the regulatory level by 11,7 times. Level of content from 0,113 mg/kg to 0,704 mg/kg with MAC- 0,06 mg/kg testifies to the excess of the regulatory levels from 1,9 times to 11,7 times, which indicates the presence of a permanent technogenic chemical pollution. Unlike water and air, which are only migratory environments, the soil is the most objective and stable indicator of man-made pollution. It clearly reflects the emission of pollutants and their actual distribution.

Perhaps the cause of contamination of soils with PCBs in Kyzylorda region is associated with the problems of the consequences of the drying out of the Aral Sea as well as with the actively developing rocket and space industry at the Baikonur cosmodrome in Kyzylorda oblast (Zimovina, 2001: 89-93).

1.2.2 Water

Observation of the dynamics concentration of PCBs in water reservoirs of Kazakhstan was obtained by a group of scientists at Institute of geography the Republic of Kazakhstan led by Amirgaliyev N.A. and A. Sh. Nazhmetdinova (Amirgaliev, 2012:27-32; Nazhmetdinova, 2014: 74-78). To analyze the state of contamination of PCBs in water reservoirs in various regions of Kazakhstan, the results obtained by scientists are presented in a table 5. Due there is no data in Kazakhstan on MAC for the content of PCBs in water, we used Russian Sanitary Regulations and Norms (Nazhmetdinova, 2017: 228-233).

The concentration of PCBs in 2012 in the water near Bugorki village, which located above Atyrau city was 0,93 µg/L, and in the vicinity of Peshnoi village, i.e. downstream of the Zhaiyk River, it increased to 1,29 µg/L. Such a rise in the PCB concentration downstream is evidently due to the influence of wastes in the form of sewage and atmospheric emissions from numerous industrial enterprises located in Atyrau and a number of large settlements along the banks of the river towards the sea. The same situation in this area is observed in 2005, but the concentration of PCB was lower (0,07 and 1,0 µg/L). Therefore an increasing contamination of Zhaiyk river can be concluded.

Comparing the materials of 2012 with the previously obtained data, it can be seen that the average concentration of PCBs in the water of the Zhaiyk river (0.91 µg/L) islower than in the water of the Shardara (8,0 µg/L) and Kapshagai (11,0 µg/L) reservoirs, the Small Aral Sea (7,0 µg/L in 1992 and 2,0 µg/L in 2000).

The concentration of PCBs in the reservoirs of Almaty in the autumn months was significantly lower than in the spring and summer periods. For example, in the Esentai River in May, the concentration was 17 µg/L, which is 17 times higher than the MAC, whereas in October the PCB concentration was only 1 µg/L, equal to the MAC of PCBs in water. On Lake Sairan, the level of PCBs in May and June was 8,5 µg /L, and in September-October was 1 µg/L, equal to the MAC of PCBs in water(Nazhmetdinova, 2017: 228-233). A similar situation is observed on the rivers Big and Small Almatinka, Terenkur. Perhaps this is due to the fact that in the spring months in the melted waters of the river there are PCBs that were kept in the air in the flue gas from burning garbage, burning landfills, and then precipitated during the winter period. These rivers flow through the territory of industrial facilities.

As it is known, the water creates a hydrological regime of life on the earth. In contrast to the air, which are the only migration environments, soil and water is themost objective and stable indicator of the technogenic pollution. They clearly reflect the emission of pollutants and their actual distribution. Conducted review results allow us to evaluate the studied regions in Almaty as unfavorable in relation to chemical and toxicological indicators and respectively show the general trend of contamination of large industrial cities with chemical contaminants.

1.3 Pesticides in environmental matrixes

Pesticides are chemicals or biological substances used to destroy or at least control pests, which are divided into three main classes: insecticides, fungicides and herbicides (or killers of weeds). About 80% of pesticides are used in agriculture and are transferred to the environment by volatilization, drainage, infiltration, transport along the food chain.

Table 5 – Concentration of PCB (μg /L water) in water at different reservoirs of Kazakhstan

Region	Sampling site	PCB[1]	Sampling date	Ref.
East Kazakhstan region	Bukhtarma reservoir, mountain part	0,61	1994	41
East Kazakhstan region	Bukhtarma reservoir, lake part	0,48	1994	41
South Kazakhstan region	Shardara reservoir	8,0	1995	41
Almaty region	Kapshagay reservoir	11,0	1993	41
Almaty region	Ile river	0,23	1993	41
Kyzylorda region	Big Aral sea	26,0	1992	41
Kyzylorda region	Small Aral Sea	9,0	1992	41
Kyzylorda region	Small Aral Sea	2,0	2000	41
Atyrau region	Zhaiyk river, Bugorki village	0,07	2005	41
Atyrau region	Zhaiyk river, Atyrau city	0,09	2005	41
Atyrau region	Zhaiyk river, Damba village	0,4	2005	41
Atyrau region	Zhaiyk river, Peshnoi village	1,0	2005	41
Atyrau region	Zhaiyk river, Bugorki village	0,93	2012	41
Atyrau region	Zhaiyk river, Atyrau city	0,99	2012	41
Atyrau region	Zhaiyk river, Damba village	0,81	2012	41
Atyrau region	Zhaiyk river, Peshnoi village	1,29	2012	41
Almaty region	Big Almaty river, low flow	1,2	before 2017	42
Almaty region	Big Almaty river, up flow	14,0	before 2017	42
Almaty region	Big Almaty river	8,0	before 2017	42
Almaty region	Terenkara river	7,0	before 2017	42
Almaty region	Esentai river	17,0	May, before 2017	42
Almaty region	Esentai river	1,5	June, before 2017	42
Almaty region	Esentai river	1,1	July, before 2017	42
Almaty region	Esentai river	1,3	September, before 2017	42
Almaty region	Esentai river	1,0	October, before 2017	42
Almaty region	Sairan lake	8,5	May, before 2017	42
Almaty region	Sairan lake	0,8	July, before 2017	42
Almaty region	Sairan lake	1,0	September, before 2017	42

Notes: 1 According to Russian Sanitary Regulations and Norms № 4630-88
Maximal allowable concentration (MAC) for the content of PCBs in water is 1,0 ɱg/l water, according to Grey background: concentration overpassing MAC 1,0 ɱg/l water cited here above

Organochlorine pesticides (OCPs) take a prominent place in the list of highly toxic chemicals covered by the Stockholm Convention (Stockholm Convention, 2009: 51). Some of these compounds such as HCB, HCH and DDT were among the most widely used pesticides in the world during 1970–1980. In Kazakhstan, they were legally used as insecticides till 1983, but they can even today be found in environmental and biological samples (Sailaukhanuly, 2016: 358). Within the first five years of independence of Kazakhstan, pesticide storage warehouses, located in our country were destroyed. Obsolete pesticides and their containers became uncontrolled and opened to the environment. Most of them had been moved in the other storages or taken by citizens for individual use without any indication of their potential dangerous to local residents. A lot of local people use the territory around the warehouse sites for private gardening, land for pasture, or even play grounds for children. Pollution of soil and water by out-of-date pesticides is a serious ecological problem in Kazakhstan. Many of these former warehouses have become hot points of contamination and represent a serious ecological danger. Therefore, the status of the residual quantity of the most OCP in soil and crops should be regularly monitored (Łozowicka, 2016:1310-1321) as it is the case in Europe or North America.

1.3.1 Soil

We analysed 4 articles, reporting concentrations of pesticides in soil of various regions of Kazakhstan. Concentrations of DDT and its metabolites and homologues of HCH are studied in the soil samples of Almaty and Akmola region in period from 2010 to 2016. These data revealed a several "hotspots" of contaminations, like Kyzyl Kairat and Aldabergenova villages in Almaty region. In these sites were located former pesticide warehouses (Nurzhanova, 2010: 87-111), the main potential source of soil contamination.

MAC for HCH, DDT and its metabolites in the soil of Kazakhstan is 0,1 mg/kgof dry soil(Sailaukhanuly, 2016: 358). In the soil of Aldabergenovavillage in 2010 was noted that the concentration of DDD-p, p'exceeds the MAC by 28 times (2,86 mg/kg of dry soil), DDT-p,p' by 19 times (1,95 mg/kg of dry soil), and HCH-β by 17 times (1,7 mg/kg of dry soil) (Nurzhanova, 2010: 87-111). Soil in Kyzyl Kairat village was investigated two times, in 2010 and 2016. In comparison, concentration of DDT and its isomers was higher than residual levels at this site previously reported in 2010. For example, concentration of DDD-p,p´ and DDE-p,p´ in 2016 exceeded more than two times concentration in samples from the first study, as shown in figure 2.

Concentrations of DDT in soil from Akmola region exceeded MAC in 10 from 17 samples (i.e. 58%), whereas only 1 from 15 samples (i.e. 20%) from Almaty detected concentrations exceeding MAC (Sailaukhanuly, 2016: 358). Average concentrations of DDT in Almaty soil samples was 0,097 mg/kg of dry soil. For comparison, DDT concentrations in agricultural soil in different countries: Argentina (0,026 mg/kg), Brazil (0,005 mg/kg), China (0,014 mg/kg), USA (0,009 mg/kg), Pakistan (0,039 mg/kg) and Germany (0.023mg/kg), Romania (0,226 mg/kg) and India (0,939 mg/kg) (Łozowicka, 2016:1310-1321).

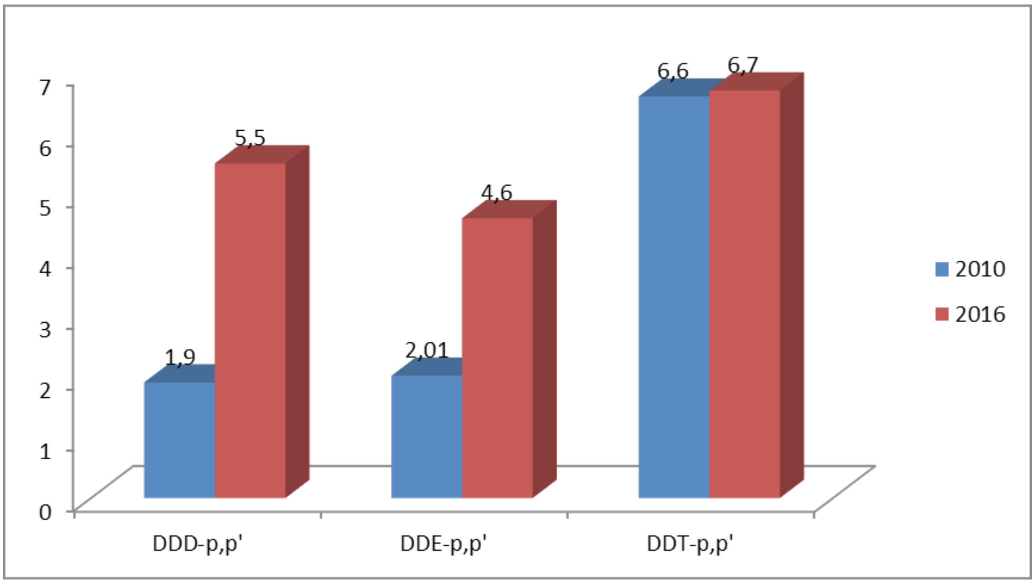

Figure 2 – Temporal distribution of DDT and its metabolites concentrations in the soil of Kyzyl Kairat village, (mg/kg of dry soil)

Based on our literature review, it follows that notable concentrations of DDT were found in the soil of three regions of Kazakhstan. This suggests that, although DDT has been limited for a long time in Kazakhstan, it continues to be a contaminant of the soil in several areas. Considering, that the main way of influence organochlorine pesticides per person is food, monitoring of OCPs in soil, especially in the one used for the cultivation of vegetable crops, should be considered today as a necessary precautionary measure. Regular monitoring of these contaminants in the soil is required to minimize the potential hazard of pesticides to public health (Łozowicka, 2016:1310-1321).

1.3.2 Water

Nowadays the issue of contamination of Kazakhstan's water bodies with organochlorine pesticides not sufficiently widely studied. Information about concentration of OCP in Kazakhstan reservoirs contained in articles of such scientists as Amirgaliev N., Isbekov K. and Burlibaev M. Elevated concentrations of pesticides-metabolites of DDT and isomers of HCH were detected in the waters of the Caspian Sea and in the falling rivers. Their total concentration in the water of the Ural River flowing into the Caspian Sea ranged from 0,21 μg/L to 3,02 μg/L, Kigash River- eastern riverbed of the Volga River from 0,81 to 9,04 μg/L. The most polluted by organochlorinated pesticides were the waters at the north-western zone of the Kazakhstan sector of the Caspian Sea, which is under the influence of the Volga river drain. The concentration of pesticides in this zone in 2003-2005 registered at the level of 6,01-20,02 μg/L, and in 2008 and 2009 – 8,88-51,80 μg/L. An increased level of pesticide contamination to 25,0 μg/dm3 is also recorded in the south-eastern part of the Northern Caspian (Isbekov, 2012: 106-113).

Water from Ili river was sampling for pesticides detection in 2013. Based on the results of the analyzes, the following concentrations of pesticides were detected: HCB-0,033 μg/L, HCH-α-0,029 μg/L, HCH-δ-0,075 μg/L, aldrin-0,015 μg/L, DDD-p,p´-0,596 μg/L, DDE-p,p´-0,032 μg/L. Kazakhstan's surface water quality standards regulate the presence of pesticides at the level of "absence", i.e. at the "zero" level (Burlibaev, 2013: 76-107). Ili River is contaminated by pesticides. Kazakhstan refused to use OCPs in agriculture but as such problems are global, a common approach with neighbor countries is necessary to decrease the pesticide concentrations in rivers of Kazakhstan.

In Kazakhstan there is a problem of pollution of reservoirs by pesticides. Such pollution is a potential threat to the local population due to the consumption of fish from these reservoirs and the use of contaminated water for irrigation of agricultural land. Therefore, it is recommended to resume monitoring of Kazakhstan's water pollution with OCPs and their less hydrophobic metabolites at the state level.

2 Concentrations of contaminants in food

2.1 Heavy metals in camel milk and shubat

Consumption of camel milk is very popular in Kazakhstan due to its therapeutic and dietary properties (Konuspayeva, 2011a: 90-96). Camel milk is mainly consumed after the process of its fermentation. Fermented camel milk, called shubat, is usually a product obtained from traditional home-grown fermentation processes (Meldebekova, 2008: 117-123). Camel milk has anticancer, hypoallergenic and antidiabetic properties(Konuspayeva, 2009: 112-118). In Kazakhstan, camels are cultivated by residents of areas close to polluting production facilities or other sources of pollution, such as industrial agriculture (cotton-growing areas) or busy highways. Products obtained on camel farms near these sources in the form of camel milk and shubat come into the food chain of human products like other dairy products In conditions of conditions of environmental degradation, increases the probability of camel milk and shubat contamination with environmental contaminants, including heavy metals (Konuspayeva, 2011a: 90-96). As heavy metals pass through the food chain along with consumed dairy products, the risk of exposure to these metals increases in human health. The effect of elevated concentrations of heavy metals on humans can lead to such diseases as saturnism, immunodepression, skin disease or cancer (Konuspayeva, 2009: 112-118). In Kazakhstan today there are not so many studies aimed at studying the concentration of heavy metals in products from camel milk. We analyzed the content of heavy metals such as Zn, Cu, Cd, Pb and Hg in camel milk and shubat, based on the four articles studied in period 2008-2016. The results of our analysis are shown in tables 6-7. There are no special MAC of toxic compounds in camel milk, but there are MAC for cow's milk in Kazakhstan and Russia, which can be applied to camel milk and shubat (Petrlik, 2016:50).

According to the literature, human activities close to the sampling zone affect the concentration of heavy metals in milk (Konuspayeva, 2011a: 90-96). The concentrations of Cu, Cd, Pb and Hg in the studied samples of camel milk and shubat are within the MAC limits (Petrlik, 2016:50). It should be noted that the Zn concentration in the shubat exceeded the MAC by 1,1-1,4 times, in camel milk – 1,06-2,82 times. Elevated Zn concentrations are probably related to the proximity of the milk and shubat sample sites from mining enterprises (Meldebekova, 2008: 117-123; Petrlik, 2016:50).

Despite the existing risk of contamination of camel milk and shubat in Kazakhstan, the remains of heavy metals do not exceed allowable concentrations, except for local high values of Zn.

Nevertheless, the metabolism of heavy metals in the body of camels and the transfer of these molecules to humans remain unknown (Konuspayeva, 2011a: 90-96).

Table 6 – Concentration of heavy metals (mg/kg of fresh weight) in shubat in different regions of Kazakhstan

Region	Zn[1]	Cu[2]	Cd[2]	Pb[2]	Sampling date	Ref
Almaty region	5,50	0,06	0,003	0,06	2007-2010	50
Atyrau region	6,50	< 0,05	< 0,001	<0,01	2007-2010	50
Kyzylorda region	5,70	< 0,05	< 0,001	0,02	2007-2010	50
Zhambyl region	4,50	< 0,05	< 0,001	0,01	2007-2010	50
South-Kazakhstan region	4,16	< 0,05	0,002	0,04	2007-2010	50
Almaty, Atyrau, Aralsk, Shymkent	7,21	0,16	n.a.	0,007	before 2009	52

Notes: 1 According to Russian Federation SanPin № 2.3.2. 2401-08, maximal allowable concentration for Zn-5mg/kg of fresh weight; 2 According to Kazakhstan SanPin № 611 MAC for Cu-0,4 ; Cd-0,03;Pb-0,1; Hg- 0,005 mg/kg of fresh weight; grey background: concentration overpassing regulation thresholds;n.a. not analyzed

Table 7 – Concentration of heavy metals (mg/kg of fresh weight) in camel milk in different regions of Kazakhstan

Region	Sampling site	Zn[1]	Cu[2]	Cd[2]	Pb[2]	Hg[2]	Sampling date	Ref
Almaty region	No data	4,90	0,07	0,003	0,06	n.a.	2007-2010	50
Atyrau region	No data	4,75	<0,05	<0,001	<0,01	n.a.	2007-2010	50
Kyzylorda region	No data	5,31	<0,05	<0,001	0,02	n.a.	2007-2010	50
Zhambyl region	No data	4,85	<0,05	<0,001	0,01	n.a.	2007-2010	50
South-Kazakhstan region	No data	4,07	<0,05	0,002	0,04	n.a.	2007-2010	50
Almaty, Atyrau, Aralsk, Shymkent	No data	5,16	0,07	n.a.	0,025	n.a.	before 2009	50
Shetpe, Mangystau region	180 km from Aktau	3,06	0,03	<0,001	<0,004	<0,001	2015	53
Baskuduk, Mangystau region	10 km from Aktau	5,28	0,08	<0,001	<0,004	<0,001	2015	53
Kuryk, Mangystau region	70 km from Aktau	4,58	0,03	<0,001	<0,004	<0,001	2015	53
Akshukur, Mangystau region	20 km from Aktau	3,11	0,02*	<0,001	<0,004	<0,001	2015	53
Tauchik, Mangystau region	100 km from Aktau	3,56	0,02*	<0,001	<0,004	<0,001	2015	53
Kyzyl Tube, Mangystau region	21 km from Aktau	14,1	0,07	<0,001	0,008	<0,001	2016	53

Notes: 1 According to Russian Federation GN 1.2.2701-10, MAC for Zn-5mg/kg of fresh weight;
2 Kazakhstan SanPin № 611 MAC for Cu-0,4 ; Cd-0,03;Pb-0,1; Hg- 0,005 mg/kg of fresh weight;
grey background: concentration overpassing regulation thresholds;n.a. not analyzed

Thus, the connection between heavy metals in camel milk and shubat, remained unexplored. All these facts indicate the need for more detailed studies in this area (Meldebekova, 2008: 117-123).

2.2 Organic pollutantsin camel milk

According to Jurjanz S., (2008), contamination of milk with POPs depends on the environment and the properties of the considered contaminants. Ruminant animals are exposed to POPs by oral ingestion. These contaminants have been the subject of research by scientists around the world to ensure food securityin the past 35 years. After release into the environment, POPs can potentially be transferred to the food chain, interacting with animals. These compounds are characterized by volatility, resistance in the environment and high lipophilic capacity, which can be reason to their accumulation in fat tissues. PCDDs and PCDFs are compounds behave similarly and are usually combined in the literature as PCDD/F, also known as dioxins. These compounds are characterized by a long half-lifetime, especially in the soil. The most dangerous is 2,3,7,8 TCDD, which has a half-life timefor 41 years. PCBs are POPs, which in their structure have two phenyl rings. These compounds defined as indicator non-dioxin-like (NDL-PCBs) and dioxin-like (DL-PCBS) congeners of PCBs, total there are 209 congeners. Indicator PCBs include PCBs 28, 52, 101, 118, 138, 153 and 180. Dioxin-like PCBs are divided into coplanar PCBs (PCBs 77, 81, 126 and 169) and nonplanar PCBs (105, 114, 118, 123, 156, 157, 167 and 189). Due to their high persistence, PCBs stay in the environment for a long time (Jurjanz, 2008: 63-83). In our review we analyzed 3 articles about contamination of camel milk by organic pollutants. In these articles were identified concentrations of organic pollutants in 6 regions of Kazakhstan in period from 2009 to2016 (Konuspayeva, 2011a: 90-96; Petrlik, 2016:50; Konuspayeva, 2011b: 351-360). Data from these articles are united intables 8-9. We have no Maximal level (ML)apart for DL-PCBs in Kazakhstan and other countries, therefore we use EU Regulation N°1259/2011, where are given maximal level for PCDD/F+DL PCBs (Petrlik, 2016:50.

In 3 sites concentrations exceeded the ML for PCDD/F + DL PCBs in the milk. The greatest concentrations observed in Tauchik, Mangystauregion (47,61WHO-TEQ g-1milk fat), it exceeds theML more than 9 times. It seems that excess concentrations indicate the ecological legacy of outdated sources of PCBs used in old transformers and capacitors as oils.

Also, high concentrations (16,27pg WHO-TEQ g-1milk fat) are noted in the Baskuduk village, a potential source of pollution there is the Koshkar Ata tailing pond. In case of Kuryk village, the main source of contaminationis domestic garbage and a lot of unorganized waste dumps. In other 3 villages of Mangystau region and Almaty, Atyrau, Aralsk, Shymkent the concentrations of PCDD/F + DL PCBs are not exceeded ML (Petrlik, 2016:50).

Table 8 – Concentration of organic pollutants (pg WHO-TEQ g-1milk fat) in camel milk samples from different regions of Kazakhstan

Region	Sampling site	DL-PCBs	PCDD/ Fs	PCDD/F + DL PCBs[1]	Sampling date	Ref
Shetpe, Mangystau region	180 km from Aktau	3,02	0,45	3,47	2015	53
Baskuduk, Mangystau region	10 km from Aktau	14,94	1,33	16,27	2015	53
Kuryk, Mangystau region	70 km from Aktau	5,25	1,30	6,55	2015	53
Akshukur, Mangystau region	20 km from Aktau	2,07	0,01	2,08	2015	53
Tauchik, Mangystau region	100 km from Aktau	47,30	0,31	47,61	2015	53
Kyzyl Tube, Mangystau region	21 km from Aktau	3,24	0,24	3,48	2016	53
Almaty, Atyrau, Aralsk, Shymkent	No data	2,18	0,80	2,98	2009-2010	55
Notes: 1 According to EU Regulation N°1259/2011, maximal level for PCDD/F + DL PCBs – 5 pg WHO-TEQ g-1 milk fat; grey background: concentration overpassing regulation thresholds						

Table 9 – Concentration of NDL-PCBs (ng/g milk fat) in camel milk from different regions of Kazakhstan

Region	101[1]	138[1]	153[1]	180[1]	28[1]	52[1]	Sum of 6 PCBs	Samp-ling date	Ref
Shetpe, Mangystau region	0,72	1,30	1,10	< 0,3	12,00	0,58	15,70	2015	53
Baskuduk, Mangystau region	0,62	3,50	3,30	0,37	14,00	0,41	22,20	2015	53
Kuryk, Mangystau region	0,22	1,30	1,10	< 0,2	5,10	0,26	7,98	2015	53
Akshukur, Mangystau region	0,16	0,45	0,35	<0,05	2,40	0,18	3,54	2015	53
Tauchik, Mangystau region	0,32	9,40	7,80	0,63	26,0	0,46	44,61	2015	53
Kyzyl Tube, Mangystau region	<0,8	0,82	<0,8	< 0,8	< 0,8	< 0,8	0,82	2016	53
Almaty, Atyrau, Aralsk, Shymkent	1,32	0,52	0,80	0,21	0,80	2,61	5,46	2009-2010	55
Kyzylorda region	n.a	0,95	n.a	n.a	n.a	0,95	1,90	2007-2010	50
Notes: 1 According to EU Regulation N°1259/2011, maximal level for sum of NDL-PCBs-40 ng/g milk fat; grey background: concentration overpassing regulation thresholds									

The concentration of NDL-PCBs in camel milk from 6 studied regions of Kazakhstan does not overpass the maximal level of these compounds, with the exception of sample from Tauchik (44,61 ng/g milk fat). The potential source of contamination could be oil extraction, in this area are located three oil fields. Also elevated concentrations detected in Baskuduk (22,20 ng/g milk fat), where located former and current large industrial enterprises, like uranium processing plant, plastic plant and other chemical factories, discharging variable toxic wastes. Sewage from the industrial zone is still discharged into the Koshkar Ata tailing pond by the open canal (Petrlik, 2016:50).

Based on the analysis of researchesabout contamination of camel milk with organic pollutants, it can be concluded that camel milk contamination depends on the remoteness of the range of ruminant animals from areas with industrial sources of pollution, such as factories, oil production facilities and waste dumps. Contaminated lakes and tailings dumps can also becomepotential sources of camel milk contamination.

At present, there is insufficient information on the pollution of animal products by organic pollutants. As a consequence, the risk of health effects of contaminated livestock products has not been fully studied in Kazakhstan. Therefore, in the future, further research is needed to fully assess the impact of organical pollutants on Humans health and animals.

2.3 Pesticides in camel milk

The impact of OCPs is one of the major environmental problems reported in several studies (Sailaukhanuly, 2016: 358; Łozowicka, 2016:1310-1321; Nurzhanova, 2010: 87-111), and is reflected in some mandatory measures at the intergovernmental level. In particular, HCB, HCH isomers, metabolites of DDT, like many other OCPs, relate to serious problems of human health and the environment due to their environmental sustainability. At present, the risk of the effects of environmental pollution on human health is being studied. Nowadays, in Kazakhstan there are not a lot of studies about pesticides concentrations in camel milk. We analyzed an article by Konuspayeva G. et al. (2011) and Petrlik J. (2016), where was detected concentrations of OCPs in camel milk samples from Mangystau region (Konuspayeva, 2011a: 90-96; Petrlik, 2016:50). The European Union limits for pesticide residues, including OCPs in milk, are set per fresh weight of milk. EU limits were not exceeded in any of the samples. Lindane (gama-HCH) reached a quarter of the EU limit value 1 ng/g of fresh weight in the sample from Kuryk (0,244 ng/g of fresh weight). In general, lindane also showed the highest levels from all the OCPs analysed in samples (Petrlik, 2016:50). High levels of OCPs were not detected also in other studies (Konuspayeva, 2011a: 90-96). An analysis of pesticides showed the presence of HCHs (beta, delta and, only in the Kyzylorda region, also gamma HCH). DDT was found in milk from the Kyzylorda region at the level of 0,8 ng/g (Konuspayeva, 2011a: 90-96), which was much higher than in study by Petrlik J. (2016) (Petrlik, 2016:50).

The degree of pollution by POPs around the world requires a common effort to improve understanding of risk factors and the proper planning of preventive measures. Further research is needed to better understand the acute and chronic the toxic effects of POPs on humans healh and animals.

Conclusions

We analyzed 34 articles, which reported concentrations of heavy metals, organic pollutants and organochlorine pesticides in environmental matrices (soil, sediments, water, plants) and camel milk from 12 regions of Kazakhstan. These data revealed a certain number of "hotspots" of contaminations. Elevated concentrations of heavy metals, like Zn, Cu, Pb, Cd and Ni in soil were noted in Ust-Kamenogorsk, Almaty, Pavlodar, Balkhash and Kurdai regions. High concentrations of Hg in soil were observed in Pavlodar. Also elevated concentrations of Zn, Cu and Pb was noted in sediments from Balkhash lake (in Bertys and Torangalik Bays), in rivers Ospansu, Shilozek and Pit Lake in Kurdai region. The highest concentrations of Hg are observed in sediment samples taken from Lake Balkyldak, Pavlodar region. It follows, that industrial activities have a direct effect on the concentration of HM in these matrices, especially when they are close to the places where soil samples were taken. Soil in Almaty exceeded the MAC for polychlorinated biphenyls nearly 12 times. Sites of soil samplings in this area are located near industrial enterprises, fuel stations. Overpassing of MAC for polychlorinated biphenyls concentrations was also observed in water in Aral Sea (26 times) and reservoirs of Almaty region – Big Almaty river (14 times), Esentai river (17 times), and lake Sairan (8,5 times). Conducted review results allow us to evaluate the studied regions in Almaty as unfavorable in relation to chemical and toxicological indicators and respectively show the general trend of contamination of large industrial cities with chemical contaminants. Concentrations of organochlorine pesticides in soil was extremely high in Kyzyl Kairat and Aldabergenova villages in Almaty region, the DDT concentrations exceeded MAC in 19 and 47 times respectively. This suggests that, although DDT has been limited since a long time in Kazakhstan, it continues to be present in the soil in several areas.In Kazakhstan a problem of pollution of reservoirs by pesticides can be noted. Such pollution is a potential threat to the local population due to the consumption of fish from these reservoirs and the use of contaminated water for irrigation of agricultural land. Therefore, it is recommended to resume monitoring of Kazakhstan's water pollution with OCPs and their less hydrophobic metabolites at the state level. The most polluted by organochlorine pesticides were the waters at the north-western zone of the Kazakhstan sector of the Caspian Sea and Ili river in Almaty region. Despite the existing risk of contamination of camel milk and shubat in Kazakhstan, the remains of heavy metals do not exceed allowable concentrations, except for local high values of Zn in camel milk and shubat from Kyzylorda region, Kyzyl tobe and Baskuduk districts of Mangystau region. Also in Mangystau region, in Tauchik and Baskuduk districts was noted high concentrations of organic pollutants in camel milk. It can be concluded that camel milk contamination depends on the remoteness of the range of animals from areas with industrial pollutionsources, such as factories, oil production facilities and waste dumps. Contaminated lakes and tailings dumps can also become potential sources of camel milk contamination. Although the industrial activity is essential for development of Kazakhstan, the numerous hotspots revealed show that more attention has to be paid to reduce its environmental impact. An increased attention would allow to control better the risk of contamination for the Food chain and to improve the health of the population.

Thus, territories containing elevated concentrations of heavy metals, organic pollutants and pesticides in various environmental components were identified. This obtained data contain useful information for further research.

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