Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 11, pp.60499-60503, November, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

FEATURES OF ASSESSING CARCINOGENIC RISKS WHEN EXPOSED TO POPS IN AKTOBE OBLAST (THE REPUBLIC OF KAZAKHSTAN)

***Aiman Nazhmetdinova**

Scientific and Practical Centre for Sanitary and Epidemiological Expertise and Monitoring, Committee for Public Health Protection of the Ministry of Health, 84 Auezov street, Almaty, the Republic of Kazakhstan

ARTICLE INFO

Article History:
Received 19th August, 2017
Received in revised form
14th September, 2017
Accepted 21st October, 2017
Published online 30th November, 2017

Key words:
Pollution,
Persistent Organic Pollutants,
Polychlorinated Biphenyls, Dioxins,
Exposure Factors,
Carcinogenic Risks,
Non-Communicable Disease.

ABSTRACT

Pollution of POPs, which are carcinogens, has an adverse effect on the environment and human health. One of the crisis regions of Kazakhstan is considered the Aral Sea area. Shalkar and Irgiz villages are located in the ecologically unfavorable zone of the Aral Sea in the territory of Aktobe oblast. On the basis of the obtained sample samples, we conducted research on the residual quantities of persistent organic pollutants (POPs), hexachlorocyclohexane (HCH), dichlorodiphenyltrichloroethane (DDT), PCBs and dioxins. Calculations of carcinogenic risks revealed that total individual carcinogenic risk (CR sum) in the village of Shalkar when exposed to POPs (most of them are PCBs, dioxins, HCH) via different routes from various environments was $2{,}0x10^{-5}$and for the village of Igriz, $5{,}2x10^{-4}$. The evaluation of the carcinogenic risks we have received is assessed by their acceptability and allows us to relate the village of Shalkarto the second-range of risk, and the village of Irgiz to the third - range risk, which indicates the unacceptability of people's lives. This necessarily requires constant monitoring with the inclusion of all environmental objects, otherwise we may lose an entire generation of children who already today suffer from diseases associated with exposure to POPs (eye diseases, endocrine system diseases and diabetes mellitus).

Citation: Aiman Nazhmetdinova. 2017. "Features of assessing carcinogenic risks when exposed to POPs in Aktobe oblast (the Republic of Kazakhstan)", *International Journal of Current Research*, 9, (11), 60499-60503.

INTRODUCTION

According to WHO, the development of health is affected not only by the biological basis in human development (age, gender, hereditary factors), but also by general socio - economic and environmental conditions, including the presence or absence of housing, the level of education, employment of the population, the quality of water, air, soil, food and various lifestyle factors (Centre for Humanitarian Technologies). Currently, a consequence of new scientific evidence confirming the relationship between the state of the physical environment and human health is the creation of new toxic chemicals called POPs and carcinogens (WHO IARC, 1997). One of the crisis regions of Kazakhstan is considered the Aral Sea area. It includes the following districts: Kyzylorda, Aktobe, South Kazakhstan and Karaganda. There are 10 districts of Aktobe oblast. Two of them belong to the Aral Sea zone: Shalkar and Irgiz villages, which were recently located in the territory of the military testing ground of Emba. The ecology of these districts is one of the unfavorable in both Aktobe oblast and throughout Kazakhstan.Although 90% of the fish stocks of Aktobe oblast are in Irgiz district, where 80 reservoirs are located(Report on the implementation, 2015; Revich, 2013).

****Corresponding author:*** **Aiman Nazhmetdinova,**
Scientific and Practical Centre for Sanitary and Epidemiological Expertise and Monitoring, Committee for Public Health Protection of the Ministry of Health, 84 Auezov street, Almaty, the Republic of Kazakhstan.

MATERIALS AND METHODS

As part of the program "Integrated approaches in the management of public health in the Aral region" we have carried out an expertiseon55 samples of water from surface water bodies , 54 soil layer samples, 36 samples of vegetable products,and 12 fish samples from reservoirs. Samples were selected in accordance with sampling procedures according to regulatory documents by specialists of the Pesticide Toxicology Laboratory. It is accredited by the State Standard of the Republic of Kazakhstan, for compliance with ST RK ISO/IEC 17025-2007 "General requirements for the competence of test and calibration laboratories" (ST RK ISO/IEC 17025-2007, 2007).Gas chromatograph with a capillary column; sample preparation, extraction and chromatographic conditions were used according to ST RK 2011-2010 as methods for the determination of residues of organochlorine pesticides –dichlorodiphenyltrichloroethane (DDT) and hexachlorocyclohexane (HCH)(ST RK 2011-2010, 2010). The determination of dioxins, polychlorinated biphenyls was conducted on the gas chromatomass spectrometer with quadruple detector produce by Agilent Company, the USA. The detector is designed for highly sensitive analysis of dioxins and polychlorinated biphenyls. All chemical reagents and materials produced by the company Merck (Germany). To assess the risk, we carried out the mathematical calculations according to the risk of chemicals polluting (№ P 2.1.10.1920-04) (Rahmanin *et al*, 2004; ISO/ IEC 31010, 2009). Calculation of the carcinogenicrisk was carried out with the use of data on the size ofthe exposure and meanings of carcinogenic potential factors (slope factor, unit risk).

Calculation of exposure:calculationof daily doses of chemical agent entry in organism by means of different ways from the main objects of the environment

The standard formula for calculating of the average daily doseand standard meanings of exposure factors with the swallowingof the surface water (water of reservoirs) is:

$$I = \frac{(C * IR * EF * ED * ET)}{(AT * BW * 365)} \qquad (1)$$

I- intake (amount of chemical exchange on the border), mg / kg body weight per day;
C-the concentration of the chemical; the average concentration, acting during the exposure period (e.g., mg / liter of water);
CR - the value of the contact; amount of contaminated medium into contact with the human body per unit of time, or in one case of exposure (eg, l /day);
EF - rate effects, the number of days / year;
ED - the duration of exposure, the number of years;
BW - body weight: an average body weight during the exposure period, kg;
AT - averaging time; averaging period of exposure, the number of days.

The standard Formula for calculating the average daily dose and the standard meanings of the exposure factors at the ingestion entry from soil substances for carcinogens is:

$$I = \frac{Cs * FI * EF * ET * CF2 * \left(\left(EDc * \frac{IRc}{BWc}\right) + \left(EDa * \frac{IRa}{BWa}\right)\right)}{AT * 365} \qquad (2)$$

I - intake with soil, mg / (kg × day);
Cs - concentration of substances in the soil, mg / kg;
IR - incoming rate kg / day;
IRc - incoming rate at age 6 years or less mg /d;
IRa- incoming rate in the age of 6 mg /d;
IRn - incoming rate mg / day. (for adults: IRn = IRa; forchildren: IRn = IRc);
ET - exposure time, hour / day;
CF2 - conversion factor, days / hours;
FI - contaminated soil fraction, rel. u;
EF - exposure frequency, days. / g;
EDn- duration of exposure, age
EDc- duration of exposure age 6years;
EDa- duration of exposure under the age of6 years;
BWn -body weight, kg
BWc- body weight at the age of 6 years or less;
BWa- body weight over the age of 6 years;
ATn- average period of exposure, years for adults 30 years of age; forchildren: 6 years;
AT - the average period of exposure, years.

The standard formula for calculating the average daily dose with cutaneous exposure

$$DAD = \frac{DAe * EF \times ED \times EV \times SA)}{BW \times AT \times 365} \qquad (3)$$

DAD - cutaneous absorbed dose, mg / (kg × day) ;
DAe-absorbed dose per event, mg/ cm^2;

$$DAe=Cs*CF*AF*ABSd \qquad (4)$$

Cs -concentration of substances in the soil, mg / kg ;
CF -conversion factor, kg / mg of 10^{-6} kg / mg;
AF - factor skin contamination, mg / cm^2;
ABSd- the absorbed fraction, rel. u ;
SA -skin surface area, cm^2;
EF -exposure frequency, event / year 350;
ED -duration of exposure, age 30 years; children: 6 years;
EV -number of events in one day event / day;
AT -the average period of exposure, age 30 years; children 6 years of age; carcinogens: 70 years;

At the evaluation of carcinogenic risks, the average daily dose, averaged taking into account the expected average human life (70 years) is used. Such doses are referred to LADD. The standard equation for calculating of LADD is as follows:

$$LADD = \frac{C * CR \times ED \times EF}{BW \times AT \times 365} \qquad (5)$$

LADD - average lifetime dose, mg / (kg × day);
C - concentration of a substance in polluted environments, mg /l mg/m3, mg /cm2 m /kg;
CR - arrival rate of exposure (drinking water, air,food, etc.), l / day, m^3 / day kg / day, etc .;
ED - the duration of exposure, years;
EF - the frequency of exposure, days/year;
BW - body weight in kilograms;
AT - averaging period of exposure (for carcinogens AT = 70 years);

$$CR = LADD \times SF \qquad (6)$$

LADD - the average lifetime dose, mg / (kg × day);
SF- the slope factor.

Objective

- to evaluate carcinogenic risks when exposed to POPs among people living in Shalkar and Irgiz villages of Aktobe oblast

Goals:

- to conduct research of environmental objects in Shalkar and Irgiz villages of Aktobe oblast on the content of residual amounts of persistent organic pollutants such as polychlorinated biphenyls (PCBs), dioxins, hexachlorane (HCH);
- calculation of dose loads and carcinogenic risks in the studied areas of Aktobe oblast;
  - to evaluate non-infectious morbidity of the population of Aktobe oblast and in the Republic of Kazakhstan

with the pathology of diseases of the skin, eyes, endocrine system;

- to evaluate carcinogenic risks of the population in Aktobe oblast located in the zone of the Aral Sea area.

RESULTS AND DISCUSSION

Aktobe oblast is located in the north-western part of Kazakhstan. The area of the oblast is 300,6 thousand square meters, which is 11% of the state territory.The main direction of the region's economy is industrial and agricultural production. There are a number of environmental problems here: groundwater contamination by chromium compounds, boron, unsolved problems of utilization and disposal of industrial and municipal waste.The consequence of a sufficiently developed industry of the Aktyubinsk region is a high anthropogenic impact on the environment, expressed in air pollution, soil and large rivers, accumulation of industrial and solid domestic waste (Alnazarova, 2010; Aybasova *et al*, 2007). Aktobe oblast borders on Kyzylorda oblast, and is considered to be a zone of the Aral Sea area (Micklin, 2004). During the implementation of the project, we studied such settlements as the village of Shalkar and Irgiz, which were referred to the zone of the Aral Sea area, and where samples were selected.

The most important parameter that reflects the effect of a chemical on the body is the dose, since it directly indicates the amount of a contaminant that has a potential effect on the target organ. The dose is the amount of pollutant received by the body with increasing exposure, taking into account the body weight.

The village of Shalkar

The daily average dose of PCBs received from the oral and dermal route from the soil was 6.4×10^{-8} for adults of the village of Shalkar and $7{,}0x10^{-7}$ mg/kg for children per day. The daily average dose of PCBs received orally from open reservoirs was 1.1×10^{-8} for adults and $1{,}2x10^{-7}$ for children mg/kg per day. The daily average dose of PCBs received with food products was$6{,}4x10^{-8}$ for adults and $3{,}0x10^{-8}$ for children mg/kg per day. As a result, the total exposure of PCBs for adults of the village of Shalkar was $1{,}4x10^{-7}$ mg/kg for adults and $1{,}1x10^{-6}$ mg/kg for children per day. The daily average of dioxins received from the oral and dermal route from the soil was $8{,}5x10^{-12}$ for adults and $1{,}0x10^{-12}$ mg/kg for children per day. The dose of dioxins received orally from open reservoirs was $5{,}2\ x10^{-14}$ for adults and $6{,}1x10^{-13}$for children mg/kg per day. The dose of dioxins received with food products was $5{,}0x10^{-10}$ for adults and $1{,}2x10^{-10}$ for children mg/kg per day. As a result, the total exposure of dioxins for adults was $5{,}0x10^{-10}$mg/kg for adults and $1{,}\ 2x10^{-10}$ mg/kg for children per day. The daily average of HCH received from the oral and dermal route from the soil was $4{,}0x10^{-10}$for adults and $2{,}0x10^{-9}$ mg/kg for children per day. The dose of HCH received orally from open reservoirs was $8{,}6\ x10^{-10}$ for adults and $9{,}4x10^{-9}$ for children mg/kg per day. As a result, the total exposure of HCH for adults was $1{,}26x10^{-9}$ mg/kg for adults and $1{,}2x10^{-8}$ mg/kg for children per day. Based on the results of the exposure, in the future, according to mathematical calculations, we carried out carcinogenic risks for each POPs along the routes of chemical exposure. Carcinogenic risks were carried out in accordance with the following formula relating to LADD. The standard equation for calculating of LADD is as follows:

$$\text{LADD} = \frac{C * \text{CR} \times \text{ED} \times \text{EF}}{\text{BW} \times \text{AT} \times 365}$$

Total individual carcinogenic risk (CR sum) when exposed to PCBs, dioxins, HCH via different routes form various environments was $2{,}0x10^{-5}$, e.g. this is an additional risk compared to the background for an individual to develop cancer during lifetime from the effects of these chemicals and from exposure to these chemicals and has accounted for 2 additional cases of cancer per 100 thousand people in the village of Shalkar.

Table 1. Carcinogenic risks of POPs for adults and child population in the village of Shalkar

	POPS			
Therouteofexposure	PCBs	Dioxins	HCH	Total
Soil				
orally	$7{,}1x10^{-7}$	$2{,}1x10^{-8}$	$7{,}8x10^{-9}$	CRsoj $7{,}4x10^{-7}$
Openreservoirs				
orally	$8{,}4x10^{-8}$	$8{,}1x10^{-9}$	$3x10^{-9}$	Craoj $9{,}5x10^{-8}$
Foodproducts				
orally	$3x10^{-7}$	$1{,}8x10^{-5}$		Crfoj $1{,}2x10^{-5}$
Totalexposure				
Totaloralexposure	$1{,}1x10^{-6}$	$1{,}8x10^{-5}$	$1{,}1x10^{-8}$	Croj $1{,}4x10^{-5}$
Total on all environments and routes	ΣCR PCBs $1{,}1x10^{-6}$	ΣCR dioxins $1{,}8x10^{-5}$	ΣCR HCH $1{,}1x10^{-8}$	ΣCRj $2{,}0x10^{-5}$

Table 2. Carcinogenic risks of POPs for adults and child population in the village of Irgiz

	POPs			
Therouteofexposure	PCBs	Dioxins	HCH	Total
Soil				
orally	$1{,}0x10^{-8}$	$1{,}5x10^{-7}$	-	CRsoj $1{,}6x10^{-7}$
Openreservoirs				
orally	$4{,}0x10^{-5}$	$6{,}7x10^{-7}$	-	CRaoj $7{,}1x10^{-7}$
Foodproducts				
orally	$1{,}1x10^{-4}$	$6{,}0\ x10^{-5}$	-	CRfoj $6{,}0x10^{-5}$
Totalexposure				
Totaloralexposure	$5{,}2x10^{-4}$	$6{,}1x10^{-5}$	-	CRoj $5{,}2x10^{-4}$
Total on all environments and routes	ΣCR PCBs $5{,}2x10^{-4}$	ΣCR dioxins $6{,}1x10^{-5}$	-	ΣCRj $5{,}2x10^{-4}$

Table 3. Morbidity of adults and children of Aktobe oblast for 100 000 thousand of population

The name of disease	Aktobeoblast 2015 2016 entirepopulation	The Republic of Kazakhstan 2015 2016 entire population	Aktobeoblast 2015 2016 female	The Republic of Kazakhstan 2015 2016 female
Diseases of the skin and subcutaneous tissue	2343,1 2316,1	1812,8 1878,7	2128,9 1955,3	1890,8 1925,5
Diseases of the eye and its adnexa, including glaucoma	2271,7 2080,2	1630,0 1848,2	2252,1 2118,7	1795,9 2023,4

Table 4. Morbidity of children aged 0 to 14 of Aktobe oblast for 100 000 thousand of population

Thenameofdisease	Aktobe oblast 2015 2016 children aged 0 to 14	The Republic of Kazakhstan 2015 2016 children aged 0 to 14
Diseases of the skin and subcutaneous tissue	3094,5 3254,4	2630,0 3032,3
Diseases of the eye and its adnexa, including glaucoma	2576,6 2136,0	1807,3 2007,3
Diseases of the endocrine system	760,8 712,8	643,2 494,4
Diabetes	7,2 7,6	5,0 5,0

The village of Irgiz

The daily average dose of PCBs received from the oral and dermal route from the soil was $2,0x10^{-8}$ for adults of the village of Irgiz of Aktobe oblast and $2,0x10^{-7}$ mg/kg for children per day. The daily average dose of PCBs received orally from open reservoirs was $1,0x10^{-6}$ for adults and $1,0x10^{-5}$ for children mg/kg per day. The daily average dose of PCBs received with food products was $5,1x10^{-8}$ for adults and $2,4x10^{-7}$ for children mg/kg per day. As a result, the total exposure of PCBs for adults was $1,3x10^{-6}$ mg/kg for adults and $1,2x10^{-5}$ mg/kg for children per day. The daily average of dioxins received from the oral and dermal route from the soil was $8,7x10^{-11}$for adults and $9,3x10^{-10}$mg/kg for children per day. The dose of dioxins received orally from open reservoirs was 4,5 $x10^{-10}$ for adults and $5,0x10^{-9}$ children mg/kg per day. The daily average dose of dioxins received with food products was $7,1x10^{-10}$ for adults and $3,3x10^{-9}$ for children mg/kg per day. As a result, the total exposure of PCBs for adults of the village of Irgiz was $7,2x10^{-9}$ mg/kg for adults and $3,4x10^{-8}$mg/kg for children per day. Individual risk is an estimation of the probability of developing an adverse effect in the exposed individual, for example, the risk of developing cancer in one individual from thousand individuals exposed (one risk per thousand or $1{\cdot}10^{-3}$). Individual carcinogenic risk (CR)is the probability of developing malignant neoplasms during a person's life due to the effects of a potential carcinogen. Carcinogenic risk is the upper confidence limit of an additional lifelong risk. The daily average dose of PCBs received from the oral and dermal route from the soil was $2,0x10^{-8}$ for adults of the village of Irgiz of Aktobe oblast and $2,0x10^{-7}$ mg/kg for children per day.

The daily average dose of PCBs received orally from open reservoirs was $1,0x10^{-6}$ for adults and $1,0x10^{-5}$ for children mg/kg per day. The daily average dose of PCBs received with food products was $5,1x10^{-6}$for adults and $2,4x10^{-5}$for children mg/kg per day. As a result, the total exposure of PCBs for adults was $1,3x10^{-6}$ mg/kg for adults and $1,2x10^{-5}$ mg/kg for children per day. The daily average of dioxins received from the oral and dermal route from the soil was $8,7x10^{-11}$for adults and $9,3x10^{-10}$ mg/kg for children per day. The dose of dioxins received orally from open reservoirs was 4,5 $x10^{-10}$ for adults and $5,0x10^{-9}$ children mg/kg per day. The daily average dose of dioxins received with food products was $7,1x10^{-10}$ for adults and $3,3x10^{-9}$ for children mg/kg per ay.
As a result, the total exposure of PCBs for adults of the village of Irgiz was $7,2x10^{-9}$ mg/kg for adults and $3,4x10^{-8}$ mg/kg for children per day. Individual risk is an estimation of the probability of developing an adverse effect in the exposed individual, for example, the risk of developing cancer in one individual from thousand individuals exposed (one risk per thousand or $1{\cdot}10^{-3}$). Individual carcinogenic risk (CR)is the probability of developing malignant neoplasms during a person's life due to the effects of a potential carcinogen. Carcinogenic risk is the upper confidence limit of an additional lifelong risk. The carcinogenic risks we received in 10^{-4} and 10^{-5},according to the Guidelines for the Assessment for the health risks for public health when exposed to chemicals contaminating the environment No.2.1.10.1920-01(Moscow, 2004), were evaluated for the risk acceptability system. The risks we identified were related to the second and third range of risks. The second range (individual risk throughout life is more than $1{\times}10^{-6}$, but less than $1{\times}10^{-4}$) corresponds to the maximum allowable risk, i.e. upper limit of acceptable risk. It is at this level that most foreign and recommended by international organizations hygiene standards were established for the general population (for example, WHO uses $1{\times}10^{-5}$ for drinking water as an acceptable risk and $1{\times}10^{-4}$ for atmospheric air). These levels are subject to constant monitoring. In some cases, additional risk reduction measures can be taken at these risk levels.

The third range (individual risk throughout life more than $1{\times}10^{-4}$, but less than $1{\times}10^{-3}$) is acceptable for professional groups and is unacceptable for the general population. The emergence of such a risk requires the development and implementation of planned recreational activities. The planning of risk reduction measures in this case should be based on the results of a more in-depth evaluation of various aspects of existing problems and determining their priority in relation to other hygienic, environmental, social and economic problems in the this territory. According to the results of our research, the village of Shalkar refers to the second range of risk, i.e. it corresponds to the upper limit of acceptable risk. In the village of Irgiz the individual risk is $5.2x10^{-4}$, it refers to the third range and requires the development and implementation of planned recreational activities. The total individual carcinogenic risks (CR sum) at the influence of PCBs dioxins via the oral route from different environments was 5,2 x 10^{-4}, i.e. this is an additional risk compared to the background for an individual to develop cancer during lifetime from exposure to these chemicals and has accounted for 52 additional cases of cancer per 100 thousand people in the village of Irgiz. Pollution with the persistent organic pollutants in the environmental objects by means of exposure and evaluation of the carcinogenic risk to human health is confirmed by the data of the statistical reporting about some morbidity in Aktobe oblast, and is specific at the influence with the persistent organic pollutants(Alnazarova, 2010; Aybasova *et al*, 2007). Table 3 and 4 reveals the highest pollution among the rural residents of the villages of Shalkar and Irgiz. The incidence of adults and children presented in these tables in rural areas of Aktobe oblast shows a significant excess of indicators in comparison with the republican level for the following diseases: the skin and subcutaneous tissue, the eye and its adnexa, including glaucoma among the entire population, female and children under the age 14 years. Among diseases of the endocrine system, the highest level in the republic was registered among the children aged 0 -14 years, which exceeded the republican in 2015 by 69.4%, the incidence of diabetes also has a high level among children of Aktobe oblast aged 0 -14 years (MazhitovaZ, 2007; Statistical collection, 2016).

Conclusion

The obtained results reveal the main environmental pollutants, which are organic pollutants that affect the environment and human health in Актюбе region, it consequently make possible to calculate the impact of carcinogenic risks affecting the health of people living in this region, which exist worldwide (Zasorin, 2010; Toleutai, 2016). The evaluation of the carcinogenic risks we have received is assessed by their acceptability and allows us to relate the Shalkar village to the second - range risk, and the Irgiz village to the third - range risk. This indicates unacceptability for the life of the population and requires the development and implementation of planned recreational activities. The high level of contamination with exceeding MAC for POPs and the results of carcinogenic risks allowed us to assess the zones of the Aral Sea area, while both villages Irgiz and Shalkarof Aktube oblast were classified as emergency ecological zones. Thus, toxicological studies indicate contamination with POPs, which are global pollutants and and accordingly dangerous toxicants, which have an adverse effect on the overall ecology. This necessarily requires constant monitoring with the inclusion of all environmental objects, otherwise we may lose an entire generation of children who already today suffer from such terriblenon-communicable diseases as skin and eye diseases, endocrine system diseases and diabetes mellitus (Vrijheid *et al*., 2016; Nazhmetdinova, 2008).

Acknowledgment

The results of the scientific and research work «Complex approaches in managing the health of the population of the Aral Sea area» conducted under the direction of Doctor Aiman Nazhmetdinova from 2014 to 2016. The following specialists of Scientific and Practical Centre for Sanitary and Epidemiological Expertise and Monitoring contributed to this work: Sarmanbetova G.K. - master, Roshina S.D - engineer, Chalginbayeva A.U - interpreter.

REFERENCES

Aybasova, J., Suyugnariev, K., Zholamanov A. and Moldayazova, L. 2007. Hygienic assessment of the level of accumulation of chemicals in soil in the territory of Aktobe oblast. Materials of the Third Congress of *Doctors and Pharmacists of the Republic of Kazakhstan*,. vol.2, p.9-11.

Alnazarova, A. 2010. Morbidity of malignant neoplasms of the population of the Aral region. Actual issues of the formation of a healthy way of life. 1: 34-36.

Centre for Humanitarian Technologies, Report of the World Economic Forum Global Risks Report,

Centre for Humanitarian Technologies.17January 2014, http://gtmarket.ru/news/2014/01/17/6578.

ISO/ IEC 31010: 2009. Risk Management. Methods of risk assessment ISO / IEC 31010: 2009 “Risk management - Risk assessment techniques”, p. 7-9.

Micklin,Ph. 2004.The Aral Sea Disaster. *Annual Review of Earth and Planetary Sciences*. 3:47-50.

Mazhitova, Z.2007.Risk factors affecting the health of children living in ecologically unfavorable regions.

Nazhmetdinova, A., Toktazhynova, A. 2008. ’The environmental consequences of the use of pesticides and other POP, *Bulletin of Kazakh National Medical University*..5: 55-57.

Report on the implementation of the fourth Program for the Development and Periodic Review of Environmental Law (The Montevideo-IV) for the period 2010-2014.2015.The United Nations Environment Program, UNEP.p.10-12.

Rahmanin, Y., Novikov, R.Shashin, T. and *et al*.2004. Gidelines for risk assessment to human health when exposed to chemicals that pollute the environment.2:82-89, 93-94, 309-312.

Revich, B. Problems of the influence of persistent organic pollutants on the health of urban population. Hygiene and Sanitation.2013. 12-19.

Statistical collection.2016.Health of the population of the Republic of Kazakhstan and activities of health care organizations in 2015.The Ministry of Health of the Republic of Kazakhstan, p. 89-91, 95-96, 110.

ST RK 2011-2010 (2010),“Water, food, feed and tobacco products. Determination of organochlorine pesticides by chromatographic methods”, pp. 5-7, 2016.Ph. Micklin,” The Aral Sea Disaster”, Annual Review of Earth and Planetary Sciences.3: p.47-50.

ST RK ISO/IEC 17025-2007 "General requirements for the competence of test and calibration laboratories". 2007. p.23-25.

Toleutai, U. Ecology Kyzylorda region and breast cancer (review). 2013. *Medicine*. 4: 17-18.

Vrijheid, M., Casas, M., Gascon M. and Valvi, D.2016.Environmental pollutants and child health. Areview of recent concerns. *Hygienic Environmental Health*, vol.219.4: 331-342.

WHO IARC.1997.Monographs on the evaluation of carcinogenic risks to humans: Polychlorinated dibenzo-para-dioxins and polychlorinated dibenzofurans.69:423.

Zasorin, B. Assessment of carcinogenic risk on the health of the population of urbanized areas under the influence of environmental factors. 2010. Monograph to the doctoral dissertation.

****