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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

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

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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L.N. Gumilyov Eurasian National University, Astana, Kazakhstan.
E-mail: kamila3.08@mail.ru

GEOGRAPHICAL ASPECTS OF THE IMPACT OF TECHNOGENESIS ON THE ACCUMULATION OF HEAVY METALS IN SOILS AND POLLUTION OF SURFACE WATERS OF CENTRAL KAZAKHSTAN

Battakova K.A. — doctoral student of the Department of Physical and Economic Geography of the L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
E-mail: kamila3.08@mail.ru, https://orcid.org/0000-0001-9576-7164;
Saipov A.A. — doctor of pedagogical sciences, professor of the Department of Physical and Economic Geography of the L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
E-mail: saipov1954@mail.ru, https://orcid.org/0000-0002-4138-0236.

Abstract. This article examines the concentrations of heavy metals in soil and water samples taken in cities and districts of Central Kazakhstan and examines the results of studying the territorial features of the impact of technogenesis on the environment. The ecological condition of the territory of Central Kazakhstan is largely due to anthropogenic factors, which often exceed the ecological capabilities of the environment, disrupt its normal functioning, which has a negative impact on human existence. In the course of the work, a study of the elemental composition of the soil was carried out, assessment and monitoring of the quality of surface waters in the territory of the Karaganda region were carried out according to the Unified System of Classification of water in water bodies, statistical processing of the obtained results was conducted using parametric methods of analysis. The study period was 10 years, from 2011 to 2021. As a result of the study, mercury pollution in the Nura River was noted, with the average mercury content in the amount of 15.137 mg/dm³ exceeding the MPC by 30.2 thousand times. The cities of Karazhal, Priozersk, Saran, Satpayev, Shakhtinsk, Topar township and all rural territories are classified as favorable zones, the cities of Balkhash, Zhezkazgan, Karaganda, Temirtau are considered unfavorable risk zones. Industrial enterprises of the mining and metallurgical industry of Kazakhmys Corporation LLP, Arcelor Mittal JSC, Balkhash Mining and Metallurgical Combine pose a threat to environmental objects, therefore, effective policies are required to mitigate the effects of environmental pollution. Measures to prevent the negative impact of technogenic factors on the health of the population, as a limiting link for the further development of the economy, are important for the Republic of Kazakhstan.

Keywords: geography, heavy metals, mercury pollution, soil, surface waters, technogenesis, urbanization, Central Kazakhstan, industrial enterprises

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Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан.
E-mail: kamila3.08@mail.ru

ОРТАЛЫҚ ҚАЗАҚСТАН ТОПЫРАҚТАРЫНДА АУЫР МЕТАЛДАРДЫҢ ЖИНАҚТАЛУЫ МЕН ЖЕР БЕТІ СУЛАРЫНЫҢ ЛАСТАНУЫНА ТЕХНОГЕНЕЗ ӘСЕРІНІҢ ГЕОГРАФИЯЛЫҚ АСПЕКТІЛЕРІ.

Баттакова К.А. — Л.Н. Гумилев атындағы Еуразия ұлттық университетінің физикалық-экономикалық география кафедрасының докторанты, Астана, Қазақстан
E-mail: kamila3.08@mail.ru, https://orcid.org/0000- 0001-9576-7164;
Саипов А.А. — педагогика ғылымдарының докторы, Л.Н. Гумилев атындағы Еуразия ұлттық университетінің физикалық-экономикалық география кафедрасының профессоры, Астана, Қазақстан
E-mail: saipov1954@mail.ru, https://orcid.org/0000-0002 -4138-0236.

Аннотация. Бұл мақалада Орталық Қазақстанның қалалары мен аудандарынан алынған топырақ пен су сынамаларындағы ауыр металдардың концентрациясы зерттеліп, техногенездің қоршаған ортаға әсерінің аумақтық ерекшеліктерін зерттеу нәтижелері қарастырылған. Орталық Қазақстан территориясының экологиялық жағдайы көбінесе қоршаған ортаның экологиялық мүмкіндіктерінен асып түсетін, оның қалыпты қызметін бұзатын, адам тіршілігіне кері әсерін тигізетін антропогендік факторларға байланысты. Жұмыс барысында топырақтың элементтік құрамын зерттеу жүргізілді, Қарағанды облысы аумағында жер беті суларының сапасын бағалау және мониторингісі су объектілеріндегі судың бірыңғай жіктеу жүйесі бойынша жүргізілді, алынған нәтижелерді статистикалық өңдеу талдаудың параметрлік әдістерін қолдану арқылы жүзеге асырылды. Зерттеу кезеңі 10 жыл, 2011 жылдан 2021 жылға дейінгі аралықты қамтиды. Зерттеу нәтижесінде Нұра өзенінің сынаптық ластануы анықталды, сынаптың орташа мөлшері 15,137 мг/дм³ мөлшерінде ШРК-дан 30,2 мың есе жоғары болып табылады. Қолайлы аймақтарға Қаражал, Приозерск, Саран, Сәтбаев, Шахтинск қалалары, Топар ауылы және барлық ауылдық елді мекендер, қолайсыз тәуекел аймақтарына Балқаш, Жезқазған, Қарағанды, Теміртау қалалары жатқызылды. Тау-кен металлургия өнеркәсібінің өнеркәсіптік кәсіпорындары «Қазақмыс Корпорациясы» ЖШС, «Арселор Миттал» АҚ, Балқаш тау-кен металлургиялық комбинаты қоршаған ортаға қауіп төндіреді, сондықтан қоршаған ортаның ластану салдарын жұмсарту бойынша тиімді саясат қажет. Қазақстан Республикасы үшін экономиканың одан әрі дамуын тежеуші фактор ретінде техногендік факторлардың халық денсаулығына кері әсерін болдырмау жөніндегі шаралардың маңызы зор.

Түйін сөздер: география, ауыр металдар, сынаппен ластану, топырақ, жер беті сулары, техногенез, урбандалу, Орталық Қазақстан, өнеркәсіп кәсіпорындары

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Евразийский Национальный Университет имени Л.Н. Гумилева,
Астана, Казахстан.
E-mail: kamila3.08@mail.ru

ГЕОГРАФИЧЕСКИЕ АСПЕКТЫ ВЛИЯНИЯ ТЕХНОГЕНЕЗА НА НАКОПЛЕНИЕ ТЯЖЕЛЫХ МЕТАЛЛОВ В ПОЧВАХ И ЗАГРЯЗНЕНИЯ ПОВЕРХНОСТНЫХ ВОД ЦЕНТРАЛЬНОГО КАЗАХСТАНА

Баттакова К.А. — докторант кафедры физической и экономической географии Евразийского национального университета имени Л.Н. Гумилева, Астана, Казахстан
E-mail: kamila3.08@mail.ru, https://orcid.org/0000-0001-9576-7164;
Саипов А.А. **—** доктор педагогических наук, профессор кафедры физической и экономической географии Евразийского национального университета имени Л.Н. Гумилева, Астана, Казахстан
E-mail: saipov1954@mail.ru, https://orcid.org/0000-0002-4138-0236.

Аннотация. В этой статье исследуются концентрации тяжелых металлов в пробах почвы и водных объектов, отобранных в городах и районах Центрального Казахстана и рассмотрены результаты изучения территориальных особенностей влияния техногенеза на окружающую среду. Экологическое состояние территории Центрального Казахстана в значительной степени обусловлено антропогенными факторами, которые нередко превышают экологические возможности окружающей среды, нарушают ее нормальное функционирование, что оказывает негативное влияние на существование человека. В ходе работы было проведено исследование элементного состава почвы, оценка и мониторинг качества поверхностных вод на территории Карагандинской области проводились по Единой системе классификации воды в водных объектах, статистическая обработка полученных результатов проведена с применением параметрических методов анализа. Исследуемый период составил 10 лет, с 2011 по 2021 годы. В результате проведенного исследования отмечено ртутное загрязнение в реке Нура, среднее содержание ртути в количестве 15,137 мг/дм³ с превышением ПДК в 30,2 тысяч раз. К благоприятным зонам отнесены города, Каражал, Приозерск, Сарань, Сатпаев, Шахтинск, поселок Топар и все сельские территории, к неблагоприятным зонам риска – города Балхаш, Жезказган, Караганда, Темиртау. Промышленные предприятия горнодобывающей и металлургической промышленности ТОО «Корпорация Казахмыс», АО «Арселор Миттал», Балхашский горно-металлургический комбинат представляют угрозу для объектов окружающей среды, соответственно требуются эффективные политики по смягчению последствий загрязнения окружающей среды. Меры предотвращения негативного влияния техногенных факторов на здоровье населения, как лимитирующего звена для дальнейшего развития экономики имеют важное значение для Республики Казахстан.

Ключевые слова: география, тяжелые металлы, ртутное загрязнение, почва, поверхностные воды, техногенез, урбанизация, Центральный Казахстан, промышленные предприятия

Introduction

According to the Global Burden of Disease, Injury and Risk Factors Study, environmental pollution causes 9 million deaths per year worldwide due to industrialization and urbanization, combined threats of pollution with hazardous chemicals, climate change and loss of biodiversity (Fuller et al., 2022; Zhang et al., 2010). Global warming, greenhouse effects, climate change, limited natural resources and their significant consumption lead to damage to the opportunities of future generations (Lafakis et al., 2019; Berrang-Ford et al., 2021; Pascal et al., 2022). There are three types of environmental pollution: water, air and soil pollution (Anderson, 2017). The soil is actively exposed to anthropogenic pollution, which gets heavy metals, due to their widespread use in industrial production, poisoning it and forming areas of landscape pollution and high toxicity to living organisms (Boltunova et al., 2017; Zharikova, 2021). Heavy metals include more than 40 elements of the periodic system of Mendeleev D.I. with an atomic mass of more than 40 atomic units: V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Mo, Cd, Sn, Hg, Pb, Bi, etc. According to N. Reimers's (1990) classification, metals with a density of more than 8 g/cm³ should be considered heavy (Dzhuvelikyan et al., 2009).

The urbanization of territories is characterized by the growth of various types of industrial production and the concentration of population in cities. This process over time causes anthropogenic pollution of the environment due to harmful emissions from industrial enterprises and, in this regard, affects the formation of the health of people living in an industrial region. As a result, the environment begins to change under the influence of constant human economic activity. New artificial biogeochemical provinces are emerging around large industrial enterprises. In each specific case, the level of pollution in these territories is determined by the development of various industries, the initial and resulting product, the peculiarities of natural and climatic conditions and the attitude of people to production (Battakova et al., 2022). The mining industry has health risks due to the adverse effects of toxic metals, dust, explosives and gases, water, soil and air pollution with heavy metals, loss of arable land, and therefore, this production should take seriously corporate responsibility, sustainable development goals, health and safety assessment, and respect for the rights of local communities (The Lancet, 2019). In particular, adverse effects of anthropogenic factors on soil characteristics were identified; various chemical elements entering the soil can be retained in it for a long time due to the formation of poorly soluble forms, as well as being activated and turning into mobile forms, and the soil cover deposits heavy metals or becomes a secondary source of pollution (Biryukov et al., 2014).

The territory of Kazakhstan is diverse in terms of climate conditions, the nature of environmental pollution due to the activities of large petrochemical, metallurgical, heat and power enterprises, the chemicalization of agriculture, everyday life, urbanization and urban growth, the peculiarities of the demographic situation and public health. To date, 493 deposits have been identified in Kazakhstan, which contain 1225 types of mineral raw materials. Kazakhstan ranks first in the world in proven reserves of zinc, barite and tungsten, and second in proven reserves of silver, lead and chromites (Grebeneva et al.,

2018). There are the following sources of environmental pollution in the Republic of Kazakhstan. The territory of Central Kazakhstan is polluted by emissions from ferrous, non-ferrous metallurgy and coal mining enterprises. There is a risk of soil contamination with heavy metals near the ore mining at the Temirtau metallurgical plant and the Balkhash mining and metallurgical plant. Sources of increased risk of mercury pollution are represented in Temirtau, the former Karbid plant and the Pavlodar Chemical Plant. Currently, measures are being taken to clean up the Nura River, in Pavloda,r it was noted that mercury is located between two clay layers, as a result of which cleaning of the territory is not advisable. The consequences of the development of oil and gas fields in the Caspian region, covering the West Kazakhstan, Atyrau and Aktobe regions, are associated with the contamination of soil, reservoirs, and, ultimately, drinking water with oil hydrocarbons. In addition, emissions of chromium-containing dust are recorded during the extraction of ores and processing of chromates at the enterprises of Aktobe city. Harmful effects are caused by emissions of lead-zinc and titanium-magnesium plants in the East Kazakhstan region, industrial waste of phosphorus and lead enterprises of the South Kazakhstan region. In the city of Ekibastuz, the largest amount of coal is burned at the thermal power plant to generate electricity, releasing heavy metals into the atmospheric air. Technogenic and anthropogenic impacts on the biosphere cause complex processes leading to the degradation of the ecosystem and changes in the health of the population (Likhodumova et al., 2008). Water quality is one of the most important characteristics and the study of the factors of pollution of water bodies due to the operation of industrial production and other sources is relevant for Kazakhstan (Berdenov, 2017 a; Berdenov et al., 2022 b).

The purpose of the study is to investigate the soil cover for pollution by heavy metals (As, Pb, Cu, Cd, Zn, Cr) and surface waters according to the physical and chemical parameters of the territory of Central Kazakhstan.

Hypothesis - assessment of the state of the environment of Central Kazakhstan in terms of the quality of soil covers and water environments identified pollution of the territory and the adverse impact of environmental factors of production and technogenic load.

Research object and methods

The study of the elemental composition of the soil was carried out in the industrial center of Central Kazakhstan – Karaganda region. The study period was 10 years, from 2011 to 2021. It should be noted that on June 8, 2022, according to the decree of the President of the Republic of Kazakhstan, in accordance with Article 9 of the Law of the Republic of Kazakhstan "On the Administrative-territorial Structure of the Republic of Kazakhstan", it was decided to form the Ulytau region with the administrative center in the city of Zhezkazgan by separating Zhanaarka, Ulytau districts, the cities of Zhezkazgan, Karazhal and Satpayev from the Karaganda region (Reference control bank, 2022). Thus, the Karaganda region is located in the central part of the republic, the area of the territory is 239,045 km², and the administrative center is the city of Karaganda (Unified ecological Internet resource, 2011). The Ulytau region was formed on June 8, 2022, the area of the territory is 188,936.61 km², and the administrative

center is the city of Zhezkazgan. The ecological condition of the territory of Central Kazakhstan is largely due to anthropogenic factors, which often exceed the ecological capabilities of the environment, disrupt its normal functioning, which has a negative impact on human existence. Measures to prevent the negative impact of technogenic factors on the health of the population, as a limiting link for the further development of the economy, are important in the Republic of Kazakhstan (Kurolap, 2006; Filatov et al., 2010).

Assessment and monitoring of soil contamination with heavy metals in the cities of Abay, Balkhash, Zhezkazgan, Karaganda, Karazhal, Priozersk, Saran, Satpayev, Temirtau, Shakhtinsk, Topar township; in the districts of Abay, Aktogay, Bukhar-Zhyrau, Zhanaarka, Karkaraly, Nura, Osakarov, Ulytau, Shet of the Karaganda region were carried out on the basis of the materials received from the National reports on the state of the environment and on the use of natural resources of the Republic of Kazakhstan, annual reports of the branch of RSE "Kazhydromet" in the Karaganda region, information bulletins on the state of the environment of the Karaganda region of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan, laboratory data of the Karaganda branch of the Republican State Enterprise "National Center of Expertise" of the Committee for Sanitary and Epidemiological Control of the Ministry of Health of the Republic of Kazakhstan. At key points, soil sampling was carried out to determine arsenic, lead, copper, cadmium, zinc, and chromium. Soil sampling was carried out in accordance with GOST 17.4.4.02-84 «Soil sampling for chemical analysis». The study period for the analysis of the obtained indicators of the geography of the impact of technogenesis on the accumulation of heavy metals in the soils of the Karaganda region was from 2011 to 2021.

The assessment and monitoring of surface water quality in the territory of the Karaganda region were carried out according to the Unified Classification System of Water in water bodies approved by Order No. 151 of the Chairman of the Committee on Water Resources of the Ministry of Agriculture of the Republic of Kazakhstan dated November 9, 2016.

Statistical processing of the obtained results was carried out using parametric analysis methods, to test hypotheses about the parameters of certain distributions of the general population, *the Student's t-criterion* (t-criterion of difference) is calculated, which allows us to find the probability that both averages belong to the same population. If this probability *p* is below the significance level *($p<0.05$)*, then the samples belong to two different populations, and using the t-criterion, two cases can be distinguished. *The null hypothesis (H0)* is reduced to the assumption that the difference between the general parameters of the compared groups is zero and the differences observed between the sample characteristics are not systematic, but exclusively random. If one sample is drawn from a normally distributed population with parameters 1 and Sx1, the other from a population with parameters 2 and Sx2, then the null hypothesis comes from the fact that 1= and Sx1 = Sx2, i.e. 1-2=0 and Sx1- Sx2=0. To test the accepted hypothesis and the reliability of the estimation of general parameters based on sample data, values and reliability criteria are used, which allow in each case to identify whether the sample

indicators satisfy the accepted hypothesis. The distribution functions of these quantities are summarized in special tables, which contain the values of the function for different numbers of degrees of freedom *R* or sample size *n* and significance levels . When testing statistical hypotheses, the following significance levels were taken: 5% (probability of an erroneous estimate p≤0.05), 1 % (probability of an erroneous estimate p≤0.01), 0.1 % (probability of an erroneous estimate p≤0.001).

Results and discussion

The analysis of the characteristics of the soil cover for the period from 2011 to 2021 showed significant differences in the territory of the Karaganda region (Figure 1). The most polluted soil is in the city of Balkhash, the concentration of lead was 649.463 mg/kg exceeding the MPC by 20 times, copper – 98.268 mg/kg exceeding the MPC by 33 times, cadmium – 14.409 mg/kg exceeding the MPC by 28 times, zinc – 295.309 mg/kg exceeding the MPC by 12 times, chromium – 8,5009 with an excess of MPC by 1.4 times (Table 1).

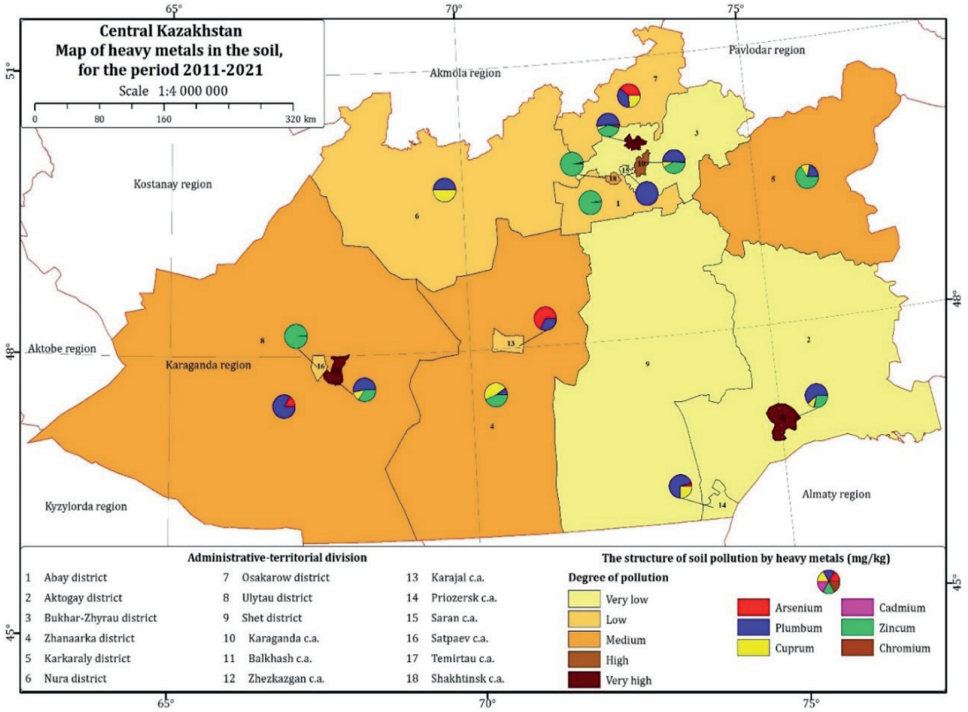

Figure 1. Map of heavy metals content in the soil of Central Kazakhstan, period 2011–2021.

Table 1. The content of heavy metals in the soil (mg/kg) by cities and townships of the Karaganda region, the period 2011 to 2021.

Indicators /Statistics	As	Pb	Cu	Cd	Zn	Cr
MPC	2	32	3	0,5	23	6
Abay						
Minimum	0	0,0021	0,0012	0	0,1	0
Maximum	0	0,0036	0,0051	0	0,5	0

Mean	0	0,0027	0,003	0	0,218	0
Balkhash						
Minimum	0	178,4	38,8	3,3	74,2	1,31
Maximum	0	1306,7	185,4	32,7	348,6	11,6
Mean	0	649,463**	98,268**	14,409**	295,309**	8,5009*
Zhezkazgan						
Minimum	0	80,9	9,46	1,02	26,9	1,09
Maximum	0	461,3	84,6	6,53	197,5	6,45
Mean	0	216,034**	50,241**	3,273*	138,790**	3,761
Karaganda						
Minimum	0,033	24,6	3,2	0,2	20,9	0,33
Maximum	0,35	38,9	5,9	0,5	28,3	1,82
Mean	0,098	31,101	4,758*	0,326	25,072*	0,81
Karazhal						
Minimum	0,0353	0,0111	0	0	0	0
Maximum	0,519	0,236	0	0	0	0
Mean	0,1226	0,0581	0	0	0	0
Priozersk						
Minimum	0	0	0	0	0	0
Maximum	0,00104	0,0154	0,0057	0	0	0
Mean	0,00093	0,0137	0,0049	0	0	0
Saran						
Minimum	0	0,0111	0	0	0	0
Maximum	0	0,0931	0	0	0	0
Mean	0	0,0225	0	0	0	0
Satpayev						
Minimum	0	0,002	0,0011	0	0,1	0
Maximum	0	0,0032	0,0057	0	0,5	0
Mean	0	0,0026	0,0027	0	0,2636	0
Temirtau						
Minimum	0	37,01	0	0	26,4	1,2
Maximum	0	52,8	6,2	0,74	37	5,3
Mean	0	42,71*	3,7218	0,5772	32,2909*	3,0127
Topar						
Minimum	0	0,001	0	0	0	0
Maximum	0	0,073	0	0	0	0
Mean	0	0,01048	0	0	0	0
Shakhtinsk						
Minimum	0,0002	0,0001	0,001	0	0,1	0
Maximum	0,028	0,028	0,0051	0	0,9	0
Mean	0,0055	0,0067	0,0024	0	0,3727	0

*Note – *p≤0.05 when compared with the comparison group (Topar township), **p≤0.01*

An excess content of heavy metals was noted in Zhezkazgan in all soil samples taken in various districts of the city, the average lead content was 216.034 mg/kg exceeding the MPC by 6 times, copper – 50.241 mg/kg exceeding the MPC by 16 times, cadmium – 3.273 mg/kg exceeding the MPC by 6 times, zinc – 138.790 mg/kg with an excess

of MPC by 6 times, chromium – 3.761. The highest indicators were also found in Karaganda in terms of copper - 4.758 mg/kg, zinc - 25.072 mg/kg and in Temirtau the content of lead was exceeded - 42.71, zinc - 32.2909.

In other cities of the Karaganda region of the Republic of Kazakhstan, the concentration of all detectable pollutants in soil samples does not exceed the maximum permissible concentrations. Thus, in the city of Abay, the average content of lead in the soil was 0.0027 mg/kg, copper - 0.03 mg/kg, zinc 0.218 mg/kg; in the city of Karazhal, the average content of arsenic in the soil was 0.1226 mg/kg, lead - 0.0581 mg/kg; in Priozersk, the average content of arsenic in the soil was 0.00093 mg/kg, lead - 0.0137 mg/kg, copper 0.0049 mg/kg; in the city of Saran, the average lead content in the soil was 0.0225 mg/kg; in the city of Satpayev, the average content of lead in the soil was 0.0026 mg/kg, copper - 0.0027 mg/kg, zinc 0.2636 mg/kg; in Topar, the average lead content in the soil was 0.01048 mg/kg; in Shakhtinsk, the average content of arsenic in the soil was 0.0055 mg/kg, lead - 0.0067 mg/kg, copper - 0.0024 mg/kg, zinc 0.3727 mg/kg.

In soil samples taken in various rural areas of the Karaganda region, it was noted that the concentration of heavy metals in the soil is within the permissible limits (Table 2).

Table 2. The content of heavy metals in the soil (mg/kg) by districts of the Karaganda region, the period 2011 to 2021.

Indicators /Statistics	As	Pb	Cu	Zn
MPC	2	32	3	23
Abay district	0	0	0	0,1
Aktogay district	0	0	0	0
Bukhar-Zhyrau district	0	0	0	0
Zhanaarka district	0	0,2496	1,18	1,09
Karkaraly district	0	0,1707	0,1024	0,52
Nura district	0	0,1	0,1	0
Osakarov district	0,12	0,1095	0,0742	0
Ulytau district	0,15	0,8	0	0
Shet district	0	0	0	0

Mean value

It follows from the above that as a result of the assessment of the soil condition of cities and towns of the Karaganda region, it was revealed that in the cities of Balkhash, Zhezkazgan, Karaganda, Temirtau, the unfavorable environmental situation in terms of heavy metals pollution.

The accumulation of heavy metals in the soil in these cities is explained by the fact that the majority of industrial enterprises of the mining and metallurgical industry of Kazakhmys Corporation LLP, Arcelor Mittal JSC, Balkhash Mining and Metallurgical Combine are located nearby. The main technogenic sources of heavy metals are: non–ferrous metallurgy - lead, zinc, copper, mercury, manganese, antimony, tungsten, cobalt, cadmium; ferrous metallurgy – nickel, manganese, lead, copper, zinc, tungsten, cobalt; energy – arsenic, antimony, selenium; petroleum industry – lead, copper, nickel, zinc,

manganese; coal burning – antimony, arsenic, cadmium, chromium, molybdenum; oil burning – arsenic, lead, cadmium.

There is a classification division of heavy metals into 3 hazard classes: Class 1 (especially toxic) – arsenic, cadmium, mercury, selenium, lead, zinc; Class 2 (toxic) – boron, cobalt, nickel, molybdenum, antimony, chromium, copper; Class 3 (low-toxic) – barium, vanadium, tungsten, manganese, strontium. Accordingly, we found six heavy metals - arsenic, lead, copper, cadmium, zinc, and chromium, four of them belong to the 1st hazard class and are especially toxic.

That is, heavy metals are dangerous environmental pollutants, industrial emissions, the development of technogenesis, urbanization and motor transport are the cause of the accumulation of various toxic substances in the surface layer of soils of urban landscapes. At the same time, the impact on the natural environment is cumulative and can last for years, resulting in a deterioration in the comfort of the habitat, the health of urban residents, and food security.

The analysis of the characteristics of water quality in water bodies in the territory of the Karaganda region for the period from 2011 to 2021 showed an unfavorable environmental situation of pollution in the cities of Balkhash, Zhezkazgan, Temirtau, Nura district, Ulytau district, Bukhar-Zhyrau and Abay districts (Table 3).

Table 3. Water quality assessment of water bodies in Central Kazakhstan, mg/dm³, period 2011 to 2021.

Name of the water body	Water quality class	Parameters mg/dm³	Concentration *Mean value*
Nura River Nura district	4th class	Copper	3,06
		Mercury	15,137
		Magnesium	37,4
		Manganese	5,55
		Phenols	0,0011
Samarkand Reservoir Temirtau	4th class	Copper	3,37
		Magnesium	32,8
		Iron	1,186
Kengir Reservoir Ulytau district	4th class	Copper	3,22
		Magnesium	50,6
		Manganese	3,04
		Mineralization	1614,3
		Sulfates	566
Kara-Kengir River Zhezkazgan	not standardized (>5th class)	Magnesium	53,51
		Ammonium ion	12,1
		Calcium	207
		BOD5	6,56
		Chlorides	364
		Mineralization	2177,2
Lake Balkhash Balkhash	not standardized (>5th class)	Copper	8,26
		Magnesium	73,557
		Mineralization	2421

Sokyr River Bukhar-Zhyrau district	not standardized (>5th class)	Copper	2,53
		Magnesium	36,697
		Manganese	3,8102
		Ammonium ion	2,61
Sherubaynura River Abay district	not standardized (>5th class)	Copper	3,81
		Manganese	0,131

The Nura River originates in the Karaganda region and flows further through the Akmola region, begins in the Keregetas mountains and flows into the Korgalzhinsky system of lakes connecting with the large Tengiz lake. The water temperature is noted within the range of 0–25.3°C, the pH value is 7.99, the concentration of oxygen dissolved in water is 8.63 mg/dm³, BOD5 is 2.13 mg/dm³. Mercury contamination was detected, in all samples taken on the Nura River, the average mercury content was 15.137 mg/dm³, exceeding the MPC by 30.2 thousand times. Mercury pollution of the Nura River is associated with the activities of the acetaldehyde production of the former production association "Carbide" in Temirtau. Since mercury is a highly toxic chemical element, this pollution causes concern of high environmental risk and damage to public health, as residents of coastal villages of the Nura district graze cattle on coastal land, grow crops, and use water for irrigation. The concentration of copper content is 3.06 mg/dm³ with an excess of MPC by 3 times, manganese – 5.55 mg/dm³ with an excess of MPC by 55 times, magnesium – 37.4 mg/dm³, phenols – 0.0011 mg/dm³. The Samarkan reservoir is located on the Nura River, the water temperature is in the range of 0-25.0 °C, the pH value is 8.08, the concentration of oxygen dissolved in water is 8.92 mg/dm³, BOD5 is 2.13 mg/dm³. The average content of copper is 3.37 mg/dm³, exceeding the MPC by 3 times, iron - 1.186 mg/dm³, exceeding the MPC by 3.9 times, magnesium - 32.8 mg/dm³.

The Kara-Kengir River is the right tributary of the Sarysu River, the water temperature is noted in the range of 0-25.2 °C, the pH value is 7.48, the concentration of oxygen dissolved in water is 5.65 mg/dm³, BOD5 - 6.56 mg/dm³. The average content of magnesium is 53.51 mg/dm³, ammonium ions - 12.1 mg/dm³, calcium - 207 mg/dm³, chlorides - 364 mg/dm³, mineralization - 2177.2 mg/dm³. The Kengir reservoir in the Ulytau region is located on the Kengir River, the water temperature is in the range of 0-24.4 °C, the pH is 7.45, the concentration of oxygen dissolved in water is 7.28 mg/dm³, BOD5 is 2.40 mg/dm³. The average content of copper is 3.22 mg/dm³, exceeding the MPC by 3 times, manganese - 0.1 mg/dm³, exceeding the MPC by 30 times, magnesium - 50.6 mg/dm³, mineralization - 1614.3 mg/dm³, sulfates - 566 mg/dm³.

In Lake Balkhash, the water temperature is within 12-26°C, the pH is 8.52, the concentration of oxygen dissolved in water is 7.96 mg/dm³, BOD5 is 1.40 mg/dm³. The average content of copper is 8.26 mg/dm³, exceeding the MPC by 8 times, magnesium - 73.557 mg/dm³, exceeding the MPC by 1.8 times, mineralization - 2421 mg/dm³.

The Sokyr River flows through the territory of the Bukhar-Zhyrau district, the water temperature is noted in the range of 0-27.2 °C, the hydrogen index is 8.01, the concentration of oxygen dissolved in water is 8.36 mg/dm³, BOD5 is 2.77 mg/dm³. The average content of copper is 2.53 mg/dm³, exceeding the MPC by 2.5 times,

magnesium - 36.697 mg/dm³, manganese - 3.8102 mg/dm³, exceeding the MPC by 38 times, ammonium ions - 2.61 mg/dm³.

The Sherubaynura River is a right-bank tributary of the Nura River, flows through the territory of the Abay region, the water temperature is noted within 0–26.0 °C, the pH value is 7.91, the concentration of oxygen dissolved in water is 8.33 mg/dm³, BOD5 is 2.61 mg/dm³. The average content of copper is 3.81 mg/dm³, exceeding the MPC by 3.8 times, manganese is 0.131 mg/dm³.

According to the Unified Water Quality Classification System in water bodies, there are 5 classes of water from a high to a low level of water quality, which are characterized according to the concentration of these indicators:

Class 1 is characterized by water, which is recommended for all types of water use, is of high-quality water;

Class 2 defines water that can be used for all types of water use, except for household and drinking purposes. In order for the water to be suitable for household and drinking purposes, simple water treatment methods are required;

Class 3 water is suitable for recreation, irrigation and industry. In order for the water to be suitable for household and drinking purposes, more effective methods of purification are required. Water of this class is not recommended for breeding salmon fish.

Class 4 water can only be used for irrigation and industrial water use, including hydropower, mining, hydrotransport. In order for the water to be suitable for household and drinking purposes, intensive water treatment is required. Water of this class cannot be used for recreational purposes.

Class 5 water is low quality water. It is suitable only for hydropower, mining, hydrotransport.

Thus, assessing the quality of water bodies in the territory of the Karaganda region, the characteristics of a high level of pollution in the city of Balkhash on Lake Balkhash, the rivers Sokyr of Bukhar-Zhyrau district, Sherubainura of Abay district and a moderate level of water pollution in the rivers Nura, Kara–Kengir, Samarkan reservoir of Nura district, and Kengir reservoir of Ulytau district were established.

Conclusion

As a result of the study, it can be concluded that the geography of the influence of technogenesis on the accumulation of heavy metals in the soils of the Karaganda region ranked the territories as follows: the favorable zones include the cities of Karazhal, Priozersk, Saran, Satpayev, Shakhtinsk, Topar township and all rural areas, unfavorable risk zones include the cities of Balkhash, Zhezkazgan, Karaganda, Temirtau. These are industrial and urbanized cities of Central Kazakhstan, which require effective policies to mitigate the effects of environmental and industrial pollution. The concentration of pollutants in the water bodies of Central Kazakhstan reveals the excess of the maximum permissible concentrations in the same territories as the cities of Balkhash, Zhezkazgan, Temirtau. Mercury pollution in the Nura River has established an average mercury content of 15.137 mg/dm³ with an excess of MPC by 30.2 thousand times. This unfavorable indicator should be considered by local executive bodies as a level of intervention and is recommended for use in taking measures to immediately correct the situation.

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