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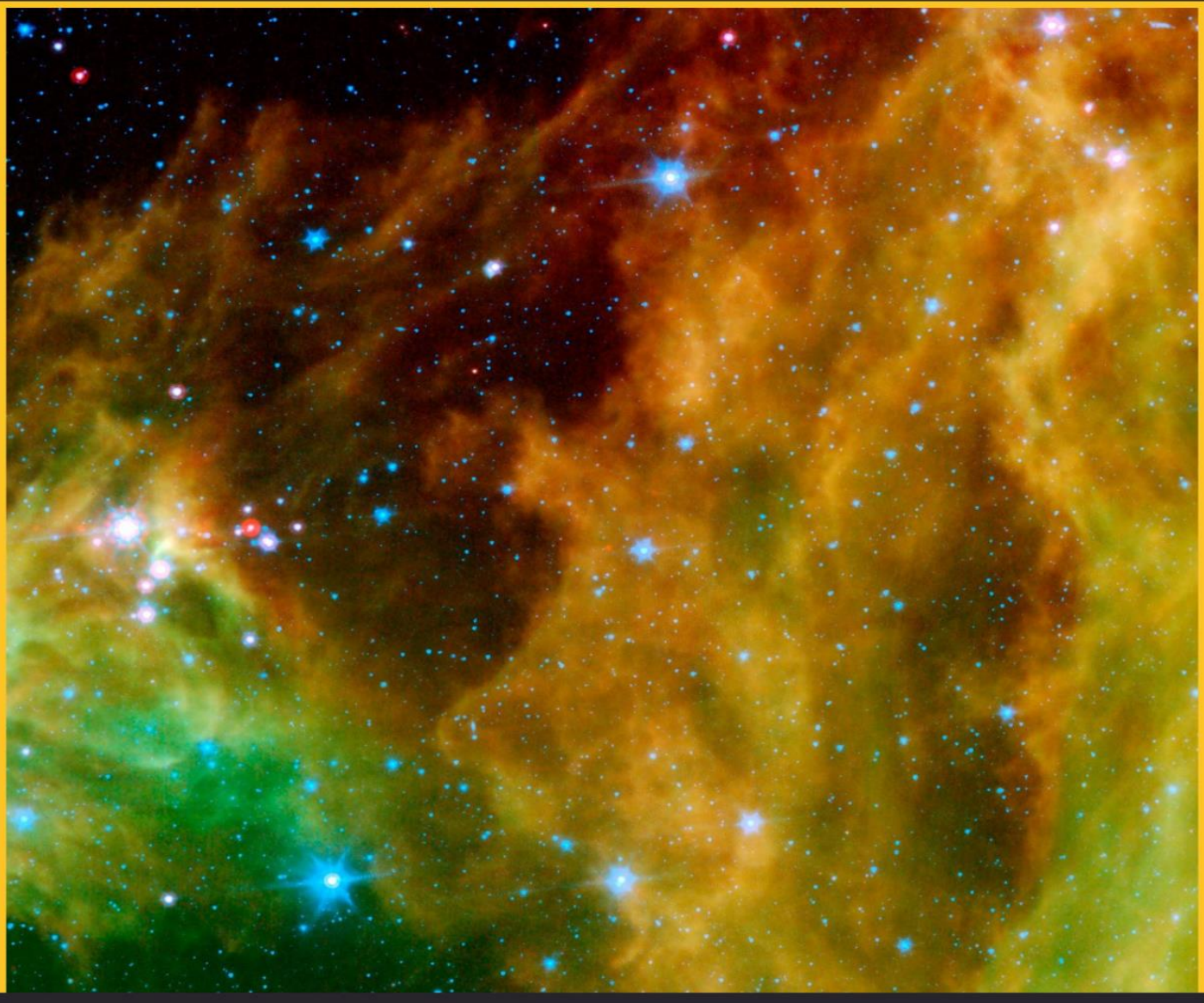

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APPLIED JURISPRUDENCE

UDC 343.9

Brager D.K., Osipova K.M., Romel S.A., Shaturskaya T.B. Separate aspects of involving a specialist in the procedure of obtaining samples for comparative study

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Abstract. *In order for the forensic examination to be carried out properly, the investigator must provide appropriate samples and properly prepare materials for conducting an expert study. In practice, there are a large number of problematic moments in the implementation of these actions. The problems of the procedural order and the application of tactical methods for obtaining samples for research, preparing materials for examinations are considered in this paper. The aim of the work is to analyze the problems of tactics for obtaining samples for a comparative study.*

Keywords*: research samples, comparative research, sampling tactics, law, tactics, expert research, comparative research, sampling.*

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At the present stage of development of society, there is a negative trend towards an increase in the level of crime in our state. Effective, quick and complete investigation of crimes

and bringing the perpetrators to justice is primarily ensured by the quality of the pre-trial investigation and the availability of an appropriate evidence base.

Obtaining samples for fingerprinting, phonoscopy, forensic and other types of examinations is almost impossible without the involvement of a specialist. The legislator procedurally regulated the ability to involve a specialist in the selection of samples for examination and left the right to choose on the side of the criminal proceedings, which filed a petition for the necessary examination.

The samples used for comparative research are objects (substances and (or) objects), including their physically fixed representations, containing a set of features of specific objects, including persons, subject to comparative research. In the process of implementing a forensic examination, samples for a specific comparative study are used by the expert conducting the study as necessary materials for comparison, but at the same time “for the investigator, they are subject to all the requirements for proof in working with evidence” [2].

Bravilova E. A. notes the requirements that samples must meet for all types of research, namely: legality, reliability, comparability and sufficient quantity [1]. Also, there is no classification of samples in the legislation, which is important for the study.

The Decree “On Forensic Examination in Criminal Cases” defines the types and concept of samples for specific studies [4]. After analyzing the scientific literature and current legislation, in general, the following types of samples can be distinguished: free, conditionally free and experimental.

A person from whom samples are taken specifically for examination can consciously change his specific properties and characteristics. Undoubtedly, this complicates the examination. "These materials were written by a person who is being checked before the opening of criminal proceedings and have no connection with him" [3].

Objects that are used as conditionally free “appear after the opening of any criminal proceedings, but are not related to the preparation of materials for examination” [5]. Samples that arise after the opening of criminal proceedings are called experimental, since appropriate conditions are usually created to obtain them. Together with the generally recognized appearances of the samples, the following: reference, samples of "materials or substances of the object under study, control and collection" [2].

To solve research issues in ballistic examinations in the examination of edged weapons, the latter is used. They should include books, albums, reference books of vehicle tread patterns, cold steel and firearms.

Such samples simplify this work of an expert, for example, when identifying a modification and brand of a foreign pistol with an obliterated marking, and in other cases [3]. Reference samples help to solve both classification and diagnostic issues.

Namely, when designating the brand of oil products, paintwork material, the name of poisonous or drugs. They are necessary in case of establishing the fact of diluting "expensive" gasoline with "cheap" one, counterfeiting alcoholic beverages, etc. [1].

Standards of materials or substances of the object under study, "depending on the situation, can take part in the form of an average sample for watery and unsteady substances, as well as sample-authorized persons of the whole" [4]. Trial samples are usually used in forensic examination of materials and substances, technical examination of documents, examination of soils, forensic bio examination of objects of animal and plant origin, etc.

They are confiscated in order to verify the properties of the object. These samples are used for control, in the examination of soils they are called soil samples. According to them, the boundaries of the territory into which the place of the criminal act enters are calculated. Earth samples are taken both from the scene itself and beyond [3]. This classification of samples for examination, like any other, is conditional.

However, applying these provisions, it can be argued:

1. Only the investigator seizes free and conditionally free samples.

2. Collection and reference samples are also selected by an expert. This state of affairs is due to the fact that when conducting identification ballistic, investigative and some forensic medical examinations, the assignment of samples for comparison is the function of an expert, since this is one of the stages of a comparative study.

3. Experimental standards are also selected in the same way, however, the samples that are obtained in the process of comparative analysis are selected by a specialist alone.

4. Samples of materials and substances of the investigated object are taken by the investigator.

If the provision of samples from the object sent for comparative analysis is carried out in the process of examination, then such an action is carried out by the expert himself, and the procedure for obtaining such samples should be reflected in the expert's opinion [3]. It is clear that at the legislative level it is impossible to provide for all cases when it is necessary to involve a specialist to carry out these investigative actions, since various situations arise in practice.

However, it is worth highlighting the main factors that determine the feasibility of involving and the role of a specialist in obtaining samples.

1. If a qualified investigator can independently take experimental samples for handwriting examination, then when selecting samples for soil science examination, it is advisable to involve a specialist, since such an investigative action requires special knowledge.

2. If obtaining free and conditionally free samples in most cases does not require special skills, then when obtaining experimental samples, the investigator must be aware of the features of the selection of such samples or involve a specialist. Samples (samples) of materials and substances, as a rule, are taken with the participation of a specialist, which is due to the complexity of these procedural actions and the need for special knowledge.

3. Investigator skills. Skilled sampling depends on the experience and knowledge of the investigator. However, this is not a decisive factor. The investigator who studied the course of criminology, has mastered only the minimum knowledge provided by the program in criminology for law schools. It is clear that the specialist has in-depth knowledge of all branches of forensic science and knows forensic technology at the current level of development.

The selection of materials for examination requires the necessary knowledge of the methods of comparative research, compliance with the rules for extracting, packaging and storing objects of comparative research. The implementation of such actions by the investigator independently bears certain risks for future examination.

Therefore, the involvement of a specialist in obtaining samples and preparing samples for comparative analysis is justified, first, by the difficulty of selecting samples for certain types of examinations, the types of samples that need to be obtained, and the level of training of the investigator. Based on the analyzed material, it can be argued that the use of special knowledge at this stage of the pre-trial investigation contributes to the qualified implementation of such actions.

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APPLIED PEDAGOGY AND PSYCHOLOGY

UDC 378.096

Belenova I.A., Markosyan Z.S., Kozhevnikov V.V., Chernykh E.A. Medico-social aspects of the adaptation of foreign students in the Voronezh State Medical University N.N. Burdenko

Медико-социальные аспекты адаптации иностранных студентов в ВГМУ им. Н.Н. Бурденко

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Abstract. *The article discusses the process of adaptation of foreign students, identifies some problems of the transition period, and also reveals the role of the teacher in overcoming difficulties during training. So, adaptation to a complex of new factors specific to higher education is a multi-level socio-psycho-physiological process and is accompanied by a significant strain on the compensatory-adaptive systems of the student's body.*

Keywords: *VSMU, student, adaptation, psychology, pedagogy*

Аннотация. *В статье рассматривается процесс адаптации иностранных учащихся, выявляются некоторые проблемы переходного периода, а так же раскрывается роль преподавателя в преодолении трудностей во время обучения. Итак, адаптация к комплексу новых факторов, специфичных для высшей школы, представляет собой многоуровневый социально-психофизиологический процесс и сопровождается значительным напряжением компенсаторно-приспособительных систем организма студентов.*

Ключевые слова: *ВГМУ, студент, адаптация, психология, педагогика*

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Цель работы: изучить особенности адаптации студентов МИМОС к учебе в России, конкретно в ВГМУ им. Н.Н. Бурденко.

Задачи: 1. Проанализировать педагогическую, социологическую литературу по теме исследования.

2. Изучить психологическую сторону иностранных студентов.

Методы исследования: теоретический, эмпирический, анкетирование.

Первый термин (в дальнейшем рабочий) введен в научный оборот американским исследователем К. Обергом в 1960г. Современные ученые, развивая идеи Оберга, установили, что опыт пребывания в новой культуре является неприятным: во-первых, потому что он неожидан в любом случае, даже если к нему готовились дома (посредники и реклама строят агитацию и систему убеждений в свою пользу); во-вторых, потому что он может привести к неожиданному пересмотру ценностей собственной культуры и даже к негативной ее оценке; в-третьих, срабатывает важнейший стихийный неосознанный фактор, определяющий коммуникативное поведение людей, – это ситуация, названная Э. Холлом «культурные очки» [1].

Простое население считает, что если иностранный студент приехал учиться, то он должен вести себя именно так, как нужно мне, а ни как иначе. И вместе с этим иностранный студент считает, что если он заплатил за учебу большие деньги, то учебный процесс, условия проживания культура и так далее должны полностью

соответствовать их или европейским традициям. Это называется синдром «культурных очков».

Выделяют 6 форм культурного шока:

1. физическое напряжение.

2. чувство потери чего либо или кого либо

3. чувство потерянности

4. нарушение ролевых ожиданий, завышенная самооценка и как следствие конфликты с преподавателями из-за оценок, страх выглядеть хуже других на занятиях

5. тревога (он хочет только денег, русские девушки ....),

6. чувство неполноценности (приступы агрессии, депрессии, запои, отказ от посещения занятий).

Самая критическая считается 3 ступень, когда учащийся испытывает чувство потерянности, и в этот период большинство студентов возвращаются на свою родину [2]. Иностранный студенты на данной ступени хотят индивидуального преподавания, разработанных лекций и занятий. С одной стороны, улучшается разговорный русский, что создает иллюзию свободного говорения и понимания, поэтому ухудшается учебная дисциплина, ведь изучать научный русский нужно системно, а это требует временных затрат и интеллектуальных усилий. Часть студентов уходят жить на квартиры, посещают увеселительные заведения, зачастую обзаводятся временными или постоянными семьями.

4-ступень Студент адаптируется к режиму учебных занятий: привыкает к необходимости рано вставать, приходить вовремя на занятия, выдерживать 8-часовой учебный день, заниматься самостоятельной подготовкой к занятиям, работать в читальном зале.

На 5-ступени студенты полностью адаптируются друг к другу. После 5 ступени у большинства из них наступает 6-я, когда возникает обратная реадаптация, то есть после возращения на Родину, ему тяжело адаптироваться к родной культуре.

Продолжительность межкультурной адаптации зависит от индивидуальных и групповых. Индивидуальные факторы считаются наиболее критические. У студентов, которые действительно настроены на получение знаний и профессии, отмечается высокая мотивация и большая скорость адаптации, прежде всего языковой и страноведческой, т.к. эти знания облегчают им процесс достижения цели.- фактор опыта пребывания в инокультурной среде способствуют облегчению адаптационного процесса.

Групповые факторы: условия страны, куда студент отправился учиться, особенности своей родной культуры. Возникает чувство дистанции с окружающими. В случае неадекватного восприятия (как в сторону увеличения, так и в сторону уменьшения) этой величины процесс адаптации затрудняется и культурный шок длится дольше. Кроме того, студенты из развитых стран считают, что они заплатили за обучение, поэтому адаптироваться должны не они, а к ним.

В опросе участвовали студенты 1 курса МИМОС, Высоко адаптируется индийская община, так как они считаются дружным коллективом, у которых есть лидер. Адаптационные трудности студентов-иностранцев обусловлены не в последнюю очередь недостатком знаний, полученных на родине, о климатических, экономических и культурных особенностях жизни в России. Довольно престижным считается медицинское образование, полученное в России. Качество получаемого образования в ВГМУ в целом удовлетворяет респондентов. Как студенты ЛИ так и ЛИА, считают уровень знаний преподавателей высоким, но около 35% респондентов считают, что преподаватели непонятно объясняют свой предмет.

Значительный вклад в процесс адаптации иностранных студентов вносят сотрудники деканата МИМОС.

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Mishina T.V. Physical activity as a form of leisure

Физическая активность как форма проведения досуга

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Abstract. *The paper considers the concept of leisure, physical activity is defined as one of the forms of its implementation. The data of a sociological survey in order to identify the leisure preferences of young people are presented.*

Keywords: *leisure; free time; physical activity; Physical Culture.*

Аннотация. *В работе рассмотрено понятие досуг, физическая активность определена как одна из форм его проведения. Представлены данные социологического опроса с целью выявления досуговых предпочтений молодежи.*

Ключевые слова: *досуг; свободное время; физическая активность; физическая культура*.

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В современном мире, под влиянием различных геополитических и глобализационных процессов, в научном обиходе понятия досуг и свободное время все чаще употребляются как синонимы. Так, досуг, определяют, как время свободное от работы и от необходимых домашних обязанностей, таких как воспитание детей, приготовление пищи, уборка и т.д.

Досуг является социальной категорией в которой отражается общественная, индивидуальная и духовная сущность человека. Еще со времен Аристотеля, досуг рассматривался как высшее благо, при этом философ указывал, что «вся человеческая жизнь распадается на занятия и досуг» и в государстве люди должны быть свободны от повседневных забот и уметь испытывать счастье и удовольствие от свободы действий. То есть истинно счастливый человек, тот кто сам определяет свое свободное время и получает от этого истинное удовольствие. Рене Декарт, в свою очередь отмечал, «свобода и досуг … этими двумя вещами я обладаю в такой полноте и ценю их в такой степени, что нет в мире монарха, который был бы настолько богат, чтобы купить их у

меня» [2]. Известный ученный А.В. Соколов, ведя размышления на тему досуга и свободного времени указывал «досуг – всегда свободное время, но свободное время не всегда есть досуг». При этом автор пояснял что свободное время может быть потрачено, по усмотрению его владельца, на сверхурочную работу или на домашние хлопоты, на отдых, а досуг - это всегда активное и продуктивное время, потраченное с удовольствием. Если не углубляться в детали дальнейшего семантического анализа понятия досуг, мы можем отметить, что различные ученные В.Н. Лавриченко, Т. Мор, К. Маркс, и другие определяя данный термин старались внести в него свое мировидение и мироощущение соответствующее историческому и политико-социальному периоду, но общей чертой явилась роль досуга в саморазвитии личности. То есть, досуг всегда основан на ментальности, социальном опыте, зависит от экономической и политической ситуации в стране и ориентирован на личность, на удовлетворение ее личных потребностей, с целью самореализации и самоудовлетворения.

Современные реалии диктуют нам новый ритм и темп жизни. Если провести параллель между проживаем в городе и селе, то одни скажут, что в городе все бегут, а в селе живут, другие скажут, что в городе развитие в деревне стагнация. И каждый будет прав. Все зависит от ориентиров, ценностей, норм отдельного человека. Таким образом, окружающая нас действительность, влияние средств массовой информации, желания и стремления побуждают человека к выбору активных форм проведения досуга [4].

Государственное правление, общественные и образовательные организации стремятся активно принимать участие в досуговой деятельности граждан [3]. Предлагают различные формы проведения досуга: культурные программы, массовые зрелищные мероприятия, спортивные площадки, тематические мастер-классы, для того чтобы побудить общество активной жизни, саморазвитию и повышению уровня здоровья населения.

Как отмечает Битарова Л.Г. «Физическая культура как явление общественной жизни является важным фактором общественного прогресса. Вовлеченность каждого человека в регулярные занятия физическими упражнениями является необходимым условием социального развития общества» [1].

В рамках данной работы, приведем блок данных полученных в ходе социологического исследования проведенного обучающимися Кубанского государственного университета физической культуры спорта и туризма с целью выявления досуговых предпочтений современной молодежи. Сразу акцентируем внимание, что опрашивали методом свободной выборки на улицах города. Опрошено было 463 респондента, в возрасте от 18 до 25 лет.

Более 40% респондентов, а это большой процент, по сравнению с аналогичными исследования 2016 и 2018 гг. отметили, что предпочитают активные формы проведения

досуга. К активным формам они отнесли занятие физической культурой, подвижные игры, прогулки на свежем воздухе. На вопрос открытого типа «Почему вы выбрали данную форму досуга» респонденты давали развернутые ответы. Было отмечено, что:

- физическая активность дает заряд энергии на весь день, пропадает сонливость, увеличивается работоспособность;
- физическая активность улучшает физическое и психоэмоциональное состояние;
- физическая активность позволяет поддерживать тело в прекрасной форме;
- прогулки на свежем воздухе, занятие в спортзале дают возможность улучшить концентрацию внимания, отдохнуть от работы, отвлечься и т.д.

При этом многие респонденты в процессе опроса отмечали, что во время занятия физической культурой они слушают не только музыку, но и аудиокниги, лекции, обучающие программы по интересующим их темам. То есть данные формы способствуют саморазвитию.

Физкультурно-спортивная деятельность является, по существу, способом самосовершенствования личности, расширяя ее мировоззренческие взгляды, нравственные представления, эстетические вкусы.

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ECONOMY, ORGANIZATION AND MANAGEMENT OF ENTERPRISES, INDUSTRIES, COMPLEXES

UDC 338

Batkovskiy A.M., Batkovskiy M.A., Kravchuk P.V., Omelchenko A.N. Optimization of financial support for diversification activities carried out by enterprises of the military-industrial complex

Оптимизация финансового обеспечения диверсификационных мероприятий, осуществляемых предприятиями оборонно-промышленного комплекса

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Abstract. *The purpose of this study is to develop methodological foundations and tools for solving the most important military-economic task currently facing the enterprises of the military-industrial complex. During the period of the special military operation in Ukraine, its scientific and practical significance has increased significantly. During the period of the special military operation in Ukraine, its scientific and practical significance has increased significantly. The increased needs of the Russian Armed Forces as a result of this operation in military equipment and weapons systems necessary for military and technical support of national security in the context of a hybrid war unleashed against Russia should be met by developing and supplying new generation weapons and military equipment to the troops. The main way to solve this problem is the diversification of production at the enterprises of the military-industrial complex, which requires significant financial resources, since diversification measures are very costly. These circumstances determine the special scientific and practical importance of optimizing the financial support of diversification activities carried out by enterprises of the military-industrial complex. It should be noted that this task has not yet been systematically and comprehensively solved. The tools proposed in the article for solving the problem under consideration are based on the use of economic and mathematical methods and a systematic approach to its solution. It makes it possible to increase the efficiency of the diversification activities of enterprises of the military-industrial complex while ensuring the security of Russia.*

Keywords: *tools, military-industrial complex, diversification, enterprises, financial support, optimization.*

Аннотация. *Целью данного исследования является разработка методических основ и инструментария решения важнейшей военно- экономической задачи, стоящей в настоящее время перед предприятиями оборонно-промышленного комплекса. В период проведения специальной военной операции на Украине ее научно-практическая значимость значительно возросла. Увеличившиеся в результате данной операции потребности Вооруженных сил России в военной технике и системах вооружения, необходимых для военно-технического обеспечения национальной безопасности страны в условиях развязанной против России гибридной войны, должны удовлетворяться путем разработки и поставки в войска образцов вооружения и военной техники нового поколения. Основной способ решения данной задачи - диверсификация производства на предприятиях оборонно-промышленного комплекса, которая требует значительных финансовых средств, так как диверсификационные мероприятия являются весьма затратными. Отмеченные обстоятельства обуславливают особую научно-практическую значимость оптимизации финансового обеспечения диверсификационных мероприятий, осуществляемых предприятиями оборонно-промышленного комплекса. Следует отметить, что данная задача до настоящего времени системно и комплексно не решена. Предлагаемый в статье инструментарий решения рассматриваемой задачи основан на использовании экономико-математических методов и системном подходе к ее решению. Он позволяет повысить эффективность диверсификационной деятельности предприятий оборонно-промышленного комплекса при обеспечении безопасности России.*

Ключевые слова*: инструментарий, оборонно-промышленный комплекс, диверсификация, предприятия, финансовое обеспечение, оптимизация.*

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Введение

Резкое ухудшение социально-политической обстановки в мире привело к росту угроз национальной безопасности России. Поэтому, чтобы сохранить свою независимость, наша страна была вынуждена принять адекватные меры,

соответствующие угрозам государства. В первую очередь, необходимые для укрепления Вооруженных сил и развития оборонно-промышленного комплекса страны. Данные открытого доступа свидетельствуют, что Вооруженные Силы России усиливаются. В войска поступают новые образцы военной техники. Боевой опыт ведения военных действий в Сирийской Арабской Республике и переход на контрактный принцип комплектования Вооруженных сил увеличивает их качественный потенциал. В оборонно-промышленном комплексе ввиду резкого роста угроз национальной безопасности России многие предприятия загружают резервные мощности и используют имеющиеся ресурсы, а некоторые из них перешли на трехсменный режим работы. Указанные меры являются необходимыми, но они реализуют в основном экстенсивный путь развития предприятий ОПК. Важнейшим направлением их инновационного развития в современных условиях является диверсификация производства продукции на предприятиях комплекса [1; 2; 3].

Диверсификация, как процесс расширения ассортимента выпускаемой продукции и освоения новых видов производства, в качестве важнейшего направления развития российского ОПК была определена еще в 2016 г. При этом, в отличие от проводимой в 90-ые годы прошлого года конверсии производства, она предполагает сохранение «основного» производства, а не его уничтожение. При проведении диверсификации производства на предприятиях ОПК не останавливаются оборонные производства. Производство продукции расширяется до уровня, позволяющего производить в требуемом объеме продукцию, как военного, так и гражданского назначения с учетом его отраслевой структуры и рисков производства [4; 5]. Диверсификация производства продукции должна быть по возможности профильной, то есть соответствовать основной специализации отраслей ОПК. При ее проведении необходимо максимально широко использовать компетенции и потенциал оборонных предприятий, а гражданские производства являются основой мобилизационной экономики и в случае необходимости они должны быть готовы вернуться к производству оборонной продукции [6; 7].

Изначально главной целью диверсификации производства на предприятиях ОПК рассматривался их выход на рынок гражданской продукции (ее доля к 2025 г. должна была достигнуть 30% от общего объема производства, а к 2030 г. - до 50%) [8]. Однако по мере ухудшения военно-политической обстановки в мире и роста угроз России со стороны США и их союзников целевые задачи диверсификации производства продукции на предприятиях ОПК уточнялись и трансформировались. После начала специальной военной операции на Украине важнейшей целью диверсификации

производства стала разработка и производство новых образцов вооружения и военной техники, которые являются гарантией безопасности России и сохранения ее государственного суверенитета. Для расширения возможностей и повышения боеспособности Вооруженных сил России необходимо не только увеличивать производство традиционных образцов вооружения, но и разрабатывать принципиально новые системы вооружения, основанные на новых физических принципах [9; 10]. При этом необходимо обеспечивать оптимизацию использования производственных мощностей предприятий оборонно-промышленного комплекса, а также концентрацию и специализацию производства продукции [11; 12].

Методы и методики

При проведении диверсификации производства предприятия ОПК должны решать одновременно 2 основные задачи: удовлетворение потребности Вооруженных Сил Российской Федерации в продукции военного назначения и потребностей национальной экономики в высокотехнологичной продукции гражданского назначения. Поэтому сущность методического обеспечения диверсификации производства заключается в определении оптимального соотношения объемов производства продукции военного и гражданского назначения при достижении экстремума выбранной целевой функции и учете соответствующих ограничений [13].

Важнейшим ограничением процесса диверсификации производства является его ресурсное обеспечение [14; 15]. В общем виде данную задачу можно представить в следующем виде:

$$C(U^*)=\sum i \sum j\, Cij \cdot Wij \Rightarrow max \qquad (1)$$

при:

$$Wij\ V \geqslant Wijpl\ V,\ Wij\ G \geqslant W\ ijpl\ G,$$
$$\sum i \sum j\, \psi\ ij(Wij\ V + Wij\ G) \leqslant Ri\ dop \qquad (2)$$

где C – интегральный критерий экономической эффективности диверсификации; U* – рациональный вариант диверсификации, $U^* \in U$, где U – множество возможных вариантов диверсификации; Wij – общий объем, производимой продукции военного назначения j-го вида (j=1 ,…,M) на i-ом (i=1 ,…, N) предприятии; Cij – стоимость j-го вида продукции военного назначения, производимой на i-ом предприятии; Wij V , Wijpl V – реальные и плановые объемы производства продукции военного назначения; Wij G, Wijpl G – реальные и плановые объемы выпуска высокотехнологичной продукции гражданского назначения; ψ ij – средние удельные затраты ресурсов на производство продукции военного назначения j-го вида (j=1 ,… ,M) на i-ом (i=1 ,…,N) предприятии; Ri dop – допустимый объем ресурсов всех видов, выделяемых i-му предприятию ОПК.

Особую роль в оптимизации процесса диверсификации производства на предприятиях ОПК играет достаточное и ритмичное финансирование данного процесса [16; 17]. Влияние различных внутренних и внешних факторов, часто имеющих неопределенный характер, требуют корректировки распределения объемов денежных средств, выделяемых на реализацию диверсификационных мероприятий с учетом текущей складывающейся военно-политической ситуации. В условиях дефицита финансовых средств, сложившихся в настоящее время, задача корректировки ассигнований, необходимых для реализации программы диверсификации производства, становится особенно значимой [18].

Поэтому в таких условиях актуальной является задача разработки и обоснования инструментария корректировки текущих ассигнований в условиях неритмичного финансирования диверсифиационных мероприятий. Чтобы решить данную задачу необходимо определить систему предпочтений для определения объема ресурсов, которые необходимо выделить для каждого диверсификационного мероприятия, входящего в программу диверсификации, при ограничениях на объем имеющихся ресурсов и временные характеристики.

Для разработки формализованной модели задачи корректировки распределения финансовых средств, выделяемых на реализацию диверсификационных мероприятий, обозначим необходимые исходные данные следующим образом:

L_i –лимиты объемов финансирования каждого i-го ($i = \overline{1,n}$) диверсификационного мероприятия на рассматриваемый период;

PCF_i^t – плановый объем финансирования диверсификационного мероприятия в период времени t ($\sum_{t=1}^{4} PCF_i^t = L_i$);

FCF_i^t – фактический объем финансирования i-го диверсификационного мероприятия в период времени t;

S – объем средств, распределяемых между диверсификационными мероприятиями, включенных в программу диверсификации производства при решении данной задачи;

$(s_1, s_2, ..., s_n)$ вектор распределения дополнительно выделяемых средств, которые должны полностью распределяться между диверсификационными мероприятиями $\sum_{i=1}^{n} s_i = S$;

$SCF_i = \sum_{t=1}^{t^*-1} FCF_i^t$, $i = \overline{1,n}$ - объем средств, использованных в рассматриваемом периоде для финансирования каждого диверсификационного мероприятия;

$SCF_i^* = L_i - SCF_i$ - объем неиспользованной на момент решения рассматриваемой задачи части лимитов финансирования каждого диверсификационного мероприятия;

$SCF^* = \sum_{i=1}^{n} SCF_i^*$ - суммарный объем неиспользованной на текущий момент части лимитов финансирования по всем диверсификационным мероприятиям программы диверсификации производства;

t^* – период времени, на который распределяются поступившие дополнительные финансовые средства;

$h_i = \frac{SCF_i}{L_i}$ - соотношение произведенных затрат и лимитов финансирования по каждому диверсификационному мероприятию;

$h^S = \frac{\sum_{i=1}^{n} SCF_i}{\sum_{i=1}^{n} L_i}$ - соотношение произведенных затрат и лимитов финансирования по всем диверсификационным мероприятиям;

$d_i = \frac{h_i - h^S}{h^S}$ - относительная переплата или недоплата всех диверсификационных мероприятий на текущий момент времени.

Формализованную модель задачи корректировки распределения финансовых средств, выделяемых на реализацию диверсификационных мероприятий, можно представить в следующем виде:

$$\sum_{i=1}^{n} (d_i + d_i^*)^2 \to \min$$

$$\begin{cases} \sum_{i=1}^{n} s_i = S, \\ SCF_i + s_i \le L_i, \\ s_i \ge 0, \end{cases} \qquad (3)$$

где $d_i^* = \frac{\frac{s_i}{SCF_i^*} - \frac{S}{SCF^*}}{\frac{S}{SCF^*}}$ – относительная переплата или недоплата средств по каждому диверсификационному мероприятию относительно уровня неоплаченной части лимитов в планируемом распределении дополнительных средств.

Допустим, что:

- программа диверсификации производства на предприятиях ОПК включает в себя *k* диверсификационных мероприятий;

- каждое из них оценивается коэффициентом важности w_i, $\sum_{i=1}^{k} w_i = 1$;

- для реализации *i*-го диверсификационного мероприятия необходим объем финансирования D_i;

- минимально допустимый уровень финансирования составляет *h%*;

Тогда степень выполнения диверсификационного мероприятия при выделении на его реализацию средств в сумме d_i составит $q_i = \frac{d_i}{D_i}$, $0 \le d_i \le D_i$.

Алгоритм решения рассматриваемой задачи представлен на рис.1.

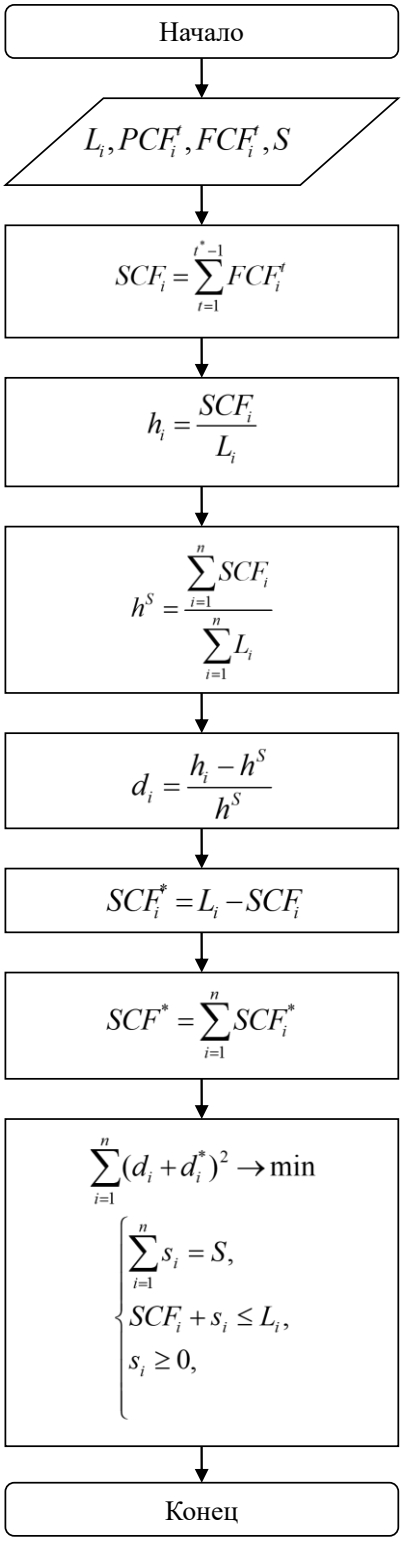

Рис. 1. Алгоритм корректировки распределения средств на реализацию диверсификационных мероприятий

Модель распределения общей суммы финансирования S по k диверсификационным мероприятиям, направленная на то, чтобы степень выполнения всей программы Q была максимальной, можно представить в следующем виде:

$$\begin{aligned} &Q \to max, \\ &\sum_{i=1}^{k} D_i > S,\ i = 1 \ldots k, \\ &d_i \geq D_i \times \frac{h}{100}, \\ &S \geq \sum_{i-1}^{k} \left(D_i \times \frac{h}{100} \right). \end{aligned} \qquad (4)$$

Предложенный инструментарий решает задачу оптимизации финансового обеспечения диверсификационных мероприятий, осуществляемых предприятиями ОПК, путем корректировки распределения текущих ассигнований, выделяемых на их реализацию.

Заключение

В предлагаемом инструментарии основными критерием оптимизации распределения средств, выделяемых на реализацию диверсификационных мероприятий при их параллельном выполнении, является пропорциональность неизрасходованной части лимита финансирования после очередного распределения выделяемых средств по каждому мероприятию. Использование данного критерия в процессе финансирования диверсификационных мероприятий повышает оптимальность управления диверсификацией производства на предприятиях ОПК.

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URBANIZATION

UDC 54.064

Ibadova S. Analysis of the ecological state of soils along the main transport routes of the city of Baku

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Abstract. *The objects of urban-ecological monitoring were the soils along the main highways of the Nizami district of Baku. The purpose of the research work was to assess the ecological state along the central highways of the city. To determine the ecological parameters of soils, an analysis of some chemical indicators of soils and biological activity of soils was carried out. In the course of the work, field and laboratory methods were used to study the soils of urbanized areas. Conducted studies based on the study of the content of heavy metals, humus content, activity of urease and catalase, as well as pH values revealed the dependence of the biochemical parameters of soils on their location along the highways of Baku. As a result of the influence of intensive road traffic on the activity of soil enzymes, high rates of urease and catalase activity, low humus content and a significant weakening of soil enzymes in soil samples from the studied areas of Baku were revealed. The high lead content in the first zone (26 mg/kg) allows us to draw a conclusion about the intensity of microbial-biochemical processes, the rate of transformation of organo-mineral compounds. An analysis of the results of the studies and foreign experience in implementing a set of measures to improve the ecology of urbanized territories made it possible to determine the degree of importance and the need for the soonest implementation of measures to improve the ecology of soils in Baku.*

Key words: *ecology, soil, indicators of soil samples, monitoring, urbanization*

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1. Introduction

One of the reasons for the deterioration of the state of ecosystems since the end of the last century is the process of urbanization. More than half of the world's population today lives in cities, and the trend of urban population growth is steadily growing. According to UN data, in 2030 about 8.3 billion people will live on the planet Earth, of which about 5 billion will live in cities (the share of the planet's urban population can grow to 60%) [17].

The object we are studying is the soils of Baku. Today, Baku is the largest metropolis in the country and the core of the Baku agglomeration. More than half of the country's population lives here, most of the socio-cultural and educational institutions function, and the industrial complexes of Azerbaijan are located. The presence of more than 70% of the country's industrial potential in the Apsheron economic region is explained solely by the historical position of the city and the Apsheron Peninsula. Baku is a large city with an area of 2430 km2 with a highly developed highway system. In addition, Baku, being the center of industry in Azerbaijan, is steadily growing and developing, and its network of transport infrastructure is also expanding.

One of the important points of the General Plan "Development Concept "Azerbaijan - 2020: a look into the future"" is the development of the country's integrated transport system. Achieving environmentally sustainable socio-economic development of Azerbaijan is one of the main goals of the concept. Measures taken to protect biodiversity, reduce and neutralize the negative impacts of existing industrial complexes on the environment, eliminate pollution of the Caspian Sea and its coastal zones and protect them, restore and plant green areas and effectively protect all existing resources have been implemented and will be implemented in the future. “Improvement of transport infrastructure” (one of the points of this program) provides for the introduction of comprehensive measures for the reconstruction of road, rail, water, air and underground (metro) transport.

Bringing the country's road transport infrastructure in line with international standards dictates the need to expand highways in the direction of the East-West and North-South transport corridors, complete projects for the reconstruction and construction of roads nationwide. To do this, it is planned to replace gravel roads with hard-surface roads, reconstruct and expand the network of roads of republican significance, ensure the transition to international environmental standards, build road junctions and bridges with high environmental safety, carry out work to modernize existing roads. All these works will be carried out on the principle of ensuring the safety of the population. Along with the work to improve the relevant infrastructure, intelligent transport control systems will be integrated in large cities, the transport system of the capital and other cities, districts, villages will be developed.

The above measures should contribute to the optimization of the functioning of vehicles and the development of a network of environmentally sound modes of transport. However, today it cannot be denied that vehicles serve as a source of pollution not only of air and water, but also of the soil cover of highways and adjacent territories [13,18]. Highways are laid both within the city and through agricultural lands, covering people, flora and fauna with

a veil of pollutants. Relatively untouched territories are allotted for the construction of transport infrastructure. In addition, the city is actually surrounded on all sides by operating oil fields, some of which are located within the city itself.

During the construction of new and repair of existing roads, the road dust released at the same time, the components of the exhaust gases of vehicles, negatively affect the land fund. When asphalting, the soil cover is covered with water- and air-tight materials, which negatively affects the properties of the soil [6, 9]. Most of the harmful substances emitted with the exhaust gases of cars intensively settle at a distance of up to 30 m from the main road. So, at a low speed, a car running on a gasoline engine emits 0.05% of hydrocarbons (of the total emission) into the environment, and at low speed, the emission of pollutants is 0.98%, carbon monoxide corresponds to directly – 5.1% and 13.8% [16].

Salt and other chemicals that are a component of anti-icing mixtures have a negative impact on the ecological state of highways (their concentration causes drying of green spaces along the roads). The ecological state of soils is also aggravated by the climatic conditions of the region: high temperatures in the warm season and a high dose of ultraviolet radiation cause intensive decomposition of petroleum products in soils. If we take into account the fact that 60-65% of the automobile transport of Azerbaijan is concentrated in Baku and the number of cars in the republic is steadily growing, then we can guess the consequences of pollution with harmful emissions of the environment [1].

The situation is aggravated by the fact that the share of vehicles that use less environmentally friendly gas fuel is only 5%. The European Economic Commission of the United Nations approved an environmental standard that reflects the need to comply with established standards for the content of various hydrocarbons and other harmful substances in automobile exhaust gases. To further reduce soil pollution in the Republic of Azerbaijan, the national standard “Road transport. Ecological classes. According to this standard, depending on the level of pollution, motor transport was divided into 6 classes, and from April 1, 2014, all vehicles operating on the territory of the republic must use fuel corresponding to the Euro-4 standard. Restrictions do not apply only to individual brands of cars.

The importation of a large number of vehicles into the country, the construction of filling stations and parking lots, which are the cause of the violation of the hydrological and geochemical regime of landscapes, the emissions of exhaust gases and oils into the environment by motor vehicles, have acutely posed the problem of preserving the city's ecology. The tension of the geoecological state of the Apsheron landscapes, expressed by the degradation of the soil and vegetation cover, is also a consequence of such factors as

climate aridity, wind erosion, desertification, a significant excess of evaporation over precipitation, a high level of radiation, non-leaching regime of soils [5].

On the Absheron Peninsula, mostly gray-brown soils. These soils are characterized by a grayish-brown color, granulometric composition - mainly clay, loam, lumpy structure. As a result of asphalting, the natural factors of soil formation change, for example, vegetation, relief, and climate change. Prior to laying asphalt-concrete pavements, preliminary work is carried out, such as filling the top layer of soil for surface uniformity or strengthening with concrete. These actions to some extent reduce the amount of natural urban soils, as soils are mixed, polluted with organic and inorganic substances (mainly construction waste and household waste). Soils are also contaminated with heavy metals and oil products. These soils are distinguished by low moisture capacity, stoniness, neutrality of the soil solution. The physicochemical parameters of gray-brown soils under the conditions of the Apsheron Peninsula depend on the type of soil cover structures (SCS) (Table 1) [8].

Table 1

Physical and chemical properties of gray-brown soils of the Apsheron Peninsula

Type of soil cover structures	Depth of cut, cm	Humus, %	$CaCO_3$, %	Grading, %		The amount of absorbed base, mg·eq	pH of aqueous suspension
				<0,001 mm	<0,01 mm		
Gray-brown soils of a radially rounded type in the foothill part	0-10	0,440	10,9	26,12	67,36	25,1	8,3
	10-30	0,448	17,2	36,12	69,00	23,00	8,4
Gray-brown swampy soils of the flat part	0-10	1,90	21,1	8,24	23,12	20,8	8,2
	10-35	0,96	21,5	7,64	21,28	22,3	8,2

The soil cover of urban areas can be considered a mirror image of the qualitative state of the city's ecology, because soil properties affect the state of all other elements of the city's ecosystem. The soil cover of the city of Baku, laid down in the climatic conditions of the arid region, is represented mainly by varieties of gray-brown soils, characterized by a low content of humus (1,2–1,8%), an alkaline reaction of the environment, low capacity absorption (about 20 meq. per 100 g of soil). Today, given the importance and relevance of the problem of protecting land and the urban environment, there is a need to monitor indicators of the soil cover of the territory along the roads and to study international experience in improving the ecology of urban areas.

2. Materials and methods

The main goal of the work is to study the ecological state of soils along the main transport routes of Baku (Nizami district) (fig. 1). The Nizami district of Baku city covers an area of 20 km^2 with a population of over 182 thousand people, the total area of green spaces is 40.0 ha.

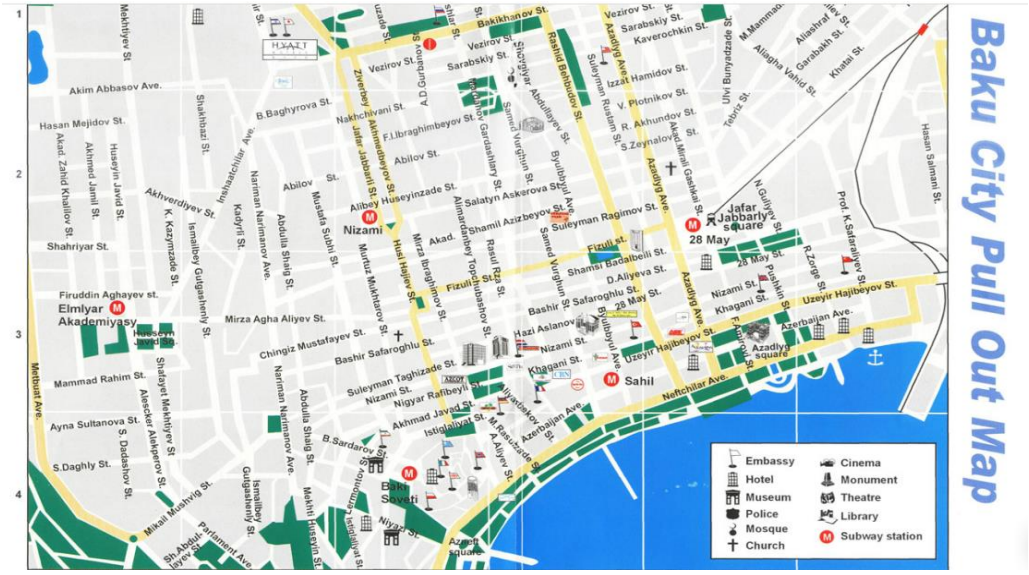

Figure 1. Map of highways of Nizami district of Baku city

When conducting research, field and laboratory methods were used to study the soils of urbanized territories [15]. Soil sampling for the determination of heavy metals was carried out at sites located close to communications; if possible, samples were taken at the same temperatures of 25–280C [15]. The upper soil layer (0–10 cm) was studied. In the soil around the highway there is an accumulation of metals such as cobalt, nickel, copper, zinc, and lead. It has been established that the degree of transport pollution depends on the location of the soil relative to the road. At a distance of up to 25 m (zone 1) - the greatest accumulation of metals. The second zone (within 25-100 m) - at this distance, the accumulation of metals weakens due to the large dispersion of the air flow. Heavy metals were also found in the third zone (200 m from the highway) (table 2).

Table 2

Metal content in soils (mg/kg)

Place of selection	Metals				
	Co	Ni	Cu	Zn	Pb
I	22	62,5	60,0	125	26,0
II	15,9	42,3	46,2	114	24,0
III	10	40,1	43,4	100,9	23,2

It is possible to inactivate heavy metals in the soil or to significantly reduce their toxic effect by different methods [2]. All these methods are mainly based on the use of lime and phosphate substances in combination with organic substances. For this purpose, along the main major highways of the Nizami district1, at a distance of 3–5 m from the road, soil samples were taken for research from depths of 0–10 cm. Soil sampling for analysis was carried out according to approved methods [15]. To identify the ecological state of the territories adjacent to highways, the chemical indicators of soils (determination of humus and actual acidity) and the biological activity of soils (determination of urease activity and catalase activity) were studied. Soil samples taken for research from the territories of 4 main highways in Baku differ in their degree of contamination.

Under conditions of technogenic impact on the urban environment, a distinctive humus is formed, the composition of which differs markedly from the humus of soils that are not subject to anthropogenic impact. To determine the degree of resistance of soils along highways to the impact of the emission of harmful and toxic substances, the value of humus was determined. Determination of the amount of humus, which is an important indicator of the ecological potential of soils, was carried out according to the method of I.V. Tyurin. To do this, a soil sample was sifted through a sieve with 0,25 mm holes and the soil sample was weighed on an analytical balance to 0,5 g. in a 1:1 ratio with diluted sulfuric acid. The contents of the flask were boiled for 5 min, then cooled and, after adding 10 drops of phenylanthranilic acid, titrated with 0,2 N solution of Mohr's salt until the solution turned dirty green.

In urbanized conditions, as a result of anthropogenic impact on the environment, there is a change in the indicator that determines important stages in the conversion of nitrogen-containing compounds in the soil [3]. As a result, there is a violation of all soil functions. Therefore, the study of urease activity, which makes it possible to assess the biochemical potential of soils, as well as their self-cleaning ability, is a very important step in identifying the ecological state of the soil. In this work, we use an express method for the determination of urease, which is advisable to carry out to assess the violation of the stages of the conversion of nitrogen-containing compounds in samples of a large volume of urban soil covers.

For analysis in laboratory conditions, the following were used: technical scales, Petri dishes (diameter ≈10 cm), indicator paper, urea, watches. A 50 g sample of soil and 0,5 g of urea preliminarily diluted in a small amount of distilled water were placed in a Petri dish. The cup was covered with a lid (leaving a gap between them for the reaction to proceed) with a strip of filter paper impregnated with the indicator solution attached to the inside. The data resulting from the decomposition of urea, accompanied by the formation of ammonia, causing

a change in the color of the indicator paper (the exposure time of the cups was 3,5 hours, the samples were taken in May), are listed in table. 3.

Table 3

Biochemical indicators of soils along the main thoroughfares of the city of Baku

Name of motorways				
Indicators	Babek Avenue	Heydar Aliyev Avenue	Kara Karaev Avenue	Rustam Rustamov street
Humus content, %	1,2	1,2	1,4	0,9
Urease activity, mg NH_3 /100g soil	3,9	4,1	4,5	3,8
Catalase activity, ml O_2/min	27	25	28	27
pH water	7,67±0,11	7,65±0,09	7,63±0,1	7,92±0,1

Changes in soil properties also have a significant impact on such a biochemical indicator as catalase activity [14]. The activity of catalase depends on the redox processes occurring in the soil and its granulometric composition. Determination of catalase activity was carried out by the gasometric method described in [15]. The gas volume was measured after 1 min.

Intensive pollution of roadside soils of motorways causes changes in the chemical composition of soils, leading to the processes of transformation of the components of the mineral and organic parts of the soil, as a result of which a change in actual acidity occurs. For better dispersion of the soil in the aqueous solution, an electric stirrer was used while shaking the flasks. Soil acidity was determined using a pH meter.

3. Results and Discussion

As can be seen from the obtained data (Table 3), the content of humus in the soils of highways in Baku varied from 0,9 to 1,2%. This difference in the humus index is explained by the fact that a gas station is located along Rustam Rustamov Street and samples were taken close to it. The reason for the low content of humus in the soil is caused by the lack of nutrients in urbanized soils, which, in turn, leads to an acceleration of the processes of humus mineralization. The low quality of soil fertility is caused by high rates of mineralization of organic matter.

When comparing the obtained data on the activity of the urease enzyme in soils near highways, a low activity of the urease enzyme was revealed. This fact indicates that the studied soils are characterized by a high number of bacterial microflora and this, in turn, is

accompanied by a low activity of soil enzymes. In the study of soil along highways with heavy traffic (Babek Avenue and Heydar Aliyev Avenue) with grass, exposed to pedestrians, exhaust gases and other anthropogenic and technogenic factors, a significant weakening of soil enzymes, which play an important biogeochemical role, was revealed. Enzymes carry out functional connections between the soil and the microorganisms inhabiting it and thereby contribute to maintaining the integrity of the ecosystem. Microorganisms, in turn, support the processes of transformation of substances that take place with the participation of various groups of enzymes.

Metabolic processes occurring in the soil are determined to a large extent by environmental conditions. Thus, as can be seen (table 3), all soil samples are characterized by a certain pH optimum. The optimal pH values for ureases and catalases are in the range from 6,3 to 7,2. Changes in soil pH lead to a decrease in urease activity as a result of a reversible process representing the ionization (deionization) of acidic (basic) groups in the active site of the enzyme. It is known that enzymatic activity decreases with increasing soil salinity [7]. High levels of urease and catalase activity in the soil sample from Kara Karaev Avenue suggest that this soil is more saline than other samples.

Very high rates of catalase activity in soils along the highways of Baku (25–28) ml O_2/1 min/1 g of soil make it possible to judge the intensity of microbial-biochemical processes, the rate of transformation of organo-mineral compounds, and, as can be seen (table 2), an increase in the lead content in the first zone (26 mg/kg). Thus, the conducted studies showed that the emissions of road transport, settling along the road as a whole, increased the activity of the studied soil redox enzymes. The manifestation of a high indicator of catalase activity at a distance of 5 m along the road is a consequence of the sedimentation of pollutants on the surface of the soil cover.

The high value of active acidity is the result of the multiplication of Azotobacter microorganisms. The limiting factor in the presence of alkali-resistant Azotobacter microorganisms in the soil cover may be the presence of a large number of toxic substances in it. Alkalinization of the soil along highways is usually the result of the penetration of calcium and magnesium chlorides into the soil, which are an integral component of the means sprinkled on the soil along sidewalks and roads in the winter season to prevent highways from being covered with ice. Considering that concrete and asphalt concrete are considered conditionally impervious coatings, and with poor-quality road surface, harmful components, being washed out, seep into the depths of the soil cover. In addition, soil alkalinization occurs due to lime dust settling when roads are covered with cement, which also contains calcium.

4. Measures to reduce and prevent soil pollution along highways

There is a direct relationship between the speed of a car and the emission of harmful substances into the environment: the higher the speed of a car, the more toxicants are emitted onto the roads (Table 4). Consequently, highways with high-speed traffic are considered the most polluted. The problem of pollution of highways with harmful emissions (changes in various soil properties, migration of pollutants, pollution of groundwater, etc.) is relevant for specialists in various fields of knowledge and encourages them to look for methods to solve it [19]. To date, effective biological products are being developed to increase the biological activity of soils at the microbiological and enzymatic levels [10].

Table 4

Approximate amount (in%) of components of exhaust gases under various modes of operation of vehicles

Exhaust components	The amount of pollution emitted under different modes			
	Engine idle	Constant speed	Acceleration from 0 to 40 km/h	Deceleration from 40 to 0 km/h
Carbon monoxide	0,5-8,5	0,3-3,5	2,5-5,0	1,8-4,5
Hydrocarbons	0,03-0,12	0,02-0,6	0,12-0,17	0,23-0,44
Nitrogen oxides	0,005-0,01	0,10-0,20	0,12-0,19	0,003-0,005

According to the recommendations of experts, the most convenient, promising and economical way is to divide the highway into separate sections, taking into account the objects adjacent to the highways. Technological solutions used in Germany and Austria (accumulative treatment facilities with deep wastewater treatment, flow-through facilities for oil products, sand and large debris, filtering treatment facilities to prevent soil erosion and clean up surface runoff) for wastewater treatment help prevent environmental pollution from highways and nearby territories [9]. Therefore, when designing new highways, building and expanding them, such technical solutions for treating main sewage should be adopted. However, all these methods require large capital costs.

Particular attention should be paid to sections of highways with light soil. It is from these areas that the unhindered penetration of toxicants into soil and underground horizons occurs, which are almost impossible to clean. A decrease in the intensity of pollutant migration in the soil environment can be embodied by an increase in the buffer capacity of soils. Given the threatening environmental conditions on the highways of Baku, it is recommended to apply organic and mineral fertilizers to improve soil fertility.

Preservation of soil ecology along highways is possible by improving the development of road transport [4]. One of the options for this kind of action can be the improvement of

internal combustion engines of vehicles without high-speed and expensive re-equipment of the enterprises producing them, as well as the transition of vehicles from a fuel-based option to an electric one, which excludes the release of hydrocarbon combustion products into the environment. Such shortcomings of cars as a short range, lack of charging are being solved today.

Another option is to improve transport infrastructure. A renovation solution for improving the transport infrastructure of Baku is the development of an environmentally friendly way of traveling by bicycle and tram, which are widely used abroad. For example, as a result of work on organizing lines of environmentally friendly modes of transport in Canada by 2031, it is expected to increase the passenger flow of cycling by 2,4 times compared to 2011 [12]. An example of the introduction of lines of environmentally friendly modes of transport is the organization in 1985 of the green corridor of the tram line in Nantes in France, the construction of a multimodal station in Melbourne in Australia and the construction of multimodal traffic lanes in Mannheim in Germany. The initial stage of the development of the tram network in Baku is the construction of a tram line along the embankment, the construction of railway lines to the Baku International Airport. Heydar Aliyev and the tourist centers of Shahdag and Gabala [12]. The successful implementation of street improvement (the concept of the development of multifunctional streets) can also have a positive environmental effect [11].

The environmental problem can also be solved by reducing the weight of the car. There are more than 1 million vehicles of various types in the Republic of Azerbaijan. If we take into account that each of them during the year is a source of pollutants emitted into the urban environment, equal to their weight, and the weight of one vehicle, for approximate comparison, is taken as 300 kg, then over 300,000 tons of pollutants are emitted into the atmosphere of Baku per year . Reducing the weight of the car, and as a result of this, less fuel consumed are conditions for reducing the environmental damage caused to the environment. All of the above predictive solutions, combined with the successful implementation of the concept for the development of multifunctional streets, will help improve the environmental situation in general and, in particular, improve the condition of the soil cover of one of the most beautiful cities - Baku.

5. Conclusions

A certain dependence of the biochemical parameters of soils on their location along the highways of Baku has been established. Experimental data on the study of the effect of heavy road traffic on the activity of soil enzymes revealed high levels of urease and catalase

activity in soil samples from the studied zones of the Nizami district of Baku and, as a result, relatively low biological activity. Foreign experience in the implementation of a set of measures to improve the ecology of urban areas has been studied. Studies of international experience and analysis of the results of the studies made it possible to determine the degree of importance and the need for the speedy implementation of measures to improve the ecology of soils in Baku.

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Mammadova R. Biotesting of soils of different functional zones of Baku city contaminated with heavy metals

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Abstract. *The aim of the work was to study the influence of soils from different functional zones of the city of Baku, contaminated with heavy metals on physical, chemical and biological indicators, to conduct a comparative assessment of soil indicators, as well as to identify the degree of contamination of the studied soil samples through biotesting. Soil samples were taken and prepared for analysis in accordance with state standards 17.4.4.02–84. Studies to determine the physicochemical parameters of soils and biotesting were carried out in the field and laboratory conditions. Biotesting of soil samples revealed a low phytotoxic effect on the third day. For watercress, soil phytotoxicity manifested itself in stimulating the development of the root system and sprout. According to the calculations, a decrease in the length of watercress roots was noted in test samples of all territories, with the exception of the soil sample from Dede Gorgud Park, which indicates a low degree of soil phytotoxicity. The watercress sprout length indicators revealed a weak degree of phytotoxicity of all experimental soil samples, with the exception of the Baku TPP experimental site, where this indicator was 40%. All districts and zones of the city of Baku, as well as recreational and residential areas, are characterized by high the integral indicator of the biological state (IIBS) of the soils taken from different functional zones. The average value of the maximum value of the IIBS of the recreational zone is 3 times higher than this indicator of the industrial zone.*

Keywords: *heavy metals, soil biota, urbanization, biotesting, functional zones of the city of Baku*

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1. Introduction

In connection with the growth of urbanization, which is inextricably connected with the development of the temps of industry, with an increase in the territories allocated for the construction of residential areas, with the rapid growth of vehicles, the analysis of urban soils is a paramount and important task today [12], [16].

Baku is a large developing metropolis, which is polluted with waste from the enterprises of the machine-building, food, oil and gas, petrochemical and oil industries. In the coming decades, it is planned to increase the area of the city, however, to expand the transport infrastructure and for the construction of residential and industrial facilities, new “untouched

open areas" are allocated, which leads to a violation of the soil profile, the death of microflora and soil animals, and the deterioration of soil properties.

The accumulation of pollutants in the soil is explained by the fact that, unlike the atmosphere, the soil is a sedentary medium and the process of migration of harmful substances proceeds much more slowly [5]. The accumulated toxic harmful substances seep into the groundwater. The rate of their entry into groundwater directly depends on the mechanical composition and physicochemical properties of soils, as well as on the geochemical characteristics of pollutants.

Taking into account the fact that within the city there are large oil territories, saline soils, oil producing and oil refineries, machine-building plants, as well as other large industrial facilities, the city is subject to severe technogenic pollution [8].

The problem of soil pollution with a large number of pollutants, among which heavy metals, which are of paramount importance in terms of the scale of pollution and the impact on biological objects, has been the subject of many scientific works and studies. However, due to the accelerated temp of economic growth, unregulated territorial development and population growth in the capital city of Baku, a long-term plan for the development of the city has been developed and the environmental and geochemical assessment of urban soils is in great demand. [9].

According to literary sources, heavy metals play an important role for the normal course of vital processes in all living organisms, but on the other hand, when the permissible concentrations are exceeded, they are toxic and can kill all living things [11], [14]. Most of the heavy metals emitted into the atmosphere as waste products from petrochemical and oil refineries and other enterprises are deposited on the surface of 0–10 cm of urbanized and 0–20 cm of arable soils.

The factors influencing the uneven distribution of heavy metals (aluminum, cadmium, chromium, copper, lead, nickel, silver, vanadium, zinc and others) in the soils of the Apsheron Peninsula include the following: population density, meteorological features, landscape conditions, geochemical factors , features of pollution sources (production of petroleum products), the introduction of organic and phosphorus fertilizers rich in cadmium and containing impurities of uranium and lead into the soil, the use of pesticides [1].

An increase in the concentration of heavy metals in the soil leads to a rupture of natural ecological bonds, an acceleration of the processes of mineralization of soil humus, a change in acidity and alkalinity, etc. Heavy metals that pose a danger to the environment include more than 40 metals from the periodic system of D. I. Mendeleev, and among them, xenobiotics, i.e., metals that are not part of biomolecules, pose the greatest danger to humans. It is these

metals and their compounds that play a primary role in increasing the number of genetic mutations, cancers and various pathologies [3], [7].

The results of scientific research on the identification of amounts of heavy metals in the soils of Baku and the Absheron Peninsula as a whole allow us to conclude that the zones with the maximum technogenic load, i.e., the zones where industrial facilities are located, or these zones are most affected by heavy metals located along major highways, in the zone of toxic landfills (there are 7 of them in the territory of Baku) and municipal solid waste (fig. 1).

Fig.1. Scheme of pollution of soils of the Absheron Peninsula with heavy metals (according to the Ministry of Ecology of Azerbaijan, 2000):
1-uncontaminated land, 2-minimal pollution, 3-light pollution, 4-medium pollution, 5-heavy pollution.

According to the literature data, due to the technogenic impact, the soils of the city of Baku are heavily polluted with heavy metals [10]. It is known that the central and industrial zone, as well as the oil production zone, are predominantly polluted with substances of the 1st and 2nd hazard class. Thus, the maximum concentration of lead exceeds the maximum permissible concentration (MPC) by 18 times, cadmium, tin and molybdenum by 2–5 times, nickel, chromium, manganese by 1–5 times. Soils in Baku are also contaminated with mercury, which comes from industrial plants in Sumgayit.

The results of studies of the impact of heavy metals on phytotoxic activity in the soil should be the foundation for the development of preventive measures aimed at preventing the negative consequences of pollution [17], [6], [18], [2].

The purpose of the work is to study the influence of soils contaminated with heavy metals on the physicochemical and biological indicators of soils, as well as on the phytotoxic activity of soils in different functional zones of the city of Baku.

In accordance with the given goal, the following tasks were set.

1. To study the scientific research works of domestic and foreign authors, whose work is aimed at studying the effect of heavy metals on the indicators and phytotoxicity of soils;
2. Conduct a comparative assessment of the indicators of soils contaminated with heavy metals taken from different functional zones of an urbanized area;
3. To identify the degree of contamination of the studied soil samples through biotesting;
4. Determine the average values of each indicator of soil biota activity according to IIBS of soils for the functional zones of the city.

2. Materials and methods

Studies to determine the physicochemical parameters of soils and biotesting were carried out in the field and laboratory conditions [20]. In particular, the soils of the city were studied in the following locations: a thermal power plant, along highways, soils of areas designated for wasteland, soils of recreational areas. Soil samples were taken and prepared for analysis in accordance with state standard 17.4.4.02–84.

Samples of open soil were taken from a depth of 0–10 cm, 10–20 cm.

To determine the ecological state of soils in urban areas, the chemical indicators of soils (determination of humus and actual acidity) and the biological activity of soils (determination of catalase activity and soil phytotoxicity) were studied.

Sampling sites include the following areas.

Crossroads is one of the busiest highways in the Narimanov region. The constant traffic flow of Tabriz and Aga Neymatulla streets (near the Nariman Narimanov metro station) is the cause of the anthropogenic load on the nearest ecosystems (and in particular on the soil, fig. 2).

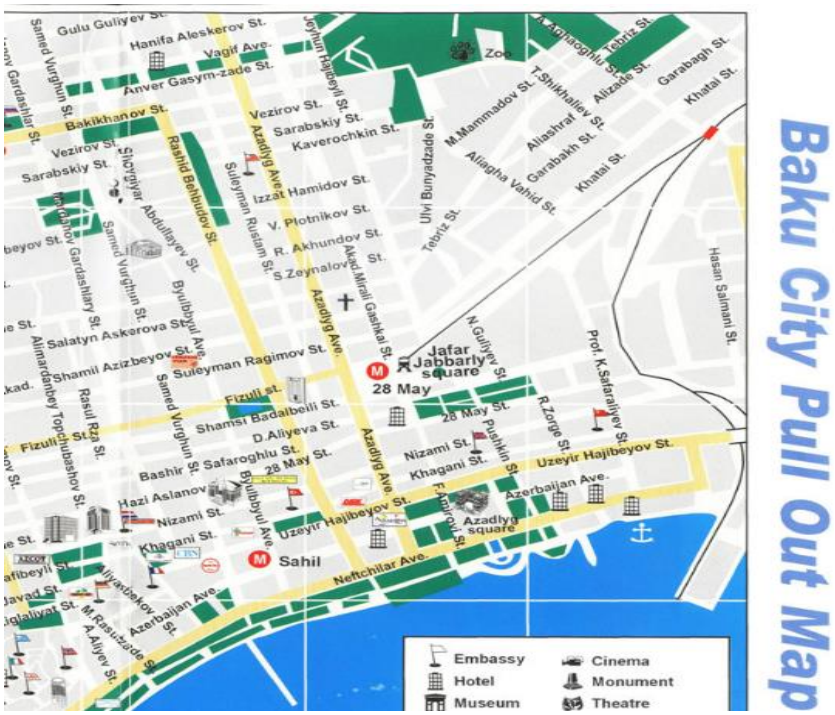

Fig.2. Crossroads of Tabriz and Aga Neymatulla streets

Wasteland along the street. Samedbek Mehmandarov and st. Abbas Fatullayeva (fig. 3). The object is fenced along the perimeter, there are no buildings, no cars and green spaces were noted.

Fig.3. Wasteland along Samad bey Mehmandarov street and Abbas Fatullayev street Baku TPP, (coordinates: 40°22′25″ N 49°55′11″ E) (Fig. 4)

Fig.4. "Azerbaijan" Thermal Power Station - Only Power Station in Country Capable of Operating on Fuel Oil

Dede Gorgud Park. The park is surrounded on three sides by highways, on which auto traffic is constantly boiling, an artificial lake with an area of three hectares and a waterfall have been created (fig. 5).

Fig.5. Dede Gorgud Park

An initial assessment of soil quality was carried out at the sampling site. During the initial assessment, such positions as the presence of vegetation, anthropogenic inclusions in the soil, hardness, stonyness, and clutter were considered. The soil samples studied by us are classified as naturally anthropogenic, superficially altered. Traces of anthropogenic load are found at all sampling points in the form of inclusions of construction and household waste. Most of the emissions of pollutants into the urban environment are concentrated on the soil surface, where they, gradually accumulating, can lead to a change in the physical and physico-chemical properties of the substrate.

Sampling was carried out under comparatively similar weather conditions.

Conclusions about soil phytotoxicity were made on the basis of seed germination data (length of roots and green sprouts). The seeds of watercress, which are highly sensitive to the presence of toxic substances in the soil, were used as a biotest.

3. Results and Discussion

The average indicators of biochemical indicators of soil samples in areas with varying degrees of technogenic load were analyzed. Environmental conditions significantly affect the metabolic processes occurring in the soil. So, as can be seen from table. 2, the optimum pH values for catalases are in the range of 5,8 to 7,92. Changes in soil pH are accompanied by a reversible process, the essence of which is the ionization of acidic or basic groups in the active center of the enzyme. According to literary sources, the primary task to overcome all negative processes (dehumification of cultivated soils, low enzymatic activity, etc.) is to increase the biological activity of the soil and the content of organic matter through the application of organic fertilizers, the use of bacterial fertilizers, the use of green manure crops and green spaces [2]. The high rate of catalase activity (0,76) in the soil sample from the intersection of Tabriz and Aga Neymatulla streets suggests that this soil is contaminated with carbonate crushed stones, which are used in the construction of highways, is more saline compared to other samples due to the use of anti-icing mixtures and other factors.

An analysis of the tabular data leads to the conclusion that the low content of humus, ranging from 0,9 to 1,4, is an important indicator of their ecological potential, characterizing the degree of soil resistance to heavy metal pollution. The low content of humus activates the rate of organic matter mineralization processes, which leads to a deterioration in soil quality, and, consequently, fertility.

The catalase enzyme is a measure of the soil's ability to process hydrogen peroxide. The catalase activity index varies from 0,58 to 0,76. The low indicator of catalase activity in soil samples from the territory of the Baku TPP and the high one in samples from the Dede Gorgud park is explained by less disturbance of the soil cover in parks than in industrial zones. The catalase activity of the soil from the territory of the Baku TPP is characterized on a scale as very weak, in three other territories - the catalase activity is weak. This fact only confirms that the city of Baku is highly prone to technogenic pollution, so there is an urgent need to reduce the intensity of heavy metal migration in the ecosystem.

Phytotoxicity is the ability of polluted soil to slow down plant growth, leading to disruption of physiological processes. Phytotoxicity is the most informative and reliable

indicator of technogenic transformation and resistance of soils in urban areas to heavy metal pollution [21] The assessment of the level of soil phytotoxicity was carried out according to the method described in work [13]. The level of soil phytotoxicity was carried out according to four levels:

- < 10% - ecologically clean soil;
- from 10 to 30% – weak phytotoxicity;
- from 30 to 50% - average phytotoxicity;
- 50% - high degree of phytotoxicity.

In table 1–4 show the lengths of the root and sprout on soil samples on days 3, 5, and 7 of research, mm.

Table 1

Morphometric indicators of the length of the root and sprout on days 3,5,7 of the study (mm) for a soil sample taken from the intersection of Tabriz and Aga Neymatulla streets

№	on day 3				on day 5				on day 7			
	check Point				check Point				check Point			
	root	sprout	root	sprout	root	sprout	root	sprout	root	sprout	root	sprout
1	10,8	6,1	20,2	8,8	33	53	27,1	40	54	49	25	54
2	6,3	5,2	17,3	6,1	29	49	13,2	32	51	44	26	49
3	9,2	6,8	23,1	10,9	24	30	21,1	38	55	47	31	52
4	13,8	8,1	15,2	6,2	20	33	34,2	45	38	46	28	59
5	16,9	7,9	12,4	12,3	25	47	32,3	47	40	40	37	56
6	8,3	4,2	21,2	14,1	15	40	22,2	36	46	47	35	47
7	17,9	7,1	14,8	10,1	29	48	31,1	40	51	41	31	55
8	14,8	5,9	6,8	5,3	15	29	13,2	18	34	44	28	52
9	16,1	8,1	22,1	13,9	22	47	25,9	35	36	35	18	41
10	8,1	6,9	14,2	7,3	28	46	16,1	38	17	39	15	35
the average	12,2	6,6	16,5	9,42	24	42,2	23,6	36,8	42,2	43,3	29,7	50

Table 2

Morphometric indicators of the length of the root and sprout on the 3rd, 5th, 7th day of the study (mm) for a soil sample taken from the wasteland along Samad bey Mehmandarov street and Abbas Fatullayev street

№	on day 3				on day 5				on day 7			
	check Point				check Point				check Point			
	root	sprout	root	sprout	root	sprout	root	sprout	root	sprout	root	sprout
1	10,8	6,1	22	10	33	53	38	35	54	49	16	54
2	6,3	5,2	13	9	29	49	29	39	51	44	32	51
3	9,2	6,8	11	11	24	30	10	34	55	47	44	47
4	13,8	8,1	21	13	20	33	16	39	38	46	35	59
5	16,9	7,9	20	10	25	47	15	44	40	40	32	61
6	8,3	4,2	24	11	15	40	47	39	46	47	55	59
7	17,9	7,1	15	9	29	48	24	29	51	41	37	25
8	14,8	5,9	20	11	15	29	34	40	34	44	49	54
9	16,1	8,1	10	7	22	47	36	39	36	35	39	56
10	8,1	6,9	16	8	28	46	25	37	17	39	41	51
the average	12,2	6,6	17,2	9,8	24	42,2	27,7	37,7	42,2	43,3	38	51,7

Table 3

Morphometric indicators of the length of the root and sprout on the 3rd, 5th, 7th day of the study (mm) for a soil sample taken from the territory of the Baku TPP

№	on day 3				on day 5				on day 7			
	check Point				check Point				check Point			
	root	sprout	root	sprout	root	sprout	root	sprout	root	sprout	root	sprout
1	10,8	6,1	24	18	33	53	26	35	54	49	36	49
2	6,3	5,2	10	7	29	49	25	34	51	44	21	45
3	9,2	6,8	14	12	24	30	20	22	55	47	34	51
4	13,8	8,1	18	17	20	33	25	40	38	46	36	40
5	16,9	7,9	11	6	25	47	38	35	40	40	41	37
6	8,3	4,2	17	8	15	40	15	31	46	47	22	44
7	17,9	7,1	22	16	29	48	19	35	51	41	26	45
8	14,8	5,9	19	12	15	29	27	29	34	44	21	39
9	16,1	8,1	15	5	22	47	26	36	36	35	15	36
10	8,1	6,9	15	6	28	46	15	38	17	39	28	39
the average	12,2	6,6	16,5	10,9	24	42,2	24	34	42,2	43,3	28,1	42,5

Table 4

Morphometric indicators of the length of the root and sprout on the 3rd, 5th, 7th day of the study (mm) for a soil sample taken from the territory of Dede Gorgud Park

№	on day 3				on day 5				on day 7			
	check Point				check Point				check Point			
	root	sprout	root	sprout	root	sprout	root	sprout	root	sprout	root	sprout
1	10,8	6,1	20	11	33	53	20	29	54	49	38	26
2	6,3	5,2	7	5	29	49	17	11	51	44	61	53
3	9,2	6,8	8	4	24	30	30	31	55	47	45	46
4	13,8	8,1	6	3	20	33	35	45	38	46	42	31
5	16,9	7,9	10	3	25	47	38	36	40	40	64	49
6	8,3	4,2	8	4	15	40	48	33	46	47	52	45
7	17,9	7,1	7	4	29	48	44	25	51	41	57	53
8	14,8	5,9	21	16	15	29	37	43	34	44	64	55
9	16,1	8,1	25	13	22	47	52	43	36	35	45	53
10	8,1	6,9	31	16	28	46	31	24	17	39	51	29
the average	12,2	6,6	14,3	7,6	24	42,2	35,4	32,2	42,2	43,3	51,9	44

According to the results of laboratory studies, the length of the watercress sprout is higher than this control indicator at the sites: “the intersection of Tabriz and Aga Neymatulla streets”and "Baku TPP" by 1,5 times, at the site "Wasteland along the street. Samad bey Mehmandarov and Abbas Fatullayev street” by 1,3 times.

The root of a plant is the organ that is in direct contact with the soil, therefore, by the rate of its growth and development, one can judge the degree of soil contamination or, in other words, its exposure to anthropogenic impact. With an excessive amount of heavy metals in the environment, the protective autoregulatory mechanisms of the plant weaken, excess ions enter both the root and the aerial part of the plants.

The ecological state of the territory was determined by biotesting with watercress. We have noted that for watercress, the length index of the main root, which characterizes the phytotoxicity of the soil, can vary from 12,2 cm in the control (distilled water) to 17,2 cm at the sites “crossroads of Tabriz and Aga Neymatulla streets”; "Baku TPP" and "Wasteland along the street. Samad bey Mehmandarov and Abbas Fatullayev st. Heavy metals also penetrate into plants through the root system. At the same time, such mechanisms can be involved in admission, through which the concentration of incoming heavy metals can be significantly minimized. For example, when using growth regulators of natural origin, the level of heavy

metals in the plant is significantly reduced and the degree of dependence of their concentration on fruit weight is noticeably reduced [19].

The difference between the length of the roots of plants germinated in aqueous extracts of the control sample (distilled water) and the test samples averaged 2–4 cm, and the length of the main root in the samples of the control sample varied from 24,0 cm to 27,7 cm.

When comparing the length of the root of the sample "Wasteland along the street. Samedbek Mehmandarov and Abbas Fatullayev Street" and two other samples "CHP" and "Intersection of Tabriz and Aga Neymatulla Streets" there was a slight increase in the first sample and a decrease in this indicator in two other cases. The lowest growth rate of watercress sprouts (42,5 cm), when compared with the control sample, is from the Baku TPP site, and the highest (50 cm) from the intersection of Tabriz and Aga Neymatulla streets. According to the studies, the length of the watercress sprout is 1,3 times higher than this indicator of the control sample from the section "crossroads of Tabriz and Aga Neymatulla streets", 1,2 times from the site "Wasteland along the street. Samedbek Mehmandarov and Abbas Fatullayev Street" and 1,1 times from the section "Dede Gorgud Park".

The highest rate of root growth (1.4 times) was observed in watercress from the "Dede Gorgud Park" site, the smallest - "Crossroads of Tabriz and Aga Neymatulla" and "Baku Thermal Power Plant". The calculated indicators of phytotoxicity of soil samples along the length of the root and along the length of the stem are presented in table. 5.

Table 5

Indicators of phytotoxicity of soil samples along the length of the root and sprout

Samples from territories	Distribution period, days					
	3		5		7	
	Spine length, mm	Root length, mm	Spine length, mm	Root length, mm	Spine length, mm	Root length, mm
By spine length						
Control sample	12,2	-	24	-	42.2	-
Crossroads of Tabriz and Aga Neymatulla streets	16,5	-	23,6	-	29.7	-
Phytotoxicity,%	35,2	-	2	-	29.62	-
Baku TPP	10,9	-	24	-	28.1	-
Phytotoxicity,%	10,7	-	13	-	33.41	-
Wasteland along Samad bey Mehmandarov street and Abbas Fatullayev street	17,2	-	27,7	-	38	-
Phytotoxicity,%	41	-	17,2	-	9.95	-
Dede Gorgud Park	14,3	-	35,4	-	51.9	-
Phytotoxicity,%	17,21	-	47,5	-	23	-
Along the length of the sprout						
Control sample	-	6,6	-	42,2	-	43,3
Crossroads of Tabriz and Aga Neymatulla streets	-	9,42	-	36,8	-	50
Phytotoxicity,%	-	42,7	-	12,8	-	15,5
Baku TPP	-	10,8	-	34	-	42,5
Phytotoxicity,%	-	63,6	-	37,7	-	51,7
Wasteland along Samad bey Mehmandarov street and Abbas Fatullayev street	-	-	-	-	-	-
Phytotoxicity,%	-	48,5	-	10,7	-	19,4
Dede Gorgud Park	-	7,6	-	32,2	-	44
Phytotoxicity,%	-	15,2	-	23,7	-	2

Biotesting of soil samples revealed a low phytotoxic effect on the third day. For watercress, soil phytotoxicity manifested itself in stimulating the development of the root system and sprout. According to the calculations, a decrease in the length of watercress roots was noted in test samples of all territories, with the exception of the soil sample from Dede Gorgud Park, which indicates a low degree of soil phytotoxicity. The watercress sprout length indicators revealed a weak degree of phytotoxicity of all experimental soil samples, with the exception of the Baku TPP experimental site, where this indicator was 40%.

Based on the obtained data on the biochemical parameters of soils, we carried out an integrated approach to determine the integral indicator of the ecological state of soils in order to generalize data on soils in different functional zones of Baku.

In table 6 shows the generalized results of determining biochemical parameters with the calculated value of IIBS.

Table 6

Generalized results of the determination of biological indicators

City zone	IIBS,%			
	Humus content,%	Catalase activity, ml O_2/ min	pH water	General IIBS,%
Industrial	2,81	28,46	5,92	12,30
Residential	8,74	39,63	30,28	26,22
recreational	12,77	47,52	45,14	35,14

4. Conclusions

It has been established that the main source of heavy metals in the soils of the city of Baku is motor transport and the oil industry. The influence of heavy metal pollution on the phytotoxicity of soils taken from different functional zones of the city of Baku was studied. Based on the generalization of the calculated averaged values, it can be argued that all districts and zones of the city of Baku, as well as recreational and residential areas, are characterized by a high soil IIBS. At the same time, it should be noted that the average value of the maximum value of the IPBS of the recreational zone is 3 times higher than this indicator of the industrial zone. This fact confirms the high technogenic impact of industrial facilities on urbanized soil. Low indicators of soil samples taken from the industrial zones of Baku were recorded. In the aggregate, all soil samples taken from different functional zones have low biochemical parameters, but at the same time, all samples are characterized by high soil IIBS. The results of the study can be used in assessing the state of contaminated soils and, as well as in the urban planning of the city of Baku.

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