ISSN 2518-1629 (Online),
ISSN 2224-5308 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Өсімдіктердің биологиясы және биотехнологиясы институтының

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Института биологии и биотехнологии растений

N E W S

OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
of the Institute of Plant Biology and Biotechnology

SERIES
OF BIOLOGICAL AND MEDICAL

1 (331)

JANUARY – FEBRUARY 2019

PUBLISHED SINCE JANUARY 1963

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

Б а с р е д а к т о р

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«ҚР ҰҒА Хабарлары. Биология және медициналық сериясы».
ISSN 2518-1629 (Online),
ISSN 2224-5308 (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.)
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 01.06.2006 ж. берілген **№5546-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,
http://biological-medical.kz/index.php/en/

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Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

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«Известия НАН РК. Серия биологическая и медицинская».
ISSN 2518-1629 (Online),
ISSN 2224-5308 (Print)
Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы)
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№5546-Ж**, выданное 01.06.2006 г.

Периодичность: 6 раз в год
Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел. 272-13-19, 272-13-18,
www:nauka-nanrk.kz / biological-medical.kz

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Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

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News of the National Academy of Sciences of the Republic of Kazakhstan. Series of biology and medicine.
ISSN 2518-1629 (Online),
ISSN 2224-5308 (Print)
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 5546-Ж, issued 01.06.2006

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://nauka-nanrk.kz / biological-medical.kz

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Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF BIOLOGICAL AND MEDICAL
ISSN 2224-5308
Volume 1, Number 331 (2019), 42 – 47 **https://doi.org/10.32014/2019.2518-1629.6**

UDC 87.15.15

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ECOLOGICAL MONITORING IN COATAL AREA OF CASPIAN SEA USING GEOINFORMATIONAL TECHNOLOGIES

Abstract. The objective need for environmental monitoring of soils in the coastal zones of the Caspian Sea in the areas of location of oil production defines due to the increasing anthropogenic pressure on land resources and the necessity of emitting of man-made changes in the state of soils for the adoption of environment-oriented decisions. When creating a geographic information model for soil assessment, it was found that it should be able to exchange information with other geographic information systems and technologies, as well as other applications.At the field stage, a visit to the area with a set of measuring equipment was carried out, which provides sampling of soil with fixing the location in the areas of SES.To ensure the automation of data processing, predictive and spatial analysis of the results of field studies, an electronic map of the state of the soils of the coastal zone of the Caspian sea in the GIS format was created.Project information analysis application "Monitoring and Analytics" was developed to the electronic map, which was implemented on a modular basis based on client-server technology. The MS Access database management system (DBMS) is chosen as a server for the accumulation of information about the results of field surveys of the locality, which ensures the reliability of the application and the correction of the layers of the electronic map. With the help of MSExcel attributive tables were created to collect information according the main soil condition indicators of each field. An electronic map soils' state of the Caspian Sea coastal zone in the areas where oilfields are located, on which all the results of environmental projects are applied with using MsAccess.

Key words: Caspian Sea, coastal soil, electronic chart, GIS, monitoring.

Introduction. The objective necessity for state environmental monitoring of coastal soils of the North-east Caspian Sea zones in areas of oil companies operation is due to the following main factors:

- increasing anthropogenic pressure on land resources;
- need to allocate anthropogenic changes in a soil condition on the background of natural environmental decision-making.

Solving these monitoring problems is very difficult without creation of the soils condition database, that is, an automated information system (AIS) of land monitoring. The created AIS should contain all of the above information that will allow virtually adopting and implementing correct environmental decisions. In this regard, the ever-growing amount of information on the status and use of land makes creation of information support for implementation of state land monitoring especially relevant.

The objective need for environmental monitoring of soils in the coastal zones of the Caspian Sea in the areas of location of oil production defines due to the increasing anthropogenic pressure on land resources and the necessity of emitting of man-made changes in the state of soils for the adoption of environment-oriented decisions.

When creating a geoinformation model for evaluation the nature of soils, it should be able to exchange information with other geoinformation systems and technologies, as well as other application programs, since no one modern GIS is able to be absolutely universal in performing tasks that are required in production [1-3].

Thus, with the implementation of the geoinformation model, it became necessary to use software programs that allow working with both attribute data and a graphic part of it [4, 5].

Methods and materials. The main source of facts is the materials of author's research at stationary ecological posts (SES), in the coastal zone of the Caspian Sea in areas where oilfields operate [6]. The evaluation method of negative processes was used, where rigorous approach and marking criteria of soil degradation in oil fields were applied. The software programs MapInfoProfessional, GeomaticsOffice, MicrosoftOfficeAccess, AdobePhotoshop were used, which allows working with attribute data, as well as with a graphic part of environmental projects [7].

Results. One of the main elements for the organization of information using GIS geoinformation technologies is attributive data models. To realize the tasks set by us, the relational model is used as a model of attributive data. Relational data models are displayed in the form of tables.

Such data models are available even for unskilled users, and it is possible to use high-level languages. Information systems which are formed on the basis of relational models are available for users who do not have much programming experience.

Since the main purpose of the work was to compile an electronic soil map of the coastal zone of the Caspian Sea, based on the results of soil monitoring (ecological projects), the first stage of database development was the conceptual level. At this stage of the research, a conceptual model of data with logical connections was created, reflecting the necessary composition of information on the state of soils in the coastal zone of the Caspian in the areas where oilfields are located (physical and chemical properties, heavy metals) in the form of a strictly ordered structure, but with the possibility of its development and dynamics.

In the process of conceptual design, a conceptual and logical model of data is created, reflecting the composition of data on soil monitoring results in the form of ordered structure.

In 2016-2017field studies were carried out at the 12 stationary ecological sites (SES) with soils sample collections of the coastal zone of the Caspian Sea in areas of oil fields to determine the content of heavy metals in soils (table 1).

Table1 – Coordinates of stationary ecological sites (SES)

SES	Field	Coordinates			
		Length		Latitud	
		Plan	Fact	Plan	Fact
1	Karazhanbas	51˚15'41.8032	51°16'03,6"	45˚8'51.306	45°08'56.8"
2	Karazhanbas	51˚16'37.38	51°16'32.3"	45˚8'49.6608	45°08'51.4"
3	Karazhanbas	51˚17'49.2108	51°17'48.0"	45˚8'49.4772	45°08'36.5"
4	Karazhanbas	51˚16'33.204	51˚16'35.10	45˚7'48.9144	45˚7'47.10
5	Fonovaya	51˚16'14.6676	51˚16'14.7	45˚6'25.866	45˚06'25.9
6	Fonovaya	51˚29'52.5156	51°29'43.9"	45˚18'24.3396	45°18'35.7"
7	Fonovaya	51˚41'42.3168	51°44'19.1"	45˚22'51.1248	45°22'39.3"
8	Arman	51˚44'58.5132	51°45'11.5"	45˚24'43.6176	45°24'30.7"
9	Arman	51˚45'22.464	51°45'36.1"	45˚24'5.5548	45°24'01.3"
10	Kalamkas	51˚55'3.0036	51°55'35.6"	45˚25'0.2784	45°25'03.5"
11	Kalamkas	51˚55'3.8712	51˚55'17.8	45˚23'21.8796	45˚23'28.5
12	Fonovaya	52˚9'2.5416	52˚07'55.6	45˚21'27.7524	45˚21'59.5

Map-scheme of monitoring points in the coastal zone of the Caspian Sea executed in the MapInfoProfessiomal 12.0 environment is shown in figure 1.

At the field stage, a trip to the region was carried out with a set of measuring instruments that provided sampling of soil with fixation of location in the areas of the SES.

According to the results of laboratory research, diagrams of physical and chemical features and dynamics of heavy metals in soils were carried out, and on the basis of which attribute tables were created in the MSExcel environment. A software analytic application "Monitoring and Analytics" was developed to the electronic state map.

Figure 1 – The scheme of monitoring points in the coastal part of Mangistau region
(implemented in the environment MapInfoProfessiomal 12.0)

The MicrosoftAccess database management system was used as a server, which provides the accumulation of information about the results of field surveys, the reliability of the application and the adjustment of the used layers of the electronic map [8].

For computerized loading of data in the database maintenance module, there is a special function called "Importing data from an Excel file"[9, 10]. With the help of MSExcel attributive tables were created to collect information according the main soil condition indicators (content of heavy metal in soils (TM)) of each field (SES) (figure 2).

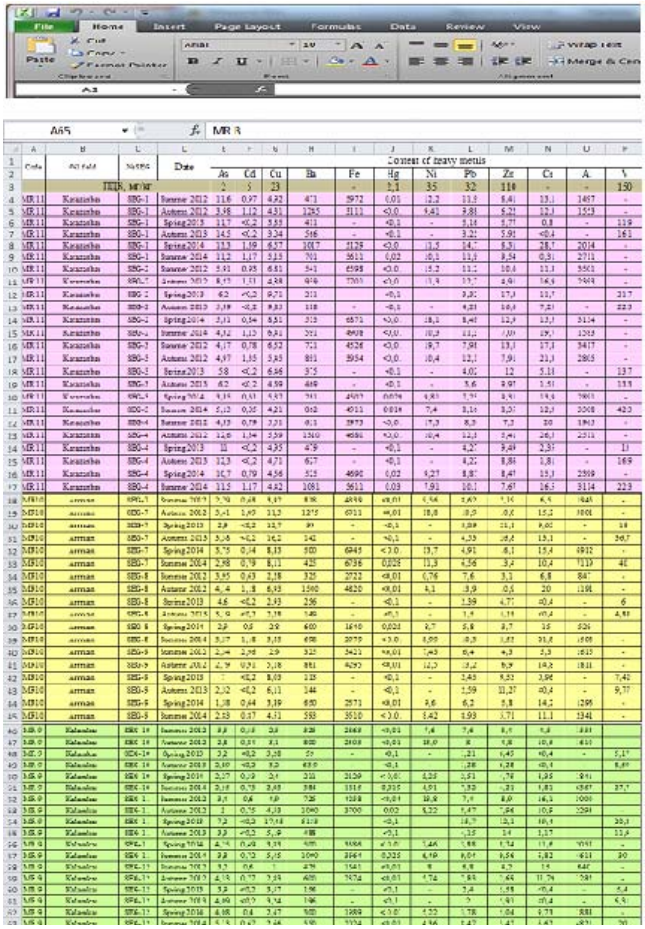

Figure 2 –
Attributive table
(the content of heavy metals in soils),
taking into account the correspondence
of field numbers of electronic maps
(Excel)

In the attributive table: hierarchical levels system organization of fields (area code + business code), name of the field (column B) and field –SES (column C) were taken into account.

As a software-tool environment for developing a physical database model, MS Access was selected, which has a high application reliability. The MsAccess program made it possible to translate this table into dbf format for the following data association to the shapefile of the electronic map of the study area. The binding of the table data to the shapefile was performed using the N_ID attribute (N_1) [11-13].

The table of results of monitoring the Caspian Sea coastal zone soils is presented in figure 3 in MS Access.

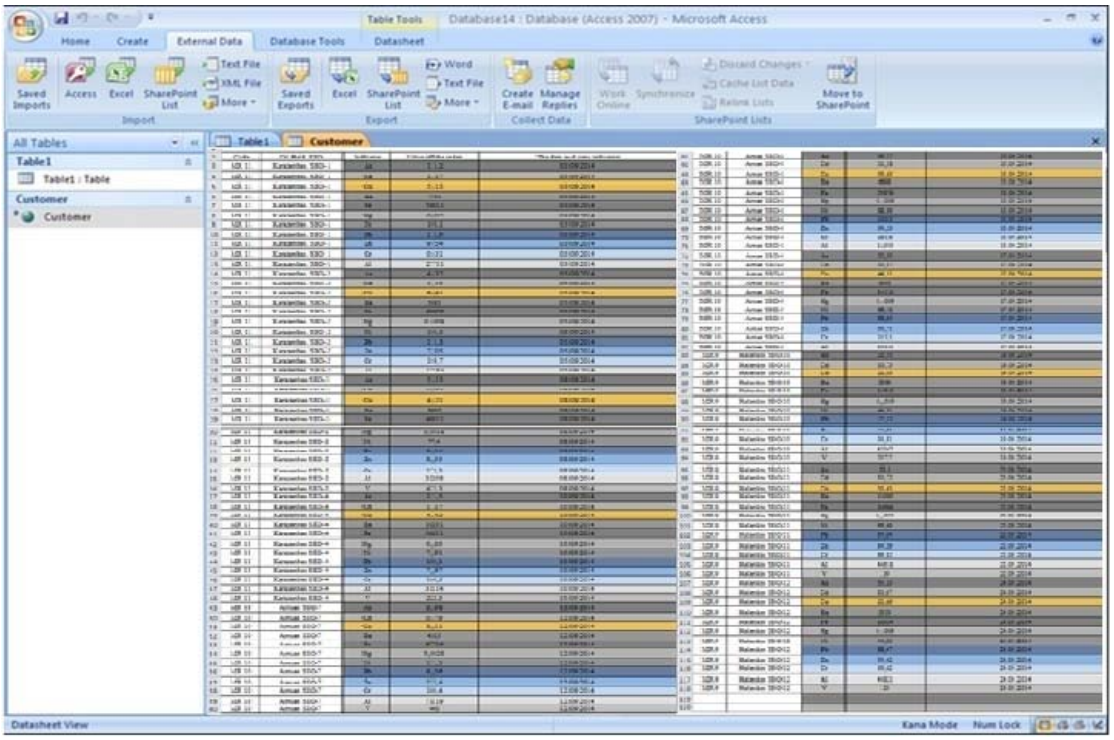

Figure 3 – Adapted in MS Access tableresults of SES monitoring

The form fields of the MsAccess of pivot Tables contain the following attributes: SES 1-15 coordinates (for oilfields, including background ones), field cipher N_ID (N_1), humus content Hum_, phosphorus content P_2O_5_, potassium content K_2O_, heavy metals As_, Cd_, Cu_ , Ba_, Fe_, Hg_, Ni_, Pb_, Zn_, Cr_, Al_, V_. indicating the date, time and year of environmental monitoring [14, 15]. The MsAccess program made it possible to translate all the above tables into the dbf format for later binding the table data to the shapefile of the electronic map of the Caspian Sea coastal zone in areas where the oilfields were located (figure 4). The binding of tabular data to the shapefile is carried out by the attribute N_ID (N_1).

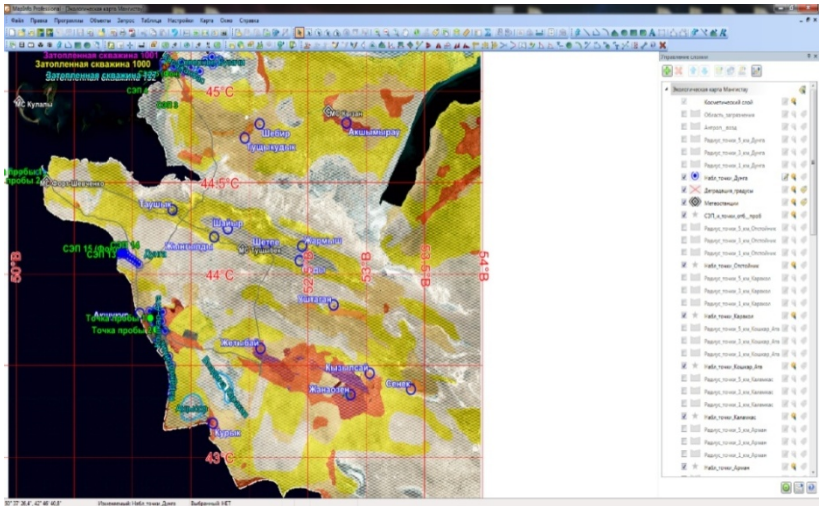

Figure 4 –
Electronic map of soils
of the Caspian Sea coastal zone

Conclusion. An electronic map soils' state of the Caspian Sea coastal zone in the areas where oil-fields are located, on which all the results of environmental projects are applied with using MsAccess.

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ГЕОАҚПАРАТТЫҚ ТЕХНОЛОГИЯЛАРДЫ ҚОЛДАНУ АРҚЫЛЫ КАСПИЙ ЖАҒАЛАУЫНДАҒЫ МҰНАЙ ӨНДІРІЛЕТІН АЙМАҚТАРДЫҢ ЭКОЛОГИЯЛЫҚ МОНИТОРИНГІ

Аннотация. Каспий теңізінің жағалау аймағының мұнай өндіру кәсіпорындары орналасқан аудандарда топырақтарының жағдайына экологиялық мониторингтің объективті қажеттілігі жер ресурстарына антропогендік қысымның артуымен және табиғатты қорғау шешімдерін қабылдау үшін топырақ жағдайында антропогендік өзгерістерді бөлу қажеттілігінен туындайды. Топырақтың жай-күйіне бағалау жүргізу үшін геоақпараттық модель құру кезінде оның басқа геоақпараттық жүйелермен және технологиялармен, сондай-ақ басқа да қолданбалы бағдарламалармен ақпарат алмасу мүмкіндігі болуы тиіс екендігі анықталды. Далалық кезеңде өлшеу аппаратурасының жиынтығымен қамтамасыз етіліп, тұрақты экологиялық алаң аудандарында орналасқан жерлерді белгілей отырып, топырақ сынамаларын алужүзеге асырылды.Деректерді өңдеу процестерін автоматтандыруды қамтамасыз ету, далалық зерттеулер нәтижелерін болжамдық және кеңістіктік талдауды қамтамасыз ету үшін ГАЖ форматында Каспийдің жағалау аймағы топырақтарының жай-күйінің электрондық картасы жасалды. Электрондық картаға клиент-сервер технологиясы негізінде модульдік тип бойынша іске асырылған "Мониторинг және аналитика" бағдарламалық ақпараттық-талдамалық қосымшасы әзірленді. Жергілікті жерді далалық зерттеу нәтижелері туралы мәліметтерді жинақтау үшін сервер ретінде MS Access деректер қорын басқару жүйесі (ДҚБЖ) таңдалды, бұл қосымшаның сенімділігін және электрондық карта қабаттарын түзетуді қамтамасыз етеді.MS Excel көмегімен әрбір алаңның топырақ жай-күйінің негізгі көрсеткіштері бойынша ақпарат жинауға арналған атрибуттық кестелер құрылды. MsAccess пайдалану арқылы экологиялық жобалардың барлық нәтижелері келтірілген, Каспийдің жағалау аймағының мұнай кәсіпорындары орналасқан аудандары топырақтарының жай-күйінің электрондық картасы жасалды.

Түйін сөздер: Каспий теңізі, жағалау топырағы, электронды карта, ГАЖ, мониторинг.

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ЭКОЛОГИЧЕСКИЙ МОНИТОРИНГ ПРИБРЕЖНОЙ ЗОНЫ КАСПИЯ В РАЙОНАХ НЕФТЕДОБЫЧИ С ПРИМЕНЕНИЕМ ГЕОИНФОРМАЦИОННЫХ

Аннотация. Объективная необходимость экологического мониторинга почв прибрежных зон Каспия в районах размещения предприятий нефтедобычи обусловлена, возрастающей антропогенной нагрузкой на земельные ресурсы и необходимостью выделения антропогенных изменений в состоянии почв для принятий природоохранных решений. При создании геоинформационной модели для проведения оценки состояния почв, было установлено, что она должна обладать возможностью обмена информацией с другими геоинформационными системами и технологиями, а также другими прикладными программами. На полевом этапе, был осуществлен выезд на местность с комплектом измерительной аппаратуры, обеспечивающей отбор проб грунта с фиксацией местоположения в районах СЭП. Для обеспечения автоматизации процессов обработки данных, прогнозного и пространственного анализа результатов полевых исследований создана электронная карта состояния почв прибрежной зоны Каспия, в формате ГИС. К электронной карте разработано программное информационно-аналитическое приложение «Мониторинг и аналитика», реализованное по модульному типу на основе технологии клиент-сервер. В качестве сервера длянакопления сведений о результатах полевых обследований местности, выбрана система управления базами данных (СУБД) MS Access, что

обеспечивает надежность приложения и корректировку слоев электронной карты.С помощью MSExcel были созданы атрибутивные таблицы для сбора информации по основным показателям состояния почв каждого поля.Создана электронная карта состояния почв прибрежной зоны Каспия в районах размещения нефтяных промыслов, на которую нанесены все результаты экологических проектов, с использованием MsAccess.

Ключевые слова: Каспийское море, прибрежные почвы, электронная карта, ГИС, мониторинг.

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ISSN 2518-1629 (Online), ISSN 2224-5308 (Print)

http://biological-medical.kz/index.php/en/

Редактор *М. С. Ахметова, Т. М. Апендиев, Д. С. Аленов*
Верстка на компьютере *Д. Н. Калкабековой*

Подписано в печать 13.02.2019.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
6,4 п.л. Тираж 300. Заказ 1.