ДНІПРОПЕТРОВСЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ
ім. О. ГОНЧАРА
ТОВ «АГЕНТСТВО «ТЕЛЕПРЕСІНФОРМ»

ЗА ПІДТРИМКИ:
НАУКОВОЇ РАДИ З ПРОБЛЕМ ҐРУНТОЗНАВСТВА НАН УКРАЇНИ
КОРДОБСЬКОГО УНІВЕРСИТЕТУ (ІСПАНІЯ)
НАУКОВО-НАВЧАЛЬНОГО ЦЕНТРУ ДНУ ім. О. ГОНЧАРА –
ПРИСАМАРСЬКОГО БІОСФЕРНОГО СТАЦІОНАРУ ім. О. Л. БЕЛЬГАРДА

ЕКОЛОГІЯ

ТА НООСФЕРОЛОГІЯ

Том 22 2011
№ 1 – 2

Науковий журнал
Заснований у 1995 році

www.uenj.cv.ua

Київ – Дніпропетровськ
2011

Рекомендовано до друку Вченою радою
Дніпропетровського національного університету ім. О. Гончара

Адреса редколегії: Асоціація засобів масової інформації України, вул. Івана Кудрі, 26, м. Київ, Україна; Дніпропетровський національний університет ім. О. Гончара, просп. Гагаріна, 72, 49010, м. Дніпропетровськ, Україна. *Телефони:* (056) 792–78–82, (0562) 76–83–81. *Web-сторінка*: www.uenj.cv.ua. *E-mail*: ecologgrunt@yahoo.com

З М І С Т

ЕКОЛОГІЧНА СИТУАЦІЯ У СХІДНІЙ ЄВРОПІ

Recio Espejo J. M., Travleyev A. P. Environment Workshops 2010 «Enviromental Situation in East-Europe: Scientific Development, Current Problems and Future Actions» 7

Травлеев А. П., Рецио Эспехо Х. М. Семинар по окружающей среде 2010 «Экологическая ситуация в Восточной Европе: научные разработки, современные проблемы и дальнейшие действия» 9

ЕКОЛОГІЧНІ ПРОБЛЕМИ МЕГАПОЛІСУ

Radchenko V. G. The modern condition and preservation of biodiversity in the anthropogenic transformed landscapes of Ukraine includinc the Chernobyl zone 13

Karpachevskiy L. O. The city and the functions of urban soils 16

Sergieieva I. Some ways to increase biodiversity in urban ecosystems of Ukraine 23

ЕКОЛОГІЧНЕ ҐРУНТОЗНАВСТВО

Travleyev A. P., Bilova N. A. Scientific principles of forest soil biodiversity research 25

Chartko N. K., Zhoomar P. V., Karpichenko A. A. Geochemical structure landscapes and soils 30

Shevyakova N. I. Nickel phytoremediatory potential and mechanisms of its detoxification in plants using for decontamination of soils 40

Bilova N. A., Yakovenko V. N., Yushchuk E. D. Micromorpholodgy of artificial edaphotopes in forest ecosystems of destructive areas of Ukraine 50

Urushadze T. F., Urushadze T. T. Soils of Georgia: condition and perspectives 58

Горбань В. А. Особенности влияния эолово-почвенных отложений на свойства лесоулучшенных почв полезащитных лесополос степной зоны Украины 64

ОХОРОНА НАВКОЛИШНЬОГО СЕРЕДОВИЩА ЛЮДИНИ

Martínez Camero A., Gil Torres J., Recio Espejo J. M. Soil salinitation and environmental conservation: Ramsar natural reserve of El Conde small-lake (Luque, Córdoba, Spain) 69

Roldán J., Cabrera E. Strategies and measures to mitigate drought impacts 74

Zubkova T. A. Pollution in humid and arid zone of Russia 81

Onoprienko D. M. Agro-ecological basis of fertigation application in the northern steppe of Ukraine 83

Havrylenko V. S. The biosphere reserve «Askania Nova» is a good model for tracking of the ecosystem processes in the protected steppes of Eurasia 90

Nekhay O., Arriaza M. Integrating social preferences and experts' subjetive information into agricultural land use optimization 98

Havrylenko N. O. Ecosystem of dendrological park «Askania Nova» as a part of an object of the nature protected fund of Ukraine 113

Romanova M., Puchilo A. Enviromental problems of the Belarus 118

ЕКОЛОГІЧНІ ПРОБЛЕМИ ВОДНИХ РЕСУРСІВ

Gadaev A., Niyazov I. Uzbekistan: Aral Sea ecological disaster and water resources management issues 120

Gadaev A. The water well clogging and rehabilitation issues 124

СОЦІАЛЬНІ ПРОБЛЕМИ ОХОРОНИ НАВКОЛИШНЬОГО СЕРЕДОВИЩА ЛЮДИНИ

Gomera Martínez A., Vaquero Abellán M., de Toro Jordano A., Aguilar Moreno J. E., Guijarro Jiménez C. Environmental management and education at the University of Cordoba 127

Volovyk I. Social and ecological aspects of rural development under influence of urbanization 132

МАТЕМАТИЧНА ЕКОЛОГІЯ

Chernyshenko S. V., Chernyshenko V. S., Alekseyev M. O. Nonlinear theory of successions in forestry biogeocoenoses: mathematical aspects 134

ЕКОЛОГІЧНІ ПРОБЛЕМИ КОСМОСУ

Головко М. Г., Безуглый В. А., Бондаренко С. Г. Анализ состояния техногенного засорения околоземного космического пространства и способы его уменьшения 147

РЕЦЕНЗІЇ

Травлеев А. П., Сумароков А. М. Монченко В. И. Свободноживущие циклообразные копеподы Понто-Каспийского бассейна. – К. : Наукова думка, 2003. – 351 с. 153

Белова Н. А. Кармазиненко С. П. Мікроморфологічні дослідження викопних і сучасних грунтів України / Відп. ред. д-р геогр. наук Ж. М. Матвіїшина. – К. : Наукова думка, 2010. – 120 с. 157

Шанда В. І., Євтушенко Е. О. Червона книга Дніпропетровської області (рослинний світ) / Гол. ред. А. П. Травлєєв. – Д. : ВВК Баланс-Клуб, 2010. – 500 с. 159

ДО УВАГИ АВТОРІВ 162

TABLE OF CONTENTS

ENVIRONMENTAL SITUATION IN EAST-EUROPE

Recio Espejo J. M., Travleyev A. P. Environment Workshops 2010 «Enviromental Situation in East-Europe: Scientific Development, Current Problems and Future Actions» 7

Travleyev A. P., Recio Espejo J. M. Environment Workshops 2010 «Enviromental Situation in East-Europe: Scientific Development, Current Problems and Future Actions» 9

ENVIRONMENTAL PROBLEMS OF MEGAPOLIS

Radchenko V. G. The modern condition and preservation of biodiversity in the anthropogenic transformed landscapes of Ukraine includinc the Chernobyl zone 13

Karpachevskiy L. O. The city and the functions of urban soils 16

Sergieieva I. Some ways to increase biodiversity in urban ecosystems of Ukraine 23

ECOLOGICAL SOIL SCIENCE

Travleyev A. P., Bilova N. A. Scientific principles of forest soil biodiversity research 25

Chartko N. K., Zhoomar P. V., Karpichenko A. A. Geochemical structure landscapes and soils 30

Shevyakova N. I. Nickel phytoremediatory potential and mechanisms of its detoxification in plants using for decontamination of soils 40

Bilova N. A., Yakovenko V. N., Yushchuk E. D. Micromorpholodgy of artificial edaphotopes in forest ecosystems of destructive areas of Ukraine 50

Urushadze T. F., Urushadze T. T. Soils of Georgia: condition and perspectives 58

Gorban V. A. Peculiarities of aeolian-soil deposits influence on the quality of forest-improved soils of forest shelter belts in steppe zone of Ukraine 64

HUMAN ENVIRONMENT CONSERVATION

Martínez Camero A., Gil Torres J., Recio Espejo J. M. Soil salinitation and environmental conservation: Ramsar natural reserve of El Conde small-lake (Luque, Córdoba, Spain) 69

Roldán J., Cabrera E. Strategies and measures to mitigate drought impacts 74

Zubkova T. A. Pollution in humid and arid zone of Russia 81

Onoprienko D. M. Agro-ecological basis of fertigation application in the northern steppe of Ukraine 83

Havrylenko V. S. The biosphere reserve «Askania Nova» is a good model for tracking of the ecosystem processes in the protected steppes of Eurasia 90
Nekhay O., Arriaza M. Integrating social preferences and experts' subjetive information into agricultural land use optimization 98
Havrylenko N. O. Ecosystem of dendrological park «Askania Nova» as a part of an object of the nature protected fund of Ukraine 113
Romanova M., Puchilo A. Enviromental problems of the Belarus 118

ECOLOGICAL PROBLEMS OF WATER RESOURCES

Gadaev A., Niyazov I. Uzbekistan: Aral Sea ecological disaster and water resources management issues 120
Gadaev A. The water well clogging and rehabilitation issues 124

SOCIAL PROBLEMS OF HUMAN ENVIRONMENT CONSERVATION

Gomera Martínez A., Vaquero Abellán M., de Toro Jordano A., Aguilar Moreno J. E., Guijarro Jiménez C. Environmental management and education at the University of Cordoba 127
Volovyk I. Social and ecological aspects of rural development under influence of urbanization 132

MATHEMATICAL ECOLOGY

Chernyshenko S. V., Chernyshenko V. S., Alekseyev M. O. Nonlinear theory of successions in forestry biogeocoenoses: mathematical aspects 134

ECOLOGICAL PROBLEMS OF SPACE

Golovko M. G., Bezugly V. A., Bondarenko S. G. Analysis of anthropogenic pollution state of circumterrestrial space and ways to decrease it 147

REVIEWS 153

TO AUTHORS' ATTENTION 163

Universidad Internacional de Andalucía

ENVIRONMENT WORKSHOPS 2010

"ENVIROMENTAL SITUATION IN EAST-EUROPE: SCIENTIFIC DEVELOPMENT, CURRENT PROBLEMS AND FUTURE ACTIONS"

Baeza, Spain. 7th to 9th October 2010

UNIVERSIDAD DE CÓRDOBA

O. GONCHAR DNIPROPETROVSK NATIONAL UNIVERSITY

ЕКОЛОГІЧНА СИТУАЦІЯ У СХІДНІЙ ЄВРОПІ

ENVIRONMENT WORKSHOPS 2010 «ENVIROMENTAL SITUATION IN EAST-EUROPE: SCIENTIFIC DEVELOPMENT, CURRENT PROBLEMS AND FUTURE ACTIONS»

October 7 th – 9th, 2010, Baeza, Spain

Organized by

Dr. Anatoly Travleyev, Dniepropetrovsk National University /National Academy of Science of Ukraine.

Dr. José Manuel Recio Espejo, University of Cordoba, Spain.

Coordinated by:

Dr. Lourdes Soria. International University of Andalusia, Spain.

Format of the workshop

The workshop brought together 17 speakers and about 50 participants (including speakers). The scientific programme started in the morning of Thursday 7th October, and ended on Saturday 9th October. Ample time for informal discussion was reserved. A field excursion was organized. Participants were invited to present posters.

Scope

A new action frame in the economic, political, social and environmental development of the European continent has provoked the quick integration of many of the old eastern european countries. The influence that they had over the world in scientific development is well known. However the cultural and social aspects of these countries are less known. Their current concept about the environmental problems is still unknown, as well as the policies that are implemented at an internal level by those emerging countries.

This international meeting constituted for us a new and innovative experience and tried to promote and improve the scientific exchange and the international cooperation in the environmental field, contributing to a bigger European integration and fusion of the scientific knowledge. The aim of this workshop was to set up new European foundations, establish new opportunities for students´ and teachers` education, showing the advance in environmental policy and preservation of natural spaces and species, to transmit the knowledge and the developed preservation techniques, and to help in solving the current environmental problems.

More specifically this seminar dealt with great eco-geographical east-european zones, Russian pedological school and the c*hernozem* as an ecological paradigm, climate change desertification, erosion and soil conservation. It also dealt with great hydraulic constructions and enviromental problems (*Araal* sea and *Dnieper* river), water sustaintability, conservation and contamination problems, mining activities, landscape restoration and scientific experimentation (*Nicopol* station), the socio-ecological, environmental values and applications of agrarian activities, protected natural reserves (*Ascania Nova* and *Presamarsky* station). And finally the seminar will discuss the environmental policy and international programmes, atmospheric contamination and global disasters (*Chernobil* case).

Dr. José Manuel Recio Espejo, dr. Lourdes Soria, dr. Anatoly Travleyev (from left to right)

Speakers

Dr. Bilova Natalia Anatolievna. Academy of Customs of Ukraine, Ukraine.
Dr. Glukhov Alexander Zacharovich. Donetsk Botanical Garden of Ukranian National Academy of Science,Ukraine.
Dr. Radchenko Vladimir Grigorievich. Scientific Center of Ecomonitoring and Biodiversity of NASU, Ukraine.
Dr. Havrylenko Viktor Semenovych. The F.E. Falz-Fein Biosphere Reserve "Askania Nova", Ukraine.
Dr. Havrylenko Nina Olexandrivna. The F.E. Falz-Fein Biosphere Reserve "Askania Nova", Ukraine.
Dr. Tengiz F. Urushadze. Ivane Javakhishvili Tbilisi State University, Georgia.
Dr. Puchilo Anatolij Vikentjevich. Institute of Experimental Botany of Belarusian Academy of Sciences, Belarus.
Dr. Karpachevskii Lev Oscarovich. Lomonosov Moscow State University, Russia.
Dr. Shevyakova Nina Ivanovna. Timiriazev Insitute of Pant Physiology of RAS, Russia.
Dr. Zubkova Tatiana Aleksandrovna. Lomonosov Moscow State University, Russia.
Dr. Ungurean Valentin Georgievich. Agricultural State University of Moldova, Moldova.
Dr. Dimitry Onoprienko. Dniepropetrovsk Agrarian State University, Ukraine.
Dr. Irina Volovik. Dniepropetrovsk Agrarian State University, Ukraine.
Dr. Abror N. Gadaev. Samarkand State University, Uzbequistan.
Dr. Alexander Neghay. Institue for Prospective Technological Studies, Joint Research Center, European Commission, Spain.
Dr. Travleyev Anatoly Pavlovich. O. Gonchar Dniepropetrovsk National University, Ukraine.
Dr. José Roldan Cañas. Fund Spain-Ukraine for International Projects. University of Córdoba, Córdoba, Spain

J. M. Recio Espejo,
University of Cordoba, Spain.

A. P. Travleyev,
O. Gonchar Dnipropetrovsk national university,

СЕМИНАР ПО ОКРУЖАЮЩЕЙ СРЕДЕ 2010 «ЭКОЛОГИЧЕСКАЯ СИТУАЦИЯ В ВОСТОЧНОЙ ЕВРОПЕ: НАУЧНЫЕ РАЗРАБОТКИ, СОВРЕМЕННЫЕ ПРОБЛЕМЫ И ДАЛЬНЕЙШИЕ ДЕЙСТВИЯ»

07–09 октября 2010 г., Баеза, Испания

7–9 октября 2010 г. в «Sede Antonio Machado» (г. Баеза, Андалусия, Испания) состоялся семинар по окружающей среде «Экологическая ситуация в восточной Европе: научные разработки, современные проблемы и дальнейшие действия».

Организаторы:

Доктор Анатолий Травлеев, председатель Научного Совета по проблемам почвоведения Национальной академии наук Украины, Днепропетровский национальный университет им. Олеся Гончара (организатор семинара);

Доктор Хосе Мануель Рецио Эспехо, директор «Nicolay Masyk» и Организации Испания – Украина для Международных проектов, Университет Кордобы, Испания (организатор семинара).

Координатор:

Доктор Лурдес Сория, Университет Андалусии, Баеза, Испания (координатор семинара).

Формат семинара

Семинар собрал около 50 участников, из них 17 докладчиков. Научная программа началась 7 октября и закончилась 9 октября. Основное время было посвящено докладам и информационной дискуссии. Программой предусмотрена и полевая экскурсия.

Семинар по защите окружающей среды 2010 г. является естественным продолжением той масштабной работы, которая была проведена Международным университетом Андалузии и Кордобским университетом совместно с Германией в 2009 году.

Нынешний семинар 2010 года под названием: «Экологическая ситуация в восточной Европе: научные разработки, современные проблемы и дальнейшие действия», который ныне проводится в замечательном историческом городе Баеза (Испания) по инициативе координатора доктора Лурдес Сория (Международный университет Андалузии, Баеза, Испания) и организаторов доктора Хосе Мануэля Рецио Эспехо, Почетного доктора Днепропетровского национального университета им. Олеся Гончара, члена бюро Научного Совета по проблемам почвоведения Национальной академии наук Украины, директора центра «Nicolay Masyuk» и Организации Испания – Украина для Международных проектов (Университет Кордобы, Испания) и доктора Травлеева Анатолия Павловича, член-корреспондента Национальной академии наук Украины, председателя Научного совета по проблемам почвоведения НАН Украины, профессора Днепропетровского национального университета им. Олеся Гончара.

Международный университет Андалусии продолжает в 2010 году выполнение программы, посвященной организации семинаров для решения неотложных проблем состояния окружающей среды.

Цель этих семинаров заключается в том, чтобы продвинуть и улучшить международное сотрудничество и обменяться опытом в области охраны окружающей среды человека. Такие семинары стимулируют и способствуют научному взаимодействию андалусских, американских экологов, стран СНГ, всего международного научного сообщества.

Персональный состав участников научного семинара зарубежных стран и бывших республик Советского Союза: доктор Радченко В. Г. (Украина), доктор Белова Н. А. (Украина), доктор Глухов А. З. (Украина), доктор Гавриленко В.С. (Украина), доктор Гавриленко Н.О. (Украина), доктор Урушадзе Т. Ф. (Грузия), доктор Пучило А. В. (Беларусь), доктор Карпачевский Л. О. (Россия), доктор Шевякова Н. И. (Россия), доктор Зубкова Т. А. (Россия), доктор Унгуреан (Грузия), доктор Оноприенко Д. (Украина), доктор Воловик И. (Украина), доктор Гадаев А. Н. (Узбекистан), доктор Нехай А. (Испания), доктор Травлеев А. П. (Украина), доктор Хосе Ролдан Канас (Испания).

7 октября 2010 г. состоялось торжественное открытие научного семинара.

В президиуме находились:

Хосе Мануель Ролдан Ногуерас – ректор Университета Кордобы;

Хосе М. Суарез Хапон – ректор Международного университета Андалусии;

Хосе Мануель Рецио Эспехо – организатор, директор лаборатории «Николая Масюка» и организации Испания – Украина для Международных проектов;

Анатолий Травлеев – организатор, Днепропетровский национальный университет им. Олеся Гончара, председатель Научного совета по проблемам почвоведения НАН Украины;

Лурдес Сория – координатор, Международный университет Андалусии, Баеза, Испания.

Работа секции № 1: председатель А. П. Травлеев (Украина)

Были заслушаны следующие доклады:

Радченко В. Г. (Украина): *Проблемы сохранения биоразнообразия (включая Чернобыльскую трагедию) и урбанизированных территорий Украины;*

Гадаев А. (Узбекистан): *Экологические бедствия в Аральском море и результаты управления водными ресурсами;*

Шевякова Н. (Россия): *Путресцин – основной элемент для детоксикации чрезмерного содержания никеля в растении, используемый для биолечения зараженных почв;*

Ролданн Х. (Испания): *Стратегия и мероприятия по уменьшению влияния засухи.*

В дискуссии приняли участие 12 делегатов. Докладчикам было задано много вопросов и высказаны предложения, имеющие взаимный интерес в разработке затронутых проблем.

Работа секции 2: Председатель Хосе Ролдан Канас (Испания)

Были заслушаны доклады:

Чернышенко С. (Германия): *Математическое моделирование нелинейных процессов в Украинских лесных экосистемах (саморегуляции, последовательности, информационные процессы).*

Карпачевский Л. (Россия): *Город и функции городских почвы.*

Нехай А. (Испания): *Интегрирующие социальные предпочтения и субъективная информация специалистов в оптимизации сельскохозяйственного землепользования.*

Зубкова Т. (Россия): *Загрязнение почвы в засушливых зонах.*

Сессия постеров

Вопросы, дискуссия, выступления. Доклады вызвали большой интерес и были активно, всесторонне обсуждены.

В заключение была организована экскурсия по историческим и культурным местам г. Баезе.

Секция 3: Председатель Белова Н. (Украина)

Были заслушаны следующие доклады:

Травлеев А. (Украина): *Лесная рекультивация нарушенных земель угольной промышленности в условиях подтопления.*

Гавриленко В. (Украина): *Биосферный заповедник «Аскания Нова» в системе охраняемых территорий Европы.*

Урушадзе Т. (Грузия): *Почвы Грузии: состояние и перспективы.*

Оноприенко Д. (Украина): *Экологический базис применения фертигации в Украине.*

Гавриленко Н. (Украина): *Результаты интродукции древесных растений дендрологического парка «Аскания Нова» в засушливых степных районах Украины.*

Вопросы, дискуссия. Доклады вызвали большой интерес и были активно, всесторонне обсуждены. В обсуждении приняло участие 10 человек.

Секция 4: Председатель Хосе Мануель Рецио Эспехо (Испания)

Были заслушаны следующие доклады:

Белова Н. (Украина): *Микроморфологическая характеристика искусственных почв в лесных экосистемах деструктивных территорий*

Воловик И. (Украина): *Социальные и экологические аспекты развития села под влиянием современных промышленных технологий.*

Доклады вызвали большой интерес. Были заданы вопросы, проведена активная дискуссия, 8 выступлений и предложений.

Далее обсуждалась тематика предстоящей экскурсии по территории Университета Кордобы под руководством Хосе Мануеля Рецио Эспехо.

Состоялся прием в Кордобском университете.

Торжественное закрытие семинара и «Круглый стол».

Участники семинара (07–09 октября 2010 г.)

Торжественное закрытия семинара.
В центре президиума – Анатолий Щерба, посол Украины в Испании

В президиуме:

- Анатолий Щерба – посол Украины в Испании;
- Хосе Мануель Ролдан Ногуерас – ректор Университета Кордобы;
- Хосе Мануель Суарез Хапон – ректор Международного университета Андалусии;
- Доктор Хосе Мануель Рецио Эспехо (Испания) – организатор;
- Доктор Травлеев А. (Украина) – организатор;
- Доктор Лурдес Сория (Испания) – координатор,

а также доктор Радченко В. (Украина), доктор Белова Н. (Украина), доктор Воловик И. (Украина), доктор Гавриленко В. (Украина), доктор Гавриленко Н. (Украина), доктор Гадаев А.

(Узбекистан), доктор Глухов А. (Украина), доктор Зубкова Т. (Россия), доктор Карпачевский Л. (Россия), доктор Нехай А. (Испания), доктор Оноприенко Д. (Украина), доктор Пучило А. (Беларусь), доктор Унгуреан (Грузия), доктор Урушадзе Т. (Грузия), доктор Хосе Ролдан Канас (Испания), доктор Шевякова Н. (Россия).

Решением семинара предусмотрена публикация материалов в журнале «Ecology and noospherology» («Экология и ноосферология»).

А. П. Травлеев,
член-корреспондент НАН Украины,
председатель Научного совета
по проблемам почвоведения НАН Украины,
профессор Днепропетровского национального
университета им. О. Гончара

Х. М. Рецио Эспехо,
директор лаборатории «Николая Масюка»
и организации Испания – Украина для Международных проектов,
Почетный доктор Днепропетровского национального
университета им. О. Гончара,
заместитель председателя Научного совета
по проблемам почвоведения НАН Украины

ЕКОЛОГІЧНІ ПРОБЛЕМИ МЕГАПОЛІСУ

UDK 574.4

V. G. Radchenko

THE MODERN CONDITION AND PRESERVATION OF BIODIVERSITY IN THE ANTHROPOGENIC TRANSFORMED LANDSCAPES OF UKRAINE INCLUDINC THE CHERNOBYL ZONE

Center for Megalopolis Ecomonitoring and Biodiversity Research of NASU

In the paper the numbers of different species of flora and fauna inhabiting the areas of Ukraine are presented. The reasons of biodiversity petering in Ukraine are defined.

Key words: biodiversity, rare species, Chernobyl zone, preservation.

В. Г. Радченко

Центр екомоніторингу мегаполісів та дослідження біорізноманіття НАН України

СУЧАСНИЙ СТАН БІОРІЗНОМАНІТТЯ ТА ЙОГО ЗБЕРЕЖЕННЯ У ЗМІНЕНОМУ АНТРОПОГЕННОМУ ЛАНДШАФТІ УКРАЇНИ, ВКЛЮЧАЮЧИ ЧОРНОБИЛЬСЬКУ ЗОНУ

У статті наведено результати підрахунків різних видів флори та фауни, які мешкають на території України. Досліджено причини зменшення біорізноманіття України.

Ключові слова: біорізноманіття, рідкий вид, Чорнобильська зона, збереження.

В. Г. Радченко

Центр экомониторинга мегаполисов и исследования биоразнообразия НАН Украины

СОВРЕМЕННОЕ СОСТОЯНИЕ БИОРАЗНООБРАЗИЯ И ЕГО СОХРАНЕНИЕ В ИЗМЕНЕННОМ АНТРОПОГЕННОМ ЛАНДШАФТЕ УКРАИНЫ, ВКЛЮЧАЯ ЧЕРНОБЫЛЬСКУЮ ЗОНУ

В статье приведены результаты подсчетов различных видов флоры и фауны, обитающих на территории Украины. Исследованы причины уменьшения биоразнообразия Украины.

Ключевые слова: биоразнообразие, редкий вид, Чернобыльская зона, сохранение.

The biodiversity has a fundamental value in functioning of ecumene, maintenance of stability of a climate and life on a planet as a whole. Given the scale of the problems associated with environmental degradation, the United Nations Organization has proclaimed 2010 year as International year of biodiversity.

The biodiversity of Ukraine in totals consist over 27 thousand species of flora (including about 7 thousand species of vascular plants, there is more than 15 thousand species of mushrooms and myxomycetes, more than 1 thousand species of lichens, almost 800 species ofbryophytes and about 4 thousand species of algae) and 45 thousand species of fauna (from them over 35 thousand species ofhexapods, almost 3,5 thousand species of other arthropods 1800 – the protists, 3320 – the worms, about 200 species of fishes and cyclostomates 17 – amphibious, 21 – reptiles, nearly 400 – birds and 108 species of mammals), that in the sum compounds not less than 35 % of a biota of all Europe. Such considerable variety is caused by those, that in Ukraine in rather small terrain (the country occupies 6 % of the area of Europe) there are 4 different natural zones which considerably differ on flora and fauna. As a result on the biodiversity indication, the Ukraine are excels almost all European countries and consequently can be considered as one of powerful reservation for restoration of a biodiversity of all Europe. The greatest biodiversity is observed in steppe zone of Ukraine which occupies 34 percent of terrain of the country. Unfortunately, catastrophic reduction of the area of terrains of natural steppe ecosystems which have remained only in several reservations and on abrupt slopes of mountains, not suitable for agriculture is now observed. Other steppe fields are occupied under agricultural lands or under city and industrial agglomeration.

At the same time, the modern state of a biodiversity of Ukraine under intensifying of anthropogenic pressure upon connatural ecosystems causes a great anxiety and requires the use of cardinal measures. Through an anthropogenic load on environment the species diversity are promptly decreases for as animals, and plants. In Ukraine under the threat of petering now there is a significant amount of the rare species (in the last edition of the Red data book of Ukraine, published in 2009 year, 826 species of plants and mushrooms and 542 species of animals are included).

The main threat for a biodiversity of Ukraine is compounded by human activity. So; on the considerable areas destruction and degradation of environments of existence of animals and places of growth of plants owing to ploughed up the earths, to cutting down the forest, artificial infringement of a hydrological mode of terrains, large-scale industrial and housing construction which leads to a fragmentation of landscapes, environmental contamination as a result of industrial and agricultural activity, wearisome use of a biodiversity components, diffusion of illnesses, depredators and parasites, adventive species are observed. Migration routes of animals that compounds threat for a biodiversity not only for Ukraine, but also for many other countries are broken. Invasive alien species negatively influence a biodiversity almost each typical ecosystem on the Earth and is one of the greatest threats of biological variability, first of all lead to decrease in number or elimination of aboriginal species and break a normal functioning of ecosystems.

The biggest anthropogenic pressure upon a biodiversity in the conditions of connatural and contaminated landscapes of megacities is observed. Here the building density is essential increases, number of urban population and quantity of motor transport grows, etc. Therefore necessity of implementation of urgent actions for defense and preservation of a biodiversity of the mentioned terrains is arises. Research of landscape and biological variety of urban terrains and revealing of the most significant influences of the anthropogenic nature on their dynamics allows receiving specifications for not wearisome use of recreation potential of wood, forest-park and park areas. These terrains require augmentation of qualitative and quantitative structure of a biota in urbanized cenosis and creation of necessary conditions for reproduction and support of artificial and seminatural ecosystems which are an indispensable and necessary component of medium of existence of the modem person.

In urban ecosystems the plants and animals undergo considerable changes because here an environment operates as a negative stressful factor in their life. In urbanized cenosis the acclimatization of plants are carried out at the expense of infraspecific differentiation and rearrangement of their population structure. In the forest region of Ukraine there is the urban technogenic aridization of a climate in city ecosystems which actually change to zones of steppes and even semi-deserts.

In natural conditions of Ukraine there is a strong tendency to reduction of number of large mammals. For example, number of the moose from 14 thousand in 1990 now has decreased almost to 4 thousand. Combined number of the priority kind of rare mammals of Europe – the auroch which exists in Ukraine in free conditions, has reached the highest level at 1992-1993 years (664 individuals). It compounded over half of their world quantity, but now number of aurochs has decreased more than in 2 times. For the last 10 years the number of hoofed animals has decreased on one third. Has sharply decreased and continues to decrease number of the brown bear and a lynx (modem number about 340 and 360 individuals accordingly). And the unique representative of one of the world's most endangered marine mammals – a seal-monk does not meet any more in waters of our country since 50th years of 20th century, and consequently it is necessary to consider, that from a fauna of Ukraine this kind has disappeared.

Now from reservoirs of Ukraine the bastard sturgeon and the sterlet have completely disappeared. The beluga (European sturgeon) is on the verge of petering. Number of the Azov sturgeon for the last 15 years has decreased from 14 million up to 0,2 million exemplars, Azov starry sturgeon - from 360 thousand up to 80 thousand exemplars.

The basic means for preservation of a biodiversity at populational-species level is: conservation or restoration of natural conditions of medium of existence of a biota; restoration and support of natural populations of species of plants; mushrooms and animal, including the most rare species from the Red data book of Ukraine; prevention of anthropogenic degradation of natural ecosystems; essential augmentation of terrains of Natural Reserve Fund to Central European level; optimization of an interrelation of natural and artificial ecosystems in frame of agrolandscapes.

On an example of Chernobyl zone, which became as natural reserve, it is possible to observe the powerful serai processes which have led to fast restoration of a feral fauna and flora; especially it concerns regenerations of a diversity and number of large mammals. On the other hand, Chernobyl region continues to remain strong threat of diffusion of radioactive materials. Owing to Chernobyl accidents it is polluted by radionuclides .about 4 million hectares of woods. In particular, forest fires lead to spread of the radioactive dust which has collected in fulcrums and branches of trees, together with a smoke on huge distances and can get even to the remote countries of Europe. Therefore the decision of a problem of liquidation of consequences of Chernobyl accident should be solved at the international level, at least on all-European.

The important mechanism of achievement of the purposes of conservation of a biodiversity is the International cooperation within the limits of global, regional and bilateral conventions, agreements, programs, etc., in particular, the Convention on Biological Diversity and Pan-European Biological and Landscape Diversity Strategy.

Надійшла до редколегії 23.12.10

UDK 631.4

L. O. Karpachevskiy

THE CITY AND THE FUNCTIONS OF URBAN SOILS

Lomonosov Moscow State University, Russia

First cities developed during the Holocene. Thus, the urban civilization exists already for 8–10 thousand years. Thus, Jericho (Palestine) – the most ancient continuously inhabited city in the world – was built ca. 9000 BCE. Cities and towns form the urbosphere within the technosphere, thus making the city a giant specific ecosystem. The urban equivalent of the landscape is called cityscape. The following cityscape elements can be found in the city.

Key words: cityscape, urbosphere, soils of towns, technosphere, degradation of soils in city.

Л. О. Карпачевський

Московський державний університет ім. М. В. Ломоносова

МІСТО ТА ФУНКЦІЇ МІСЬКИХ ҐРУНТІВ

Перші міста сформувалися в біосфері у голоцені. Вік міської цивілізації вже 8–10 тис. років. Найдавніше із діючих міст – Ієрихон, приблизно 9 тис. років. Міста та селища утворюють урбосферу та техносферу і представляють собою специфічні екосистеми. Місто еквівалентне природному ландшафту. У ньому можна знайти найрізноманітніші екосистеми.

Ключові слова: міський ландшафт, урбосфера, ґрунти міста, техносфера, деградація ґрунтів міста.

Л. О. Карпачевский

Московский государственный университет им. М. В. Ломоносова

ГОРОД И ФУНКЦИИ ГОРОДСКИХ ПОЧВ

Первые города сформировались в биосфере в голоцене. Возраст городской цивилизации уже 8–10 тыс. лет Самый старый из действующих городов – Иерихон , около 9 тыс. лет Города и поселки образуют урбосферу и техносферу и представляют собой специфические экосистемы. Город эквивалентен природному ландшафту. В нем можно найти самые разные экосистемы.

Ключевые слова: городской ландшафт, урбосфера, почвы города, техносфера, деградация почв города

The urban civilization accompanies human development through most of its history. There are historic evidences that early cities appeared already in ancient times, at least 10 thousand years ago. Of currently existing cities the most ancient is Jericho (Jordan). Its habitation is dates back more than 7 thousand years. The most ancient cities of the Russian civilization are around 1000 years old (Velikiy Novgorod, Staraya Russa). The town of Derbent in the Caucasus is said to be more than 2000 years old. In Western Europe, some cities emerged more than 3 thousand years ago. Increasing agricultural productivity and growing population under conditions of shrinking readily available arable lands force people to move from rural areas to the cities. This process was observed already in ancient times. However, once some cities successfully develop, others gradually decline. Sometimes cities were deserted after being destroyed by aggressive invaders (Troy, Babylon). However, history knows examples when cities were abandoned without a clear reason (Latin America, India) or after sharp deterioration of living conditions. The latter can be exemplified by cases of Chernobyl and Pripyat (Ukraine) and Times Beach (the US). One of the reasons of city decline is sharp deterioration of the quality of soils in cities.

URBAN SOILS

Early studies of soils in cities were conducted already by V. V. Dokuchaev (soils of Saint Petersburg). However, the most comprehensive research of soils was conducted quite recently by G. V. Dobrovolskiy, M. N. Stroganova, T. V. Prokofyeva and A. D. Myagkova.

The classification of urban soils was developed. Briefly all soils were divided in four groups. The 1st group is morphologically intact soils. The 2d group is soils with disturbed morphology but with some horizons preserved. The 3d group is completely disturbed soils (soil-like bodies). The 4th group is man-made soils (under planted trees, lawns, beds of flowers etc.).

Soils can be also classified by the degree of pollution, although almost all urban soils are polluted to some extent. Pollution takes place permanently, so urban soils contain a great number of various pollutants. Some works (Privalov) show that there is certain dependence between the type of pollution and some particular health problems (including those typical for children). Relationships between soils and sanitary conditions of cities were established already by Potenkofer and Gantimurov. These relationships were studies in details by Yu.N. Ashin and T.A. Zubkova.

The objective of this paper is to discuss possible roles of soils in the life of cities.

SPECIFICS OF CITIES

Globally there are 7 cities with population over 15 million (Mexico City, Shanghai, Karachi, Istanbul, Tokyo, Mumbai and Buenos Aires) and more than 10 cities with population over 10 million (Dacca, Delhi, Manila, Moscow, Seoul, Kinshasa, Sao Paolu etc.). More than 100 cities have more than 1 million inhabitants. The growth of a city apparently creates serious problems for its inhabitants.

One of the main features of cities is the input of various products fabricated outside of the city – a great matter cycling. The city with more 1 million inhabitants, which occupies the area of 1000 thousand km^2, creates intensive matter cycling at all its lands (Tables 1 and 2).

Table 1

Matter input (million tons per year) to cities with over 1 million inhabitants

Name of matter	Amount
Pure water	470.0
Air	50.2
Minerals and construction materials	10.0
Coal	3.8
Crude oil	3.6
Raw materials for black metallurgy	3.5
Natural gas	1.7
Liquid fuels	1.5
Mineral and chemical raw materials	1.2
Raw materials for colored metallurgy	1.0
Technical plant raw materials	1.6
Raw materials for food industries, ready-to-use food	1.0
Energy and chemical raw materials	0.22

Table 2

Atmospheric emissions (thousand tons per year) in cities with over 1 million inhabitants

Name of matter	Amount
1	2
Water (vapor, aerosols)	10800
Carbon dioxide	1200
Sulphurous anhydride	240
Carbon monoxide	240
Dust	180
Hydrocarbons	108
Nitrogen oxides	60
Organic compounds	8
Chlorine, hydrochloric acid aerosols	5
Hydrogen sulphide	5
Ammonia	1.4

Continued of the table 2

1	2
Fluorides (recalculated per fluorine)	1.2
Carbon disulfide	1.0
Hydrogen cyanide	0.3
Lead-containing compounds	0.5
Nickel (with dust)	0.042
Surface-active agents (including benzo[a]pyrene)	0.08
Arsenic	0.031
Uranium (with dust)	0.024
Cobalt (with dust)	0.018
Mercury	0.0084
Cadmium (with dust)	0.0015
Beryllium (with dust)	0.0012

In natural ecosystems, the respective area (100 thousand km^2) annually receives 1-4 million tones of water, 2-5 million tones of organic residues and 50-200 thousand tones of dust. This shows that in terms of matter cycling the city exceeds natural ecosystems. It even exceeds local geological matter cycles, of course, except in areas with volcanic activity.

Natural ecosystems emit into the atmosphere significant amounts of water (1600 thousand tones) and carbon dioxide (5 thousand tones per 1 thousand km^2). Emissions of all other components are many times less.

Atmospheric emissions and general matter cycling in cities is by many times greater than those in natural ecosystems. The matter cycling in cities is greater than local geological matter cycling and is comparable with planet’s matter cycling.

THE CITY AS A SPECIFIC ECOSYSTEM

The city is a habitat for numerous human-beings, other animals and plants. The city can be considered a relatively large urban ecosystem. The latter consists of smaller lower-level urban ecosystems such as:

1. City streets
2. City yards
3. City buildings
4. City managed roadside vegetation
5. Green spaces and boulevards
6. Parks
7. Industries
8. Dumps and
9. Sewage water treatment stations.

Urban ecosystems in cities are very specific and even characterized by own biota. For example, various organisms dwell in ecosystems of city buildings. Birds, wasps and other insects inhabit mansard roofs. Basements are inhabited by mice, rats, mosquitoes and ants. Ticks, flies and mosquitoes can be found in apartments. A big variety of domestic animals (hamsters, turtles, dogs, cats, birds, fishes etc.) is kept in apartments. Domestic plants can be found in apartments and on stairways. Fungi and microflora are present everywhere.

Urban ecosystems of city yards. Green space in yards can be represented by trees, shrubs and herbaceous plants. Yards are used to walk domestic animals. Some birds like crows, sparrows, jackdaws and pigeons permanently live in yards, while some birds could be found there on occasion: tits, bullfinches, Bohemian waxwings, common magpies. Some insects (butterflies, mosquitoes, wasps, flies, ants etc.) could often live here. Soil fauna and microflora, including pathogenic ones, dwell on unsealed patches. Noteworthy, in the 19th century jackdaws were quite abundant on crosses of churches, while in 20th and 21st centuries they were outcompeted by crows. This shows that urban ecosystems are characterized by natural competition among species.

Urban ecosystems of streets, lanes and squares. The most typical biological elements here are individual trees planted in special pits along paved roads. Lawns and beds of flowers could be established along many streets and near buildings. Typical street inhabitants are birds, insects, dogs, cats, sometimes rats and mice. One sometimes may observe riding horses. Streets could have patches of unsealed soil. Each tree and isolated lawns can be considered as an ecosystem.

Boulevards, green spaces and waste lands are urban ecosystems with man-made and disturbed soils. Living organisms here are represented by birds, insects and other invertebrates living in soil and on plants, trees, lawns and beds of flowers.

Parks are remnants of natural ecosystems, often strongly modified by humans, or new artificial ecosystems. Parks are habitats of numerous native and introduced species – alien for particular natural conditions. Biological diversity in cities could be higher than in nearby natural ecosystems because of abundant alien species introduced to urban ecosystems.

BIOSPHERIC FUNCTIONS OF CITIES

As a totality of different ecosystems, the city plays a special organizing role in the biosphere.

1. The city accumulates food products and various kinds of natural resources in general (fuel, mineral resources);
2. The city produces waste;
3. The city is congestion of pathogenic microorganisms;
4. The city is congestion of "parasitic" invertebrates;
5. The city is congestion of a diverse genetic fund;
6. The city is the source of major ideas of progress in technologies, thinking, health care and social relations;
7. The city is an island almost at homeostatic conditions (in residential apartments "climate is constant");
8. The lifespan of humans in city is longer than in rural areas.

Being a spatial element of the biosphere, the city in various ways influences conditions of biosphere functioning:

1. It changes climate (climatic characteristics, temperature, amount and composition of precipitation, illumination);
2. It changes radioactive background and magnetic field;
3. Not only the city pollutes itself, it also pollutes nearby ecosystems;
4. Natural ecosystems of a new type, strongly impacted by recreation, develop around the cities.

Climate change:

1. The average temperature in cities is by 2-4 degrees above that in nearby natural ecosystems.
2. In some places in cities, soils become wetter, i.e. the amount of precipitation increases.
3. Indoor temperature is by tens of degrees higher than outdoor temperature.
4. Flooding regime in river valleys is disturbed inside the city and at some distance from it.
5. Groundwater discharge increases, thus changing hydrological regime of the area.
6. Discharged sewage waters cause heat, biological and chemical pollution of city freshwater ecosystems.

Zoos and botanical gardens in cities are keepers of a diverse genetic fund. D. Darrel even proposed a semi-utopist project to use them for preserving all planet's diversity.

The proximity of natural ecosystems to the city stimulates outdoor recreation activities and visits of natural ecosystems. This results in development of a network of paths, recreation areas, distortion of animals, changes in flora and even destruction of patches of vegetation. Picnics often cause fires.

The city is a special element of antroposphere. There is no theory of city decline so far, while there are recent examples of vanishing and decline of cities. The main reason of vanishing cities in the past were invasions followed by taking people into slavery, destroying and robbing houses etc. Among other reason the following could be listed:

1. Lack of water.
2. Unemployment related to destruction (decline) of city's main industrial activities.
3. Break off with rural population, which supplied city with food.
4. Development of pathogenic microorganisms and epidemics.

Cities, as a rule, were established on rivers, typically on high bank. Nevertheless, flooding as well as earthquakes could also destroy the city.

Can the humankind exist without cities? It is possible if the size of population does not exceed that after expelling from Eden. Population growth (which is the case already for 7 thousand years) made cities a necessary social element of anthroposphere. It is characterized by overuse of energy and water, high pollution, concentration of everything, including waste. This raises the question, is any internal (immanent) reason for city decline or only external ones, listed above?

The biosphere is characterized by successions – alternation of communities within the same ecosystem. This is why natural ecosystems could exist at current climatic fluctuations almost forever. There is some alternation, replacement and change of urban ecosystems. According to the ecosystem evolution, urban ecosystems do not have internal reasons for dying, … unless:

- They are supplied with water;
- They are supplied with energy;
- They are supplied with water; and
- People have jobs.

Once one of these conditions is breached, the city nears extinction.

Studies of animals and plants in cities show that urban ecosystems are still rich with plant and animal species, even not accounting for species introduced by humans. Hence, the city is the same component of the biosphere as other ecosystems. In principle, the city cannot be treated separately from the biosphere.

SOILS AND THE CITY

One of the reasons of cities decline is destruction of natural soils in cities, partly because of pollution. Soils play an important role in preventing development of pathogenic organisms.

As shown above, four main groups of soils occur in cities.

1) ***Natural soils*** are preserved in park (forest parks).

They perform their ecological functions only to some extent, or, more precisely, manifestations of ecological functions are restricted by human pressure. (Almost no restoration of natural zonal ecosystems takes place, seed pool in soil does not work, soil partly loses its sanitary functions, and the diversity of soil fauna decreases. Nonetheless, soils preserve their structure and order of horizons. Nevertheless, properties of these horizons can be sufficiently changed by chemical pollution.

2) ***Disturbed natural soils*** are preserved beneath sealed surfaces, in yards, wastelands, boulevards, green spaces, some lawns and under trees along streets.

They partly preserve their ecological functions. Once abandoned they may restore basic zonal properties. Very often they are polluted with various toxic compounds and pathogenic microorganisms.

3) ***Man-made soils*** develop beneath planted trees and some lawns.

Soil-like bodies occur near technological facilities of factories, workshops, gasoline stations, construction places and dumps. They almost lack basic ecological functions, are often toxic for plants, soil fauna and even microorganisms. Therefore they may preserve pathogenic microorganisms.

Can be change of soils be a cause of city decline?

1. City completely change the soil pattern in the area;

2. City partially destroy and partially disturb soils in the area;
3. Physical and chemical properties of soils in the area are changed;
4. Water, temperature and gaseous regimes of soils in the area are changed;

The original soil pattern of the city area corresponds to zonal soil pattern and is formed as a result of interaction of elementary landscapes on floodplains, slopes and watersheds.

City development destroys most of soils (soil of floodplains, slopes and watersheds) or bury them under mineral substratum, paved surface, construction waste etc. Superficial soil horizons are being compacted by humans, machines, buildings etc. Soil pH increase due to growing alkalization.

Some soils completely loose humus horizon, while others are characterized by increased humus content and higher thickness of humus horizon. The composition of soil biota, including bacteria and microorganisms, sharply changes.

Natural regimes of soil also change:

1. Winter soil temperatures become higher, thus making the climate milder, because of higher air temperature and increased temperature inside soil due to underground communications.

2. Water regime sharply changes. The water content in soil increases due to additional watering and water discharge. Sealed surfaces prevent evaporation of water from soils. Hydromorphic soil-like bodies (waterlogged grounds) are developed. Flooding in river valleys does not occur within the cities. The pattern of water distribution along slopes also changes.

Gaseous regimes of soils and atmosphere change. Gases toxic for humans could accumulate in canalization wells. This means that city emits significant amounts of alien gases into the atmosphere. All urban ecosystems emit into the atmosphere not only gases, which do not occur in natural atmosphere as well as gases, whose concentration becomes simply above normal values. Since there is permanent exchange of matter between atmosphere and soils and soil-like bodies, if they have pores, could contain "unusual" gases such as CO, CH_4, ethylene, CO_2, N oxides etc.

Urban soils contain increased contents of nitrogen, phosphorous and potassium. While nutrient regime is favorable, pollution and technogenic dust adversely affect plants. Thus, technogenic dust along streets is toxic for plants.

The role of chemical pollution can be illustrated by the fate of American city Times Beach. The city is the place of one of the most terrible environmental catastrophes in the US. Since 1972 to 1976 American authorities sprayed waste oil on roads to prevent dust formation. Unfortunately, someday waste oil was used that contained dioxin, a toxic carcinogenic compound. Dioxin penetrated into soil; rains and flooding distributed it throughout the area. Liquidation of the town in 1983 cost American government USD 36.7 million. After multiple attempts to clean the town the area became the Route 66 State Park.

Ukrainian towns Chernobyl and Pripyat had similar fate. Radioactive pollution in 1986 forced people to abandon these towns. However, plants and animals not only continue to inhabit the cities and the nearby area, but even increased in numbers. Vegetation slowly takes over streets and squares.

What is the role of soils in sustainability of cities? A dilemma is being proposed. Until the city is capable to improve its soils, it is sustainable. Once the city becomes incapable of maintaining its soils, it begins to decline.

Some districts in cities could completely lose natural soils. However, city parks with natural soils could still preserve a pool of natural microorganisms, thus keeping soil clean from pathogenic microorganisms. The system of health care in cities partly mitigates the impact of pathogenic organisms, although the number of the last steadily increases.

By preserving natural soils in landscape we preserve human settlements being part of this landscape. Therefore, conservation of patches of the biosphere with natural soils is a necessary condition for survival of humans as a species. This concept is debatable but plausible. Convincing evidences are not available so far, although this is an intriguing line of research. Under current conditions fighting against pathogenic organisms is organized very well, especially in cities. The system of disease prevention is quite developed.

However, could it be true that in the past, before the development of the modern system of health care, abandoned and destroyed cities could be the consequence of various health problems of local people? This is especially applicable to countries with warm climate, where earth's first civilizations emerged.

CONCLUSIONS

1. Cities are an obligatory component of anthroposphere. Humankind cannot exist without them.
2. Cities change all natural elements and their ecological functions, while creating homeostatic conditions for humans.
3. Natural soils in cities are being destroyed that may lead to unpredictable results, the death of city in first turn.

REFERENCES

Ashinov Yu. N., Zubkova T.A., Imgrunt I.I. and Karpachevskiy L. O. Soil and the Socium [Pochva i sotsium]. Maikop, Poligrafizdat Adygeya. 2006. In Russ.

Karpachevskiy L. O. Ecological Soil Science [Ekologicheskoye pochvovedenie]. Moscow: GEOS, 2005. In Russ.

Naryshkin M.A. Long before Chernobyl. Ecology and Noospherlogy, V. 3, no. 1-2, Kiev; Dnepropetrovsk. 1995.

Prokofieva T. V. and Poputnikova V. O. Anthropogenic Transformation of Soils of Pokrovskoe-Streshnevo Park (Moscow) and nearby Living Residential Blocks. *Pochvovedenie*, No. 6, 2010, pp.748-758. In Russ.

Sokolov M. S., Dorodnykh Yu. L. and Marchenko A. I. Healthy Soil as a Necessary Condition of Human Life. *Pochvovedenie*, No. 7, 2010, pp.856-867. In Russ.

Stroganova M. N., Miagkova A. D. and Prokofieva T. V. Role of Soil in Ecological Systems. *Pochvovedenie*, No. 1, 1997, pp. 1094-1103. In Russ.

Stroganova M., Miagkova A., Prokofieva T. and Skvortsova I. Soil, City and Environment (Soils of Moscow and Problems of Urban Environment). Moscow. 1998.

Zvyagintsev D. G. Soils and Microorganisms [Pochva i mikroorhanizmzy]. Izd. Mosk. Gov. Univ., 1987. In Russ.

Надійшла до редколегії 18.11.10

UDK 574.4

I. Sergieieva

SOME WAYS TO INCREASE BIODIVERSITY IN URBAN ECOSYSTEMS OF UKRAINE

I. I. Shmalhausen Institute of Zoology National Academy of Sciences of the Ukraine

In the paper the ways of biodiversity increase in urban ecosystems of Ukraine are presented. Among them there are restoration of green areas, maintenance of city ecosystems, etc.

Key words: biodiversity, urban ecosystems, biota.

І. Сергєєва

Інститут зоології ім. І. І. Шмальгаузена НАН України

СПОСОБИ ЗБІЛЬШЕННЯ БІОРІЗНОМАНІТТЯ В УРБАНІЗОВАНИХ ЕКОСИСТЕМАХ УКРАЇНИ

У статті представлені способи збільшення біорізноманіття у міських екосистемах України, серед яких відновлення зелених зон, збереження екосистем міста та ін.

Ключові слова: біорізноманіття, міськіекосистеми, біота.

И. Сергеева

Институт зоологии им. И. И. Шмальгаузена НАН Украины

СПОСОБЫ УВЕЛИЧЕНИЯ БИОРАЗНООБРАЗИЯ В УРБАНИЗИРОВАННЫХ ЭКОСИСТЕМАХ УКРАИНЫ

В статье представлены способы увеличения биоразнообразия в городских экосистемах Украины, среди которых восстановление зеленых зон, сохранение экосистем города и др.

Ключевые слова: биоразнообразие, городские экосистемы, биота.

Biodiversity protecting and preservation is the important problem because in connection with anthropogenic influences on natural ecosystems many species is disappearing. Normally, the ecosystem can withstand strong anthropogenic pressures due to the possibility of self-control, self-preservation and maintenance of its species composition and rebalancing of populations of many species interacting in biocenoses and, in general to maintain functional stability. But with growth and development of large cities in the vast territories the sustainability of ecosystems was sharply declined. Reduced species diversity of plants and animals in urban ecosystems drastically disrupted the natural mechanisms of regulation biocenoses. It is known that the more diverse views presented by each group, the more stable the ecosystem as a whole, thanks to the interchangeability of species.

The trophic attitudes between species have special values for normal homeostasis of ecosystems. The diversity of species determines the stability of biocenoses due to abundance of trophic chains, the necessary for transformation and destruction of organic matter of the biosphere. In natural ecosystems the biota supports a balance between production and destruction of organics. But in urban areas the processes of environmental degradation is catastrophically increasing. We know that climate and biotic component of the urban environment is very differing from natural ecosystems. Cities that have historically created on the field of natural ecosystems, in some areas preserved the islets of living nature in the form of park areas or simply undeveloped land. At such sites, biota largely replenished from the surrounding city environment. Therefore condition of the biocenoses in suburban line plays the extremely important role in maintenance of city ecosystems. It is necessary to enrich connatural ecosystems symbiosing around the city, to reduce a degree of their degradation and pollution by urban wastes. The modern city represents an unstable artificial ecosystem for which maintenance the constant care of the person is necessary. The special role in cities is played by green regions promoting conservation of a diversity of aboriginal species of animals and plants. Therefore the main task of ensuring normal living of the population in urban conditions is the restoration of green areas, which clean the air basin, reduce the effect of increased urban temperatures and employees of food and shelter for animals.

In modern conditions in cities are massive replacement of native species and introduction of exotic species. As a result is used only a few species of woody plants, which leads to a dramatic reduction of biodiversity and to forming the unstable fragile natural ecosystem with few species. Directional and accidental introduction of the resettlement adventive species also violate the established functional relationships between the populations in biocenoses and sharply reduce their resistance. In the green areas of cities with adventive plant species appear their pests, often yielding dramatic flare size, distributed pathogens of animals and humans. The large cities are generally characterized by a variety of natural systems and green areas, which gives rise to a large number of ecological niches. This is created normal conditions for increasing biodiversity and the existence of the species composition of flora and fauna of cities can be quite rich. Such diversity is ensured not only by native species, but also a large number of exotic species, accidentally or purposefully brought by a man for a long history of cities as places of mass resettling of people. Therefore, introduced species, along with native species, play an important role in urban biocenoses. Status of-perennials in the city-depends on the degree of compaction and soil pollution, air quality, water availability. In the maintenance of green areas at cities the birds and insects particularly important roles are played. They regulate the number of harmful plants invertebrates, provide pollination and the resettlement of their seeds and fruits. Studying the dynamics and mechanisms of adaptation of insects to the urban conditions showed that it is necessary to take care of the maintenance of their habitat in a state close to their natural conditions. In this case the city should maintain or restore essential habitat types, to ensure their conditions for nesting. Need to restore native species of vegetation and protected natural areas still left, which can not be replaced by artificial ones, because the last usually is not giving shelter and fodder for animals. In parks and squares should stop mowing flowering wild plants, as this will remain without food and die many kinds of butterflies, bumblebees and other useful insects. Necessary to create conditions for the settlement and artificial breeding in parks cities some of the most important pollinators of flowering plants, such as representatives of the superfamily Apoidea, in particular the genera Osmia, Megachile, Bombus, which simultaneously increases the diversity of wild flowering plants.

Надійшла до редколегії 08.12.10

ЕКОЛОГІЧНЕ ҐРУНТОЗНАВСТВО

UDK 631.4

A. P. Travleyev, N. A. Bilova

SCIENTIFIC PRINCIPLES OF FOREST SOIL BIODIVERSITY RESEARCH

O . Gonchar Dnipropetrovsk National University

Fundamental soil properties defining their genetic biodiversity in compliance with the types of biogeocoenotic systems are stated.

Key words: soil, biodiversity, biogeocoenotic systems.

А. П. Травлеев, Н. А. Белова

Днепропетровский национальный университет им. О. Гончара

НАУЧНЫЕ ПРИНЦИПЫ ИССЛЕДОВАНИЯ БИОРАЗНООБРАЗИЯ ЛЕСНЫХ ПОЧВ

Излагаются основные свойства почв, которые определяют их генетическое биоразнообразие в соответствии с типами биогеоценотических систем.

Ключевые слова: почва, биоразнообразие, биогеоценотические системы.

А. П. Травлєєв, Н. А. Білова

Дніпропетровський національний університет ім. О. Гончара

НАУКОВІ ПРИНЦИПИ ДОСЛІДЖЕННЯ БІОРІЗНОМАНІТТЯ ЛІСОВИХ ҐРУНТІВ

Наводяться основні властивості ґрунтів, які визначають їх генетичне біорізноманіття у відповідності до типів біогеоценотичних систем.

Ключові слова: ґрунт, біорізноманіття, біогеоценотичні системи.

Forest biogeocenoses passing through natural selection have perfect structural and functional arrangement, ensuring exchange material-energy processes and self-regulation of living creatures' biodiversity in ecosystem. Eventually integrity of biodiversity provides persistent biological cycle inherent in ecosystem.

Trophic structure and trophic function are presented in ecological pyramid form, the base of it is the first level – the level of producers; phytophages and zoophages of different order form the following levels.

Consortiums work on the principle, where multiplicity of pyramids reflected complex net of consortium relations of different types and levels form eventually synthetic integrated ecological pyramid characterizing biogeocenosis with its cycle of matters and energy flow.

Biodiversity of organisms occupying certain ecological (trophic) niche provides functioning of system. Sharp reduction of specific diversity leads to destruction of trophic relations, ecological niches, to impoverishment of biogeochemical exchange, to degradation of ecosystem and finally to collapse and death of biogeocenosis system.

Ch. Darvin told about biodiversity in "Origin of species".

For the argument of biological diversity of organisms origin Ch. Darvin used different breeds of animals and plants and showed that natural selection sequent of struggle for existence can only act for the benefit of the orgaism. "But to fully understand the action of natural selection we need to imagine, if possible, a complete picture of the universal struggle between the organic beings." (Timiryazev, 1905, p.128)

Biodiversity issues were studied by N.I. Vavilov (1921, 1931) in his classical works "Linnean Species as a system" and "The law of homology series in genetical mutability". Species composition reveals quite clearly the marks of parallelism in genetical mutability of allied species, allied generations, within the whole families.

Therefore, the basic rightness defining hereditary structure of Linnean species, its system N.I. Vavilov named "the law of homology series". Linnean species (Komarov, 1927) is a morphological system multiplied by geographical definiteness.

Linnean species, by definition of N.I.Vavilov, is an isolated complex mobile morphophysiological system connected in its genesis with certain environment and area, complied the law of homological series in its intraspecific genetical mutability.

Complex biogeocenosis system (type of forest biogeocenosis) is formed of species which correspond to ecotypes – groups of biotypes within the same Linnean species united near the hereditary constant characters and adapted to concrete conditions of habitation. Environment, by Vavilov, may further or destroy the development of species system. In consortium system subject to conditions of habitation, to anthropogenic press level on the basis of homological series the colossal form variety could be recognized, thousands of new types, races, unknown to science, could be discovered and have great practical interest. And, finally, the most interesting fact is geographism.

It is known that the position in conditions of certain climatic zone is determined by ecotope – type of habitat. Hence the zonality impact on biodiversity of plants and animals species occurs. S. A. Direnkov, V. N. Fedorov, C. O. Grigoryeva (1981) established, that species diversity of plant associations of aboriginal taiga spruce forests is joined at first with trophic habitat conditions, then – with variability of ecological conditions and, finally, with edificatoric characteristics of certain species in basic layers of cenoses. When we question inevitability of forest podzolic soil formation – we take into account the geographism, geographic specificity. The truth is clear: the plant impact on the soils is not biogenic, but bioclimatogenic (Zonn, 1964). New generated paradigm in soil science and biogeocenology: properties ← processes ← factors, when the researcher examines the influence of factors through processional block (blackbox), which is controlled by ecological system developing in certain physiographic zone environment, is a "cornerstone" of ecology, biogeocenology and nature conservation. Here the resources and properties of structural-functional organization of biogeocenosis, its exchange of materials and energy are appeared. Mentioned consortium, structural-functional formations in nature first were developed by V.N.Beklimishev (1951) and L.G.Ramensky (1952).

Developing the ideas of consortium biological diversity in biogeocenosis T.A.Rabotnov (1973), V.V.Mazing (1976) suggested the scheme of consortium ctructure. Consortium associates organisms – consorts, joined in their activity with certain autotrophic non-epiphitic plant-determinant.

It is known that structural-functional organization of biogeocenosis is formed of spatial and functional (Dilis, 1964; Byallovich, 1973; Manuel Angel Duenas Lopes, Yose Vanuel Recio Espejo.- 2000). Studying biodiversity we analyse vertical structure – biogeohorizons (laterals, radials, biogeomasses) and horizontal (parcels, catenas, etc.).

Functional structure of biogecenosis is presented by consortiums. Consortiums and usable by organisms constituent stagnant environment could be considered as primary biostagnant unit, composing biogeocenoses (Rabotnov, 1974). In consortiums the groups of species are concentrated. They are formed as a result of conjugated evolution, consisting of coenotic population of autotrophic plant and of dependent on it organisms, generally of trophically dependent heterotrophs. It should be noted that conjugacy, by A.A.Uranov (1931), is a parallel change in quantity of two species in the same cenosis. He recognized: negative conjugacy, positive, two-figure and indifferent, and he also established competitive conjugacy.

Structural-functional organization of different life forms generates biological diversity of its components, which is determined by heredity, variability, natural selection defining "appropriateness" which ensure ecological accordance of organisms to habitat conditions.

Unfortunally scientific-and-technological advance does not always develop in a balanced manner sparing the interests of natural environment, preserving its multiform system organization. When we suggest fastness of forest biogeocenosis, we mean the fastness, vitality of its species biodiversity, which provides functional life activity of all holocoenotic system, of soil and biogeocenosis.

When the destructive factors (lack of care, ungrounded cuttings, overpasturing, fires, underfloodings, pesticide poisoning, etc.) influence on a forest biogeocenosis, ecological niches are being destroyed, the trophic relations are being interrupted, species composition is decreasing. Monocoenosis (Belgard, 1971) replaced by amphicoenosis, in which the divergence of cycles is happened (Sibirtsev, 1914).

Here two or sometimes several types of matter cycles and energy flow are crossed: forest and steppe, steppe and semidesert; in other cases - semidesert and desert, forest and marsh, meadow and saline, etc. Ecological pyramids, biological matter cycle become deformed, go to ruin. Former biogeicenoses together with their soil are replased with new ecosystems, extrinsic for steppe nature.

Under optimal species composition of biota forest associations and soils, rich in their diversity, are formed. Forest soils are the most interesting; they have perfectly unique biogeochemical and classification properties, worthy of recording in Red data book of soils. Their biological diversity appear on kingdom, division, association, family, type, subtype, generation, species, variety, rank levels (Tichonenko, 2001).

The processes of desertification (other destructive phenomena) reduce species diversity of forest associations and the diversity of forest steppe zone soils where the manifestation of type, subtype, generic features concentrates. Forest soils are divided into groups according to depth of humus horizon, humus content, leaching degree, alkalinity, salinization, destruction, eroding, depth of carbonate bedding, groundwater level.

Desertification deforms characteristics, peculiarities of evolution and genesis of forest biogeocenosis, created over a period of long history of its existence.

Spesial meaning we give to works of N.A.Dimo. He was one of the first who discovered forest chernozem in forests of Moldavia.

Our long-term researches (Belgard, Zonn, Karpachevsky, Krupenikov, Travleyev, Bilova and others) show clearly, that forest vegetation does not have fatal inevitability to podzolize the soils. Accumulation of humus and cindery matters is inherent for forest as well as for steppe vegetation. Quite interesting information K.B. Novosad (2001) adduces in his works. He discovered and corroborated not only the absence of degradation processes under the forest vegetation in wooded steppe, but also its positive role that set conditions for forest chernozem formation under forest canopy.

Protection of biota and soils biological diversity is dictated by necessity of Ukrainian natural environment preservation. Generated biological diversity of forest soils in steppe is a great national heritage. It is known how excited was V.V.Dokuchaev when created (with the help of V.I.Vernadsky) Russian section in Paris, where for the first time the soils of then Russia, chernozems in the first place, were presented. In October 1900 V.I.Vernadsky reported from Paris that on the exhibition the collection of soils got a gold medal. Dokuchaev obtained the world recognition of his genetic soil science.

At present, when 118 years passed after the appearance of Docuchaev's Russian chernozem in the world, considerable negative changes happened in soil cover of steppe zone of Ukraine and Moldova. Once the curator of V.P.Viliams Soil Museum of K.A.Timirjazev Agricultural Academy – N.P.Kolpenskaja (disciple of V.P.Viliams) – persuaded us in necessity of ravine forest chernozem samples delivery for replenishment of museum collection. In many museums of Ukraine there are collections of soils of our country. But even the most perfect keeping of soils, delicate herbarium could not be like a natural soil and plant cover of a region. It could be only a witness of former flora and vegetation as monitoring value for ecologists.

It is necessary to pay attention to preservation of biological diversity of soils, plant species, animals, microorganisms straight in nature. Conservation of unique worldwide famous Samara forest is sacred duty of steppe Dnieper residents.

In Samara biospheric station of DNU by Cabinet Council of Ukraine the wildlife preserve is established with the aim of conservation of biological diversity of ravines and small woods, floodplain forests, meadows, marshes, lakes Samara region, forest and forest-improved chernozems.

Only in Samara area we discovered 111 forest associations worthy of recording in green book of forest associations and more than 240 soil individuals which are of great historical-geographical and genetic-evolutional interest.

Uniqueness of biological diversity of forest associations and soils consists is in the fact that ravine forests, growing in steppe zone with peculiarity of water deficiency, being under the cross influence of other environment factors, form types of forest and soil of great biological potential. Methodological base of steppe forest biogeocenoses restoration and preservation is to direct scientific and practical forces for conservation for future generations still extant unique forest associations and forest chernozems, for ability not to allowed the destruction of consortiums, trophical pyramides, biological cycles, to prevent desertification of natural environment of our region.

It is known that as early as 1989 ecological programme of U.N.O. (UNEP) was the initiator in preparation of global Convention on biological diversity. In 1992 in Rio (de) Janeiro (Brasil) the Convention was accepted on the conference of U.N.O. on environment and development. In Constitution of Ukraine nature and environment conservation issues are elucidated in 9, 13, 16, 66 articles.

Convention is ratified by Supreme Council of Ukraine on November, 29th 1994.

Biological diversity, its preservation has not only conservation aspect, but social, connected with mentality of Ukrainian people, with its history and fortunes of future generations.

REFERENCES

Адерихин П. Г. Влияние лесной растительности на черноземы П. Г. Адерихин, А. Л. Бельгард, С. В. Зонн, И. А. Крупеников, А. П. Травлеев / Русский чернозем. 100 лет после Докучаева. – М. : Наука, 1983. – С. 117-126.

Белова Н. А. Лес и степные почвы / Н. А. Белова, А. П. Травлеев. – Д. : ДНУ, 2000. – 345 с.

Бельгард А. Л. Степное лесоведение / А. Л. Бельгард. – М. : Лесная промышленность, 1971. – 335 с.

Бяллович Ю. П. Системы биогеоценозов / Ю. П. Бяллович // Биогеоценотические основы теории системы лесов. – М. : Наука, 1973. – С. 37-47.

Вавилов Н. И. Закон гомологических рядов в наследственной изменчивости / Н. И. Вавилов // Сельское и лесное хозяйство. – 1921. – № 1-3. – С. 84-99.

Вавилов Н. И. Линеевский вид как система / Н. И. Вавилов // Тр. по прикл. бот., ген., и сел. – 1931. – Т. XXVI, вып.3. – С. 109-134.

Дарвин Ч. Происхождение видов путем естественного отбора / Ч. Дарвин // Сочинения. Т. 3. – М. ; Л. : Изд-во АН СССР, 1939. – 832 с.

Димо Н. А. Почвы Молдавии, задачи изучения и главнейшие особенности / Н. А. Димо. – Кишинев : Картя Молдовеняскэ, 1958. – 24 с.

Зонн С. В. Высокогорные лесные почвы восточного Тибета / С. В. Зонн. – М. : Наука, 1964. – 235 с.

Зонн С. В. Географо-генетические аспекты почвообразования эволюции и охраны почв / С. В. Зонн, А. П. Травлеев. – К. : Наук. думка, 1989. – 220 с.

Зонн С. В. Алюминий. Роль в почвообразовании и влияние на растения / С. В. Зонн, А. П. Травлеев. – Д. : ДГУ, 1992. – 224 с.

Мазинг В. В. Что такое структура биогеоценоза / В. В. Мазинг // Проблемы биогеоценологии. – М. : Изд-во Наука, 1973. – С. 148-156.

Медведев В. В. К вопросу об использовании баз данных в агропочвоведении / В. В. Медведев, Т. Н. Лактионова и др. / Вісник ХДАУ, серія «Грунтознавство, агрохімія, землеробство, лісове господарство». – 2001. – № 3. – С. 79-82.

Новосад К. Б. Еволюція чорноземів типових глибоких південно-східного Лісостепу України під різними фітоценозами / К. Б. Новосад / Вісник ХДАУ : зб. Нук. пр. / Харк. Держ.аграр. ун-т. – 2000. – № 1. – С. 143-153.

Работнов Т. А. Некоторые вопросы изучения почвы как компонента биогеоценоза / Т. А. Работнов // Вестник МГУ. – 1974. – № 3. – 1974. – С. 10-18.

Сибирцев Н. М. Почвоведение / Н. М. Сибирцев. – СПб., 1914. – 504 с.

Тимирязев К. А. Чарльз Дарвин и его учение / К. А. Тимирязев. – М. : Типо-литография Т-ва И. Н. Кушнеров и К, 1905. – С. 128-129.

Тихоненко Д. Г. Про класифікацію грунтів України / Д. Г. Тихоненок / Вісник ХДАУ, серія "Грунтознавство, агрохімія, землеробство, лісове господарство. – 2001. – № 3. – С. 33-39.

Уранов А. А. О сопряженности компонентов растительного ценоза / А. А. Уранов // Уч. Записки Моск. госуд. педагог. ин-та. – 1931. – С. 59-85.

Шеляг-Сосонко Ю. Р. Концептуальні засади наукового розуміння біорозмаїття / Ю. Р. Шеляг-Сосонко, І. Г. Ємельянов / Конвенція про біологічне розмаїття: громадська обізнаність та участь. – К., 1997. – С. 11-23.

Duenas Lopes M. A., Recio Espejo J. M. Bases ecologicas para la restauracion de los humedales de La J anda (Cadiz, Espana). – Servicio de Publicaciones Universidad de Cordoba, 2000. – P. 433-445.

Надійшла до редколегії 08.12.10

UDK 574.4:631.4

N. K. Chartko, P. V. Zhoomar, A. A. Karpichenko

GEOCHEMICAL STRUCTURE LANDSCAPES AND SOILS

Belarusian State University

Different types of lateral and radial geochemical structures have been considered in the framework of structural approach. The adduced technique of the geochemical diversity assessment is based on the account of numerous combinations of geochemical structures within elementary technogenic landscape. Their connection with landscape and biological diversity has been considered in the article.

Key words: landscape, geochemical structure, diversity.

Н. К. Чертко, П. В. Жумарь, А. А. Карпиченко

Белорусский государственный университет

ГЕОХИМИЧЕСКАЯ СТРУКТУРА ЛАНДШАФТОВ И ПОЧВ

В рамках структурного подхода рассмотрены латеральные и радиальные геохимические структуры. Приведенная методика оценки геохимического разнообразия основана на учете множественных комбинаций геохимических структур в пределах элементарного техногенного ландшафта. В статье рассмотрена связь между ландшафтным и биологическим разнообразием.

Ключевые слова: ландшафт, геохимическая структура, разнообразие.

М. К. Чертко, П. В. Жумар, О. О. Карпиченко

Білоруський державний університет

ГЕОХІМІЧНА СТРУКТУРА ЛАНДШАФТІВ ТА ҐРУНТІВ

У межах структурного підходу розглянуто латеральні та радіальні геохімічні структури. Наведена методика оцінки геохімічного різноманіття ґрунтується на врахуванні чисельних комбінацій геохімічних структур у межах елементарного техногенного ландшафту. У статті розглянуто зв'язок між ландшафтним та біологічним різноманіттям.

Ключові слова: ландшафт, геохімічна структура, різноманіття.

European landscapes are permanently exposed to the intensive geochemical technogenic load owing to transborder and regional pollutants. They are transformed into oxides of elements with different toxicity level. Elements are concentrating in landscapes, carrying out from them or redistributing within their borders due to natural conditions, processes and geochemical barriers. Thus geochemical structure forms by mentioned factors. It may be an indicator of the landscape contamination level. We use it for the establishment of geochemical diversity of landscapes.

OBJECTS AND METHODS

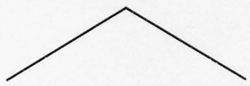
Geochemical structure is a regular lateral and radial distribution of chemical elements within landscape geochemical system and caused by their differentiation under the influence of external and internal migratory factors. Geochemical structure consists of radial and lateral structure, which characterize vertical (R-analysis) and horizontal or slope (L-analysis) redistribution migratory vectors of matter in landscapes (Chartko, 1981).

Owing to the absence of general definitions of different geochemical structures and their difficulty we developed primary concepts of structures kinds with the objective of systematization of the information about structural geochemical peculiarities of different landscapes. It allows describe and estimate diversity of landscapes and their technogenic transformation (tab. 1).

We have selected five type of lateral structures within landscape geochemical profile: ascended structure is differed by the increasing of element content within the catena from the top to the bottom; descended structure is identified by the reduction of element concentration; depressive structure is distinguished by low element concentrations in the middle part of the slope and its growth to the top and to the bottom; spike structure, conversely, has high amounts of element concentration in the middle of the slope, which are decreased to the top and to the bottom and uniform structure doesn't reveal any significant changes of concentration within the profile. The leading feature of radial structure identification is a set of regularities of chemical elements distribution by soil layers (tab. 2).

Table 1

The classification of lateral geochemical structure of landscapes

Kind of structure	Peculiarities of elements distribution	Structure form
Ascending (rising)	The element concentration increases from eluvial landscapes to superaqual	
Descending	The element concentration diminishes from eluvial landscapes to superaqual	
Depresive	The element concentration diminishes from eluvial landscapes to transeluvial and increases again to superaqual	
Peak-looked	The element concentration increases from eluvial landscapes to transeluvial with following decrease to superaqual	
Uniform	The element concentration is equal within catena	

There are following types of radial structures: uniform (chemical elements are distributed equally); humic (accumulation has occurred in a humic soil layer); humic-illuvial (accumulation has occurred in humic and illuvial layers); eluvial (elements has concentrated in humic and eluvial layers); eluvioilluvial (both eluvial and illuvial layers concentrate chemical elements) and lessivage structure is differed by leaching of elements to the lower layers with gradual concentration growth with the depth, i.e. bedrocks concentrate element more then overlying soil layers.

We shell consider the estimation procedure on the example of secondary fluvioglacial landscape of the Republic of Belarus. Its catena presented on the fig. 2 was built in the central part of the counry. This genus of landscapes is most common for the Belarusian ridge and Polessye. Their forming is connected with the activity of melted glacial waters. The sedimentation of anisomerous sands with gravel and pebble matter had been occurred. They covered by fluvioglacial loamy sands and loess-type loams. Their thickness is reached about 0,3–2,0 m.

Absolute altitudes are come to 150–190 m with relative excesses about 2–5 m. The relief is wavy, sometimes is flat or flat-wavy with separate hills achieving 5-7 m in height. Waterlogged depressions with lakes and shallow gullies have a subordinate significance. Sod-podzol loamy sandy and sandy soils are dominating in such landscapes. Surface wash is expressed weakly. Pine forests are prevailing on sandy rocks in dry places.

Arable lands have replaced deciduous forests with spruce, oak, lime-tree, somewhere with hornbeam and small-leaved species (birch, aspen andalder-tree). Different types of grasslands are spread in depressions (Klitsunova, Schstnaya, 2002). The share of arable lands is not exceeding 45% and the share of forests is varied from 20% to 30%.

Biogeochemical barrier is a basic in considering landscapes, because acidic and subacidic reaction of soils accelerates the transfer of chemical elements into mobile form and their carrying-out into local waterways. Redox conditions are changing more sharply and have an influence on the accumulation or on the acceleration of migratory processes for dome elements with changeable valency.

Table 2

The classification of radial geochemical structure of landscapes

Uniform	The element concentration is similar in all soil layers	
Humic (humic -accumulative); organogenic (for peat soils)	Accumulation of element in a humic (peat) soil layer	
Eluvial	Accumulation of element in an eluvial soil layer	
Illuvial	Accumulation of element in an illuvial soil layer	
Humic-illuvial	Accumulation of element in an illuvial and a humic soil layers	
Humic-eluvial	Accumulation of element in a humic and an illuvial soil layers	
Eluvioilluvial	Accumulation of element in an eluvial and an illuvial soil layers	
Lessivage or pseudolessivage (for peat soils)	Accumulation of element in lower soil layers	

RESULTS AND THEIR DISCUSSION

Lateral differentiation of chemical elements in secondary fluvioglacial landscape is considered on the example of mentioned catena. Superficial fluvioglacial coherent and mellow loamy sands are lying down on the substrate of fluvioglacial coherent and mellow sands with gravel and pebble matter. There are crops of barley in eluvial and superaqual landscapes of the catena. Sod-podzol sandy soils are combining with sod-podzol bogged soils (fig. 1). The thickness of loamy sand increases from 30 cm in eluvial landscapes to 60 cm in superaqual landscapes.

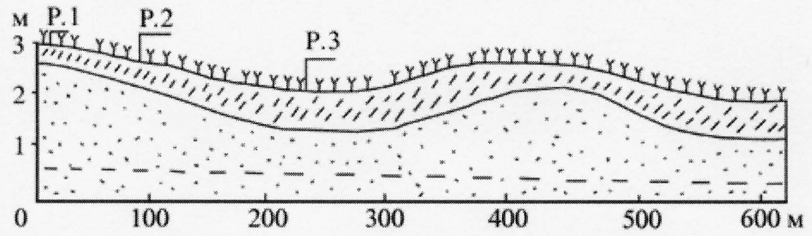
Lateral differentiation of chemical elements in soil catena is expressed weakly for major part of them because of slopes are slightly flat with relative heights 2–3 m. It is connected with the activity of biogeochemical and agritechnogenic factors.

The concentration of sustainable elements at hypergenic conditions (Si, Al) is not expressed in superaqual and transeluvial accumulative landscapes. Coefficients of local migration 1.0–1.15 are most common for this group of elements.

The monotonic accumulative type of lateral coupling is characteristic in conjugate series of facies for secondary fluvioglacial landscapes formed on the monolith superficial rock. Si and Al are excluded, because monotonic eluvial type of composition. They are well-drained. The acidity variability is not sufficient within the catena.

All listed circumstances are a cause of wide spreading of uniform lateral (Na, S, Cu, Co, Mo) and weakly expresses ascending (Ca, Mg, K, P, Mn, Zn, B) geochemical structures. Discending geochemical structure observes for elements sustainable to migration, i.e. Si and Al. Depressive structure is expressed for Fe.

Radial differentiation of chemical elements in secondary fluvioglacial landscapes indicates a presence of humic sorption barrier in a humic layer, which is almost not expressed.



	P.1	L	P.2	L	P.3	L
Particles	13,24	–	15,82	–	18,29	–
pH in KCl	5,45	–	2,45	–	3,10	–
Humus, %	2,30	–	5,56	–	5,63	–
Elements, %,						
Si	46,92	1,0	45,33	0,92	44,81	0,95
Al	3,12	1,0	2,90	0,99	2,60	0,83
Fe	1,10	1,0	0,92	1,19	1,15	1,04
Ca	0,32	1,0	0,40	1,14	0,52	1,62
Mg	0,26	1,0	0,33	1,10	0,39	1,50
Na	0,31	1,0	0,31	1,02	0,30	0,96
K	1,10	1,0	1,45	1,16	2,15	1,95
P	0,047	1,0	0,053	1,28	0,060	1,46
S	0,073	1,0	0,072	1,40	0,055	0,89
n 10^{-3}, %:						
Mn	37,00	1,0	39,4	1,11	40,34	1,09
Zn	2,40	1,0	2,57	1,15	2,79	1,15
Cu	0,90	1,0	0,99	1,14	0,99	1,01
B	1,92	1,0	1,87	1,12	2,11	1,15
Co	0,60	1,0	0,60	1,38	0,63	1,05
Mo	0,075	1,0	0,077	1,28	0,076	1,04

Fig. 1. **Geochemical profile of secondary fluvioglacial landscape**
P1–P3 – profile numbers within catena, L – coefficient of lateral geochemical differentiation

Agritechnogenesis influences on the radial differentiation weakly because the intensity of its impact within soil catena is equal, the infiltration is similar for all soil profiles. K and P have highest eluvial-accumulative coefficients and caused by the application of fertilizers (tab. 3). Geochemical structures are practically equal for all elementary landscapes.

Transeluvial and superaqual landscapes have the greatest similarity, which have following radial geochemic structures: humic-illuvial (Mg, K, P, S, Mn, Zn, Cu, B, Co, Mo), lessivage (Al, Fe) and uniform (Si) structures. Eluvial landscapes have a similar situation but humic accumulative structure observes for Ca, S, Cu, B, Co, Mo.

The spreading of lateral and radial geochemical barriers is insignificant for secondary fluvioglacial landscape. Humic sorption barrier is dominating. Other types of barriers have a subordinate significance.

Ground waters have been sampled from the profile 3 in superaqual landscape from the depth 130 cm. Their chemical composition is following, mg/l: Si 1,2, Fe 0,015, Ca 26,45, Mg 5,83, Na 2,50, K 3,60, N 0,5, C 65,3, P 0,016, S 8,5, Cl 12,31, Mn 0,025, Zn 0,005, Cu 0,012, B 0,0011, Co 0,009, Mo 0,0012, general mineralization 126,3, pH 5,8. Chemical elements have composed a following regulation of the water migration coefficient decrease: C 1288 > Cl 1214 > S 122 > Ca 52,2 > N 26,3 > Mg 14,4 > Mo 13,5 > Co 13,4 > Cu 12,9 > Na 8,9 > K 1,9 > Zn 1,7 > Mn 0,68 > B 0,54 > P 0,28 > Si 0,019 >Fe 0,008. Such elements as C, Cl, S, Ca, N, Mg are most active migrants in the landscape because a major part of them are bringing in with fertilizes on the background of high solubility of their compounds.

A chemical composition of barley biomass within the conjugate series of facies of secondary fluvioglacial landscape has been determined in samples of eluvial and superaqual landscapes. Total barley biomass in eluvial landscape is averaged to 95,12 centnes/ha at the grain harvest about 28,0 centners/ha. These values for super-aqual landscapes are equal to 100,14 and 30,10 centners/ha correspondingly. As far as general ash level is higher in superaqual landscape consequently concentrations of chemical elements are higher too (tab. 4). However the difference in the contents of chemical elements is not sufficient. Insignificant augmentation of their concentration is caused by higher humification of sod-podzol boggy soils. Geochemical conditions are similar within whole catena, but biogeochemical barrier is expressed better in superaqual landscape.

Biosorption coefficient (Kb) has also similar values and lowers in superaqual landscape excluding Kb of Si and S, which is caused by the difference f soil fertility.

Barley absorbed vastly such elements as N, P (Kb>100). A number of elements are adsorbing moderately K, Ca, Mg,S, Zn, Cu, Mo (Kb =10–100) and Si, Na, Mn, B (Kb=1– 10) are absorbed by barley weakly.

GEOCHEMICAL DIVERSITY

Geochemical diversity may be applied at the establishment of the grade of geo-chemical optimization of natural and technogenic landscapes, their differentia-tion by geochemical specialization, determination of the degree of their stability. Landscape diversity is a basis for the biodiversity preservation, which is considered as variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (The Convention ...).

In this case landscape diversity is considered as an organizing and structuralizing system for the biodiversity realization where connection with its elements supports by flows of matter, energy and information exchange. The key definition at their study is a geochemical structure. Its account in the landscape diversity research may be considered as a basis for the analysis of environment-forming function of landscapes, for a number of ecological assessments and for the solution of applied problems of nature use.

Thereupon we are dealing with structural and functional elements of the diversity. Structural diversity demonstrates how elements of geochemical structure are correlated in spatial and temporal dimensions.

Among sizes and shapes of landscapes, disposition of lower rank units inside of it structural diversity includes a quantity and distribution of different geochemical structures correlated with them. It is concerning to combinations of radial and lateral structures.

Functional diversity is referred to the diversity of ecologically significant processes of migration and accumulation of chemical elements (erosion, deflation, sorption, biosorption etc.). Their spatial and temporal variability determines a geochemical structure balance and a geochemical balance of landscape as a whole.

As far as it is seeing from the fig. 2 (option 1) a diversity reaches a maximum in case of big number of individual geochemical structures at their equal and proportional availability inside of one landscape unit. If one of them is dominating in the presence of insignificant number of others then such diversity is should to be low. Model of low diversity is reflected on the fig. 2 (option 2).

Typical diversity occurs if one or several are dominated at about equal quantity of others. It is seeing on the fig. 2 (option 3).

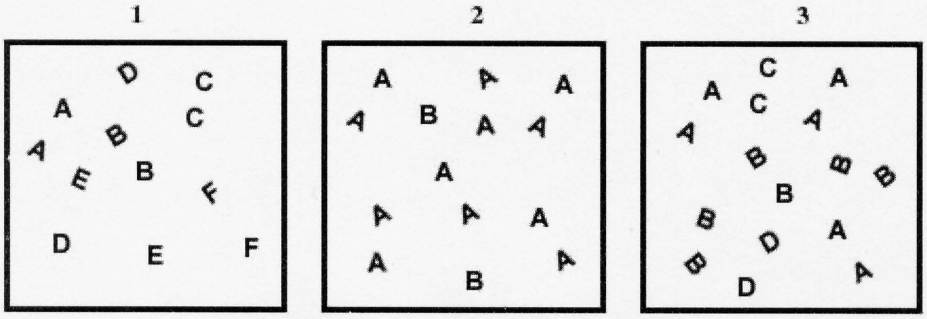


Fig. 2. **Examples of different degrees of geochemical structures**
1 – high; 2 – low; 3 – typical.

A geochemical structure of elementary landscape or estimation results of lower taxonomic level is taking into account during the assessment of diversity at the transition to higher landscape level. Diversity may be low in case of comparison of several elementary technogenic landscapes with identical diversities. As a whole a diversity of estimating landscapes couldn't be higher then diversity of their composing units. If each such elementary division is differed by either the type of structure or the diversity degree even in case of forming of landscape diversity by different units with lower diversity of geochemical structures and these structures are different, then landscape diversity may be high (fig. 3).

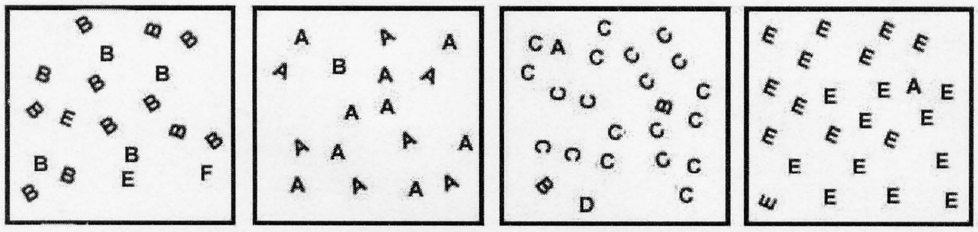


Fig. 3. **The model of high landscape diversity at low diversity of geochemical structures within elementary landscapes**

The main source of the information for the landscape geochemical diverdity analysis is a passport of geochemical structure of landscapes. Given documents are derived from the field information proceeding and presented in a view, which is convenient for following works.

The presence of landscape geochemical catena profile with points of soil profiles, tables of radial and lateral distribution of chemical elements within soil cover inside of considered catena as well as concentrations of chemical elements in phytomass and in waters. A kind of lateral and radial geochemical structure establishes for a one or another taxonomic units on the ground of this passport. Matrixes for the determination of the diversity degree are composed for each elementary landscape within soil profiles and catena. Analogous geochemical structures may be selected for the phytomass (roots, perennial ground-based part, branches and leaves) and for waters depending on the depth of their deposition. The frequency of occurrence for one or another kind of geochemical structure determines after the matrix construction. A diversity degree establishes according to adduced scheme (fig. 2). The example of such matrix is demonstrated on the fig. 4.

A matrix of lateral structure includes a list of following chemical elements: Si, Al, Fe, Ca, Mg, K, P, S, Mn, Zn, Cu, B, Co, Mo. The important thing for the studying of lateral structures diversity is that one geochemical structure is corresponding to a one chemical element within catena.

A process of the estimation of radial structure diversity is more difficult because it is necessary to know concentrations of elements within each soil profile. Chemical elements in the estimative matrix are situated in columns and appropriate soil profiles are in rows. Structural indices of occurred radial structures are input according to tab. 3 for each i-element within each j-profile.

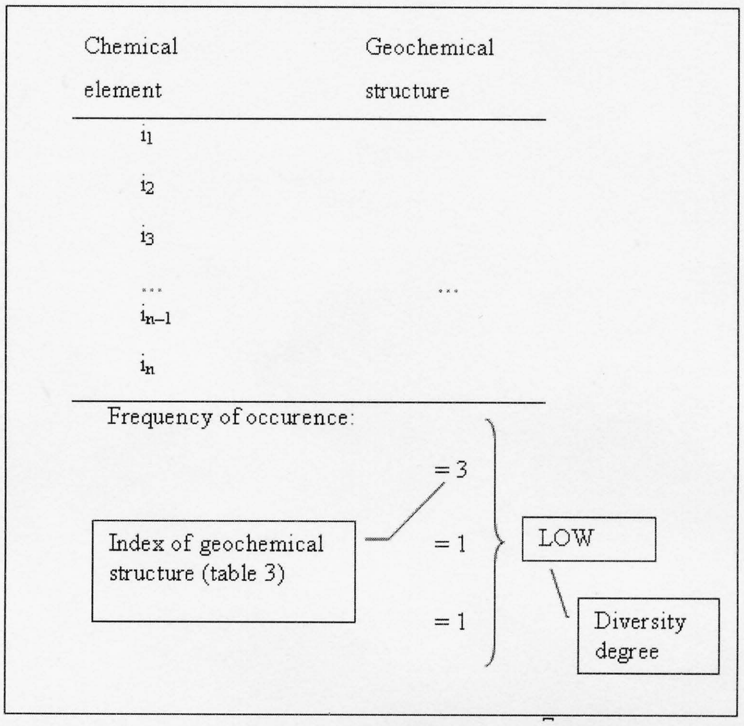


Fig. 4. **The scheme of an estimative matrix of the diversity of lateral geochemical structures**

The frequency of occurrence of individual geochemical structures is differed both for the whole facia (columns) and for each profile (raw). It is possible to assess a diversity of structures on the base of these data for both cases.

A diversity of radial geochemical structure for each chemical element estimates by the frequencies of occurrence of one or another kind of individual geochemical structures of elements and their quantity within soil profiles. As far as seeing from the fig. 6 indices of geochemical structures put down into cells are taken from the tab. 2–3. Thus, individual structure for each chemical element reflects within each profile.

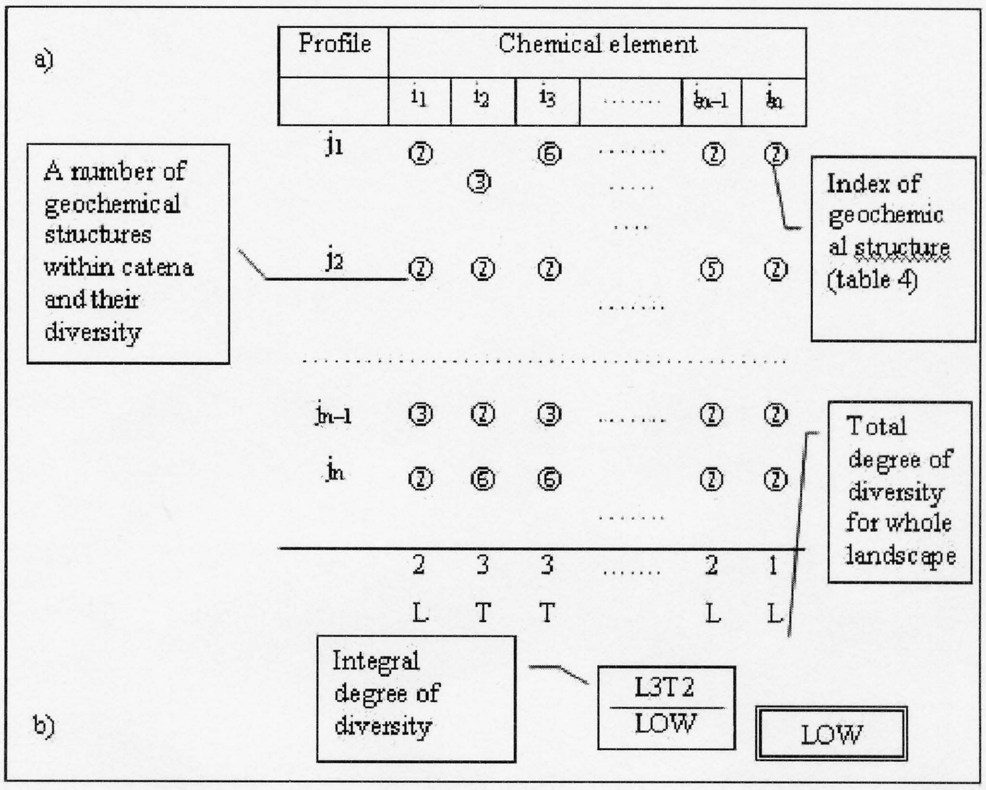
A number of structures in catena indicates in the total record line as far as seeing on the fig. 4 (option a). A degree of diversity is depending on this datum: L – low, T – typical, H – high. The formula of diversity for whole catena is written in the bottom from the right. Frequencies of occurrence of diversity degrees by elements are put down into the numerator and one degree with prevalent frequency is written into the denominator. It is expressed a geochemical diversity for whole catena.

Frequencies of occurrence of different kinds of geochemical structures in each profile are taking into account at the second stage. A matrix of frequencies of occurrence of geochemical structures is constructed as far as demonstrated on the fig. 5 (option b). Profiles are placed in rows and geochemical structures are written in columns. A frequency of occurrence of an appropriate kind of geochemical structure is put down for each profile. The assessment of diversity is proceeding by rows of matrix. A degree of diversity is indicated in the right end of each row of matrix. A degree of diversity for radial structures for a one elementary landscape is given by prevalent element structures within profile. Their frequencies are summarizing in rows (by kinds of geochemical structures) and sums should to be put down in the total record line where prevalent geochemical structure should be selected.

Table 3

Radial differentiation of chemical elements in soils of secondary fluvioglacial landscape according to R value

Elementary landscapes, profile №	Sampling depth from the layer, cm	Particles <0,01 mm	Chemical elements and R value													
			Si	Al	Fe	Ca	Mg	K	P	S	Mn	Zn	Cu	B	Co	Mo
Eluvial landscape with acidic oxidative medium, profile 1	A 5–15	13,24	0,99	0,6	0,9	1,14	1,4	1,37	1,34	1,2	1,3	1,14	1,15	1,2	1,2	1,2
	EB_1, 35–45	8,31	0,98	0,7	0,9	0,9	1,1	1,22	1,1	0,9	1,0	1,10	0,8	0,9	0,7	0,9
	B_2 78–85	6,89	0,99	0,8	1,1	1,0	1,2	1,15	1,0	0,95	1,1	1,0	0,9	1,0	0,9	0,9
	B_3C 130–140	6,32	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Transeluvial accumulative with weakly acidic oxidative gley medium, profile 2	A 5–15	15,82	0,95	0,80	0,7	1,25	1,2	1,4	1,5	1,15	1,35	1,1	1,2	1,3	1,15	1,05
	EB_1 32–40	16,29	0,98	0,85	0,8		1,1	1,2	1,1	1,15	1,26	1,0	1,15	1,12	1,08	1,02
	B_2 63–70	8,91	0,96	0,88	1,2	1,18	1,0	1,03	1,05	1,0	1,3	1,05	1,08	1,05	1,0	1,0
	B_3C 120–130	7,56	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Superaqual with weakly acidic oxidative and reductive gley medium, profile 3	A 5–15	18,29	0,92	0,8	0,8	1,3	1,2	1,45	1,53	1,18	1,4	1,2	1,25	1,32	1,18	1,11
	EB_1 35–45	17,69	0,96	0,83	0,95	1,15	1,18	1,2	1,27	1,15	1,3	1,1	1,05	1,2	1,1	1,05
	B_2 10–80	9,39	0,98	0,95	0,99	1,0	1,02	1,01	1,1	1,03	1,1	1,0	1,0	1,03	1,04	1,0
	B_3Cg 97–105	7,80	1	1	1	1	1	1	1	1	1	1	1	1	1	1



	①	②	③	④	⑤	⑥	⑦	⑧		
j1		3	1			1			→	LOW
j2		4			1				→	LOW
......										
jn-1		3	2						→	TYPICAL
jn		3				2			→	LOW
		13	3		1	3			→	LOW

Degree of diversity

Fig. 5. **Estimative matrix of the diversity of radial geochemical structures**

Thus, we obtained three indices of radial geochemical structure diversity: 1) the diversity of element structures (for separate chemical elements); 2) the diversity of individual structures of elementary landscapes (facies) by soil profiles; 3) the diversity of frequencies of geochemical structures for whole landscape. They should be recorded in tables and map legends in such order as it is presented in the tab. 4, i.e. LLT, LTT, HTT etc.

This is an integral estimative index of the diversity of geochemical structures. It's derived from the results of synthesis of other mentioned indices and indicates a degree of diversity by three parameters simultaneously.

In case of combined estimation of structures total record has a view of fraction where structure is placed in a numerator and an integral parameter of radial structures diversity is put down in a denominator, for example: T/LTT.

Table 4

Combinations of degrees of radial geochemical structures diversity

Diversity of element structures for separate chemical elements	Diversity of individual structures of soil profiles within a facia	Total degree of frequencies of occurrences diversity of geochemical structures for whole landscape (urochishche)	Integral index of the diversity of geochemical structures
L	L	T	LLT
L	T	T	LTT
H	T	T	HTT

Thus the assessment of geochemical structures diversity has been realized in the Republic of Belarus on the level of landscape genera. Its results are reflected in the tab. 5.

Table 5

Landscape diversity of Belarus on the base of geochemical structures

Landscape	Diversity of lateral structures	Diversity of radial structures				Total index of landscape diversity for whole landscae
		Diversity of element structures	Diversity of individual structures of soil profiles	Diversity of frequencies of occurrences of geochemical structures for whole landscape	Integral index of the diversity of geochemical structures	
Hilly-moraine-erosive	L	L	L	L	LLL	L / LLL
Moraine lacustrine	L	H	L	L	HLL	L / HLL
Loess	L	T	T	T	TTT	L / TTT
Secondary moraine	T	T	T	T	T	T / TTT
Secondary fluvioglacial	L	T	L	T	TLT	L / TLT
Alluvial terraced	H	L	T	T	LTT	H / LTT
Nonsegmented with the prevalence of wetlands	L	T	T	H	TTH	L / TTH

REFERENCES

Chartko N.K., 1981: Landscape Geochemistry. – Minsk: Belarusian State University, 1981. 255 pp. (in Russian).

Klitsunova N.K., Schstnaya I.I., 2002: Natural and anthropogenic landscapes of Belarus: classification, structure, territorial distribution. Natural and anthropogenic landscapes. Irkutsk–Moscow. pp. 33–43.

The Convention on Biological Diversity. Convention Text. Article 2. Use of Terms. URL: http://www.cbd.int/convention/articles.shtml?a=cbd-02. – 22.02.2011.

Надійшла до редколегії 16.11.10

UDK 631.4

N. I. Shevyakova

NICKEL PHYTOREMEDIATORY POTENTIAL AND MECHANISMS OF ITS DETOXIFICATION IN PLANTS USING FOR DECONTAMINATION OF SOILS

Timiryazev Institute of Plant Physiology, Russian Academy of Sciences, Russia

Plants have developed various mechanisms that allow them to tolerate soils that are polluted with heavy metals (Ni, Cd, Pb et al). One of their main protective mechanisms is excessive HM chelation by different organic compounds. The aim of this work was the analysis of a possibility to apply polyamines (putrescine and et al) as possible ligands for Ni detoxification and for Ni increasing content in plant biomass applying for phytoremediation of contaminated soils. Again, it was established by us that Ni can induce endogenous accumulation of free polyamines in rape plant (*Brassica napus)* by 4.5 times as compared with control.

Key words: heavy metals, soil, polyamines, chelates, phytoremediation.

Н. І. Шевякова

Інститут фізіології рослин ім. Тімірязєва Російської академії наук, Росія

ФІТОРЕМЕДІАЦІЙНИЙ ПОТЕНЦІАЛ НІКЕЛЮ ТА МЕХАНІЗМИ ЙОГО ДЕТОКСИКАЦІЇ У РОСЛИНАХ, ЯКІ ВИКОРИСТОВУЮТЬСЯ ДЛЯ ОЧИЩЕННЯ ҐРУНТІВ

Забруднення ґрунтів важкими металами (ВМ) представляє велику небезпеку як для культивованих рослин, так і для людини із-за їх високої токсичності. Проблема розробки технології очистки забруднених ґрунтів від ВМ за допомогою рослин-зверхакумуляторів ВМ (Ni, Cd, Pb та ін.), здатних виносити їх з ґрунту з біомасою набуває все більшого значення. Пошук таких рослин ґрунтується на їх здатності акумулювати ВМ, розвиваючи різноманітні механізми знешкодження їх в клітинах. Одним з головних захисних механізмів являється виникнення координаційних зв'язків різних органічних речовин з ВМ, так зване хелатування. В цій роботі проведено аналіз застосування знешкодження нікелю поліамінів (путресцину та інших), які здатні створювати з ним хелати та тим самим знижувати його токсичність й підвищувати акумуляцію Ni в надземній масі. Цей прийом дозволить такі рослини як *Brassica napus* L., *Amaranthus cruentus* L., *Calamagrostis epigeios* L. застосовувати для очистки ґрунтів від Ni за допомогою фіторемедіації.

Ключові слова: важкі метали, ґрунт, поліаміни, хелати, фіторемедіація.

Н.И. Шевякова

Институт физиологии растений им. Тимирязева Российской академии наук, Россия

ФИТОРЕМЕДИАЦИОННЫЙ ПОТЕНЦИАЛ НИКЕЛЯ И МЕХАНИЗМЫ ЕГО ДЕТОКСИФИКАЦИИ В РАСТЕНИЯХ, ИСПОЛЬЗУЕМЫХ ДЛЯ ОЧИСТКИ ПОЧВ

Загрязнение почв тяжелыми металлами (ТМ) представляет большую опасность как для культивируемых растений, так и человека из-за их высокой токсичности. Проблема разработки технологии очистки загрязненных почв от ТМ с помощью растений-сверхаккумуляторов ТМ (Ni, Cd, Pb и др.), способных выносить их из почвы с биомассой приобретает все большее значение. Поиск таких растений основывается на их способности аккумулировать ТМ, развивая различные механизмы обезвреживания их в клетках. Одним из главных защитных механизмов является образование координационных связей различных органических веществ с ТМ, так называемое хелатирование. В настоящей работе проведен анализ применения для обезвреживания никеля полиаминов (путресцина и других), которые способны образовывать с ним хелаты и тем самым снижать его токсичность и повышать аккумуляцию Ni в надземной массе. Этот прием позволит такие растения как *Brassica napus* L., *Amaranthus cruentus* L., *Calamagrostis epigeios* L. применять для очистки почв от Ni с помощью технологии фиторемедиации.

Ключевые слова: тяжелые металлы, почва, полиамины, хелаты, фиторемедиация.

At present, biosphere pollution with heavy metals (HM), nickel in particular, becomes increasingly actual problem. HM are accumulated in air, soil and water rather rapidly and removed from it extremely slowly. Half-life of Pb, Cd and Cu in soil are more than thousand years. HM are one of the most dangerous pollutants for human and for most crops (fig. 1).

on most crops

- **Inhibition of photosynthesis**
- **Disturbance of mineral nutrition**
- **Suppress of growth**
- **Disturbance of water and hormonal status**

on human

- **Cancerogenic and mutagenicity action**
- **Disturbance of metabolism and nutrition**
- **Cytotoxic effect**
- **Action on nervous system**

Fig. 1. **Harmful effect of heavy metals**

However, many species of terrestrial plants could inhabit soil ecotops enriched in HM and accumulate toxic metals in their aboveground organs in high concentration without any signs of damage (Raskin, Ensley 2000). Most of them are Ni hyperaccumulators (from 1.0 to 30 g Ni/kg shoot dry wt). Potencial use of wild-type plants for extracting contaminant metals from polluted soils, as it is called, phytoremediation, has received much attention in recent years (fig.2). Countries in which technologies of phytoremediation are realized: USA, Bulgaria, Spain, Great Britain, New Zealand, China et al.

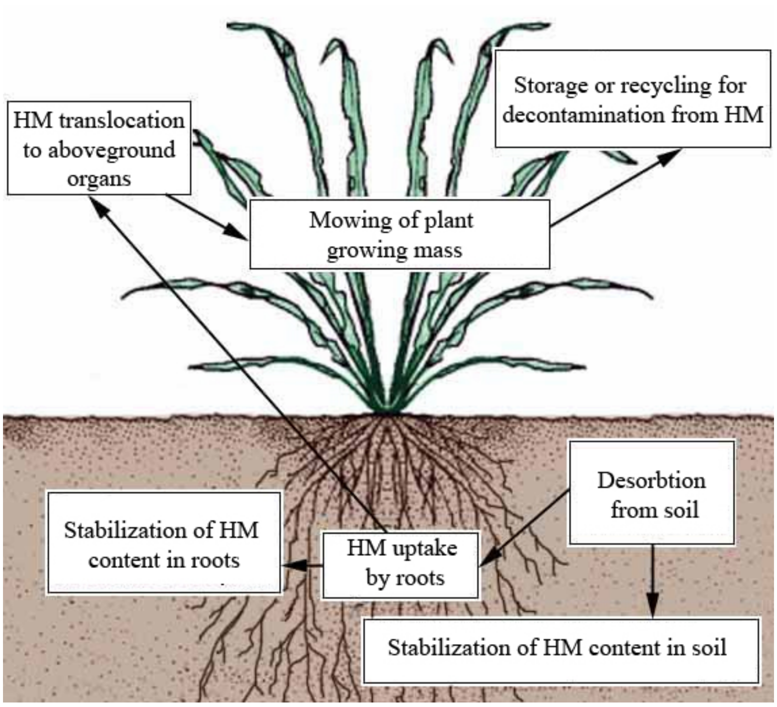


Fig. 2. **Technological scheme of phytoremediation (Prasad, 2003)**

However, the main obstacle for application of natural HM-hyperaccumulators for phytoremediation is their relatively small biomass and low growth rate. Therefore, for efficient phytoremediation it is necessary to select plant species, which are not only capable of HM accumulation but also produce large biomass and have developed various mechanisms of adaptation to HM.

Screening of Ni-accumulating species could be also performed among ruderal plants inhabiting waste buring soils in megapolis. As an example, perennial grass *Calamogrostis epigeios* (L) Roth is capable of Ni accumulation in the aboveground (more than seven hundred mg/kg dry wt) (Madzhugina, Shevyakova, Kuznetsov, 2008) (fig.3).

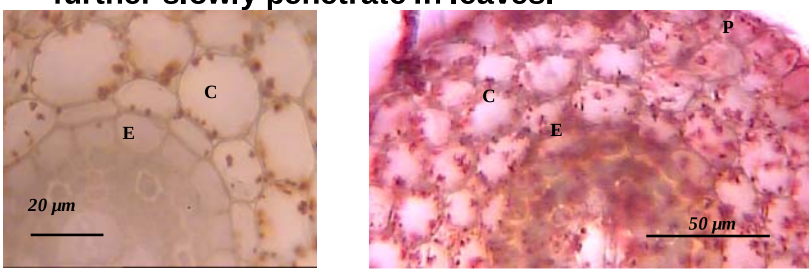
This plant is a typical flora representative in the central climatic zone characterized by a high tolerance to soil pollution. On the polygons for Megapolis Waste *Calamogrostis epigeios* plants produced the monopopulation of high productivity of green mass.

Fig. 3. **Perennial grass *Calamogrostis epigeios* L (wood small reed-grass)**

The main task of our investigations was to characterize plants as *C. epigeios* tolerance to HM on basis of cytological and physiological parameters: hystochemical analysis of Cd, Pb (ditizon) and Ni (dimethylglyoxime) distribution in tissues after seed germination, potencial of seed germination in the presence of HM and so on.

Like other plant species reed-grass (*C. epigeios)* accumulated various metals (Pb and Cd) and especially large amounts in roots (fig. 4).

By means of specific for each metal hystochemical test (Ivanov, Seregin, 2003) was indicated that Cd and Pb were accumulated in the main of cortex and endoderms. The hypothesis provides an explanation for slowly penetration of these metals in conductive vessels and may be further slowly penetrate in leaves.



In presence of 200 µM $Pb(NO_3)_2$ In presence of 200 µM $CdCl_2$

Fig. 4. **Cd and Pb distribution in tissues of *C. epigeios***

However, distribution of Ni in root tissues of this plant indicates that in distinct of Cd and Pb, root endodermis is not a barrier limiting Ni transport into stele and Ni rapidly penetrated in aboveground organs of reed-grass (fig.5).

(C – cortex; P – pericycle; MX – metaxylem; CV – conductive vessel; E – endodermis; Rh - rhizodermis)

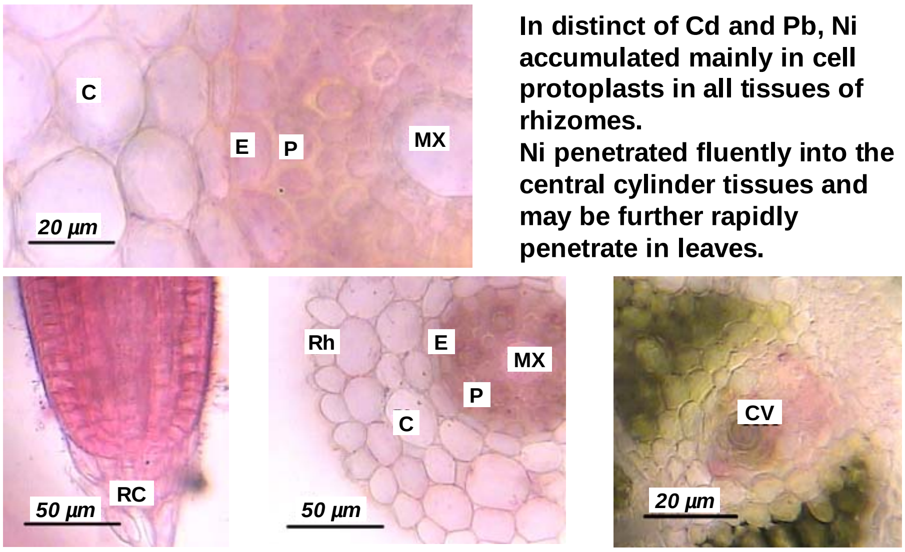


Fig. 5. **Ni distribution in tissues of *C. epigeios***

The assessment of HM action on seed germination of this plant demonstrated their relatively more higher tolerance to Zn and Ni. Thus, seed germinability was not affected by 1 mM $ZnSO_4$, or Ni $(NO_3)_2$ whereas 1 mM $CuSO_4$ and 1 mM Pb $(NO_3)_2$ were more toxic (fig. 6).

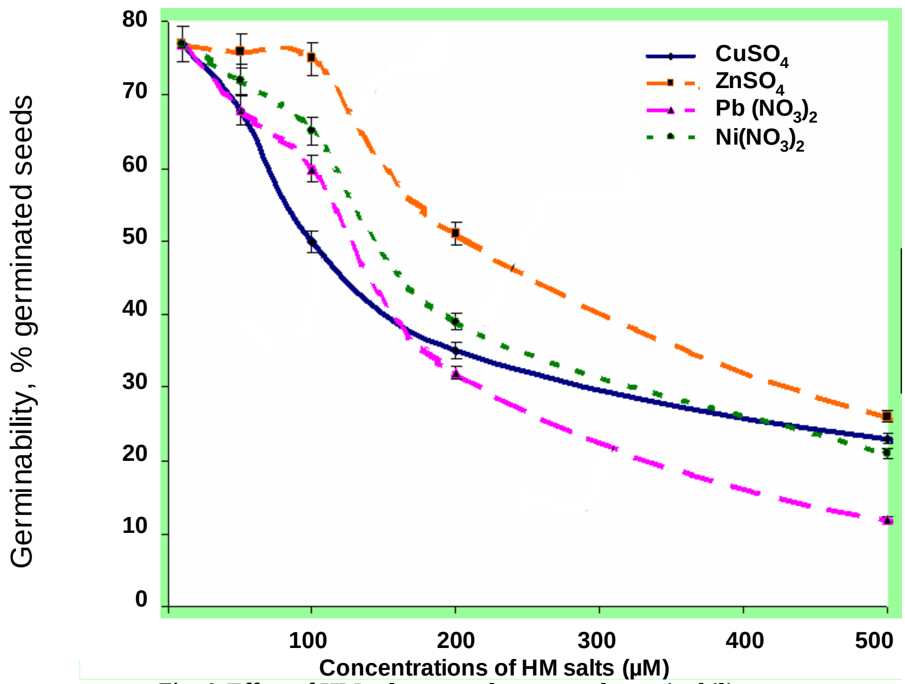


Fig. 6. **Effect of HM salts on reed-grass seed germinability**

On the important characteristics of this plant as a possible phytoremediant could be its capability to accumulate HM in green mass. To assess a possibility for this plant usage for recultivation of polluted soils, it was important to evaluate plant tolerance to mowing and to determine the level of metals removal with mowed plant biomass in plant grown in soil culture in the presence of HM (fig. 7).

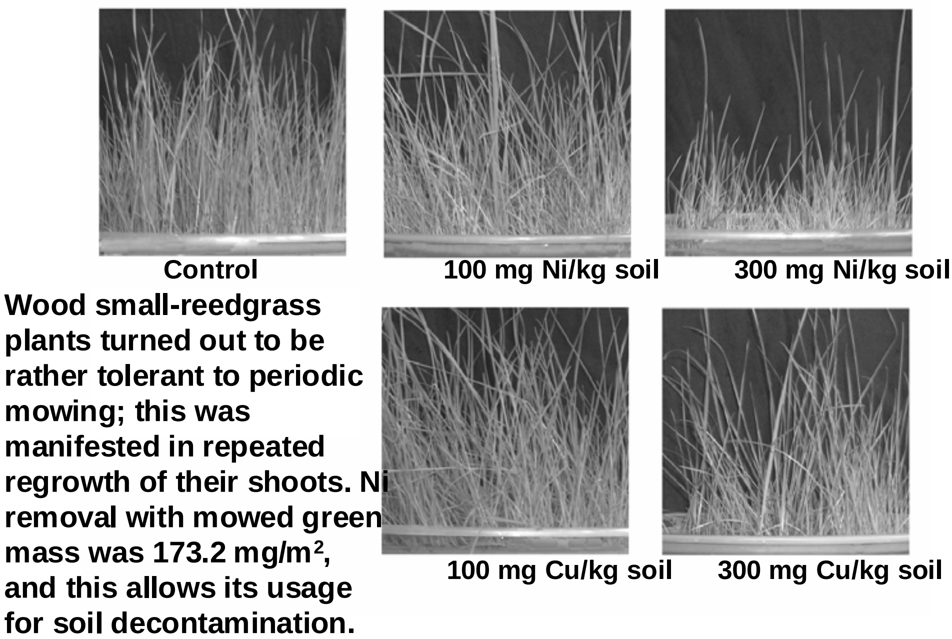


Fig. 7. **Shoot regrowth after mowing of reed-grass**

These data indicate that, at a short-term action of the high Ni concentration in nutrient medium, wood small reed-grass plants turned out to be rather tolerant to periodic mowing. Ni removal with mowed green mass was 173.2 mg/m^2 and this allows its usage for soil decontamination.

Potentials of *C. epigeos* plants for polygon recultivation for megapolis waste in Moscow oblast (Russia) are demonstrated in figue 8.

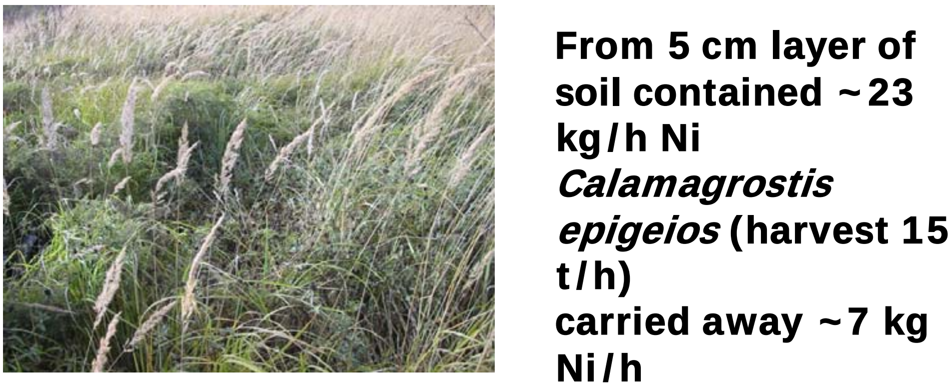


Fig. 8. **Green mass of plants *C. epigeos* periodic mowing on polygons of waste buring soils would result in soil cleaning of Ni for 5-10 years**

Thus, in this work, we performed a search of Ni accumulator among wild ruderal plants inhabiting polygons. However, to apply this plant species as phytoremediant of agricultural lands, it is necessary to produce on its basis new cultivars with a higher efficiency of HM removal and the increased rate of shoot productions.

The main task of further investigations was to characterize

To assess a possibility usage cultivated plants for recultivation of polluted soils, it was important to evaluate not only the level of metals removal with mowed plant biomass but also plant tolerance to HM. Therefore, in the next work we plans for new lines of approaches to phytoremediatory methods.

It is evident from the foregoing equation (Raskin, Ensley 2000) many species of terrestrial plants could inhabit soil ecotops enriched in heavy metals and accumulate these toxic metals in their aboveground organs in high concentration without any signs of damage. Most of them are wild Ni hyperaccumulators and belong mainly to the Brassicaceae family but have relatively small biomass and low growth rate. There are in more than 400 such plant species in the genus *Alyssum*.

For the goal of such plants selection among cultivated crops we have chosen rape plants (*Brassica napus*) (fig. 9). In this connection, we planned to establish upper limit of rape tolerance to Ni during plant vegetative growth and to reveal physiological targets of nickel toxicity. Rape (canola) is not HM hyperaccumulator. However, it can be suitable species for sol decontamination fron Ni due to its genetics (Brassicaceae family) and large biomass (Prasad 2003). Rape is annual oil plant of hybrid origin resulting from spontaneous cross-pollination between cabbage (Brassica oleracea) and field mustard (Brassica campestris), i.e. it is a closest turnip relative. Rape is cultivated in varios countries; it is characterized by a short growth period, great biomass production, and easy acclimation. Yield potential for spring cultivar: 2000 to 2800 $kg.ha^{-1}$, for winter canola – 4400 to 5600 $kg.ha^{-1}$ for central Washington (Hang et al. 2008). Rape is a promising target for agrobacterial transformation aimed the increase in its phytoremediatory potential. It is also widely applied as a biofue (Hang et al. 2008).

Fig. 9. **Rape plants (*Brassica napus* L.)**

Ni accumulation by different leaves of adult rape plants shown in figue 10 A. At 125 µM $NiCl_2$ in medium cotyledonary leaves and young leaves accumulated 150 and 325 mg Ni/kg dry wt, respectively. At 250 µM $NiCl_2$ the content of Ni in young leaves almost doubled, whereas at 500 µM $NiCl_2$, it increased to 1000 mg/kg dry wt. However, in young leaves content of Fe (B) and Cu (C) – essential elements, were reduced. In result of it, chlorosis in leaves was manifested.

Thus, contrasting NI-induced changes in the content of Fe in the leaves of different age could indicate that Ni prevents Fe and Cu uptake by rape plants. This clearly demonstrates the disruption of this plant nutrition with essential metals. Moreover, Ni accumulation in aboveground organs induced oxidative stress and increase the intensity of lipid peroxidation (content of malondialdehyde –indicator of membrane disturbance) (D).

These features do not allow this plants to extract sufficiently high amounts of Ni from contaminated soils. Various biotechnological strategies were developed to overcome these difficulties. One of such technology is application of various plant protective metabolites and low-molecular ligands for HM, enhancing their absorption and long-distance transport over the plant.

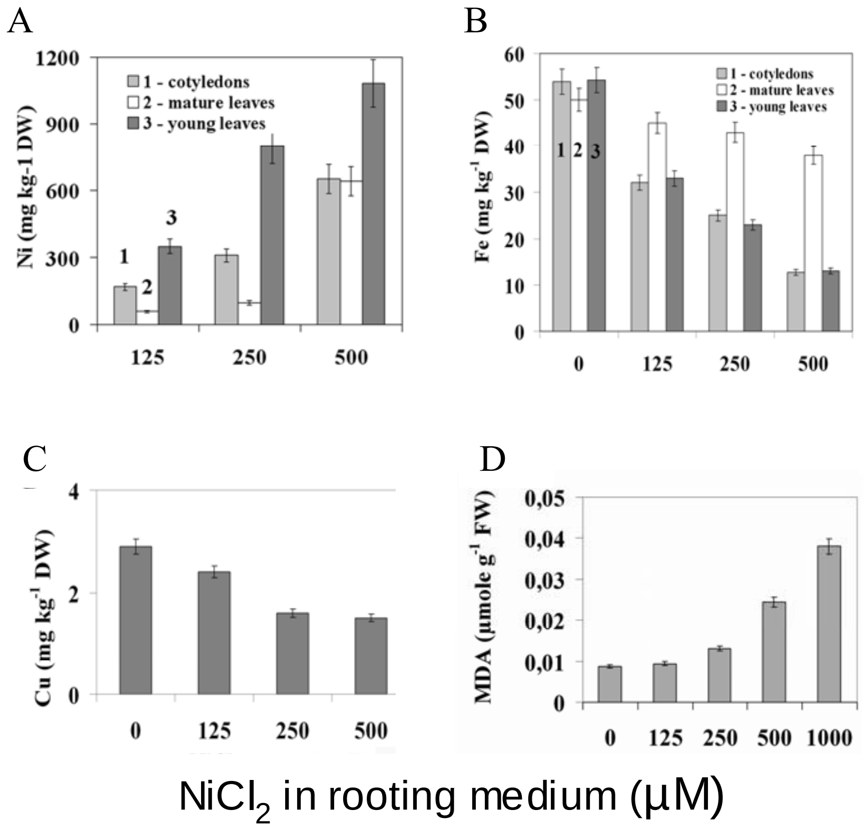
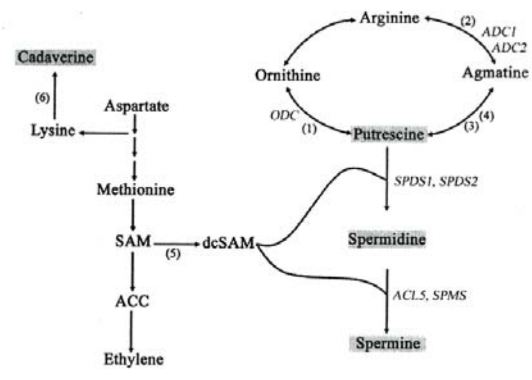


Fig. 10. **Effect of $NiCl_2$ on accumulation Ni, Fe, Cu and MDA**

Various natural low molecular chelators (citrate, oxalate, malate, histidine, and others) and high molecular chelators (phytochelatines, thioneines and so on) can form HM-chelate complex which detoxifies metal and accelerate its movement along root xylem and further to shoots (Shevyakova et al. 2010).

One of chelators, forming Ni—PAs, as showed by Koutensky et al (1995) and others, could be polyamines (PAs). In several studies, a Ni-induced accumulation of universal organic polycations polyamines was observed (Hauschild 1993; Bergmann et al. 2001). Stress-induced polyamines accumulation in plants is known to fulfill a multifunctional protective role against damaging action of various abiotic factors, including HM pollution (Kuznetsov and Shevyakova 2007; 2010).

As known in plants putrescine, spermidine and spermine are most abound polyamines (fig. 11). But the PA metabolic pathways are regulated by a limited number of key enzymes and genes. The main precursor of polyamines are aminoacids of ornitine cicle and S-adenosylmethionine (SAM).



(1) - ODC, ornitine dacarboxylase,

(2)- ADC, arginine decarboxylase,

(3)- agmatine iminohydrolase,

(4)- N-carbomoylputrescine amidohydrolase,

(5)- SAMDC, SAM decarboxylase,

(6)- SPDS, spermidine syntase,

(7)- SPMS, spermine syntase,

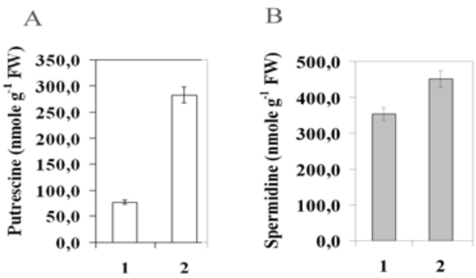
(8)- LDS, lysine decarboxylase, ACC, 1-aminocyclopropane-1-carboxylic acid; dcSAM, decarboxylated S-adenosyl-methionine.

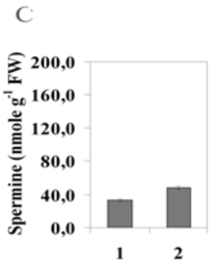
The genes involved are ADC1, ADC2, ODC, SPDS1, SPDS2, ACL5, SPMS

Fig. 11. **Pathway of biosynthesis of main plant polyamines (putrescine, Spermidine, Spermine and Cadaverine)**

On the basis of these data, we proposed that polyamines accumulation in plants might improve plant tolerance to Ni due to chelate formation.

The next aim of this work was to study a possibility of polyamines accumulation in rape plants (*Brassica napus* L.) under Ni pollution in soil. We showed that exogenous Ni stimulates biothynthes of endogenous polyamines of putrescine family in rape plants (Fig. 12).





1 – control, 2 – 250 µM $NiCl_2$,

A – Putrescine, B – Spermidine, C – Spermine.

Fig. 12. **Effect of $NiCl_2$ on endogenous content of free polyamines in young leaves of 5-day-old rape plants**

On the basis of these data, we propose rape plant can be as potential Ni accumulator for soil decontamination. However, it is necessary to increase plant capability of metal accumulation, aboveground organ biomass and plant tolerance to Ni toxicity. Therefore we attempted to improve the aforementioned parameters by increasing polyamines content in leaves (fig. 13). Earlier we have shown, that treatment of adult plants with putrescine increased biomass of roots and shoots, the content of chlorophyll in leaves. Taking it into account, we expected that exogenous putrescine would activate plant growth and improve tolerance to nickel-induced stress, and what is especially important, activated Ni accumulation in leaves. We assumed that exogenous putrescine penetrates from leaf surface via phloem into leaf parenchyma and then into xylem, where it could a complex with nickel causing Ni detoxification and increasing its transport into aboveground biomass. The obtained data demonstrated that treatment of exogenous putrescine increased the amount of Ni in leaves to the level attained by natural Ni-accumulators (~ 3000 mg/kg dry wt).

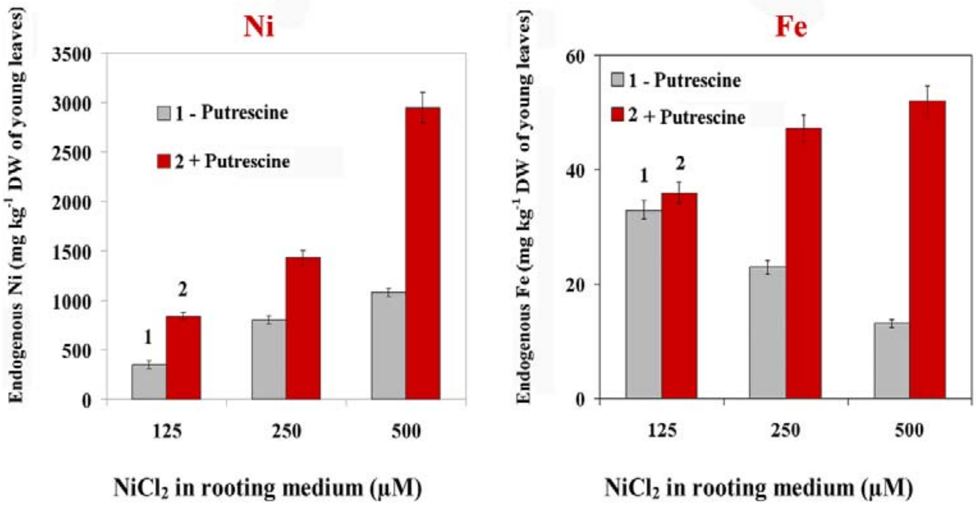


Fig. 13. **Effect of leaf treatment with exogenouse putrescine on Ni and Fe**

In an analogous way leaf spraying with exogenous putrescine of another cultivated plant (*Amaranthus cruenthus*) demonstrated the increase of Ni accumulation and its transport into aboveground biomass. It was shown in figure 14.

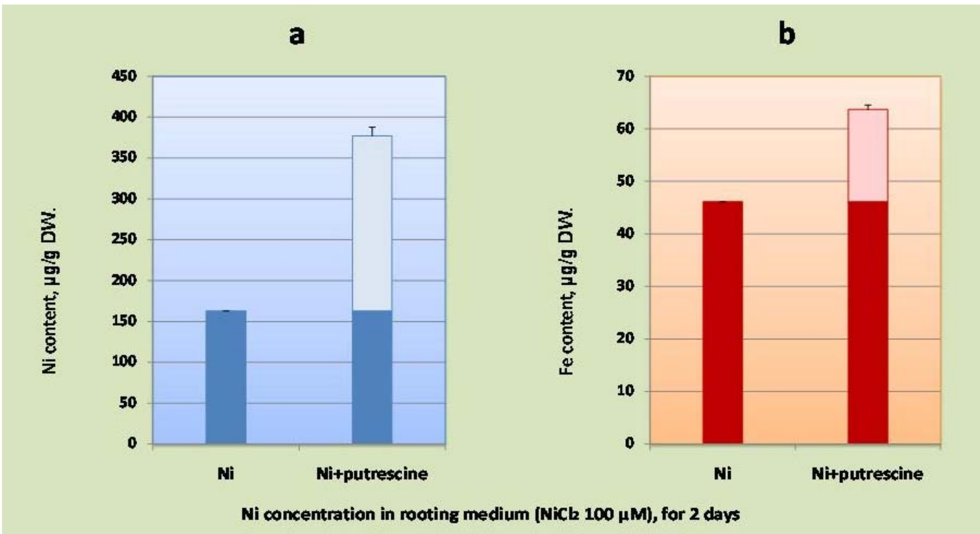


Fig. 14. **Effect of leaf treatment with exogenouse putrescine on Ni and Fe accumulation by young leaves of *Amaranthus cruentus* L. plants**

Such effects opens a possibility for creation of transgenic plants with enhanced production of endogenouse polyamines, which would be of interest for phytoremediation. This could be one of the efficient strategies for accelerated hyperaccumulator-mediated soil decontamination from HM.

REFERENCES

Raskin L., Ensley B.D. 2000. Phytoremediation of toxic metals. Using plants to clean up the envieonment. New York: Wiley and Sons. 685 p.

Prasad MNV. 2003. Phytoremediation of metal-polluted ecosystem: Hype for commercialization. Russ. J. Plant Physiol 50: 686-700.

Madzhugina Yu.G., Kuznetsov Vl, Shevyakova N.I. 2008. Plants inhabiting polygons for megapolis waste as promising species for phytoremediation. Russ J Plant Physiol. 55: 410-419.

Hang An N., Collins H.P. and Fransen S.C. 2008. Biofuel feedstock research for central Washington. 2008 Joint Meeting 5-9 October 2008. Houston Texas. Abstract 546-12.

Shevyakova N.I., Ill´ina E.N., Stetsenko L.A., Kuznetsov Vl.V. 2010. Nickel accumulation in rape shoots (*Brassica napus* L.) increased by putrescine. Int. J Phytorem. 2010. Doi: 10.1080/15226514.2010.495147.

Koutensky J., Koutenska M., Kotyzova D., Eybl V. 1995. Interaction of nickel and some polyamines in vivo. Toxicology Letters. 78:Supplement 1. 49-50.

Hauschild M.Z. 1993. Putrescine (1.4-diaminobutane) as indicator of pollution-induced stress in higher plants: barley and rape stressed with Cr(III) or Cr(VI). Ecotoxicol Environ Saf 26:228-247.

Bergmann H., Machellett B., Lipmann B.,Friedrich Y. 2001. Influence of hevy metals on the accumulation of trimethylglycine, putrescine and spermine in food plants. Amino Acids. 20:325-329.

Kuznetsov Vl., Shevyakova N.I. 2007 Polyamine and stress tolerance of plants. Invited Review. Plant Stress. 1:50-71.

Kuznetsov Vladimir.V. and Shevyakova Nina I Polyamines and Plant Adaptation to Saline Environments. In: K.G. Ramavat (ed). Desert Plants. Springer Verlag. Berlin-Heidelberg. 2010. P. 261-296.

Надійшла до редколегії 08.12.10

UDK 631.4

N. A. Bilova[1], V. N. Yakovenko[1], E. D. Yushchuk[2]

MICROMORPHOLODGY OF ARTIFICIAL EDAPHOTOPES IN FOREST ECOSYSTEMS OF DESTRUCTIVE AREAS OF UKRAINE

[1]O. Gonchar Dnipropetrovsk National University
[2] Krivyi Rih Pedagogical University

In the paper the materials of construction and development of artificial forest edaphotopes, their micromorphological dynamics in Western Donbass technogenesis environment are stated.

Key words: micromorphology, forest edaphotopes, technogenesis, Western Donbass.

Н. А. Белова[1], В. Н. Яковенко[1], Е. Д. Ющук[2]
[1]Днепропетровский национальный университет им. О. Гончара
[2]Криворожский педагогический университет

МИКРОМОРФОЛОГИЯ ИСКУССТВЕННЫХ ЭДАФОТОПОВ В ЛЕСНЫХ ЭКОСИСТЕМАХ ДЕСТРУКТИВНЫХ ТЕРРИТОРИЙ УКРАИНЫ

В статье изложены материалы конструкции и развития искусственных лесных эдафотопов, их микроморфологическая динамика в условиях техногенеза Западного Донбасса.

Ключевые слова: микроморфология, лесные эдафотопы, техногенез, Западный Донбасс.

Н. А. Білова[1], В. М. Яковенко[1], Є. Д. Ющук[2]
[1]Дніпропетровський національний університет ім. О. Гончара
[2]Криворізький педагогічний університет

МІКРОМОРФОЛОГІЯ ШТУЧНИХ ЕДАФОТОПІВ У ЛІСОВИХ ЕКОСИСТЕМАХ ДЕСТРУКТИВНИХ ТЕРИТОРІЙ УКРАЇНИ

У статті викладені матеріали конструкції та розвитку штучних лісових едафотопів, їх мікроморфологічну динаміку в умовах техногенезу Західного Донбасу.

Ключові слова: мікроморфологія, лісові едафотопи, техногенез, Західний Донбас.

In Western Donets Basin under the influence of undermining of coal beds subsidence of valley area of Samara Dniprovska occurs. Consequently underflooding destroys all components of forest biogeocenoses. But it happens step-by-step that gives an opportunity to plan the sequence and rates of subsidence phenomena, to identify the death stages of certain areas of Samara pine forest, to devise the methods and periods of its restoration.

Over the time of 35 years the unit on destructive land recultivation of Complex Expedition of O. Gonchar Dnipropetrovsk National University have been doing monitoring researches of destructive edaphotops, have been taking part in development of projects for design and formation of artificial soils and forest ecosystems in anthropogenic environment of Western Donets Basin.

Undermining of the territory and subsequent subsidence at 5-7 m runs nonuniformly and forms wide diversity of silva. This phenomenon is caused by different circumstances: geological stratigraphy, depth and pace of undermining of coal beds, depth of underground waters, relief, availability of different types of vegetation, etc.

For prevention of depth of natural valley forests on the area of more than 5 hectares it was necessary to develop guidelines and introduce into industry a whole number of nature conservation methods:

- The first method. Making a dam on the territory for delaying the water flowing from the water basin arisen as a result of subsidence of adjacent woods.
- The second method. So as not to allow the penetration of water through the protective dum and save the territory from underflooding and death of woodland, the method of vertical drainage was used. It was realized through laying of

the shaft wells with continual pumpdown of the water and dropping it into the riverbed of Samara.

- The third method is the cases when there is no subsidence, but underflooding occurs because of the overflow, appeared bodies of water and disturbance of processes of floodplain in spring.
- The fourth method. Territories where there is no underflooding, but destruction and death of forest biogeocenoses occurs because of interbiogeocenosis relations. Forest planting perished with underflooding and affections is a source of disease of weakened and aged trees.
- The fifth method. The artificial rise of day at original level (5-7 m) by formation of platforms of mine rocks with subsequent construction of filling on their surface. It ensures regular growth and development of forest plantings.
- The sixth method. Making soil artificial horizons from substrates of potential genetic propinquityof creating soil morphons (horisons).
- The seventh method. Use of creating typology of artificial forest culture biogeocenosis in anthropogenic landscape environment compiling on basis of typological principles of professor Belgard.

For diagnosing and fundamental guidelines along with conventional physicochemical methods micromorpholodgical soil structure analysis was made. One side of the study was ecological micromorpholodgy of standard alluvial genetic types of soil and soils of different degrees of destruction, degradation and death under the influence of subsidence deformations and underflooding. The other side of the study was ecological micromorpholodgy and physicochemical primary and prolonged processes of soil formation, development of methods of design of artificial soils by arrangement of soil horizon and whole soil profile in accordance with the selection of wood and shrub species, defining the principles of typology of artificial forests for revegetation of mine dumps in Ukraine. Special attention was paid to:

- syngenetic processes – primary embryonic soil formation;
- depth and characters of soil profile;
- depth and characters of soil horizons;
- the possibility of ecological and biological processes interprenetrating between individual horizons;
- lack of historical and genetic relations of individual bulk layers, soil (geological) horizons;
- biological compability of horizons;
- biological conditional compability;
- biological incompability;
- absolute biological incompability of constructible horizons;
- the level of ecological concordance of forest culture phytocenosis to habitat;
- absolute ecological concordance of forest culture biogeocenosis to habitat;
- relative concordance;
- absolute discordance of forest phytocenosis to habitat.
- level of forest suitability of established silvicultural conditions.

Monitoring observations for 1975 – 1985 – 1995 – 2010 testify that under the influence of underflooding silvicultural characteristics of soil retrogress, destruction of macro-, meso- and microstructure of soil mass occurs, sodium and potassium penetrate to soil-absorptive complex.

Ecological micromorpholodgy can penetrate into the depth of soil processes up to molecular and crystalline level and define by the instrumentality of polarized and scanned microscopes, computer and video equipment nucleation of chemical compounds which cannot be defined by method of physical-chemical analysis. Any destruction of soil by chemical analysis does not enable to define functioning of certain components in their interaction, interconnection and interdependence. Sample of “mince” made of experimental frog enable to get empirical notion about chemical composition, but not about structure functional organization of organism. Triturated watch put to the most careful gross analysis does not enable to discover the peculiarities of their construction and principle of operation. Ecological micromorpholodgy reveals qualitative and quantitative composition of substratum without destruction of sample's architectonics. It documents not only the levels of structural organization, but also in combination with physicochemical analysis it discovers the secrets and features of soil formation.

Studying the deformed and destructive soils in technogenesis environment in Western Donets Basin, Alexandria and Lviv-Volyn coalfields we managed to get the data which throw light upon the ecological essence of soil formation progressing in substrates (edaphotopes) making by nature or by man.

Among 6 experimental areas let's dwell on the area № 1 (3,2 ha), where the monitoring tests had been conducted for 35 years. Here 16 wood species are tested on the common platform with capacity of 10 – 12 m, filled in the territory of subsidence. The platform serves as a base, on the surface of which the artificial edaphotopes of different thickness, configuration and structure had been constructed.

Variant 1. Floodplain of the river Samara, subsided area and the platform built of mine rocks. The layer of the same rock of 2-meter thickness was specially applied on the platform. The task is to show ecological fitness (unfitness) of mine rock for growing of forest plantations on it.

Typological formula: heavy clay, dryish clay, level of morphological organization (LMO) – 1, half-cleared structure of plantation, initial structure of forest – 10 Robinia.

By 1999 plantation of robinia, common birch, black poplar, Bolle polar are completely degraded.

Micromorphological description of mine rock (2010).

Mine rock is heavy clayey mass on its granulometric composition. It consists of siltstone, mudstone and 16-20 % of organic matter coagulated irreversibly. The organic matter is resinous polymerized chemical compounds.

By the research findings the organic matter of mine rocks is not mineralizable and doesn't become available for plants' nutrition. Mine rocks by their physicochemical, water-air, mechanical properties are unfit for growing plants. They are absolutely impervious, have high density, hardness, viscosity, stickiness. In the time of drying up they are cemented, in the time of moistening they turn into sticky clay without air, as a rule with total moisture capacity. In point of chemical fertility mine rocks are anazotic compounds. They have trace of phosphorus, potassium, calcium, magnesium, sulfur, iron and microelements. Pyrite influences distinctly negatively. Content of pyrite is near 1%, it causes drop of pH to 3,2.

It is paradoxical that mine rock in the leach process has no adverse impact on water bodies. Our experiments have shown that fresh mine rock ejected on the daylight has solid residual 0,2 % at the most. Volume weight of mine rock is 1,6 – 2,2 g/cm3, specific weight – 2,7 – 2,5 g/cm3.

Ratio of Cha/Cfa reaches 10. It indicates that humic humus acids prevail over fulvic acids.

In consideration of ecological micromorpholodgy of mine rocks it could be concluded that for 35 years of functioning of rock, its connection with atmospheric air, oxidation processes, had affected the rock construction, which at the present time is notable for mixed character and heterogeneity of its structure, compared with fresh rock ejected from a mine (fig. 1).

Light-colored sections alternate with brown-colored carbonate-clay sections. As a result of physical and chemical weathering, under the influence of exothermal reactions, against the background of decomposition of primary mine substrates the oxidation process (combustion) of the rock occurred intensively.

After crushing the coal rock (rock of the Concentration Plant) the total surface, the area contacting with atmospheric air and primitive but active biota increase. Here the reactions of hydration, dehydration, hydrolysis, oxidation, dissolution and exchange are the most accepted. Pyrite interacting with oxygen and water undergoes the following changes:

$2Fe\ S_2$ (pyrite) $+ 7O_2 + 2H_2O = 2FeSO_4 + 2SO_4$;

$12FeSO_4 + 6H_2O + 3O_2 = 4Fe_2\ (SO_4)_3 + 4Fe(OH)_3$;

$2Fe(SO_4)_3 + 9H_2O = 2Fe_2O_3 \times 3H_2O$ (limonite) $+ 6H_2SO_4$.

As a result of the reaction the limonite is generated. This mineral in the sections has brown color and is consisted of separate particles capable to absorb the moisture.

Hydration is typical for the reactions attaching water. Red iron ore, ferric oxide – hematite interacting with water generates hydroxide or limonite.

$2Fe_2\ O_3 + 3H_2O = 2Fe_2O_3 \times 3H_2O$, dehydration is an inverse process progressing under water deficit. Pyrite as iron solphide prevails in the mine dumps where considerable part of iron is represented as its oxide compounds.

On the clear sections after 35 years of their physical, chemical and biological transformation it can be observed that the top layers of rock are different from the underlying. On the fig. 1 the primary distribution of plasma, fine-dispersed material generally consisting of clay are clearly defined.

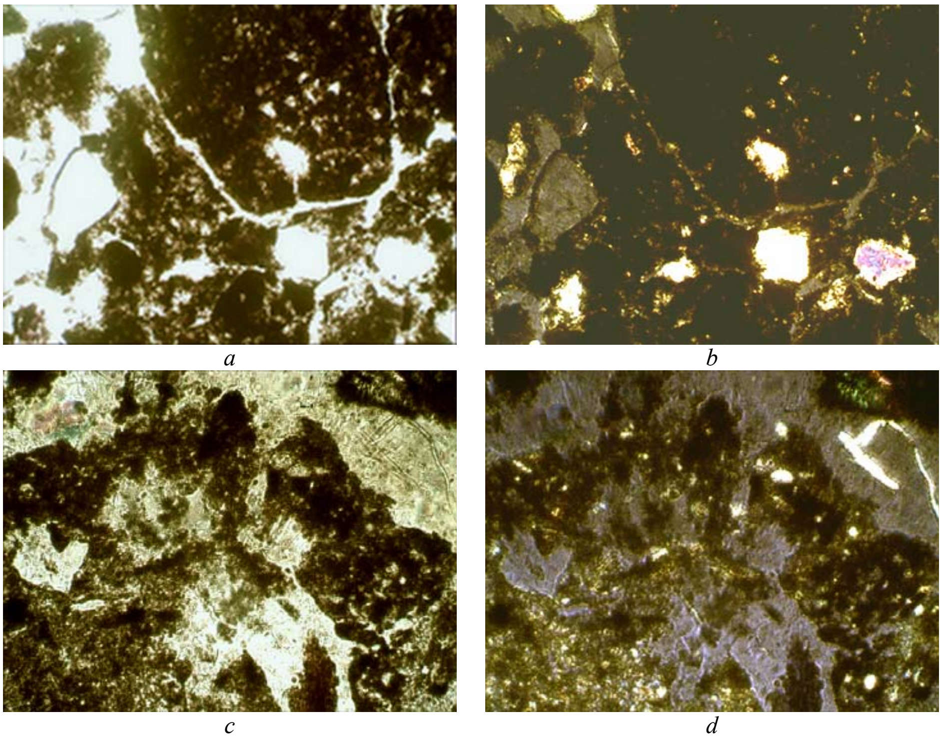


Fig. 1. **Fresh mine rock** (a – Nick. II. x 70; b – Nick. +. x 70);
mine rock after 35 years (c – Nick. II; d – Nick. + x70)

Elementary structure changes along the certain sections sandy-plasma-pulverescent. Structural aggregations are not isolated. Skeleton is of pulverescent size, there are some sandy grains 1,4 mm, 0,5 mm. Large grains of quartz and calcite are thrown about the whole mass. The trace of mica in the form of glowing sticks distributed in clayey mass. Carbonate-clayey plasma is rather saturated, greatly heterogeneous, optically unoriented. Pores are of anomalous form, not intercommunicating. Diameter of some of them is 0,6 mm. There is no new formation.

Variant 2. Description of plantation and ecological micromorpholodgy of soil profile on the second variant of reclamation (in 35 years)

Type of silvicultural conditions – L0-1 (dryish loam). Stratigraphic structure of edaphotope: loess 0 – 50 sm; tertiary sand – 50 – 100 sm; mine rock – 100 – 70 sm.

Type of plantation light structure – half-lighted, light condition – normal, of the second age phase (polewood).

Type of stand – 10 Robinia of 24 years, height 5,5 – 6,5 m, diameter of a trunk – 95 – 120 mm, spread of branches – 350 – 420 mm, density – 0,9.

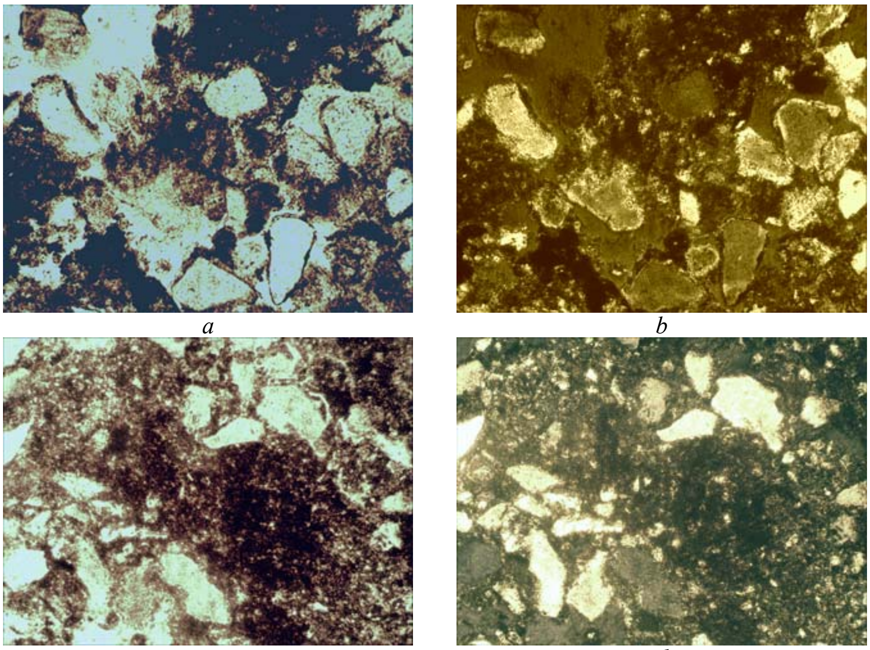
Typological formula:
L0-1 (0 – 50 cm)
S0-1 (50 – 100 cm)
C2 (100 – 700 cm) LMO – 3
Half-lighted, third age degree.

Macro- and micromorphological structure description of soil profile on the variant 2 in 24 years.

H 0 1 0 – 7 cm Forest litter of robinia leaves, herbal admixture (bedstraw, celandine), seldom - cereals.

H0 2 7,0 – 15 cm dusty mass covering the soil and serving as a mulch against the settlement of steppe herbaceous vegetation.

Hp1 15 – 35 cm Loess-like loam medium-humused at a depth of 0 – 15 cm with grayish tint. Microstructure is friable. Carbonate-clayey material forms aggregates of size 0,02 – 0,5 mm. Grains of mineral skeleton (quartz, feldspars, glauconite, hornblende) occupy 40 – 60 % of section area; they are homogeneous by size, have rounded and half-rounded shape. Crystalline calcite fills plasma and cements loessial aggregates. There are certain large grains of calcite. From 1995 to 1999 pore space had been continuing to form pores-cracks of 1 – 2 mm. In the under study section there are clods and inspissations of round shape, generated by clayey material. Biopores frequently filled by coprolith or coprolithlike remains have been progressing. Upper horizons of soil have acquired grey color through availability of humic matter and considerable quantity of dusty mass of litter (fig. 2).



a *b* *c* *d*

Fig.2. **Fresh loess** (a – Nick.II; b – Nick. +. x 70); **loess after 35 years** (c – Nick. II; d – Nick. +. x70)

Comparing the observations of primary soil formation in initial loessial substrates (1975) and the same rocks in 30 and 34 years it is clear that forest vegetation doesn’t acidate the loessial substrate so that the destruction process of sparingly soluble compounds would be evident. At first quite the contrary the process of humus accumulation, structure formation, arisen humate calcium procure the improvement of silvicultural conditions. On bare loessial edaphotopes of steppe environment the process of humus accumulation occurs more intensive under forest vegetation than on open steppe. Forest accumulate the litter which goes to ruin slowly, undergo the stages of decomposition, mineralization and condensation of humus matters. The condition of humus of this "forest" edaphotopes in comparison with initial not afforested loesses and loess-like loams is at its apogee. In consideration of the opinion of V. V. Dokuchaev to the effect that "loesses are soils", it could be mentioned that falling under the influence of active biological environment they become capable to resuscitate their potentialities rapidly and to acquire the qualities of chernozem type of soil formation.

Variant 3, 4. Planting description and ecological micromorpholodgy of soil section on the forth variant of reclamation (in 35 years).

Considered variant is the most favourable, productive and inexpensive.

The type of forest conditions – L0-1 (dryish loam). Here sandy interlayer is not on the bottom of the productive layer, but in the middle, developing receptacle of moisture as a result of condensation processes and free absorption of backup water level of underlying loam. The moistening conditions in this connection could be qualified as atmospheric-ground. The thickness of artificial soils has the following stratigraphy: chernozem – 0 – 50 cm; tertiary sand – 50 – 100 cm; loam – 100 – 150 cm; clay – 150 – 700 cm.

The type of light structure – half-lighted, the type of stand – 10 Robinia, 24 years.

Typological formula:

L0-1 (0 – 50 cm)

S2 (50 – 100 cm)

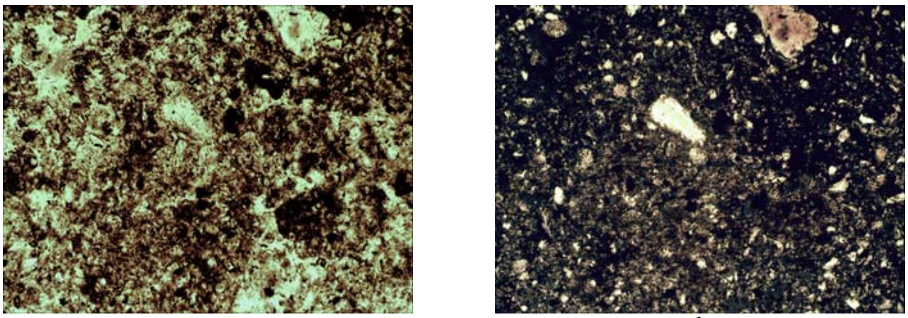
L2 (100 – 150 cm) 10 Robinia

C2 (50 – 700 cm)

Half-lighted third age stage

General density – 0,8 – 0,9. The plantation is characterized by high vitality, richness in fruits, virtually absence of pests. The grass stand is well-developed. Rootstock grasses predominate (Poa compressa, Elytrigia repens), covering – 45 %.

Description of macro- and micromorphological structure of forest improved chernozem on Variant 4 in 35 years (2010) (fig. 3).



a *b*

Fig. 3. **Development of chernozem layer on experimental areas 3 – 4** (a – Nick.II; b – Nick. +. x 70)

Hor. 0 – 30 cm over a period of time from 1975 to 2010 under the influence of forest vegetation had been acquiring a number of positive qualities. The structural composition has been improved. The quantity of large rounded aggregates has been increased. Pore space occupies 45-55% in upper layers and 25-35% in lower layers. The horizon's coloring is dark-brown, almost black. Mineral skeleton includes feldspars, micas, epidottsoizite minerals. Zircon is found rarely. Throughout the section the active work of burrowing mesofauna is found. In the upper horizons there is a considerable quantity of coprolites of earthworms. The size is 0,2 – 0,6 mm, 1 – 2 mm. Microstructure is friable. Organic matter is dispersed along the full soil mass. Humus is a sort of silt. In certain zonules the incrustation of clay are visible. Vegetable remains in half-decomposed and decomposed condition.

As it has already been said, undermining of coal layer causes slumps of surface area with consequent various serious consequences, underflooding in the first place conditional of ground water outlet on the day surface. Underflooding causes the death of forest plantings, negative transformation of forest fertile soils, with deteriorated water, air, physical-mechanical and physicochemical properties. Mineralization of mine water reaches 9,427 mg/l with rigidity of 48,8 mg-eq. According to Alekin (1946) such water labels as salty, hard, chloride type. In the central floodplain, where forest plantations were filled by water to 1,5 – 2,00 m the chemical composition of water is notable for increased rigidity (51, 6 mg-eq.), strong salinity (solid residue > 10 000 mg/l), labels as chloride class, sodium-potassium group, type of strong mineralized soil. High mineralization of underflooding water causes by outlet of water from a mine, for instance Pavlograd mine where the salt load reaches to 46 g/l. For comparison of salt loads, we would remind you that irrigation water should contain insignificant amount of salt. Water with salt load of 1g/l fits all types of irrigation. Limiting salt content is 1,5 g/l. It is clear that so high mineralization of water in mine dumps area with solid residue about 9427 – 10734 mg/l doesn't create favourable conditions for growing of forest biogeosenoses. Monitoring observations for 1975 – 1985 – 1995 – 1999 – 2010 argues for destruction of macro-, meso- and microstructure of soil mass, penetration of sodium and potassium into soil-absorbing complex. Solid residue increases to 0,75%. Soils change from meadow-forest into strongly saline by the degree of salinization, into chloride-sulphate soils by the type of salinization. To compare the pace and pattern of change of micromorphological features we had advisedly planned the scientific research on the model test areas, located on monitoring ecological geobotanical profiles of Samara Biosphere Station of Complex Expedition of DNU. The level of detrimental effect of mentioned mine high-mineralized water on forest soils is disclosed: mudding of porous space by fine-dispersed mass, formation of homogeneous (clayey) and mixed (sandy-pulverescent-cleyey) incrustations, microzonality foundation, negative transformation of humus form, washing it out of the floor profile, erosion of floor profile horizons, death of pedofauna. Speed of deformation depends on salt load of water environment, genetic type of soil, duration of flooding process. For prevention of forest soils' destruction it is necessary to apply damming, vertical and horizontal drainage, carry out regeneration of soils by forestry and silvicultural methods in the course of their reuse.

REFERENCES

Адерихин П. Г. Влияние лесной растительности на черноземы / П. Г. Адерихин, А. Л. Бельгард, С. В. Зонн, И. А. Крупенников, А. П. Травлеев / Русский чернозем. 100 лет после Докучаева. – М. : Наука, 1983. – С. 117–126.

Белова Н. А. Лес и степные почвы / Н. А. Белова, А. П. Травлеев. – Д. : ДНУ, 1999. – 345 с.

Бельгард А. Л. Степное лесоведение / А. Л. Бельгард. – М. : Лесная промышленность, 1971. – 335 с.

Бяллович Ю. П. Системы биогеоценозов / Ю. П. Бяллович // Биогеоценотические основы теории системы лесов // М. : Наука, 1973. – С. 37-47.

Вавилов Н. И. Закон гомологических рядов в наследственной изменчивости / Н. И. Вавилов // Сельское и лесное хозяйство. – 1921. – № 1–3. – С. 84-99.

Вавилов Н. И. Линеевский вид как система / Н. И. Вавилов // Тр. по прикл. бот., ген., и сел. – 1931. – Т. XXVI, вып. 3. – С. 109-134.

Дарвин Ч. Происхождение видов путем естественного отбора / Ч. Дарвин. – Сочинения. – Т. 3. – М. ; Л. : Изд-во АНСССР, 1939. – 832 с.

Димо Н. А. Почвы Молдавии, задачи изучения и главнейшие особенности / Н. А. Димо. – Кишинев : Картя Молдовеняскэ, 1958. – 24 с.

Зонн С. В. Высокогорные лесные почвы восточного Тибета / С. В. Зонн. – М. : Наука, 1964. – 235 с.

Зонн С. В. Географо-генетические аспекты почвообразования эволюции и охраны почв / С. В. Зонн, А. П. Травлеев. – К. : Наук. думка, 1989. – 220 с.

Мазинг В. В. Что такое структура биогеоценоза / В. В. Мазинг // Проблемы биогеоценологии. – М. : Наука, 1973. – С. 148-156.

Медведев В. В. К вопросу об использовании баз данных в агропочвоведении / В. В. Медведев, Т. Н. Лактионова, И. В. Плиско // Вісник ХДАУ, серія «Грунтознавство, агрохімія, землеробство, лісове господарство». – 2001. – № 3. – С. 79-82.

Новосад К. Б. Еволюція чорноземів типових глибоких південно-східного Лісостепу України під різними фітоценозами / К. Б. Новосад / Вісник ХДАУ : зб. Наук. пр. Харк. держ. аграр. ун-т. – 2000. – № 1. – С. 143-153.

Работнов Т. А. Некоторые вопросы изучения почвы как компонента биогеоценоза / Т. А. Работнов // Вестник МГУ. – 1974. – № 3. – С. 10-18.

Сибирцев Н. М. Почвоведение / Н. М. Сибирцев. – СПб., 1914. – 504 с.

Тимирязев К. А. Чарльз Дарвин и его учение / К. А. Тимирязев. – М. : Типо-литография Т-ва И. Н. Кушнеров и К, 1905. – С. 128-129.

Тихоненко Д. Г. Про класифікацію грунтів України / Д. Г. Тихоненко / Вісник ХДАУ, серія «Грунтознавство, агрохімія, землеробство, лісове господарство». – 2001. – № 3. – С. 33-39.

Уранов А. А. О сопряженности компонентов растительного ценоза / А. А. Уранов // Уч. Записки Моск. госуд. педагог. ин-та, 1931. – С. 59-85.

Шеляг-Сосонко Ю. Р. Концептуальні засади наукового розуміння біорозмаїття / Ю. Р. Шеляг-Сосонко, І. Г. Ємельянов / Конвенція про біологічне розмаїття: громадська обізнаність та участь. – К., 1997. – С. 11-23.

Надійшла до редколегії 25.11.10

UDK 631.4

T. F. Urushadze[1], T. T. Urushadze[2]

SOILS OF GEORGIA: CONDITION AND PERSPECTIVES

[1]*Ivane Javakhishvili Tbilisi State University, Georgia*
[2]*Georgian State Agrarian University, Georgia*

Georgia is characterized by very interesting types of soils. Some of the world soils were first described in Georgia. One of the fundamental laws of soil geography – the law on vertical distribution of soils was stated by professor. V. Dokuchaev on the example of the Caucasus, particularly on the example of Georgian soils. Ecological conditions of the soils of Georgia are very heavy. Very big areas are eroded, polluted by radionuclides and heavy metals. The problems may be decided by joint activities.

Key words: soils, vertical distribution, eroded, radionuclides, heavy metals.

Т. Ф. Урушадзе[1], Т. Т. Урушадзе[2]
[1]*Тбіліський державний університет ім. І. Явакхишвілі, Грузія*
[2]*Грузинський державний аграрний університет, Грузія*

ҐРУНТИ ГРУЗІЇ: СТАН ТА ПЕРСПЕКТИВИ

Для Грузії характерні дуже цікаві види ґрунтів. Деякі всесвітньо відомі ґрунти вперше були описані у Грузії. Один з основних законів географії ґрунтів – закон вертикального розподілу ґрунтів – був сформульований професором В. В. Докучаєвим на прикладі Кавказу, в даному випадку на прикладі грузинських ґрунтів. Екологічний стан ґрунтів Грузії дуже важкий. Великі площі еродовані, забруднені радіонуклідами та важкими металами. Проблеми можуть бути вирішені об'єднаними зусиллями.

Ключові слова: ґрунти, вертикальний розподіл, еродований, радіонукліди, важкі метали.

Т. Ф. Урушадзе[1], Т. Т. Урушадзе[2]
[1]*Тбилисский государственный университет им. Иване Явакхишвили, Тбилиси, Грузия*
[2]*Грузинский государственный аграрный университет, Тбилиси, Грузия*

ПОЧВЫ ГРУЗИИ: СОСТОЯНИЕ И ПЕРСПЕКТИВЫ

Для Грузии характерны очень интересные виды почв. Некоторые всемирно известные почвы впервые были описаны в Грузии. Один из основных законов географии почв – закон вертикального распределения почв – был сформулирован профессором В. Докучаевым на примере Кавказа, в частности, на примере грузинских почв. Экологическое состояние почв Грузии – очень тяжелое. Обширные площади – эродированы, загрязнены радионуклидами и тяжелыми металлами. Проблемы могут быть решены объединенными усилиями.

Ключевые слова: почвы, вертикальное распределение, эродированный, радионуклиды, тяжелые металлы.

It is not accidental that at the end of XIX centre founder of soil science professor V. V. Dokuchaev called Georgia "Museum of soils in the open air".

For more that 50 soil types have been described on the territory of the Georgia. It is a result of complex bioclimatic and different litho logical and geomorphologic conditions. Some of the soils were first described in the Georgia and only afterwards distinguished in many other countries. Diverse conditions of soil formation are complicated by the influence of man's activities of different durations upon the soils

Some of the world soils were first described in Georgia, among them Cinnamonic (Cambisols Chromic), Meadow-Cinamonic (Cambisols Chromic), Yellow-Brown Forest (Acrisols Haplic).

It is very important, that one of the fundamental laws of soil geography – the law on vertical distribution of soils was stated by professor. V. Dokuchaev on the example of the Caucasus , particularly on the example of Georgian soils

In 2009 the Soil Map of Georgia was published in scale 1 : 500 000. For the first time in the post soviet space the soil classification was compared with the modern international classification of soils (WRB). The map was composed by more than 50 scientists and practitioners under the leadership of professor T. Urushadze. Leader authors of the map – 7 in all were awarded the State Prize

In 2002-2006 the realization of Cadastre and Land Register Project co-financed by KFW was of great significance. In the framework of this project large groups of soil scientists were retrained according to modern standards. The international classification of soils (WRB) was studied and discussed in the field and cameral conditions. The working version of "World Reference Base for Soil Resources" was translated into Georgian and published in 2005. The textbook on field investigation of soils was also prepared and published in 2006

The following soils are spread in Georgia: Mountan-Meadow (Leptolos), Brown Forest (Cambisols Eutric), Cinnamonic (Cambisols Cromic), Alluvial (Fluvisols), Raw Humus Calcareous (Leptosols Rendzic), Yellow Brown Forest (Acrisols Haplic), Meadow Cinnamonic (Cambisols Chromic), Subtropical Podzols (Luvisols Albic), Yellow Soils (Acrisols Haplic), Red Soils (Nitisols Ferralic), Black (Vertisols), Grey Cinnamonic, Meadow Grey-Cinnamonic (Cambisols Chromic, Cambisols Chromic), Chernozems (Chernozems), Bog (Gleysols), Raw Humus Sulphate and Salt (Gypsisols, Solonetz, Solonchaks).

Total area of soil cover is 69 958 724 ha, among them – brown forest soils – 24,4 % (17 089 287 ha), mountain-meadow – 19,7 % (13 791 065 ha), cinnamonic – 8,9 % (6 218 847 ha), alluvial – 8,2 (5 733 897 ha), raw humus calcareous – 7,1 % (4 939 482 ha), yellow brown forest – 6,5 % (4 529 358 ha), meadow-cinnamonic – 4,8% (3 371 334 ha), subtropical podzols – 4,3 % (2 983 831 ha), yellow soils – 4,1 % (2 898 094 ha), black – 3,6 % (2 507 539 ha), grey-cinnamonic – 2,6 % (1 841 357 ha), chernozems – 2,3 % (1 618 394 ha), red soils – 2,2 % (1 533 308 ha) etc

Meadow cinnamonic soils are characterized by low or medium humus contents. Total nitrogen contents is low or medium, total phosphor – low or medium, total potassium – medium or high. Hydrolyzable nitrogen contents is medium or high, absorbed phosphor in virgin soils is low and in developed soils – medium, metathetical potassium contents is high. Soils are supplied with boron, copper and cobalt. Zinc contents is low what is related to presence of carbonates in soil and transformation of zinc into heavily digestible forms.

Mountain-meadow soils are of high humus composition. Total nitrogen, phosphor and potassium contents are high. Hydrolyzable nitrogen contents is high, absorbed phosphor – medium and high, exchangeable potassium contents is low and medium.

Grey-cinnamonic soils are characterized by low humus contents. Total nitrogen contents is low and moderate, total phosphor is – medium, total potassium – high. Hydrolyzable nitrogen contents is moderate, absorbed phosphor is low and metathetical potassium – high.

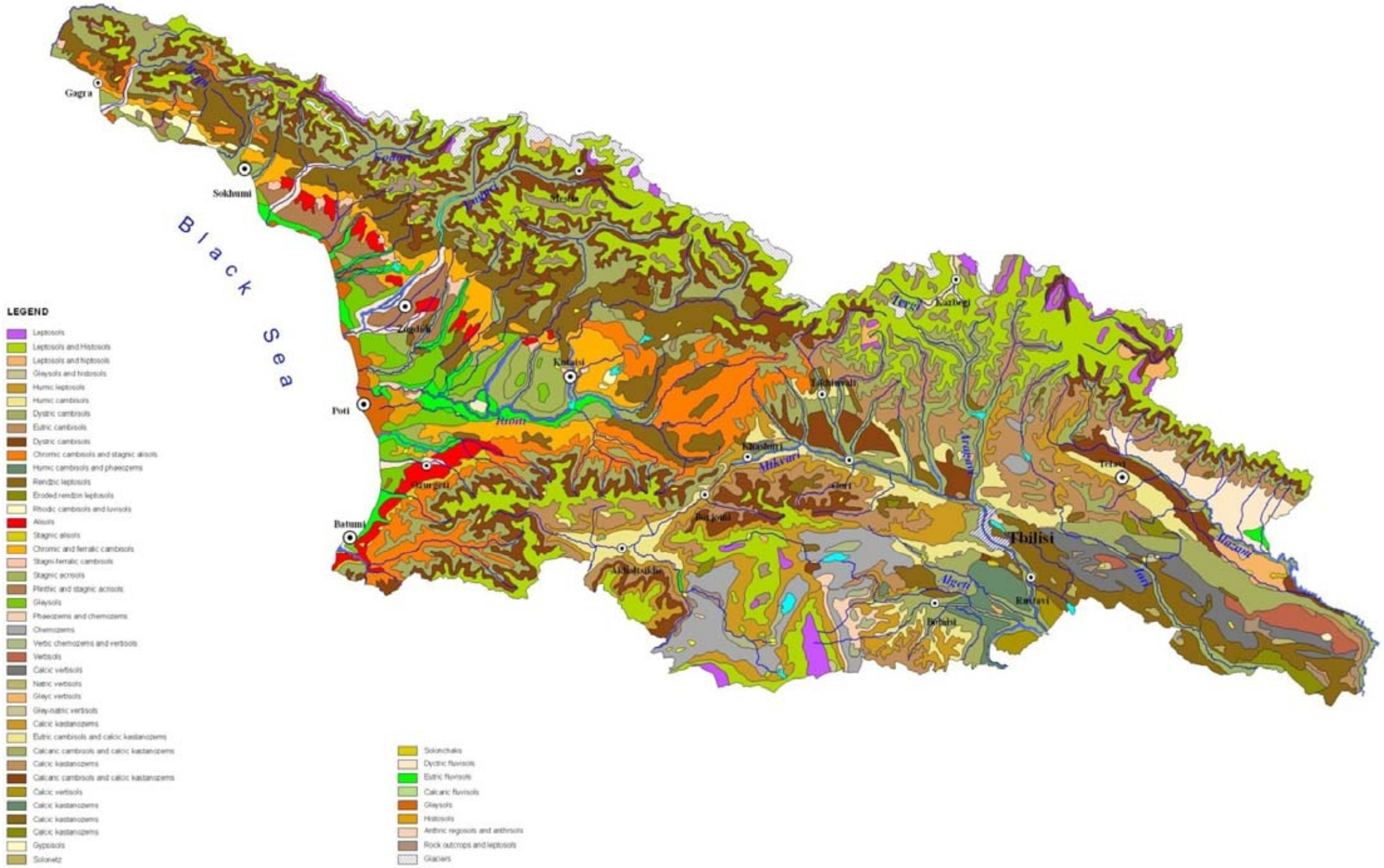
Cinnamonic soils are characterized by medium and deep humus contents. Total nitrogen contents is low and moderate. Hydrolyzable nitrogen contents in low humus soils is low or moderate; in medium humus soils hydrolyzable nitrogen contents is high. Total phosphor contents is low, moderate or high and absorbed phosphor contents is low or moderate. Soils have low zinc contents, high boron contents and medium copper and cobalt composition.

Black soils (i.e. plane chernozems) are characterized by high humus contents. Total nitrogen contents is medium, total phosphor – low, total potassium – medium. Hydrolyzable nitrogen contents is medium, absorbed phosphor – low, medium and high, metathetical potassium contents is high.

Chernozem (i.e. mountain chernozems) soils are characterized by high humus contents. Total nitrogen, phosphor and potassium contents are high. Hydrolyzable nitrogen contents is medium, absorbed phosphor – low, medium and high and metathetical potassium contents is medium.

Red soils are characterized by quite high humus and nitrogen contents. Total phosphor contents is low and total potassium contents is medium. Hydrolyzable nitrogen contents is enough. Absorbed phosphor contents is medium and high, exchangeable potassium contents is low or medium.

Soil Map of Georgia



Brown forest soils are characterized by medium humus contents. Total nitrogen and potassium contents are high; Hydrolyzable nitrogen and absorbed phosphor – medium.

Subtropical-podzolic soils are characterized by low contents of humus, total nitrogen and phosphor what respectively rarely exceeds 2.85; 0.15; 0.10. Hydrolitic nitrogen and plant available phosphor is low or moderate, and exchangable potassium is low, moderate or high.

Alkaline soils comprise saline soils and solonetzs. *Solonetzs and solonchak* are characterized with bad physical properties, alkaline reaction, moderate content of humus (3-4%), total nitrogen concentration is low or moderate, total phosphorous.

Raw-humus calcareous soils are characterized with humus and total nitrogen contents are moderate or high. Hydrolyzable nitrogen contents is moderate, total phosphor contents is moderate, available phosphor – low; total potassium contents is high, available potassium – medium.

Alluvial soils are characterized with total nitrogen contents is low or of medium level, total phosphor contents is low, moderate or high, total potassium contents is low or moderate. Hydrolyzable nitrogen contents is moderate or high, absorbed phosphor – low and available potassium – low or moderate.

The impact of pesticides on the soil is rather substantial, though so far poorly analyzed. Under the influence of the distant activity of the humid subtropics they accumulate in the soil, plants, animals and can cause profound and irreversible changes of the biological cycle and a decrease in the productivity of the landscapes. The most alarming is the fact that animals feeding on plants that have accumulated biocides cannot dissolve them.

In some regions of the Georgia the cultivation of soil with the frequent use of watering has a history of many centuries while there are regions where the cultivation of soil has been conducted for only a century.

A soils of Georgia are eroded – total water eroded area – 196,7 thousand ha, among them weak and medium – 74,4 thous/ha, strong – 12,1. In West Georgia eroded area – 54,0 thous/ha, weak ans medium – 23,3 and strong – 0,3 thous/ha. In East Georgia – total water eroded area – 142,7 thous/ha, weak and medium – 51,1 and strong – 11,5 thous/ha

Soils of Georgia are polluted by radionuclide, heavy metals, pesticides Radionuclide contamination in Georgia took place not only during nuclear weapon tests, but also during Chernobyl atomic electric power station wreak. At that time Georgia was the fourth among the most contaminated countries after Ukraine, Belarus and Russia.

The risk of pollution may be external and internal – while consuming food of vegetative and animal origin.The importance of the investigation of the radioactive pollution of the territory of Georgia with long living radionuclides (Sr-90 and Cs-137) is linked with geographical location.

It is known that maximum of pollution with radionuclides is observed on medium width (40-500, north width) of north hemisphere, where Georgia is located

The capacity of the exposure doses (PER) in some regions of the Black Sea coast (May 9-10, 1986) thousand times exceeded its maximum permissible background values

During 2005-2009 Ilia Vekua Sokhumi Institute of Physics and Technology (prof. G. Bokuchava) in collaboration with the Department of Biophysics of the Institute of Plant Protection (prof. M. Kvachantiradze) and Ivane Javakhishvili Tbilisi State University (prof. T. Urushadze) have been investigating contents of radionuclides on the whole territory of Georgia in the framework of MNTZ project (Project G-1106). The Project was financed by Euro Union, collaborators were Justus Libikh University (Gissen, Germany) and University of Barselona (Spain).

Now we have the data base which gives a full picture about the pollution of the country before the Chernobil wreck.

Taking into account that Georgia is in the zone with the most radionuclide fallings from the atmosphere (40-500 north width) as well as specific features of soil-climate conditions for realization of the Project ,all the questions were investigated on regional depending of the territory (total 12 regions) (Urushadze, Kvachantiradze, Bokuchava, 2007).

It was stated that the regions of West Georgia (Adjara, Samegrelo, Abkhazia, Guria, Imereti, Racha-Lechkhumi, Kvemo Svaneti) are more polluted than regions of East

(Kakheti, Mtskheta-Mtianeti, Shida Kartli, Kvemo Kartli, Environs of Tbilisi) and South (Samtskhe-Javakheti) Georgia.

Investigations were conducted both in field and in laboratory conditions with the use of innovative methods and modern equipment. More than 1600 soil and vegetable samples were analyzed on the whole territory of Georgia at the altitude from 0 to 4000 meters above sea level. 56 maps of pollution have been drawn up. As a result regional measures of improving environmental conditions were developed.

Table 1

Contents of Radionuclides (Sr^{90}, Cs^{137}) in the regions of West Georgia, bk/kg

№	Region	Sr-90	Cs-137
1	Abkhazia	85–1392	0–637
2	Samegrelo	90–827	16–1279
3	Racha-Lechkhumi. Kvemo Svaneti	0–174	0–177
4	Semo Svaneti	0	0
5	Imereti	35–1050	15–965
6	Guria	87–871	0–640
7	Adjara	101–1205	10–1098

Table 2

Contents of Radionuclides (Sr^{90}, Cs^{137}) in the regions of East Georgia, bk/kg

№	Region	Sr-90	Cs-137
1	Mstkheta-Mtianeti	11–416	0–319
2	Shida Kartli	0 – 397	0–173
3	Kvemo Kartli	95–696	0–343
4	Kakheti	25–566	20–469
5	Environs of Tbilisi	74–411	0–166
6	Samtskhe-Javakheti	86–393	38–319

Table 3

Contents of Radionuclides(Sr^{90}, Cs^{137}) in the main soils

№	Soils	Depth, cm	Sr^{90}	Cs^{137}
			bk/kg	
1	Acrisols	0–20	149–503	85–662
		20–40	93–368	87–436
2	Alisols	0–20	83–429	0–898
		20–40	33–746	20–242
3	Albeluvisols	0–20	114–286	62–310
		20–40	36–242	41–54
4	Rendzic Leptosols	0–20	89–706	66–794
		20–40	0–219	0–728
5	Kastanosems	0–20	57–156	15–44
		20–40	18–198	0–25
6	Cambisols	0–20	19–160	6–71
		20–40	6–239	0–80
7	Cambisols Chromic	0–20	79–157	0–43
		20–40	17–131	0–59
8	Chernozems	0–20	21–160	39–167
		20–40	26–175	0–66
9	Eutric and Distric Cambisols	0–20	94–249	21–291
		20–40	26–189	26–133
10	Fluvisols	0–20	59–382	75–653
		20–40	24–334	0–258

The most damaged was West Georgia which is washed by Black Sea. Soils in West Georgia are more contaminated, among them yellow brown forest soils – 9200–898 bk/kg, raw humus calcareous – 177–680 bk/kg, subtropical podzol – 197–680 bk/kg, yellow soils – 140–396 bk/kg. Soils of East Georgia are less contaminated than in West Georgia: cinnamonic carbonate – 66–228 bk/kg, cinnamonic typical – 80–162 bk/kg, cinnamonic leached – 13–99 bk/kg.

At the 80's years of last centuries in Georgia were eroded more than 300 000 ha, among them 200 000 ha with water erosion (in West Georgia) and 100 000 ha with wind erosion(in East Georgia). At the end of the last centuries total area of eroded soils was nea 1 mln ha, among them 380 000 ha of arable soils and 547 000 ha – pasturages (Gogichaishvili, Urushadze, 2006). Now in country washed 15–20 t/ha.

Table 4

Loss of Soils in Georgia in Rivers Basin (Gogichaishvili, Urushadze, 2006)

Loss of Soils, t/ha	Square of River Basin (km^2)	
	West Georgia	East Georgia
< 5	–	4,217
5–10	5,118	10,803
10–15	–	–
15–20	5,900	4,980
20–30	17,060	4,351
➢ 30	6,484	10,987

Soils of Georgia are polluted by heavy metals in Mashavery river basin in East Georgia and Kvirila river basin – in West Georgia.

Situation in Mashavery river basin are investigated last 7 years under the leadership of famous soil scientist, prof. P. Felix-Hennigsen from Institute of Soil Science and Soil Conservationm Justus-Liebig-University, Giessen, Germany (Felix-Henningsen, 2007a, 2007b).

The fertile irrigated soils (Chernozems, Kastanozems) of the Mashavera valley have a high agricultural yield potential The river water used for irrigation, however, is polluted with heavy metals resulting from mining activities of a copper and gold mine situated in the mountainous region of the middle reaches of the Mashavera River. Furthermore waste water from a floatation plant, erosion material from floatation waste deposits and acid mine drainage leads to high concentrations of dissolved and suspended sulphidic heavy metals. The Cu, Zn and Cd concentrations of mud from irrigation channels and the Mashavera river are extremely high. It is estimated that annual transfer of heavy metals by irrigation water is in the range of several g/ha-1 for Cd and several kg/ha-1 for Cu and Zn.

So it may be concluded that soil cover of Georgia are characterized with big diversity. Its ecological condition are very heavy. First of all very big area are eroded, polluted by Radionuclides and Heavy Metals.

REFERENCES

Gogichaishvili G.P. and Urushadze T.T. Estimation of Erosion Danger Lands of the Reclamation Fund in Georgia // Journal of Agriculture and Rural Development in the Tropics and Subtropics, vol. 107, No 1, 2006, pp. 85-94.

Peter Felix-Henningsen, Tengiz F. Urushadze, Eliso I. Narimanidze, Lars-Christoffer Wichmann, Dietrich Steffens, Besik B. Kalandadze, Heavy Metal Pollution of Soils and Food Crops due to Mining Wastes in the Mashavera River Valley // Bulletin of the Georgian National Academy of Sciences, vol. 175, no. 3, 2007, pp.97-106.

Felix-Henningsen P., Urushadze T.F., Narimanidze E.I., Wichmann L., Steffens D., Kalandadze B.B. Heavy Metal Pollution of Soils and Food Crops Due to Mining Wastes in an Irrigation District South of Tbilisi, Eastern Georgia // Annals of Agrarian Science, vol.5, No. 3, 2007, pp.11-27.

Tengiz Urushadze. The Main Soils of Georgia // "Metzniereba", Tbilisi, 1997, 268 pp. (in Georgian).

Urushadze T., Kvachantiradze M., Bokuchava G. Contamination of Same Soils of Georgia with ^{137}Cs. In: Changing Soils in a Changing World: the Soils of Tomorrow. Book of Abstracts // Palermo, University Camous, 2007, pp. 367.

Надійшла до редколегії 16.11.10

УДК 631.4

В. А. Горбань

ОСОБЕННОСТИ ВЛИЯНИЯ ЭОЛОВО-ПОЧВЕННЫХ ОТЛОЖЕНИЙ НА СВОЙСТВА ЛЕСОУЛУЧШЕННЫХ ПОЧВ ПОЛЕЗАЩИТНЫХ ЛЕСОПОЛОС СТЕПНОЙ ЗОНЫ УКРАИНЫ

Днепропетровский национальный университет им. О. Гончара

Рассмотрены особенности эолово-почвенных отложений в полезащитных лесополосах степной зоны Украины и их влияние на свойства лесоулучшенных почв. Представлена сравнительная характеристика погребенных эолово-почвенным материалом лесоулучшенных почв и зональных почв по некоторым физическим свойствам, содержанию полевой влажности, содержанию и групповому составу гумуса, водорастворимым формам химических соединений.

Ключевые слова: эолово-почвенные отложения, лесоулучшенные почвы, полезащитные лесополосы.

В. А. Горбань

Дніпропетровський національний університет ім. О. Гончара

ОСОБЛИВОСТІ ВПЛИВУ ЕОЛОВО-ҐРУНТОВИХ ВІДКЛАДІВ НА ВЛАСТИВОСТІ ЛІСОПОКРАЩЕНИХ ҐРУНТІВ ПОЛЕЗАХИСНИХ ЛІСОСМУГ СТЕПОВОЇ ЗОНИ УКРАЇНИ

Розглянуто особливості еолово-ґрунтових відкладів у полезахисних лісосмугах степової зони України та їх вплив на властивості лісопокращених ґрунтів. Наведено порівняльну характеристику похованих еолово-ґрунтовим матеріалом лісопокращених ґрунтів та зональних ґрунтів за деякими фізичними властивостями, вмістом польової вологи, вмістом та груповим складом гумусу, водорозчинними формами хімічних сполук.

Ключові слова: еолово-ґрунтові відклади, лісопокращені ґрунти, полезахисні лісосмуги.

V. A. Gorban

O. Gonchar Dniepropetrovsk National University

PECULIARITIES OF AEOLIAN-SOIL DEPOSITS INFLUENCE ON THE QUALITY OF FOREST-IMPROVED SOILS OF FOREST SHELTER BELTS IN STEPPE ZONE OF UKRAINE

The peculiarities of aeolian-soil deposits of forest shelter belts in steppe zone of Ukraine and their influence on the quality of forest-improved soils are considered. The comparison characteristic of buried by aeolian-soil material forest-improved soils and zonal soils by certain physical properties, content of field water capacity, content and type content of humus, water-soluble forms of chemical compounds is produced.

Key words: aeolian-soil deposits, forest-improved soils, forest shelter belts.

В условиях степной зоны Украины под влиянием искусственных лесных насаждений формируются лесоулучшенные черноземы (Стадниченко, 1955), которые отличаются от зональных черноземных почв увеличенным содержанием гумуса и питательных веществ, большей емкостью поглощения, более глубоким вымыванием карбонатов, лучшими физическими свойствами (Соловьев, 1967; Травлеев, 1977; Белова, 1999; Новосад, 2001). Полезащитные лесополосы в степи являются аккумуляторами эолово-почвенного материала, который во время пыльных бурь выносится с полей. Мощность эолово-почвенных отложений в лесополосах в некоторых случаях достигает 2 м и более (Высоцкий, 1962; Долгилевич, 1978; Можейко, 2000; Травлеев, 2008).

Целью данной работы является исследование влияния отложений эолово-почвенных отложений на свойства лесоулучшенных почв полезащитных лесных полос в условиях степной зоны Украины.

ОБЪЕКТЫ И МЕТОДЫ ИССЛЕДОВАНИЯ

Свойства эолово-почвенных отложений в полезащитных лесополосах исследовались в условиях Присамарья Днепровского (Новомосковский р-н, Днепропетровская обл.) – чернозем обыкновенный лесоулучшенный с эолово-почвенными отложениями мощностью 47 см (ПП 203) и чернозем обыкновенный (ПП 202), Приазовья (Первомайский р-н, Донецкая обл.) – чернозем приазовский лесоулучшенный с эолово-почвенными отложениями мощностью 15 см (ПП ЧП–В1) и чернозем приазовский (ПП ЧП–В1к) и Аскании-Нова (Чаплинский р-н, Херсонская обл.) – темно-каштановая почва лесоулучшенная с эолово-почвенными отложениями мощностью 8 см (ПП АН–09) и темно-каштановая почва (ПП АН–09к).

Исследовались физические свойства: гранулометрический состав – ареометрическим методом, плотность скелета – методом парафинирования, плотность твердой фазы – пикнометрическим методом, общая пористость и диапазон активной влажности – с помощью расчетов, полевая влажность – весовым методом (Вадюнина, 1986); общий гумус определяли по И. В. Тюрину (Аринушкина, 1970), групповой состав гумуса – по М. М. Кононовой и Н. П. Бельчиковой (Орлов, 1981); водорастворимые формы химических соединений определяли по общепринятым методикам (Аринушкина, 1970).

РЕЗУЛЬТАТЫ И ИХ ОБСУЖДЕНИЕ

Отложение эолово-почвенного материала в полезащитных лесополосах в результате пыльных бурь, который характеризуется супесчаным гранулометрическим составом, приводит к увеличению содержания физического песка в верхних генетических горизонтах погребенных черноземах обыкновенных лесоулучшенных по сравнению с зональными черноземами обыкновенными (табл. 1). В результате этого происходит изменение лесорастительных условий лесополосы (Горбань, 2008).

Вследствие более легкого гранулометрического состава эолово-почвенные отложения и погребенных черноземов обыкновенных лесоулучшенных наблюдается их меньшая плотность скелета и плотность твердой фазы по сравнению с черноземами обыкновенными, что положительно влияет на формирование благоприятного водно-воздушного режима лесоулучшенных черноземов. Из-за меньшей плотности почвы с эолово-почвенным материалом характеризуются большей величиной общей пористости в сравнении с черноземами обыкновенными (табл. 1). В целом по почвенному профилю наблюдается постепенное увеличение плотности и уменьшение пористости, что обусловливается давлением верхних слоев почвы на нижние (Качинский, 1965).

Таблица 1

Гранулометрический состав и некоторые физические свойства эолово-почвенных отложений и погребенных черноземов обыкновенных лесоулучшенных (ПП 203) и эталонных черноземов (ПП 202)

Генетический горизонт	Содержание физической глины, %	Название почвы по гранулометрическому составу (по Н. А. Качинскому, 1965)	Плотность скелета, г/см^3	Плотность твердой фазы, г/см^3	Общая пористость, %
Пробная площадь 203					
H_1eol	21,63	суглинок легкий	1,16	2,22	47,9
H_2eol	17,61	супесок	1,26	2,39	47,4
[H]	15,11	супесок	1,31	2,27	42,4
[Hp]	30,29	суглинок средний	1,36	2,27	40,0
[Ph]	31,92	суглинок средний	1,30	2,25	42,3
Пробная площадь 202					
Hop	35,91	суглинок средний	1,33	2,45	45,7
H	39,15	суглинок средний	1,40	2,42	42,2
HP	34,73	суглинок средний	1,54	2,61	41,0
Pk	36,08	суглинок средний	1,58	2,57	38,5

Результаты исследования содержания полевой влажности в погребенных черноземах обыкновенных лесоулучшенных представлены на рис. 1. Максимальные величины полевой влажности обнаружены в верхнем слое эолово-почвенного материала и погребенном гумусовом горизонте, которые отличаются повышенным содержанием органического вещества. Рис. 2 иллюстрирует распределение полевой влажности в черноземе обыкновенном, которые, вследствие их более тяжелого гранулометрического состава, характеризуются более значительными запасами влажности в верхнем метровом слое (248 мм) по сравнению с черноземами обыкновенными лесоулучшенными с эолово-почвенными отложениями (220 мм).

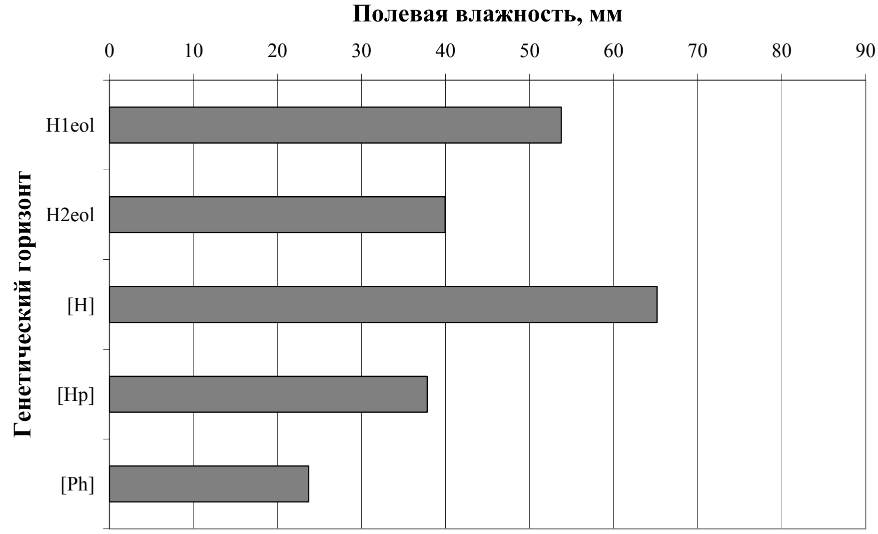


Рис. 1. **Содержание полевой влажности в эолово-почвенных отложениях и погребенных черноземах обыкновенных лесоулучшенных пробной площади 203** (октябрь 2009 г.)

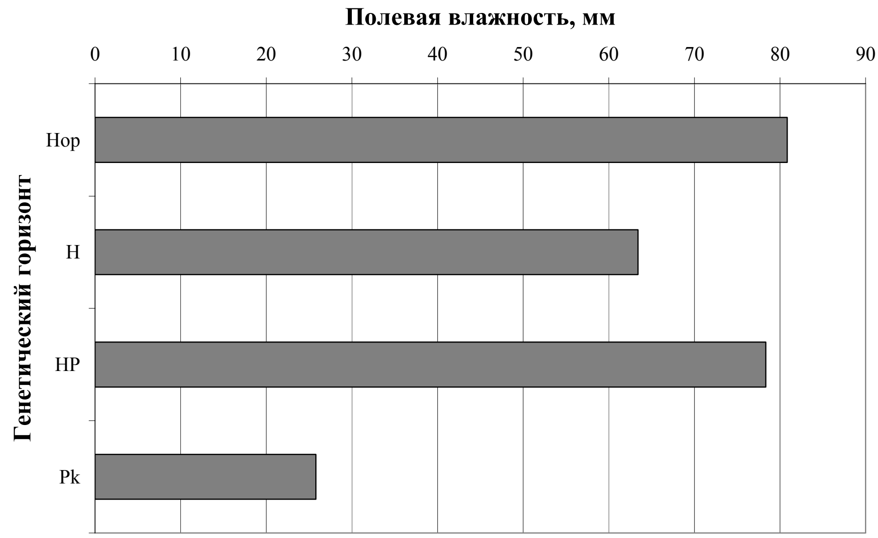


Рис. 2. **Содержание полевой влажности в черноземах обыкновенных пробной площади 202** (октябрь 2009 г.)

Черноземам обыкновенным характерны меньшие величины диапазона активной влажности (ДАВ) в сравнении с погребенными черноземами вследствие их более тяжелого гранулометрического состава, который обусловливает значительные запасы прочносвязанной влажности, которая является недоступной для использования растениями. Черноземы обыкновенные отличаются меньшей величиной ДАВ (206 мм) в сравнении с погребенными почвами (367 мм) в верхнем метровом слое. ДАВ черноземов обыкновенных составляет 43–62 % от полевой влагоемкости, а ДАВ погребенных черноземов – 73–76 %.

Исследованные темно-каштановые почвы и эолово-почвенный материал характеризуется гуматным типом обмена веществ по С. В. Зонну (1964). Эолово-почвенные отложения и погребенная темно-каштановая почва лесоулучшенная характеризуется большими запасами гумуса в сравнении с темно-каштановыми почвами (табл. 2). Также лесоулучшенные почвы отличаются от зональных почв большими величинами Сгк/Сфк.

Таблица 2

Содержание и состав гумуса в эолово-почвенных отложениях и погребенных темно-каштановых почвах лесоулучшенных (ПП АН–09) и эталонных темно-каштановых почвах (ПП АН–09к)

Генетический горизонт	Общий гумус	С общий	С гуминовых кислот	С фульво-кислот	С неразло-жившегося остатка	Сгк/Сфк
	%	%	% к почве			
Пробная площадь АН–09						
Heol	3,48	2,02	0,55	0,32	1,15	1,72
[H(e)]	3,90	2,27	0,61	0,31	1,34	1,97
[Hpk(i)]	2,84	1,65	0,45	0,27	0,93	1,67
[Ph]	1,59	0,92	0,21	0,20	0,51	1,05
Пробная площадь АН–09к						
Hop	3,07	1,78	0,54	0,31	0,93	1,74
Hp	2,45	1,42	0,44	0,23	0,75	1,91
Phk	2,07	1,20	0,34	0,22	0,64	1,55
Pks	1,76	1,02	0,23	0,21	0,59	1,07

Исследование водорастворимых форм химических соединений показало отсутствие признаков засоления как в эолово-почвенных отложениях и погребенных ними черноземов приазовских лесоулучшенных, так и черноземов приазовских (табл. 3). Среди анионов преобладает HCO_3^-, среди катионов – Ca^{2+}. Реакция водной вытяжки близка к нейтральной.

Таблица 3

Показатели анализа водной вытяжки эолово-почвенных отложений и погребенных черноземов приазовских лесоулучшенных (ПП ЧП–В1) и черноземов приазовских (ПП ЧП–В1к)

Генетический горизонт	Сухой остаток, %	Анионы, мг-экв./100 г почвы			Катионы, мг-экв./100 г почвы				pH водной вытяжки
		HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	K^+	
Пробная площадь ЧП–В1									
Heol	0,12	0,68	0,14	0,15	0,81	0,19	0,06	0,02	6,8
[H]	0,14	0,72	0,11	0,13	0,72	0,21	0,09	0,04	6,9
[Hp]	0,13	0,51	0,12	0,19	0,64	0,29	0,11	0,08	6,9
[Ph]	0,16	0,55	0,15	0,16	0,78	0,21	0,15	0,12	6,9
Пробная площадь ЧП–В1к									
Hop	0,07	0,53	0,13	0,42	0,84	0,26	0,14	0,03	6,9
H	0,08	0,61	0,14	0,24	0,66	0,30	0,11	0,02	7,2
hP	0,10	0,64	0,13	0,41	0,77	0,23	0,08	0,02	7,1
Pk	0,11	0,71	0,13	0,23	0,59	0,29	0,08	0,10	6,9

ВЫВОДЫ

В результате исследования свойств эолово-почвенных отложений, которые образовались вследствие пыльных бурь в полезащитных лесополосах степной зоны Украины, и их влияния на лесоулучшенные почвы было установлено, что:

1. Отложение эолово-почвенного материала в полезащитных лесополосах приводит к облегчению гранулометрического состава лесоулучшенных почв.

2. Эолово-почвенные отложения и погребенные почвы отличаются улучшенными физическими свойствами (плотность и пористость) по сравнению с зональными почвами.

3. Эталонные почвы характеризуются увеличенными запасами полевой влажности по сравнению с погребенными лесоулучшенными почвами, при этом эталонные почвы содержат меньше продуктивной влажности (ДАВ).

4. В погребенных лесоулучшенных почвах наблюдается увеличенное накопление общего гумуса и рост соотношения углерода гуминовых кислот к углероду фульвокислот по сравнению зональными почвами.

5. Погребенные лесоулучшенные и зональные почвы отличаются следами признаков осолонцевания.

СПИСОК ИСПОЛЬЗОВАННОЙ ЛИТЕРАТУРЫ

Аринушкина Е. В. Руководство по химическому анализу почв / Е. В. Аринушкина. – М. : МГУ, 1970. – 478 с.

Белова Н. А. Естественные леса и степные почвы (экология, микроморфология, генезис) / Н. А. Белова, А. П. Травлеев. – Д.: ДГУ, 1999. – 348 с.

Вадюнина А. Ф. Методы исследования физических свойств почвы / А. Ф. Вадюнина, З. А. Корчагина. – М.: Агропромиздат, 1986. – 416 с.

Высоцкий Г. Н. Материалы по изучению черных бурь в степях России / Г. Н. Высоцкий // Избранные сочинения. Т. 2. Почвенные и почвенно-гидрологические работы. – М.: АН СССР, 1962. – С. 9-18.

Горбань В. А. Особливості впливу еолових відкладів на лісорослинні умови степової зони України / В. А. Горбань // Екологія та ноосферологія. – 2008. – Т. 19, № 3-4. – С. 83-87.

Долгилевич М. И. Пыльные бури и агролесомелиоративные мероприятия / М. И. Долгилевич. – М.: Колос, 1978. – 160 с.

Зонн С. В. Почва как компонент лесного биогеоценоза / С. В. Зонн // Основы лесной биогеоценологии. – М. : Наука, 1964. – С. 372-457.

Качинский Н. А. Физика почвы / Н. А. Качинский. – М.: Высш. шк., 1965. – 322 с.

Можейко Г. А. Лесо-аграрные ландшафты Южной и Сухой Степи Украины / Г. А. Можейко. – Х.: ООО «ЭНЕЙ», 2000. – 312 с.

Орлов Д. С. Практикум по химии гумуса / Д. С. Орлов, Л. А. Гришина. – М. : МГУ, 1981. – 272 с.

Соловьев П. Е. Влияние лесных насаждений на почвообразовательный процесс и плодородие степных почв / П. Е. Соловьев. – М. : МГУ, 1967. – 292 с.

Стадниченко В. Г. Почвы Велико-Анадольского леса / В. Г. Стадниченко // Велико-Анадольский лес. – Х.: ХГУ, 1955. – С. 53-63.

Травлеев А. П. Лес как фактор почвообразования / А. П. Травлеев, Н. А. Белова // Ґрунтознавство. – 2008. – Т. 9, № 3-4. – С. 6-26.

Травлеев А. П. Характеристика почв лесных культурбиогеоценозов настоящих степей УССР / А. П. Травлеев // Вопросы степного лесоведения и охраны природы. – Д.: ДГУ, 1977. – С. 8-21.

Надійшла до редколегії 15.12.10

ОХОРОНА НАВКОЛИШНЬОГО СЕРЕДОВИЩА ЛЮДИНИ

UDK 631.4

A. Martínez Camero, J. Gil Torres, J. M. Recio Espejo

SOIL SALINITATION AND ENVIRONMENTAL CONSERVATION: RAMSAR NATURAL RESERVE OF EL CONDE SMALL-LAKE (LUQUE, CÓRDOBA, SPAIN)

University of Córdoba, Spain

The main objective of this paper is a geomorphological and sedimentary study about the international *Ramsar* Reserve of El Conde small-lake (Córdoba, Spain) to know its genesis and current evolution, and to have more details about the probably influence of anthropic activities in its formation with collecting and detour of two around streams and the arrival of sediments to a gypsum triassic depression.

Key words: anthropogenesis, Ramsar Reserve formation, El Conde small-lake, Spain.

А. Мартинез Камеро, Х. Гіл Торрес, Х. М. Рецio Еспехо

Університет Кордоби, Іспанія

ЗАСОЛЕННЯ ҐРУНТУ ТА ЗАХИСТ НАВКОЛИШНЬОГО СЕРЕДОВИЩА: РАМСАРСЬКИЙ ПРИРОДНИЙ ЗАПОВІДНИК (КОРДОБА, ІСПАНІЯ)

В роботі описано геоморфологічне та осадкове дослідження міжнародного Рамсарського заповідника озера Ель Конде (Кордоба, Іспанія), метою якого є вивчення походження та еволюції даного озера, а також одержання більшої інформації про можливий вплив людини на його формування, появі двох потоків навколо нього і накопиченні осадку в гіпсово-тріасову впадину.

Ключові слова: антропогенез, Рамсарський заповідник, озеро Ель Конде, Іспанія.

А. Мартинез Камеро, Х. Гил Торрес, Х. М. Рецио Эспехо

Университет Кордобы, Испания

ЗАСОЛЕННОСТЬ ПОЧВЫ И ЗАЩИТА ОКРУЖАЮЩЕЙ СРЕДЫ: РАМСАРСКИЙ ПРИРОДНЫЙ ЗАПОВЕДНИК (КОРДОВА, ИСПАНИЯ)

В работе описано геоморфологическое и осадочное исследование международного Рамсарского заповедника озера Эль Конде (Кордоба, Испания), целью которого является изучение происхождения и эволюции данного озера, а также получение большей информации о возможном влиянии человека в его формировании, появлении двух потоков вокруг него и накоплении осадка в гипсово-триасовую впадину.

Ключевые слова: антропогенез, Рамсарский заповедник, озеро Эль Конде, Испания.

"El Conde" small-lake (40-100 hect. surface) (Luque, Córdoba, Spain) (Fig.1) is currently an international *Ramsar* Reserve, located in a typical mediterranean semiarid region of the southern part of Spain (Recio Espejo, 1988). Its genesis and evolution are directly relationed with an anthropic control carried out in the end of XIX century (Arjona y Estrada, 1977), and with some swamp soils problems in the neighbouring area Fig. 2 y 3). The dynamic of this ecosystem is initially related with a current geomorfological evolution of the drainage net during late-holocene (catchs, palaeo-valley and palaeo-streams) (Fig. 4 y 5), controlled by a great plain take up by triasic gypsum (El Salobral) (IGME 1988) that constituted the local basin topographic-level. And later by a human and historical connection/canalizing during XIX century of two independent fluvial streams. A greater water volume and sediment arrival in this hydrological basin would be the main factor of small-lake water sheet origin.

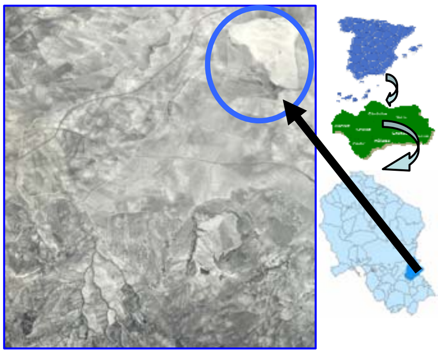


Fig. 1**. Geographical location of El Conde small-lake**

Fig. 2**. “El Conde”smalle-lake in landscape around**

Fig. 3**. “El Conde” small-lake**

MATERIALS AND METHODS

Geological information to 1:50.000 scale (IGME, 1988), aerial photographs (1955), topographic maps (1:10.000), core by percussion Hammer model HM1800; colour (Munsell Color,1990); carbonate contents (Duchaufour, 1975); X-ray difracction minerals identification (Bryndley and Brown, 1980); water physico-chemical characteritation (M.A.P.A.,1999). The preexisting bibliography and the field works completed the materials used.

Figure 4 contain Carrascón headwater stream to ±600 m. altitude and with NNW direction. At ±500 m. a important direction change is carried out, changing its course to NE direction with a clear palaeovalley and stingy capture. In ±470 of altitude existing a clear aluvial fan inmersed in olive area cultivation. This geoecological situation with sediments and hidromorphic presence make impossible the cultivation development.

To remove this natural situation, a channel was build to connect this alluvial fan in the finish part of the stream with the initial sector of other smaller water course present in triassic plain and communal territory of El Salobral area (Fig. 5). Here a paleovalley at 470-430 m. altitude and a clear migration of drainage system to SE direction is very clear too. The new water stream created would be the valley of current Carrascón river.

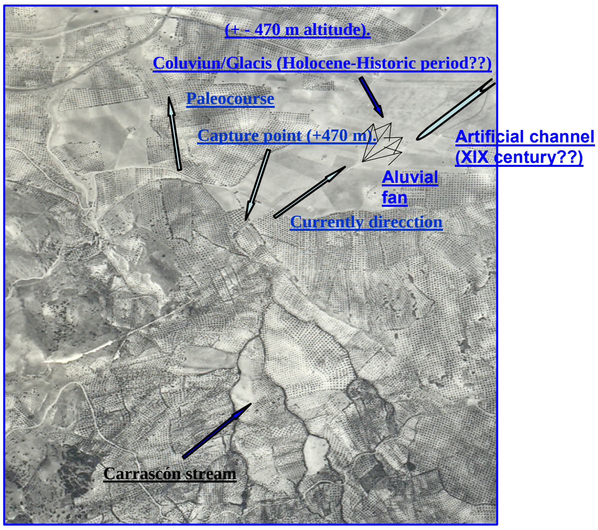


Fig. 4. **Geomorfological interpretation of initial part of Carrascon stream**

This artificial new situation provoked the formation of ±120 cm. thickness clayed sediments, no carbonate and illitic nature above the gypsum plinth. The permeability discontinuity existing between both materials to permit the formation of an underground water layer strongly saline (164 g/l) responsible during the dry winter and summer period of the water sheet small-lake ecosystem formation (±100 cm of depth).(Fig. 5).

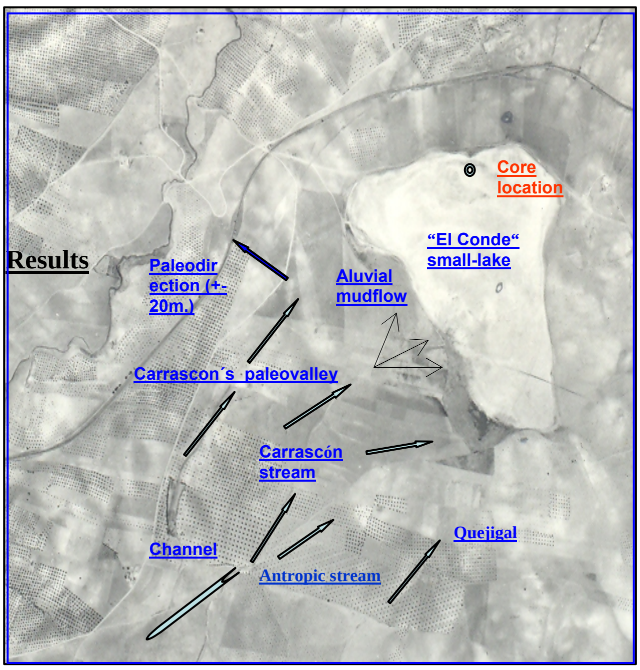


Fig. 5. **Geomorfological interpretation of final part of Carrascon stream**

Figure 6 summarize the physico-chemical characterization of this sediments in a core made in the small-lake bottom depresión (photograph, 1) (Figure 5). The chroma is indicative of this new situation too: grey in sediments by the hydromorfic situation, and white colours in gypsum lithology (Munsell colour, 1990). The X-ray diffraction shows the presence of smectites and illite minerals in sediments, and only gypsum in material parental.

Table II contain the analysis of this sub-surface water, with a very high concentration in salt dissolved derived by the evaporation-drained annual processes (Fig. 7).

Fig. 7**. El Conde small-lake bottom during the summer period (salts deposit)**

CONCLUSIONS

The search for a permanently solution to an agricultural problem in XIX century motivated the formation of the currently international *Ramsar* Reserve of El Conde small-lake. An ancient agricultural problem was transformed in a currently ecological advantage.

A natural evolution of drainage water network during holocene period represented an initial situation of important changes in the territory. Human activities were the final creative of the current landscapes.

With the new results obtained the ecological and hydrological functioning model of Moya (1988) must be changed.

REFERENCES

Arjona Castro, A.; Estrada Castillo, V. 1977. Historia de la villa de Luque (Córdoba). Edit. Escudero. Córdoba. 326 pp.

Brindley, C.W.; Brown, C. 1980. Crystal structures of clay minerals and their X-ray identification. Mineralogical Society. London.

Duchaufour, Ph. 1975. Edafología. Edit. Toray-Masson. Barcelona. 476 pp.

IGME 1988. Hoja geológica a escala 1: 50.000 nº 967 (Baena). Public. Instituto Geológico y Minero de España. Madrid.

M.A.P.A. (1999): Métodos de análisis del Ministerio de Agricultura, Pesca y Alimentación. Public. Secretaría Gral. Técnica. Madrid.

Moya Mejías, J.L. 1988. Hidrogeología de las Zonas Húmedas de la provincia de Córdoba. Tesis Doctoral. Universidad de Córdoba.

Munsell Color 1990. Munsell Soil Color Charts. Koll Morgen Instruments Corporation. Maryland.

Recio Espejo, J. M. 1988. Aspectos genéticos del fenómeno endorreico al sur de España. La laguna de El Conde (Luque, Córdoba). Estudia Oecológica. VII: 7-18.

Надійшла до редколегії 25.11.10

UDK 574.4

J. Roldán[1], E. Cabrera[2]

STRATEGIES AND MEASURES TO MITIGATE DROUGHT IMPACTS

[1]University of Cordoba, Spain
[2]Polytechnic University of Valencia, Spain

The authors of this paper share their own reflections on drought and drought management. Different aspects such as the development of drought impact matrixes, drought impact assessment and strategies designed to mitigate drought have been discussed here. Direct long term or proactive actions, direct short term or reactive actions and supplementary or indirect actions are also analyzed.
Key words: drought, drought management, drought impacts.

Х. Ролдан[1], Е. Кабрера[2]
[1]Університет Кордоби, Іспанія
[2]Політехнічний університет Валенсії, Іспанія

СТРАТЕГІЇ ТА ЗАХОДИ З ПОПЕРЕДЖЕННЯ ДІЇ ПОСУХИ

В роботі описано форми дії посухи, оцінювання даного впливу, а також стратегії, спрямовані на скорочення розвитку посухи. Аналізуються прямі довгострокові або профілактичні заходи, прямі короткострокові або реактивні заходи, а також додаткові або посередні заходи.
Ключові слова: посуха, система контролю посухи, дія посухи.

Х. Ролдан[1], Э. Кабрера[2]
[1]Университет Кордобы, Испания
[2]Политехнический университет Валенсии, Испания

СТРАТЕГИИ И МЕРЫ ПО ПРЕДУПРЕЖДЕНИЮ ВОЗДЕЙСТВИЯ ЗАСУХИ

В настоящей работе описываются формы воздействия засухи, оценивание данного воздействия, а также стратегии, направленные на сокращение развития засухи. Анализируются прямые долгосрочные или профилактические мероприятия, прямые краткосрочного или реактивные мероприятия, а также дополнительные или косвенные мероприятия.
Ключевые слова: засуха, система контролирования засухи, воздействие засухи.

Drought can be defined as a long period of abnormally low rainfall or a prolonged shortage of rainfall, especially one that adversely affects growing or living conditions. Drought is a natural phenomenon with a cyclic behavior more frequent in regions where rainfall is very irregular. However, climate change seems to be responsible for the increase in extreme weather, such as floods and droughts, in other regions.

In this paper, the authors will discuss aspects such as the development of drought impact matrixes, drought impact assessment and strategies designed to mitigate droughts. All droughts raise, namely, “How much damage is inflicted by drought?”, “Who is most affected by drought?” and “Where is damage inflicted most?” With this aim, the present document is structured in such a way as to bring to light certain initiatives whose results have provided an adequate answer to these three questions. The first question can be answered from impact matrixes that have been developed to facilitate decision-making process during periods of drought (WDCC, 1998; Rossi et al., 2005). The answer to the second question can be found in the Drought Management Plans that have been developed for this purpose (Wilhite et al., 2005), while the third can be answered from our knowledge about available water resources, the uses that must be satisfied, the possibilities for saving water, and finally, the flexibility of the system.

The most innovative document is one in which the impact of droughts is assessed by means of matrixes constructed for the three components that lead to sustainable water policy: social, economic and environmental. Not only do we require the necessary resources and time to carry an action out, but must also consider if such an action or measure can be applied immediately or not; an essential step towards defining whether actions are direct or indirect. At the same, direct actions can be either of a long term (or proactive) nature or short term (or reactive) nature.

GENERAL IDEAS ABOUT ACTIONS

Let us first refer to direct long term or proactive actions. These are actions whose results become evident particularly in the mid and long term. Ultimately, they are actions which will permit water policy to be adapted to the current circumstances. Secondly, there are short term or reactive actions which are implemented during a drought and follow the pace of its evolution. To a large degree their efficacy will depend on the proactive actions that have been implemented in advance. Thirdly, there are the so-called supplementary or indirect actions. This type of action is aimed at facilitating the implementation and development of the other groups of measures (proactive or reactive) with which drought is managed in a direct manner.

Let us take a look at the figure 1 (USACE, 1994), which defines drought from a hydrologic viewpoint. While water availability largely depends on the hydrologic year, consumption follows a more uniform pattern. Although the possibilities of increasing water supply are limited in developed countries, the margin of action concerning consumption is much larger and continues to widen. In any case, proactive measures are understood as any action that either contributes to increasing resources (for example, reutilization) or permits water use to be reduced (for example by improving water network performance). Measures of a proactive nature require time and how and to what degree they should be implemented necessitates discussion and negotiation in times of abundance. We should not forget that, in addition to time, all measures require funding and on many occasions, legal reforms. Periods of drought clearly do not favor the proper state of mind needed to introduce the far-reaching proactive measures.

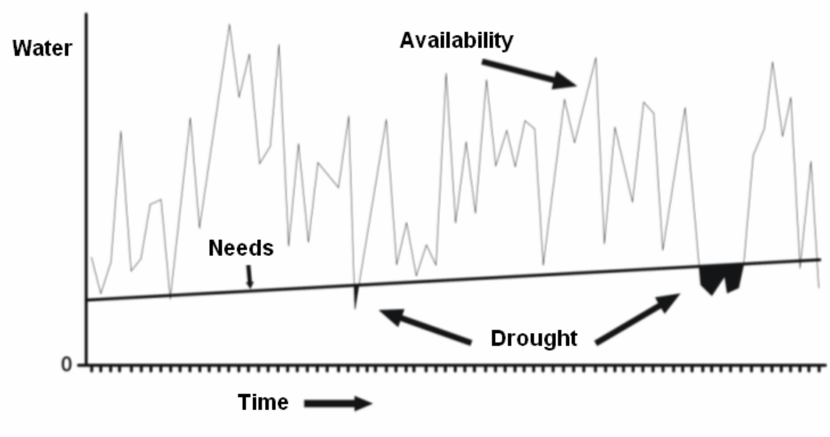


Fig. 1. **Drought from a hydrologic viewpoint**

On the other hand, reactive measures are measures which are implemented to reduce impact when in the throes of a drought. In other words, these are strategies which are taken during periods of scarcity, but which should be negotiated by all of the parties involved when the situation is "normal". To reduce the impact of water shortage it is useful to previously develop an impact matrix that classifies the consequences of drought and allows decisions to be made in a reasonable manner. One example of an impact matrix for drought management (figure 2) has been developed in detail by the Western Drought Coordination Council (WDCC, 1998).

In short, drought impact decision matrixes are little more than assessment tools that account for a variety of criteria (those in the table are some of the most obvious, but not the only ones) concerning the damage that can be inflicted as a result of restrictions. Based on the final ranking in the matrix analysis, it is possible to establish how to ration water in the most convenient way from the viewpoint of the general public (Wilhite et al., 2005).

Impact	Cost	Equally Distributed?	Growing?	Public Priority?	Equitable Recovery?	Impact Rank

Fig. 2. **Example of an impact matrix**

It is common to group impacts according to a variety of criteria (economic, environmental and social) that should be envisaged in all sustainable water management plans. The first of these, albeit not necessarily the most important, are the most evident. Thus, for example, the loss of crops or livestock or the costs incurred when water is restricted are perfectly quantifiable. On the other hand, environmental impacts include, among many other consequences, the loss of animal and plant diversity or the disappearance of wetlands and natural springs. Finally, droughts produce numerous social impacts. An example of this type of impact includes the numerous conflicts that arise among users who compete for water in times of drought. A detailed list of such impacts appears in a report by the Western Drought Coordination Council (WDCC, 1998). This report also includes tree diagrams to analyze and follow-up on impacts in terms of the different uses.

Yet of all these criteria, the economic criterion is the most "measurable" (that which is most quantifiable) and obvious of all. It should come as no surprise, then, that researchers and institutions (Jenkins et al., 2003; USACE, 1994) propose methods to analyze the economic losses deriving from water shortages. There is no question that mitigating the economic impact is an essential part of proper drought management.

In fact, measures are considered reactive precisely because of the fact that they are provisional. But their development, discussion and implementation are conditioned not only by the physical and legal framework which encompasses them, but by the serenity that they demand. When the necessary calm is lacking, it is almost impossible to discuss priorities. When restricting consumption, the ranking will be more efficient the more robust the system.

Finally, there is a wide range of actions aimed at minimizing the impact of drought. However, as they do not directly affect the water balance, they should not be considered direct measures. Instead, these are measures that serve to complement direct actions as their ultimate objective is none other than to smooth the way for the latter. Thus, for example, a new economic water policy oriented towards promoting efficiency and therefore giving meaning to a large number of direct actions, indirectly contributes to achieving a balance between resources and uses; an especially difficult balance to reach in times of drought.

DIRECT PROACTIVE ACTIONS

Because these measures are incompatible with improvised actions, they should be implemented in a progressive manner. The principle measures are outlined below according to how they contribute to increasing resources or rationalizing consumption.

Increasing and diversifying supply

- New storage facilities.
- New surface water extractions, generally through transfers between basins.
- Centers for the exchange of water rights.
- Desalination.
- New groundwater extractions.
- Recharging aquifers, a simple and efficient way to conjunctively use surface waters and groundwaters that should be highlighted in an explicit manner.
- Reutilization.
- Optimize resources through better hydrologic planning and monitoring. Make better use of the enormous possibilities that the conjunctive use of surface waters and groundwaters affords, especially in times of drought.

- Finally, it is fundamental to manage a system's resources in preparation for episodes of drought. To do so, it is essential to have an adequate early warning system and drought characterization system as well as using mathematical models that aid in decision-making processes for the management of reservoirs in real time according to the risk of drought (Andreu et al., 1996; Rossi et al., 2005).

Many of these actions require an extended period of implementation, large budgets, political negotiation, social acceptation and when appropriate, modifications to the legislation. This is of foremost importance given that these are works which, in addition to affecting hundred of thousands of people, will be carried out over several terms of office from the time they are conceived until they become operational.

The actions above were ranked beginning with the most difficult (of any kind) to develop and concluding with the easiest to implement. Nevertheless, and as regards their execution, the final decision should, as always, be based on economic, environmental and social criteria. Logically, the work concerning these actions should be oriented towards analyzing the minimum requisites demanded by each of them and from there, assessing their possibilities for development and ultimately, their feasibility. Finally, a comparative analysis of the possibilities afforded by each and every one of the strategies would be of great utility.

Managing demand

This second via began to be explored in detail in the developed world some decades ago and thanks to this new line of study the margin of savings is now quite large. A recent survey (Pacific Institute, PI, 2003), which serves as a point of reflection, estimates the potential savings in urban and residential water use in California (where for some years programs have been set up to foment efficiency) at a minimum of 33%.

While potential savings in urban and residential water use is notable in Spain, it only accounts for a quarter of the demand in the country and in fact, much greater savings can be achieved in irrigation. Indeed, there are clear indications to this effect. When assuming the energy costs for elevation, groundwater irrigation is five times more productive than surface water irrigation in economic terms (Corominas, 2000). In this line, and according to the provisions set out by the Ministry of Agriculture, Fisheries and Foods (MAPA, 2002) in the National Irrigation Plan, more than 5000 hm3 of irrigation water can be saved in Spain through programs to improve water consumption in irrigated areas and reduce excess supply. Indeed, due to the important role of irrigation, numerous studies have been dedicated to optimizing water use in the countryside (Pereira et al. 2002). This knowledge is essential for managing droughts in a rational manner.

These are specific actions that contribute to reducing water demand which on many occasions need to be adapted to the different uses to which water is put (urban, residential, commercial, agricultural and industrial). Among others, these include:

- Measuring all of the uses and resources (including groundwater wells).
- Improving the performance of water transport systems (canals, irrigation channels, transport and distribution pipelines and even installations inside buildings).
- Using rainfall (water harvesting).
- Reutilization of gray waters in homes and industries. Industrial recirculation.

DIRECT REACTIVE ACTIONS

In this second group, we must refer to the decision tree diagram that sets out how to manage a drought according to its evolution based on the established protocol and taking into consideration risk matrixes. These are decision trees or protocols that, in accordance with current legislation and logic, should take into account at least two levels: that of the hydrographic basins and that of the city.

The protocols have to summarize and discuss all of the factors that must be taken into consideration in the event of a drought. They include such issues as the makeup of the teams in charge of developing a drought management plan, how to reconcile conflicting interests, methods of measurement that must be taken into account with a view to making objective decisions as well the negative impact of outdated legislation on drought management.

It is important to highlight that after consulting the vast information that is available on this issue, especially in the United States (drought management plans for thirty different states can be found at http://drought.unl.edu/plan/stateplans.htm/), we have come to the conclusion that the Drought Management Plans developed in any country must follow similar criteria.

In Spain, we are all, in some way or another, following in the wake of the Isabel II Canal, city of Madrid, that has recently updated its plan (Cubillo and Ibáñez, 2003); a plan that is, without a doubt, a first-rate document. But, as I have already said, due to its singular characteristics, the Isabel II Canal is not an example that can be followed by the majority of Spanish cities.

This is not the case of England where the Environment Agency (EA, 2003) has recently published the second revision of the drought management plans developed by water companies in the country. Prior to these plans, the EA had provided clear guidelines for drought management.

Many other urban contingency plans are available on water company websites, especially those which are publicly owned. This is the case for example of Melbourne Water in Australia (MWC, 2001) or Denver Water in the United States (DW, 2004). The Water Conservation Committee of the AWWA (WCC, 2002) has developed a model drought management plan. This plan serves as a support tool for the development of drought plans that will facilitate the work of managers in water companies.

Considering the above, the excellent and thorough work Managing Water for Drought (USACE, 1994) merits particular attention as it is the result of a thorough study carried out by more than one hundred professionals. The study was conducted in the early nineties and it was the administration's reaction to the low rainfall recorded in the western United States at the end of the eighties.

SUPPLEMENTARY OR INDIRECT SUPPORT ACTIONS

Given that the indirect actions do not directly mitigate the effects of drought - even when they lead to the success of direct actions of both reactive and proactive kind - we will considered them separately by structuring them into two different blocks according to the type of direct actions that they influence.

Measures that support proactive actions

These measures facilitate the implementation of complex, but necessary direct proactive actions. Among others, these include:

- Citizen awareness.
- The participation of sociologists and communicators that aid in transmitting the message.
- Media involvement.
- Foster citizen participation.
- Adequate economic policies that foment efficiency and flexibility of use.
- Proactive water policies that monitor both water use and water resources.
- Adapt the legislation to the current context. Revise historical water rights.
- Adaptation of the administration. Water management and monitoring needs to be coordinated.
- Centers for the exchange of water rights.
- Provide technical assistance to towns and irrigation communities

The importance of the first four actions in the above list should be underscored. These are actions that are essential to achieving the viability of the other actions. The remaining actions are those that directly contribute to mitigating the impact of drought. However, it is clear that if we do not prepare the ground beforehand, it will be unfeasible to implement them.

Measures that support reactive actions

A Drought Management Plan resembles a decision tree diagram which, depending on the circumstances, guides planners in one direction or another. Decision-making is a dynamic process. In short, all of the actions that permit us to remain one step ahead of the problem are included in this section, as well as supplementary actions. Forecasting and characterizing droughts is a research topic that has gone hand in hand with the stochastic analysis of hydrologic series (Yevjevich, 1967; Dracup et al., 1980). Due to the growing impact of water shortages, research continues to be conducted in this line (Salas et al., 2005).

However, in order to manage drought in such a way as to mitigate its impact before a drought occurs, and from the viewpoint of needs that must be satisfied, we must assess the water deficit. The balance between availability and need is the origin of other indicators; indicators which activate the various stages of a Drought Management Plan (Fisher and Palmer, 1997). To sum up, when reliable information is available, it is possible to foresee the events and properly manage reactive actions that have been designed in advance for this purpose.

The remaining strategies and actions either facilitate the development of drought management plans (conflict management) or promote both the acquisition and dissemination of knowledge. All of these actions would therefore include:

- Meteorological accurate follow-up and adequate data treatment.
- Meteorological drought indicators.
- Drought management indicators.
- Activation thresholds for the different phases of a plan.
- Conflict resolution.
- International relations.
- Technical assistance.

CONCLUSIONS

The main conclusion that can be drawn from the above is that a drought cannot be managed efficiently without a plan that has been properly developed beforehand. A plan that takes into account both proactive and reactive measures will permit exceptional measures to be reduced to a minimum; measures which until now have been applied in a systematic manner (curiously, exceptional is an antonym of systematic) and characterize the actions implemented by water administrations in many countries in times of drought. Thus, the final goal is to ensure that planning, rather than improvisation, prevails in the event of a drought.

The economic, social and environmental impacts caused by the increasingly frequent water shortages occurring in the 21st century will continue to worsen. Although it has not been mentioned explicitly in this report, we should not forget the looming threat of climate change, making rational drought management of vital importance to the future. To achieve such an aim, however, we must travel down a very long road that should not demoralize those who walk upon it.

REFERENCES

Andreu J., Capilla J. and Sanchis E., 1996. AQUATOOL: A generalized decision support system for water resources planning and operational management. Journal Hydrology, 177:269-291.

Corominas J., 2000. El papel económico de las aguas subterráneas en Andalucía. Papeles del Proyecto Aguas Subterráneas. Fundación Marcelino Botín.

Cubillo F. and Ibáñez J.C., 2003. Manual de abastecimiento del Canal de Isabel II. Canal de Isabel II. Madrid.

DW (Denver Water). 2004. Drought Response Program. http://www.denverwater.org/drought/DRP04_04.html/

Dracup J.A., Lee K.S., Paulson Jr. E.G., 1980. On the definition of droughts. Water Resources Research, 16(2):297–302.Environment Agency (EA), 2003. Review of water company drought plans. Environment Agency, Rio house, Bristol, UK.

EA (Environment Agency). 2003. Review of water company drought plans. Environment Agency, Rio house, Bristol, UK.

Fisher S. and Palmer R.N., 1997. Managing water supplies during drought: triggers for operational responses. Water Resources Updated, 3(108):14-31.

Jenkins M.W., Lund J.R. and Howitt R.E., 2003. Economic losses for urban water scarcity in California. Journal of the American Water Works Association (AWWA).

MAPA (Ministry of Agriculture, Fisheries and Foods). 2002. Plan Nacional de Regadíos. Horizonte 2008. Madrid.

MWC (Melbourne Water Corporation). 2001. Drought Response Protocol. www.melbournewater.com.au/

PI (Pacific Institute). 2003. Waste not, want not. The potential for urban water conservation in California. Pacific Institute, Oakland, California.

Pereira L.S., Cordery I. and Iacovides I., 2002. Coping with water scarcity. Technical Documents in Hydrology nº 58. UNESCO. Paris.

Rossi G., Cancelliere A. and Giuliano G., 2005. Case Study: Multicriteria Assessment of Drought Mitigation Measures. Journal of Water Resources Planning and Management.

Salas J.D., Fu C., Cancelliere A., Dustin D., Bode D., Pineda A., and Vicent E., 2005. Characterizing the severity and risk of drought in the Poudre River, Colorado. Journal of Water Resources, Planning and Management.

USACE (U.S. Army Corps of Engineers, Institute for Water Resources). 1994. Managing Water for Drought. IWR Report 94 – NDS – 8, USACE, USA.

WCC (Water Conservation Committee). 2002. Drought Management Planning. Drought Management Handbook, pp. 1-37. American Water Works Association, Denver

WDCC (Western Drought Coordination Council). 1998. How to reduce drought risk. Western Drought Coordination Council, USA.

Wilhite D.A., Hayes M.J. and Knutson C.L., 2005. Drought Preparedness Planning: Building Institutional Capacity. Chapter 5 (pp. 93-135) in Drought and Water Crises: Science, Technology and Management issues. Ed. Taylor and Francis.

Yevjevich, V.M., 1967. An objective approach to definition and investigation of continental hydrologic droughts. Hydrology Pap. 23, Col. State Univ., Fort Collins, USA.

Надійшла до редколегії 17.11.10

UDK 574.4

T. A. Zubkova

POLLUTION IN HUMID AND ARID ZONE OF RUSSIA

Lomonosov Moscow State University, Russia

In the paper the pollution factors in different zones of Russia are studied. The difference between further fate of technogenic associations in humid and arid regions is analyzed.

Key words: pollution, technogenic associations, humid zone, arid zone.

Т. О. Зубкова

Московський державний університет ім. М. В. Ломоносова

ЗАБРУДНЕННЯ ВОЛОГИХ ТА ПОСУШЛИВИХ ОБЛАСТЕЙ РОСІЇ

У роботі досліджуються фактори забруднення різних областей Росії. Аналізується різниця між подальшим розвитком техногенних сполук у вологих та посушливих регіонах.

Ключові слова: забруднення, техногенні сполуки, волога зона, посушлива зона.

Т. А. Зубкова

Московский государственный университет им. М. В. Ломоносова

ЗАГРЯЗНЕНИЕ ВЛАЖНЫХ И СУХИХ ОБЛАСТЕЙ РОССИИ

В работе исследуются факторы загрязнения различных областей России. Анализируется разница между дальнейшим развитием техногенных соединений во влажных и засушливых регионах.

Ключевые слова: загрязнение, техногенные соединения, влажная зона, засушливая зона.

There are three associations of elements in soils: geochemical, inherited from the rock, biochemical - inherited from the plants and biogeochemical or soil.

In rocks a correlation of chemical elements is more stably. The biochemical association depends on selectivity of plants in relation to elements. For enough mature soils this correlation is stable for the concrete territory, but differs from biochemical and geological. The technogenic association sharply changes a correlation of elements in soils. And this can serve as the passport for revealing of pollution source. For example, in east area of Moscow, where there are 3 factories, pollution of soils by metals (Cu, Pb, Hg, Zn and others) is established. It is possible to define, from what factory there is a pollution on a correlation of technogenic elements.

Natural associations of elements are selected on structure of rock, plants and on soil structure. These three associations can connect with technogenic association, which it is easy to define on a ratio of elements, even at an initial stage. It is possible to reveal a direction of technogenic associations development at continuation of technogenic influence.

The composition of technogenic association is defined by intensity of pollutant, technogenic object, distant from object and an area wind rose. These parameters or pollution factors are studied. "However it is not enough attention to influence of soils on the further pollution fate. The part of technogenic association can change up to a total disappearance depending on character of a soil matrix, type of a water regime, a hydrological soil profile. .

Theoretically it is necessary to expect that in humid and arid regions the further fate of technogenic associations will be different. In humid regions the part of elements will leave with a water drain in ground waters, the rivers and the seas. Other part will be preserved in humus and illuvial horizons. In arid soils all elements will be fixed in the top horizons of soils and not to move almost on a profile. Pollution in arid conditions remains as a constant factor of these soils. The essential changes of a composition of technogenic association are possible in humid soils.

In arid and humid soils, one of the factors determining the fate of pollution (anthropogenic associations) is geochemical barriers. They accumulate number of elements, changing their ratio compared to the original technogenic association, and create a new soil association.

The microrelief participates in redistribution of polluting substances also. However if in an arid zone pollutants are more on macroelevation, in humid zone is on the contrary.

The accumulation of metals is a new stage in the soil life. Heavy metals interact with organic matter and form organometallic complexes that are catalysts for chemical reactions in the soil. Oxides of manganese and iron accelerate the redox reactions, for example - decomposition of hydrogen peroxide and organic hydroperoxides. There are Fe-Mn formations and mangaia (manganese Kutans), which many in the lower soil horizons (horizons B). We should expect new catalytic reactions (even unpredictable) as a result of pollutants accumulation in the soil.

Надійшла до редколегії 25.11.10

UDK 631.4

D. M. Onoprienko

AGRO-ECOLOGICAL BASIS OF FERTIGATION APPLICATION IN THE NORTHERN STEPPE OF UKRAINE

Dnepropetrovsk State Agrarian University

The presented results of long-term fertigation research are aimed at energy and resources increase by optimization of norms, methods and timing of mineral fertilizers under intensive cultivation technology of maize for corn growing, taking into account environmental factors.

Such studies are of great importance for the development and justification of resource and environment-friendly cultivation techniques of growing programmed yields of maize under irrigation.

Key words: fertigation, mineral fertilizers, yield.

Д. М. Онопрієнко

Дніпропетровський державний аграрний університет

АГРОЕКОЛОГІЧНІ ОСНОВИ ЗАСТОСУВАННЯ ФЕРТИГАЦІЇ В ПІВНІЧНОМУ СТЕПУ УКРАЇНИ

Наведені результати багаторічних наукових досліджень фертигації спрямовані на підвищення енерго- та ресурсозбереження насамперед завдяки оптимізації норм, способів і термінів внесення мінеральних добрив за інтенсивної технології вирощування кукурудзи на зерно з урахуванням екологічних факторів.

Такі дослідження мають велике значення для розробки та обґрунтування ресурсозберігаючих те екологічно безпечних технологій вирощування запрограмованих урожаїв зерна кукурудзи при зрошенні.

Ключові слова: фертигація, мінеральні добрива, урожай.

Д. М. Оноприенко

Днепропетровский государственный аграрный университет

АГРОЭКОЛОГИЧЕСКИЕ ОСНОВЫ ПРИМЕНЕНИЯ ФЕРТИГАЦИИ В СЕВЕРНОЙ СТЕПИ УКРАИНЫ

Приведенные результаты многолетних научных исследований фертигации направлены на повышение энерго- и ресурсосбережения за счет оптимизации норм, способов и сроков внесения минеральных удобрений при интенсивной технологии выращивания кукурузы на зерно с учетом экологических факторов.

Такие исследования имеют большое значение для разработки и обоснования ресурсосберегающих и экологически безопасных технологий выращивания запрограммированных урожаев зерна кукурузы при орошении.

Ключевые слова: фертигация, минеральные удобрения, урожай.

The area of irrigated lands in Ukraine is 2,17 million hectares, over 60% of them are black soils. Nowadays under the current agricultural system on the irrigated lands we often deal with deterioration of their soil and ecological conditions such as the loss of soil fertility and the imbalance of the natural systems in general. This happens because the modern system of agriculture in the most cases is oriented on receiving agricultural products and doesn't take into account the need to preserve the soil, to harmonize of its productive and ecological functions.

An important factor in the development of land irrigation is environmental and climatic conditions. According to these conditions there are three climatic zones in Ukraine:

- excessively wet forest (25% of the territory);
- insufficient moisture steppe (35%);
- arid steppe (40%).

Almost on the 75% of the territory of Ukraine agricultural crops are grown in the insufficient natural dampening. Moisture deficit is a major limiting factor in crop productivity.

More clearly about the natural moisture supply in different regions of Ukraine we can talk basing on the zoning of its territory. There is the average long-term dampening coefficient, proposed by the Institute of Hydraulic Engineering and Reclamation NAAS (National Academy of Agricultural Sciences) (Остапчик, 1989):

$$K_{damp} = \frac{(\sum P + Wo)}{\sum E_o},$$

where K_{damp} - dampening coefficient; $\sum P$ - the sum of atmospheric precipitation for vegetative period, mm; W_o - active moisture stocks in the dead soil layer at the beginning of vegetative period, mm; $\sum E_o$ - evaporation of water for vegetative period, mm.

The analysis of the territory of Ukraine according to K_{damp} gives reasons to consider that high-yielding growing of agricultural crops, especially hygrophilous ones in the steppe and forest steppe is possible only under irrigation. The lack of moisture over a large territory of Ukraine combined with high level of thermal resources provision, solar radiation and fertile soils are the natural conditions for the irrigation revival and development. In this case, irrigation should be considered as a factor significantly increasing the agricultural efficiency and reducing its dependence on the unfavorable climatic conditions (Ромащенко, 2000).

Another important factor that should be taken into account while analyzing the conditions of existence and development of irrigation in Ukraine is global climate change. On the global, and as a consequence, on the regional level the society should solve the extremely important and complex issues associated with developing and implementing strategies of its existence in terms of global climate change.

Ukraine is among the world's regions, where ongoing climate change is visible. Even without carrying out special observations, one can see that the duration of winter periods decreased significantly and the winters themselves became less cold. Droughts were observed more often. In the last century 43 years of drought were recorded on the territory of Ukraine, including 7 of them in the past 15 years (Ромащенко, 2003).

Good agro-ecological condition of irrigated lands is a condition for their effective use. Therefore, the development and implementation of actions for improving agro-ecological conditions of irrigated lands are among the priority.

In the complex of actions to maintain the fertility of irrigated lands at the necessary level and to generate the highest possible agricultural crop yields of high quality, a fertilization program is very important. It should be a plan for the use of mineral and organic fertilizers in crop rotation with their doses, time and method of application (Шляхи.., 1999).

One of the ways for intensification of the irrigated agriculture is the combination of irrigation with the use of chemicals, in particular the application of mineral fertilizers (which was called fertigation, from the English words *irrigation* and *fertilizer*), herbicides (herbigation), ameliorants and microelements.

Let us consider the results of our research about use of fertigation in the northern Steppe of Ukraine in the intensive cultivation technology of irrigated corn. Fertigation is a logical consequence of the development and improvement of irrigation techniques, increasing the level of use of chemicals and land reclamation, construction of technically advanced irrigation systems, use of modern wide-sprinkling machines (Сахаров, 1991).

Application of mineral fertilizers together with irrigation water fully meets the idea of multiple uses of irrigation systems and sprinkler equipment, increases the efficiency of water and fertilizers, favors the preservation of soil structure, and improves ecological conditions for growing maize. Fertigation allows to introduce the complex mechanization and automatization, ensuring corn yields at the level of 10 – 12 t/ha and reduce the energy resources cost (Півер, 1995, 2007).

The use of fertilizers with irrigation water solves the problem of even distribution of fertilizers in the active layer of soil to the level comparable with the even distribution of irrigation water. Very important advantage of this method is the possibility to apply fertilizers in small doses during the vegetative period without mechanical damage of plants and chemical burns (Ківер, 1993).

The combination of fertilizers and irrigation in a single technological process causes the phenomenon of synergy. Two of the most important factors of corn yield – irrigation and fertilization mutually reinforce each other, resulting in an additional factor – their interaction (Сахаров, 1991).

One third of the energy costs for growing corn in the Steppe of Ukraine is formed by fertilizers application. Traditional technology of mineral fertilizers application by surface method remains imperfect. Technological factors are dominated in it above biological ones, because soil is generally fertilized, not plants. When fertilizers apply with primary cultivation almost 6 month before they intensively use by maize, plants lose a lot of nutrients. In the result of mineralization, evaporating into the air and leaching into deeper soil layers these nutrients contaminate environment.

Technological possibilities of machines with centrifugal dispersive device are very low (Сахаров, 1991). Allowable uneven distribution of solid mineral fertilizers within a field is ± 25%, but in practice fluctuations (deviations) during applying high doses may reach 50 – 75%. It is naturally that uneven applying, especially one of a large amount of fertilizers, leads to their irrational use and sometimes to the long-term negative consequences not only for the plants but also for the soil (nutrients surplus in some areas and their shortage in others, nitrate contamination, etc), which are often difficult to eliminate.

The use of heavy machine-tractor aggregate for application and fertilizers closing cause compaction of the upper layers of soil, decreasing of its physical characteristics, reducing yields and quality of maize. Mineral fertilizers are produced and supplied unevenly. So if producers purchase fertilizers in the period of maize vegetation they cannot use them. This is due to the fact that the use of row-crop cultivators for feeding is restricted at the moment of closing of maize crops in rows. Frequent small fertilizer tanks refilling on cultivators lead to considerable labor costs. Use of aircrafts for feeding have not been widely spread yet.

In view of the above, in recent years the system of intensive cropping includes the advanced method of applying mineral fertilizers with irrigation water.

Applying fertilizers at the same time with irrigation water provides the opportunity to optimize the supply of moisture to the plant over the whole vegetative period.

Fractional nitrogen fertilizers application with irrigation water provides more even nutrient availability, than their one-time application before seeding. In this case the terms and doses of fertilizers application for feeding are calculated by taking into account biological characteristics of crops, soil conditions and coordinated with irrigation schedule.

It is well known that the corn till the pinnacle injection phase consumes about 30% of nitrogen of the overall consumption of this element. Further the need of nitrogen increases especially in the period from pinnacle injection till milky ripeness of grain. At that time maize consumes the largest part of nitrogen. In the period from milky to full ripeness nitrogen consumption decrease to 13,7 – 26,6% (Ківер, 1995).

Experiments, conducted at the Institute of Grain Farming, NAAS of Ukraine showed that under application of fertigation maize yields increase by 5 – 10% (Ківер, 1993, 2007). The best were the results of the nitrogen fertilization scheme, where the full amount of nitrogen was applied with irrigation water fractionally in equal doses after sowing, in 10 – 12 leaves phase, pinnacles ejection and at the beginning of milky ripeness phases. In conditions of experiment this phase provided the 11,2 – 12,3% of yield increasing (Куница, 1990). The elements of this agricultural practice (terms, doses, methods of fertigation, ecological factor) are not thoroughly studied yet, that's why the further research is essential.

The aim of our research is to study the optimal norms, methods and timing of mineral fertilizers application in terms of intensive technology of growing maize for grain under irrigation.

MATERIALS AND RESEARCH METHODS

Field experiments were conducted over the period of 1999 – 2001 on the educational-experimental farm of Dnipropetrovs'k State Agrarian University "Samarskiy". Soils are ordinary eroded loamy black earth. Thickness of humus layer is 65 – 70 cm, content of humus in topsoil is about 3,0%. Content of nitrogen after 7 days of composting (by Kravkov) in 100 gr. of tight soil is 1,4 – 3,8, phosphorus content (by Chirikov) is 11,9 – 15,5, potassium content (by Maslova) is 10,0 – 14,4 mg/100 gr. of soil. Subsoil water lies at the level more than 15 meters.

Weather conditions during the research years were generally favorable for growing maize under irrigation. During the vegetative period (May – September) of the year 1999 there were 128 mm of atmospheric precipitation, in 2000 – 216 mm, and in 2001 – 192 mm.

During the experiments the middle-early hybrid of maize Pioneer 3978 was sown. The norms of mineral fertilizers calculated for 8 and 10 t/ha, grain yield were studied. The technology of maize growing has been accepted as common use for this crop in the northern Steppe zone of Ukraine. Sprinkler irrigation was performed with unit DDA-100MA. Mineral fertilizers were dosed into irrigation water with a special fertilizer injector, manufactured in the laboratory of the Institute of Grain Farming NAAS of Ukraine. Irrigation schedule provided moisture level in the active soil layer not less than 70 – 80% MWC (minimum water capacity). Irrigation rate norm was 1800 – 2100 m^3/ha.

Sowing area of the experimental fields was 630, and researched one was 150 m^2. Repetition was fourfold.

Statistical processing of the results was performed with the help of analysis-of-variance method according to the known procedure (Доспехов, 1985).

As fertilizers carbamide, granulated superphosphate and potassium salt were used. Phosphoric and potassium fertilizers were added in calculated doses to the working plots for cultivation, carbamide – in accordance with the research program for cultivation and with irrigation water.

Doses of mineral fertilizers for planned maize grain yield were calculated with the help of balanced method due to the content of major nutrients in the soil.

To study the efficiency of nitrogen fertilizers with irrigation water compare to the traditional surface method and defining optimal parameters of fertigation the following options were developed.

Technological schemes of applying nitrogen fertilizers are the next:

1 – full norm under fall-plowed land cultivation (control);

2 – fractionally: 40% of norm with cultivation, and 20% with irrigation water in the phases of 10 – 12 leaves, pinnacle ejection and milky ripeness of the grain;

3 – fractionally: 40% of norm with cultivation, and 40% with irrigation water in the phase of 10 – 12 leaves and 20% in the phase of pinnacle ejection;

4 – full norm of nitrogen with irrigation water fractionally in doses of 20% in the phases of 10 – 12 leaves, pinnacle ejection and milky ripeness of grain, and 40% in the phase of pinnacle blooming stage;

5 – full nitrogen norm with irrigation water fractionally in doses, 40% after sowing in the phase of 10 – 12 leaves, 40% in the phase of pinnacle ejection and 20% in the phase of milky ripeness of grain.

THE RESULTS OF RESEARCH

The study has shown that the nitrogen content in soil, which plays an important part in plant fertility under irrigation, depends on method and terms of fertilizers application (table 1).

In autumn under using mineral fertilizers randomly nitrates migrate from root soil layer, and according to the received data it gets exhausted. Before the period when maize plants need nitrogen intensively (10 – 12 leaves) there were less nitrates in the soil than during the period of 5 –6 leave on 15,3% and in the phase of milky ripeness of grain – on 50,3%. At the same time under numerous nitrogen applications with irrigation water the content of nitrates in soil in that period was less, furthermore there was much more of them, especially in a milky ripeness phase that positively affected yields.

The results of research have shown that the use of nitrogen fertilizers with irrigation water increase maize yields more than under surface application method (table 2).

Table 1

Nitrate concentration in the soil layer of 0 – 60 cm, depending on nitrogen fertilizers application for programmed yield 8 t/ha (average 1999 – 2001) mg/kg of soil

Variant	Phase of Development		
	5-6 leaves	10-12 leaves	milky ripeness of grain
1 - N_{150} P_0 K_{60} (at random for cultivation)	30,8	26,1	15,3
5 - N_{150} P_0 K_{60} (with irrigation water)	20,5	25	18,8

With increasing of mineral fertilizers dose corn yield was increasing in average by 2,72 – 4,36 t/ha (6,6 – 10%) comparing to the option without fertilizers.

Table 2

The yield maize hybrid Pioneer 3978, depending on the dose and method of mineral fertilizers application, t/ha

Calculated dose of mineral fertilizers for yield	Nitrogen fertilizers application scheme	Year			Average	± to control	
		1999	2000	2001		t/ha	%
Without fertilizers		5,16	5,96	5,48	5,53	–	–
8,0 t/ha	1 (control)	7,86	7,75	8,01	7,87	–	–
	3	8,14	8,46	8,54	8,38	0,51	6,6
	5	8,28	8,65	8,58	8,51	0,63	8,1
	Average	8,09	8,28	8,37	8,25	–	–
10,0 t/ha	1 (control)	9,28	9,34	9,46	9,36	–	–
	3	9,87	10,20	10,06	10,04	0,62	6,7
	5	10,14	10,32	10,42	10,29	0,93	10,0
	Average	9,76	9,95	9,98	9,89	–	–
$HCP_{0,5}$ t/ha for schemes		0,03	0,47	0,21	–	–	–
$HCP_{0,5}$ t/ha for doses		0,24	0,32	0,13	–	–	–

Evaluating any technological method it is important to take into account not only its impact on the amount of yield but also on its consumer qualities. Under irrigation with yield increasing, the deterioration of the grain quality is often observed, exactly the reduction of protein content. Our research had shown that with the increasing of mineral fertilizers norm the protein content increases too (table 3).

Table 3

Grain quality of maize hybrid Pioneer 3978, depending on the method and terms of nitrogen fertilizers application for different levels of mineral nutrition (average 1999 – 2001)

Norm of mineral fertilizers	Option of nitrogen fertilizers application	Content in grain, %			
		Crude protein	Fat	Starch	Gluten
Without fertilizers		8,9	4,9	61,8	2,9
Estimated for yield 8 t/ha	1 (control)	9,1	4,9	62,2	3,1
	3	9,5	4,8	64,3	2,9
	5	9,4	5,0	63,1	3,0
	average	9,3	4,9	63,2	3,0
Estimated for yield 10 t/ha	1 (control)	9.4	4,9	62,9	2,9
	3	9,4	5,0	63,1	3,0
	5	9,6	5,0	61,8	3,0
	average	9,4	4,9	62,6	2,9

The method of nitrogen fertilizers application has also affected the content of protein in grain. With the use of fertigation the content of protein in grain was growing. The method of applying nitrogen fertilizers hadn't significantly affected the content of starch, fat and gluten in grain.

As it is known the application of rised doses of nitrogen fertilizers increases the danger of nitrates accumulation in yield, that's why particular attention in our research was paid to peculiarities of nitrate accumulation in maize grain under different methods of fertilizers application.

The results showed (table 4) that the nitrate content was varying greatly from year to year of the research, due to the weather conditions influence in the period of grain formation. In the year 2000 the grain formatted in conditions of relatively low temperatures, that is why the nitrate content in grain was 82,3 – 98,05 mg/kg.

Table 3

Nitrate content in the maize grain, depending on the method of nitrogen fertilizers application and level of mineral nutrition, mg/kg

Norm of mineral fertilizers	Option of nitrogen fertilizers application	Research year		
		1999	2000	2001
Without fertilizers		36,80	82,30	47,70
Estimated for yield 8 t/ha	1 (control)	53,73	98,05	47.40
	3	37,05	84,25	47,45
	5	36,25	82,30	49,90
Estimated for yield 10 t/ha	1 (control)	34,85	91,50	52,60
	3	38,55	89,60	44,70
	5	37,05	86,70	44,75

In hotter conditions of the given period in years 1999 – 2001 the content was 34,85 – 55,73 and 44,7 – 52,6 mg/kg respectively. At all studied soil fertility nitrate content was lower than admissible concentration limit (MPC nitrate content in maize corn is 300 mg/kg). Applying of high norms of mineral fertilizers as well as applying nitrogen fertilizers along with irrigation water didn't increase the nitrate content in maize grain.

CONCLUSIONS

Nowadays it is very important to implement new, effective and ecologically safe agricultural technologies, that stipulates the decrease of mineral fertilizers doses and increase of their rate of return in 1,5 – 2 times by means of optimization of terms and methods of application. Under the intensive technology of maize growing on irrigated soils in northern steppe of Ukraine it is reasonable to apply nitrogen fertilizers along with irrigation water in proportions as follows: 40% of the overall dose in the period of 10 – 12 leaves, 40% – in the phase of pinnacle ejection and 20% in the phase of milky ripeness of grain. Under these conditions of nitrogen application maize grain yield in average had been increased on 2,72 – 4,36 t/ha, than without fertilizers application.

The tendency of protein rising in maize grain under nitrogen fertilizers with irrigation water application was observed. High norms of mineral fertilizers application and fractional application of nitrogen fertilizers with irrigation water didn't affect the nitrate content in grain and didn't deteriorate its quality.

The results of research indicate that combining irrigation with mineral fertilizers application (fertigation) is an effective method of decreasing energy and material resources, increasing yields and quality of maize grain and protect soil from degradation.

REFERENCES

Наукові основи охорони та раціонального використання зрошуваних земель України./ За ред. С. А. Балюка і М. І. Ромащенка. – К. : Аграрна наука, 2009. – 624 с.

Остапчик В. П. Информационно-советующая система управления орошением / В. П. Остапчик, В. В. Костромин, А. М. Коваль и др. – К. : Урожай, 1989. – 245 с.

Ромащенко М. І. Зрошення земель в Україні. Стан та шляхи поліпшення / М. І. Ромащенко, С. А. Балюк. – К. : Світ, 2000. – 114 с.

Ромащенко М. І. Про деякі завдання аграрної науки у зв'язку зі змінами клімату. Наукова доповідь-інформація / М. І. Ромащенко, О. О. Собко, Д. П. Савчук та ін. – К., 2003. – 46 с.

Шляхи підвищення родючості ґрунтів у сучасних умовах сільськогосподарського виробництва / за ред. Б. С. Носка. – К. : Аграрна наука, 1999. – 112 с.

Сахаров В. Д. Химигация в культуре кукурузы: итоги науки и техники / В. Д. Сахаров. – ВИНИТИ, Растениеводство. – 1991. – Т. 8. – 156 с.

Ківер В. Х. Зниження витрат енергоресурсів при вирощуванні запрограмованих урожаїв кукурудзи за інтенсивною технологією в умовах зрошення / В. Х. Ківер, В. М. Куниця // Вісник аграрної науки. – 1993. – № 9. – С. 14-20.

Ківер В. Х. Ефективність удобрювального зрошення при вирощуванні кукурудзи на зерно / В. Х. Ківер, Д. М. Онопрієнко // Вісник Дніпропетровського державного аграрного університету. – 2007. – № 1 – С. 52-55.

Ківер В. Х. Норми, способи та строки внесення добрив під кукурудзу на зрошенні / В. Х. Ківер, І. Д. Галечко // Енергозберігаючі технології вирощування зернових культур у степу України. Збірник наукових статей. – Д., «Пороги». – 1995. – С. 61-66.

Куница В. М. Потребление основных элементов питания при выращивании запрограммированных урожаев кукурузы в условиях орошения Степи Украины / В. М. Куниця, В. Т. Пашова // Использование удобрений при интенсивных технологиях возделывания сельскохозяйственных культур. – Д., 1990. – С. 69-75.

Доспехов Б. А. Методика полевого опыта с основами статистической обработки результатов исследований / Б. А. Доспехов. – М. : Агропромиздат, 1985. – 351 с.

Надійшла до редколегії 18.11.10

502.72(477.72)

V. S. Havrylenko

THE BIOSPHERE RESERVE «ASKANIA NOVA» IS A GOOD MODEL FOR TRACKING OF THE ECOSYSTEM PROCESSES IN THE PROTECTED STEPPES OF EURASIA

F. E. Falz-Fein Biosphere reserve «Askania Nova», National Academy of Agrarian Sciences of Ukraine

The regularities of location of the steppe reserves of Eurasia are considered. The peculiarities of behavior of succession processes in different reserving regimes are discussed. It is indicated that mesophyting processes and phanerization of ecosystems are intensified without pressure of the hoofed animals especially at the small steppe reserve of the East Europe. The most of regularities of succession processes founded during one hundred years practice of the steppe reserving has its reflection in the Biosphere Reserve «Askania Nova».

Key words: the steppe reserves, productivity, specific diversity, mesophyting processes, phanerization, hoofed animals.

В. С. Гавриленко

Біосферний заповідник «Асканія-Нова» імені Ф.Е. Фальц-Фейна НААН України

БІОСФЕРНИЙ ЗАПОВІДНИК «АСКАНІЯ-НОВА» ІМЕНІ Ф.Е. ФАЛЬЦ-ФЕЙНА – ВДАЛА МОДЕЛЬ ДЛЯ ВІДСТЕЖЕННЯ ЕКОСИСТЕМНИХ ПРОЦЕСІВ В ЗАПОВІДНИХ СТЕПАХ ЄВРАЗІЇ

Розглядаються закономірності розміщення степових заповідників Євразії, обговорюються особливості протікання сукцесійних процесів в різних режимах заповідності, вказується на посилення процесів мезофітизації і фанеризації екосистем при відсутності пресу копитних тварин, що особливо проявляється в малих степових заповідниках Східної Європи. Більшість закономірностей сукцесійних процесів, виявлених протягом 100-літньої практики степового заповідання, мають своє відображення в Біосферному заповіднику «Асканія-Нова».

Ключові слова: степові заповідники, продуктивність рослинних угруповань, видове різноманіття, мезофітизація, фанеризація, копитні тварини.

В. С. Гавриленко

Биосферный заповедник «Аскания-Нова» имени Ф. Э. Фальц-Фейна НААН Украины

БИОСФЕРНЫЙ ЗАПОВЕДНИК «АСКАНИЯ-НОВА» – УДАЧНАЯ МОДЕЛЬ ДЛЯ ОТСЛЕЖИВАНИЯ ЭКОСИСТЕМНЫХ ПРОЦЕССОВ В ЗАПОВЕДНЫХ СТЕПЯХ ЕВРАЗИИ

Рассматриваются закономерности размещения степных заповедников Евразии, обсуждаются особенности протекания сукцессионных процессов в разных режимах заповедности, указывается на усиление процессов мезофитизации и фанеризации экосистем при отсутствии пресса копытных животных, что особенно проявляется в малых степных заповедниках Восточной Европы. Большинство закономерностей сукцессионных процессов, выявленных на протяжении 100-летней практики степного заповедания, имеют свое отражение в Биосферном заповеднике «Аскания-Нова».

Ключевые слова: степные заповедники, продуктивность растительных сообществ, видовое разнообразие, мезофитизация, фанеризация, копытные животные.

The Biosphere Reserve “Askania Nova” is a largest steppe reserve of Europe and oldest on Planet by antiquity of the reserving. The fist evaluation of state and productivity of the Askania Nova steppes was assessed by F. Teetzmann in 30th of XIX century (Теетцманн,1926). On the beginning of XX century the reserve functioned as a private, and since 1919 it became the state scientific natural protected institution. Every generation of scientists made their contribution to cognition of reserving processes therefore the long chronological lines of observations for abiotic and biotic environment factors. The scientists of the reserve did expeditions to many reserves of Eurasia from Daurian steppes to Hungarian pushts (steppes). It gave rich comparative materials for definition of a role of reserved steppe ecosystems on biodiversity conservation and of contribution of Askania Nova in cognition of reserving processes.

OBJECTIVE OF RESEARCHES

The objective hereof presentation is an analytical review of steppe ecosystems at the reserves of States allocated in the steppe zone; identification general trends of succession processes at the reserves of the steppe zone; description of prospects of biodiversity conservation, estimate of a state of the protected steppe ecosystems and some approaches for management of steppe ecosystems.

RESULTS AND DISCUSSION

The variety of living conditions of species, which are adaptive to arid and subarid conditions, is determined by large length of Eurasian steppes in latitudinal and meridional directions and also formation of set the steppe biocoenosis.

The numerous indexes of presence of reserves and national parks in the steppe zones, in which an area of steppe spaces exceeds 30%, are shown in Table.

Quantity of steppe reservats in States of the steppe zone

Hungary	Rumania	Moldova	Ukraine	Russia	Kazakhstan	Mongolia	China
1	1	2	5	5	4	2	2

It should be noted that transition steppe ecosystems occur in many reserves bordering with natural zones, subzones or conditional by an alpine zonation at the mountain regions. At that time many steppe reserves are located with deviation from one to three degrees between 46°22' - 49°58' of the northern latitude: Hortobagy (Hungary), Yagorlyk (Moldova), Yelanetsky steppe, Askania Nova, The Stone Graves, Khomutovsky steppe (Ukraine), Naurzum Natural Reserve, Korgaldzhinskiy Nature Reserve, Altyn Dala Reserve (Kazakhstan), the Rostovsky reserve, The Black Lands, Daurian reserve (Russia), the Great Gobi reserve (Mongolia). The Biosphere Reserve "Askania Nova" clear fit in with this coordinates scheme (Fig. 1).

Fig. 1. **Location of main steppe protected area of Eurasia**

We confirm the opinion of many researchers that a man has played the important part in steppification of the big spaces for 3-4 thousand years and especially for two last centuries. Absolutely all steppe reserved sites of Europe carry a mark of human activity and now their spontaneous development in many respects depends on a degree of influence of the anthropogenic environment. Absolutely reserved regime, which is established in the most natural reserves of the post soviet space, allowed finding a common mechanism of rapid spontaneous overgrowing of the herbaceous ecosystems by wood plants.

Analyzing the results of numerous researches, which are conducted in the protected steppes, we see that scientists have received most important and summary results there, where the long-term permanent researches were started, but the reserves had substantial sizes. On Ukraine only the Biosphere Reserve "Askania Nova" meets these requirements at present day. The most of our reserves have a steppe territory from some hundreds hectares till three thousand in spite of great number of the protected steppe plots. Allocation of some reserves scattering about subzones has a cluster feature. There is no way they create a continuum of the steppe ecosystems. In this sense there are Asian reserves more preferable: Naurzum Natural Reserve, Korgaldzhinskiy Nature Reserve and newly creating Altyn Dala Reserve in Kazakhstan, the Great Gobi reserve in Mongolia, and also a transboundary Daurian reserve on the frontier with Russia, Mongolia and China. The last ones have areas from some hundreds of thousands till four million hectares.

The first reserved steppe plots were excluded by Friedrich Falz-Fein – owner, sheep breeder and naturalist – in 1898.

The first description of the reserved plots was done by Josheph Pachosskiy in 1902, who continued description of these territories until the middle of XX century. The expansion of a network of the protected areas on the Eurasian continent gave the opportunity to go on the studying of peculiarities of the reserving successions, which are presented in the biosphere reserve "Askania Nova" completely.

The regularities are identified as a result of analysis of the spontaneous ecobiological processes and exogenous factors at the Biosphere Reserve "Askania Nova". Also they are visible in other steppe reserves of Eurasia, but they are shown in the reserve fully. The replacement of ruderal vegetation by zonal one happens in the first years after reservation. This regularity was noted by J. Pachosskiy (Пачосский,1908,1917,1924). In the first ten years after institution of the reserving regime the regular increase of saturation and projective covering of zonal steppe vegetation happens (Пачосский, 1908, Шалит, 1938). The analysis summarized by Ye.P. Vedenkov (Веденьков,1995) on example of askanian steppes (Table 2) shows that the protected regime influenced positively on increasing of some zonal associations of the steppe vegetation prima facie fescue grass (Festuca vallesiaca Gaud.).

Table 2

Succession of vegetation cover of the first protected plot "Stara" in Askania Nova, reserved in 1898 (according to Vedenkov, 1995)

Name of allotments and associations	Years of investigations and areas of formations on the map of the protected steppe in %			
	1927	1952	1968	1980
Feather grass formations	47,4	30,5	26,8	18,1
Fescue grass formations	30,9	50,3	52,5	53,9
Mesophilous Rhizome grasses	6,2	6,8	18,9	22,1
Anthropogenic derivative vegetation	4,4	12,4	1,8	1,3

It simultaneously happen the reduction of areas occupied by the anthropogenic derivative vegetation.

However in further the regular accumulation of the steppe felt (litter), that is kept till present time (Fig. 2), with following stabilization or activation of mesophytization mechanism, which is leading to gradual increase of areas with rootstock grasses and sedges is observed (Table 2). Accumulation of the steppe felt (litter) impedes development of the spring ephemerous species, habitation of steppe mammals' species: little souslik *Spermophilus pygmaeus*, great jerboa *Allactaga major,* steppe polecat *Mustela eversmannii* belonging to protected species, for their sake the reserving was done. Such picture is seen in the most of steppe reserves. This process is especially observed in north reserves with meadow steppes in the Central Chernozem Biosphere Reserve (Russia) for example. On the figure 3 we represented diagrams of quantity changes of plants' species subject to regime of the protected steppe according to materials of Sobakinskikh (1995).

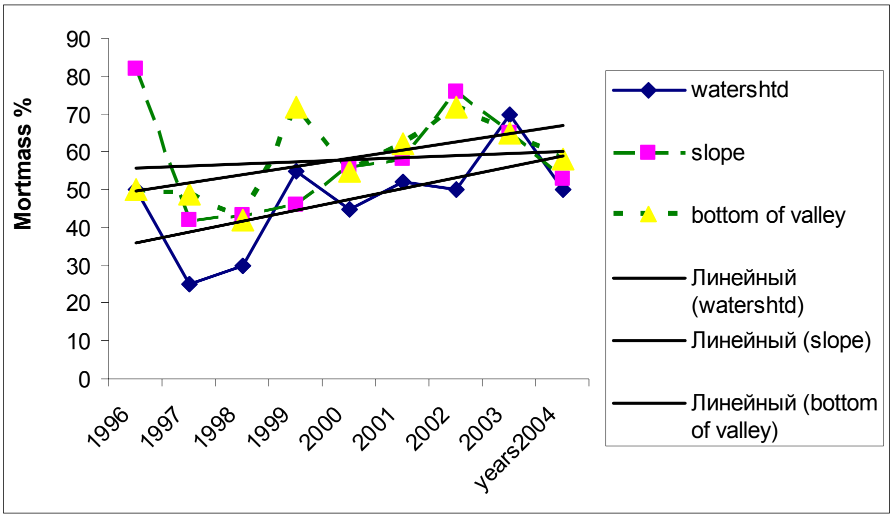


Fig. 2. **Dynamics of relative weight of dead plant residues in the ecological line of protected steppe "Askania Nova"** (according to Гавриленко В.С., Дрогобич Н.Ю et al., 2006)

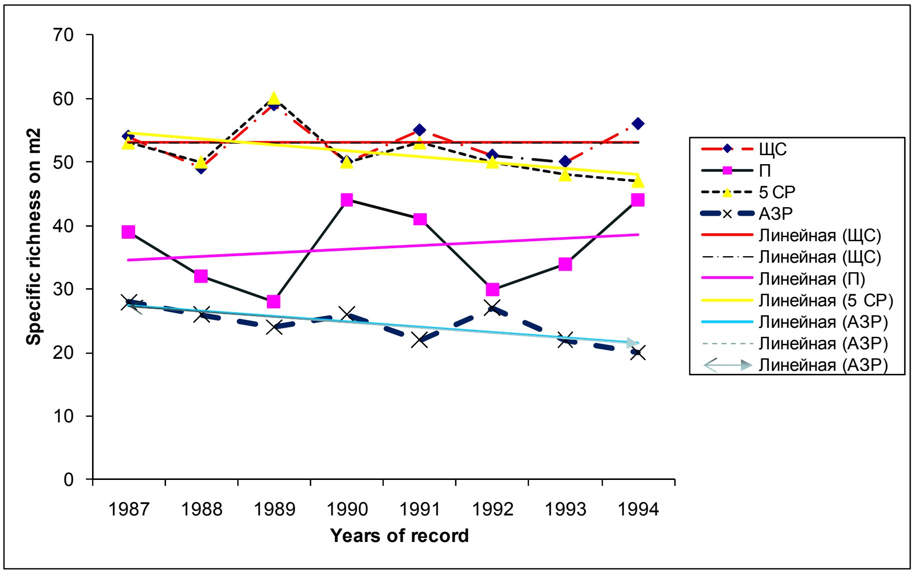


Fig. 3. **Influence of natural use regimes on the specific richness of grass stand in the Streletskaya Steppe of the Central Chernozem Biosphere Reserve (Russia) on the base of data of Sobakinskikh**

It should be noted that besides regimes, a small territory of plot influences and will influence on reduction of specific diversity in this reserve.

This process is tracked in the Biosphere reserve "Askania Nova" also, because of territories with different protected regimes are larger here. The process of further environment transformation is going on and vice versa the increasing of total number of flora and fauna species is tracking (Table 3).

Table 3

Change of flora diversity of the Biosphere Reserve "Askania Nova"

Author of plants' list	Year of listing	Square of area's investigation (ha)	Number of naturally growing plants' species	Index of diversity (species number on 100 ha)
Pachosskiy	1923	32 000	310	0,97
Korotkova	1954	22 000	357	1,62
Vodopyanova	1975	11 000	436	4,00
Vedenkov, Yelonova	1990	11 000	478	4,35
Shapoval	2010	11054	509	4,40

However the increasing of species happens through the adventitious flora and animals of dendrophilous complex which occupy the ecosystems neighboring with the reserve more active, penetrating into the core area. The reasons of this process will be considered lower.

It is known that steppe ecosystems have regular substantial fluctuations of phytocenosis productivity subject to a hydrometric regime. The dynamics indices of elevated living phytomass of grass stand in grazing period before reserving (according to Teetzmann), and also under conditions of the reserving (according to Drogobych, Shapoval) are presented on the fig. 4.

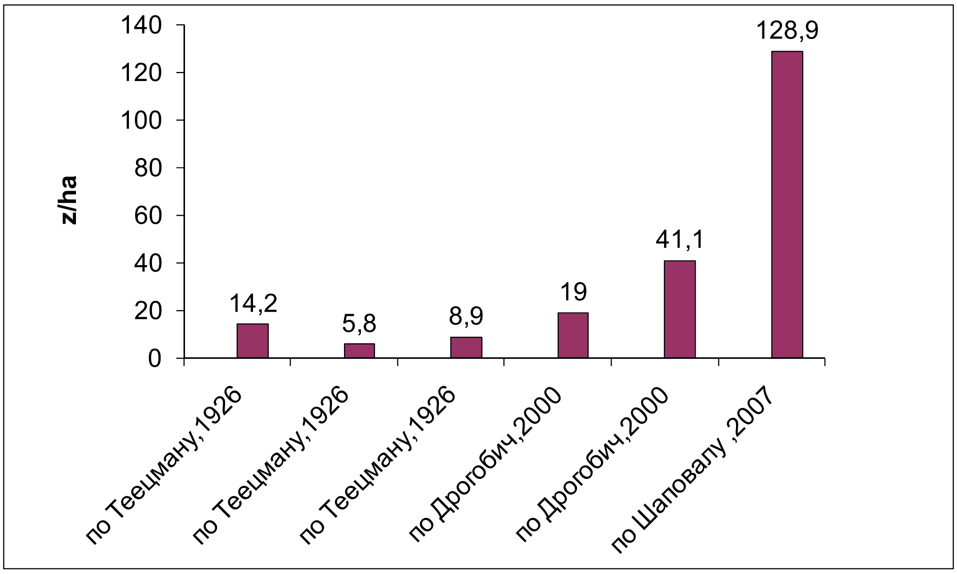


Fig. 4. **Productivity amplitude of herbaceous associations in askanian steppe**
(according to data of different authors)

Total growth of productivity increased through both cases the lowering of grazing load and increasing of total amount of precipitations that is observed last ten years. It is visually confirmed by comparative analysis of temperature regime and precipitation in Askania Nova since 1926 (Fig. 5).

The same regularity occurs in the east regions of the steppe zone and that's why this process affected the population of saiga antelope Saiga *tatarica* in Kalmykia (Абатуров, 2007). The growth of average annual amount of precipitations increases not only accumulation of the steppe felt but assists to intervention of wood vegetation into protected territories. Phanerization of the protected steppe ecosystems of the East Europe received an extensive distribution. The influence of this fact is appreciable especially in the small reserves without impact of the big hoofed animals. Thesis of well-known phytocoenologist T.A. Rabotnov remains absolutely right and actual: "a first priority of the steppe reserves must be permanent destruction of faunistic inferiority" (Работнов, 1982). Thirty years passed and we had to state that process of forestation in a line of reserves went so far that some steppe territories grew over with shrubs and wood vegetation. This fact takes place even in arid region where the Biosphere reserve "Askania Nova" is situated. The active overgrowth of new fallow lands by wood vegetation from forest belts happens in the buffer zone because of absence of the hoofed animals. Such phenomena did not observe here earlier. (Fig. 6. A.B.)

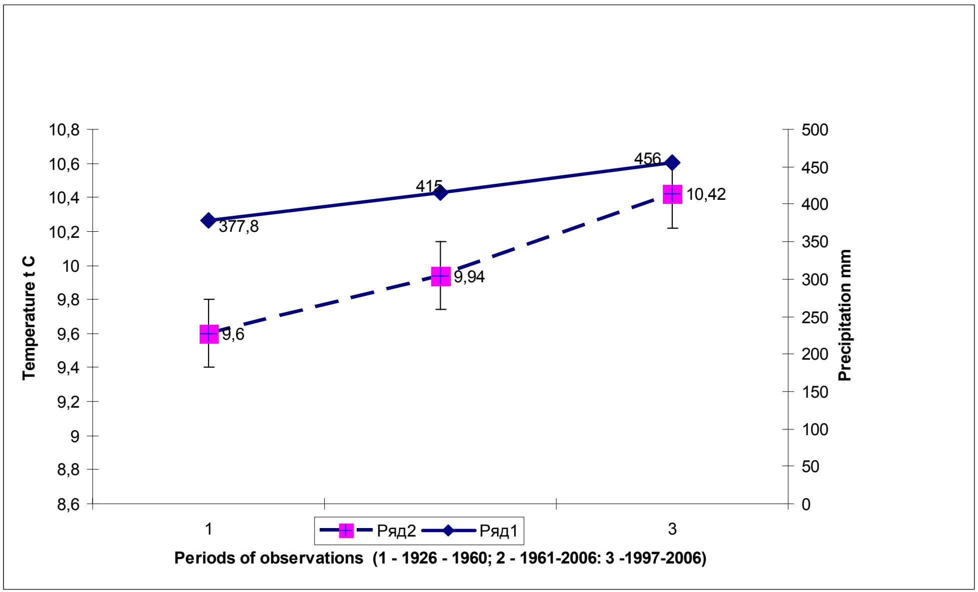


Fig. 5. **Growth of temperature and precipitation for different periods of observations** (according to data of meteostation "Askania Nova")

Thereby the steppe reserves of the East Europe lost the big herbivorous animals-destructors of grass cover; they were unable to resist both the internal tendencies to the overgrowing by shrubs and external intervention of wood vegetation. The direction of sylvatization process and its speed is connected directly with area of an object, a degree of environment transformation of the reserve and an aggressivity of alien species, displanted by human in the artificial forest belts.

A

B

Fig. 6. **A. The reserve "Mychajlovskaya tselina" became as a shrub phytoceonosis for 50 years. B. Overgrowth of the buffer zone by elm in the Biosphere Reserve "Askania Nova" (ten years fallow land)**

Development of sylvatization processes is begun after removal of the anthropogenic press. It may be stopped in case of renovation of stress by the roofed animals. The overgrowing by wood vegetation and change of the steppe associations by forest is increasing from the south to north. The development of sylvatization processes on the sites with steppe vegetation is watching for fescue grassland and meadow steppe of the East Europe in the first 5-10 years of the reserving. A tendency of the steppe's overgrowing by wood vegetation because of absence of the hoofed animals influence is clearly visible on the figure 7 presented below. This tendency was observed in the natural reserve "Yelanetsky Steppe" in conditions of 15^{th} years experiment.

Fig. 7. **The left – 8 American bison at 70 ha keep a steppe in the natural state. On the right of fence a steppe begins to overgrown by shrubs**

The balance of warmth and atmospheric precipitation in the vegetation period and also thickness of litter complex exerts the largest influence on the rates of the overgrowing. The litter intensifies mesophyting processes and forwards to the root proliferous overgrowing by shrub vegetation (i.e. to the first phase of sylvatization at the meadow steppes: Mychajlovskaya tselina (Ukraine), the Central Chernozem Biosphere Reserve (Russia) and others (Ткаченко, Генов, Лисенко, 2003; Ткаченко, Гавриленко, 2007, Гавриленко, 2007). These processes are observing at the south steppes where Askania Nova is situated. For the period of 100 years the overgrowing by shrub vegetation Amygdalus nana and Caragana scythica, which were presented by solitary shrubs at the steppe in 1917, occupies nearby 10 ha now due to a large area of the single reserved massif (more than 8 thousand ha of 11054) (Пачосский, 1923). However the wood introduction plants appeared in the steppe as a result of the zoochoric and anemochorous distribution. Diaspores of wood plants have the possibility to grow successfully only in cases of the baring of a soil cover after fires or zoogenic influence on the steppe vegetation, for example the burrowing activity of rodent. The further litter's accumulation gradually favoures the distribution of associations of the rhizome cereals though the zonal species of feathers and fescues. The reserve succession doesn't forward the conservation of many ephemerous species, which often make up a rarity component of flora. The complex of coprophagous species became poorer because of the falling of the big roofed animals from nutrition lines. The increasing of habitus of grass plants under conditions of the reserving doesn't favour the conservation of many steppe species of small vertebrate animals. According to observations the steppe species can be in the resting stage for long time and give the population flash after fires.

Integrally the protected steppes of the East Europe need the management on the part of human solved a main problem of determination of tendencies of reserved successions. This is a difficult process. An individual approach and analysis of all previous periods of ecosystems' function is necessary for solution of problems of each protected site.

CONCLUSIONS

The Biosphere Reserve "Askania Nova" is a good model for the tracking of long-term spontaneous processes in the south steppes of Ukraine. It allows discovering the general regularities of changes happened in the protected steppe ecosystems outside its region.

The steppe protected ecosystems of Eurasia undergo consequence changes under the influence of the reserve successions. They have the general processes, which rate and directions depend on original state of ecosystems excluded from economic use, an area of the protected site, geographic location, a degree of transformation the areas surrounding it and peculiarities of the update using of the areas.

The small steppe reserves without renovation of herbivorous animals can promptly turn into derivatives of the forest ecosystems.

REFERENCES

Абатуров Б. Д. Популяции сайгака в России и проблемы ее сохранения / Б. Д. Абатуров // Вестник Российской академии наук. – 2007. – Т. 77, №9. – С. 785–793.

Веденьков Е. П. О разнообразии флоры биосферного заповедника «Аскания-Нова»/ Е. П. Веденьков // Проблемы сохранения разнообразия природы степных и лесостепных регионов. – Москва, 1995. – С. 147–148.

Гавриленко В. С. Некоторые итоги заповедного степеведения: чего хотели, что получили, что может быть? / В. С. Гавриленко // Заповідні степи України. Сучасний стан та перспективи їх збереження : мат-ли Міжнар. наук. конф. (Асканія-Нова, 18-22 вересня 2007 р.). – Армянськ : ПП Андрєєв О. В., 2007. – С. 16–19.

Гавриленко В. С. Сучасні проблеми взаємодії біоти ядра Біосферного заповідника "Асканія-Нова" з оточуючим агроландшафтом / В. С. Гавриленко, Н. Ю. Дрогобич, В. П. Думенко, І. К. Поліщук // Науковий вісник Національного аграрного університету. – 2006. – Вип. 93. – С. 117–132.

Дрогобыч Н. Е. Постпирогенная динамика надземной фитомассы степных фитоценозов Причерноморья / Н. Е. Дрогобыч // Степи Северной Евразии: стратегия сохранения природного разнообразия и степного природопользования в XXI веке: Мат-лы Междунар. симпоз. – Оренбург, 2000. – С. 148–150.

Пачоский И. Причорномоския степи. Ботанико-географический очерк / И. Пачоский // Из "Записок Императорского о-ва сел. хоз. южной России". – Одесса : Славянская типография Е. Хрисогелос. – 1908. – №7-9. – 42 с.

Пачоский И. К. Описание растительности Херсонской губернии / И. К. Пачоский. – Херсон : Паровая типо-литография С. И. Ольховикова и С. А. Ходушина, 1917. – Т. II : Степи. – 366 с.

Пачоский И. К. Целинная заповедная степь Аскания-Нова / И. К. Пачоский // Аскания-Нова – степной заповедник Украины. – М. : Госиздат, 1924. – С. 81–113.

Собакинских В. Д. К вопросу сохранения видового разнообразия луговых степей / В. Д. Собакинских // Проблемы сохранения разнообразия природы степных и лесостепных регионов. – Москва, 1995. – С. 72–73.

Теетцман Ф. Про південно-російські степи та маєтки герцога Ангальт-Кетенського, що знаходяться в Таврії / Ф. Теетцман // Вісті Держ. Степового Заповідника "Чаплі". – Харків, 1926. – Т. III. – С. 121–146.

Ткаченко В. С. Резерватные смены и охранный режим в степных заповедниках Украины / В. С. Ткаченко // Степи Евразии : проблемы сохранения и восстановления. – СПб.-М. : Ин-т географии РАН, 1993. – С. 77–88.

Ткаченко В. С. Структурні зміни в рослинному покриві заповідного лучного степу Михайлівська цілина за даними великомасштабного картування у 2001 році / В. С. Ткаченко, А. П. Генов, Г. М. Лисенко //Вісті Біосферного заповідника "Асканія-Нова". – 2003. – Т. 5. – С. 7–17.

Ткаченко В. С. Криза регулювання та ефективність регуляторних заходів у степових заповідниках України / В. С. Ткаченко, В. С. Гавриленко // Вісті Біосферного заповідника "Асканія-Нова". –2007. – Т. 9. – С. 5–20.

Шалит М. С. Деякі відомості за процес відновлювання степової рослинності на перелогах Державного Степового Заповідника "Чаплі" (кол. Асканія-Нова) / М. С. Шалит // Вісті Держ. Степового Заповідника "Чаплі". – Асканія-Нова, 1930. – Т. VII. – С. 139–152.

Шалыт М. С. Растительность степей Аскании-Нова / М. С. Шалыт // Изв. Крымского пед. ин-та им. М. В. Фрунзе. – Симферополь, 1938. – Т. 7. – С. 45–133.

Шаповал В. В. Флора та рослинність депресій Лівобережжя Нижнього Дніпра : автореф. дис. на здобуття наук. ступеня канд. біол. наук : спец. 03.00.05 «Ботаніка».– Ялта, 2007. – 20 с.

Надійшла до редколегії 16.11.10

UDK 631.4

O. Nekhay[1], M. Arriaza[2]

INTEGRATING SOCIAL PREFERENCES AND EXPERTS' SUBJETIVE INFORMATION INTO AGRICULTURAL LAND USE OPTIMIZATION

[1]*Institute for Prospective Technological Studies, Spain*
[2]*Instituto de Investigación y Formación Agraria y Pesquera, Spain*

The production system management of olive plantations (*Olea europaea* L.) in Southern Spain is analysed from an economic, social and environmental perspective. The economic approach addresses the viability of the farming activities, the social criterion aims to prevent population loss in rural areas, whereas the environmental analysis involves the consideration of the reduction of soil erosion, the improvement of ecological diversity, the control of fire risk and the provision of quality agricultural landscapes.

The main purpose of the present work is social optimization of the olive farming area in the Montoro municipal territory (Andalusia, Spain). This optimization could serve for the local administration as a support guide to allocation of subsidies and corrective measures. To achieve this purpose the following exercises was carried out: *i*) six main functions performed by olive farming were selected; *ii*) the selected functions was evaluated by the local population via the AHP questionnaire (480 respondents); *iii*) at the same time several territorial models were made that evaluate the performance of the area with respect to each function under consideration; *iv*) the expert opinions about the performance of each alternative with respect to the selected function were collected; *v*) finally each of four considered alternatives and its most suitable allocation were evaluated.

According to the population's responses, the groups of environmental and socio-economic functions have equal importance (42% each), leaving the provision of agricultural landscape with a weight of 15%. Individually, keeping the rural population in the villages (24%), the production of olive oil (18%), the prevention of wildfires (17%) and the reduction of soil erosion (16%) are the most valued functions.

In order to aggregate public and expert opinions we have used the AHP technique which makes pair-wise comparisons of functions and olive management, respectively. In the erosion evaluation case, the ANP method was used instead of the AHP, making it possible to consider the interactions among factors to determine the corresponding map.

Keywords: olive plantations, AHP, ANP, GIS, land use optimisation.

О. Нехай[1], М. Аріаза[2]
[1]*Інститут технологічних досліджень, Іспанія*
[2]*Дослідницький та освітній інститут сільського господарства та рибної ловлі, Іспанія*

ЗАГАЛЬНОВІДОМІ ПЕРЕВАГИ ТА СУБ'ЄКТИВНІ ДАНІ ЕКСПЕРТІВ В ОПТИМІЗАЦІЇ СІЛЬСЬКОГОСПОДАРСЬКОГО ВИКОРИСТАННЯ ЗЕМЕЛЬ

Метод процесу аналітичної ієрархії (ПАІ) був використаний для оцінки переваг громадян щодо функцій плантацій маслини європейської (Olea euroраеа L.) в гірській місцевості. За відповідями населення, найбільш цінні функції – це збереження населення в сільській місцевості (24 %), виробництво оливкової олії (18 %), попередження пожарів (17 %), скорочення ерозії ґрунтів (16 %). Загальна модель систем географічних даних (СГД) показує, що дві третини традиційної продукційної системи слід переключити на інтегровану й біологічну підприємницьку системи, а також відновлення середземноморського лісу.

Ключові слова: плантації маслини європейської, процес аналітичної ієрархії (ПАІ), процес аналітичної мережі (ПАМ), система географічних даних (СГД), оптимізація використання земель.

А. Нехай[1], М. Арриаза[2]
[1] *Институт технологических исследований, Испания*
[2]*Исследовательский и образовательный институт сельского хозяйства и рыбной ловли, Испания*

ОБЩЕСТВЕННЫЕ ПРЕДПОЧТЕНИЯ И СУБЪЕКТИВНЫЕ ДАННЫЕ ЭКСПЕРТОВ В ОПТИМИЗАЦИИ СЕЛЬСКОХОЗЯЙСТВЕННОГО ИСПОЛЬЗОВАНИЯ ЗЕМЕЛЬ

Метод процесса аналитической иерархии (ПАИ) был использован для оценки предпочтений граждан касательно функций плантаций маслины европейской (*Olea europaea* L.) в горной местности. По ответам населения, наиболее ценные функции – это сохранение населения в сельской местности (24 %), производство оливкового масла (18 %), предотвращение пожаров (17 %), сокращение эрозии почвы (16 %). Общая модель систем географических данных (СГД) показывает, что две трети традиционной продукционной системы следует переключить на интегрированную и биологическую производственные системы, а также восстановление средиземноморского леса.

Ключевые слова: плантации маслины европейской, процесс аналитической иерархии (ПАИ), процесс аналитической сети (ПАС), система географических данных (СГД), оптимизация использования земель.

The production system management of olive plantations (*Olea europaea* L.) in Southern Spain is analysed from an economic, social and environmental perspective. The economic approach addresses the viability of the farming activities, the social criterion aims to prevent population loss in rural areas, whereas the environmental analysis involves the consideration of the reduction of soil erosion, the improvement of ecological diversity, the control of fire risk and the provision of quality agricultural landscapes.

In recent years, the driving force of the observed changes in the management of these agricultural systems, mainly from conventional management to agricultural land abandonment in mountain areas, is the implementation of the CAP reform of 2004 (Council Regulation (EC) No 864/2004) which entitles farmers to a fixed payment irrespective of their olive oil production[1]. The socio-economic and environmental consequences of these changes have been underestimated since more than 20 per cent of the Spanish olive plantations, mainly located in steeply sloping landscapes, will be better off leaving the farming activity since their low yields do not cover their higher production costs. Only in South Spain it has been estimated that an area of 220.000 ha is at risk of abandonment (Guzmán-Álvarez and Navarro-Cerrillo, 2008).

Since in most cases these agricultural mountain areas neighbour Protected Natural Parks, like the case presented in this study, their environmental functions, and the risks derived from agricultural abandonment (MacDonald et al., 2000), must be taken into account in order to determine which type of management, including a controlled abandonment, meets what Society demands on the one hand and the profitability of farming on the other.

In the present study the optimization of the agricultural land use integrates Society's preferences for the commercial and non-commercial functions of the olive plantations in mountain areas and the subjective experts' opinion about the suitability of the alternative agricultural system management to achieve these functions into a Geographical Information Systems (GIS).

Although this integrated approach is common in multiple land use optimization exercises (Stewart et al., 2004; Tait et al., 2004; Hajkowicz et al., 2005; Vold, 2005; Sikder, 2009), it is less frequent in agriculture (Santé and Crecente 2007; Gerber et al., 2008; Santé-Riveira et al., 2008; Sadeghi et al., 2009) and even more rare when the landscape component and other environmental issues are simultaneously considered (Tixier et al., 2008).

Other work that deals with the assessment of three different olive growing systems is Parra Lopez et al. (2008). Although this work dose not takes in to account a territorial dimension of the problem, it considers the mayor part of the function of the olive growing systems under three different scenarios.

The main purpose of the present work is social optimization of the olive farming area in the Montoro municipal territory (Andalusia, Spain). This optimization could serve for the local administration as a support guide to allocation of subsidies and corrective measures. To achieve this purpose the following exercises was carried out: *i*) six main functions performed by olive farming were selected; *ii*) the selected functions was evaluated by the local population via the AHP questionnaire (480 respondents); *iii*) at the same time several territorial models were made that evaluate the performance of the area with respect to each function under consideration; *iv*) the expert opinions about the performance of each

[1] This fixed payment accounts for 95% of the subsidies received during the base period under the former production-linked scheme.

alternative with respect to the selected function were collected; *v*) finally each of four considered alternatives and its most suitable allocation were evaluated.

The paper is organized as follows: Firstly, the study area, a typical Mediterranean mountain area covered almost entirely with olive groves, and the methodology followed in the study are presented. Secondly, based on the opinion of Society and several groups of experts, the territorial and general models are obtained and discussed. Finally, some conclusions are outlined.

AREA OF STUDY

The municipality of Montoro is located in the province of Cordoba in Southern Spain (Figure 1). The territory enjoys typical Mediterranean continental climate conditions with irregular precipitation distribution during the year (less than 600 mm/year). The Municipality of Montoro represents a variety of agricultural ecosystems (pasture, olive groves and annual crops) and forest/shrub natural vegetation near agricultural areas. Its 58,103 hectares are divided into olive plantations (34.2%), arable crops (8.1%), forest (17.5%), scrubland (28.7%), *dehesa* and other pastures (8.7%), water reservoirs (1.1%), urban area and infrastructure (0.8%) and other land uses (0.9%).

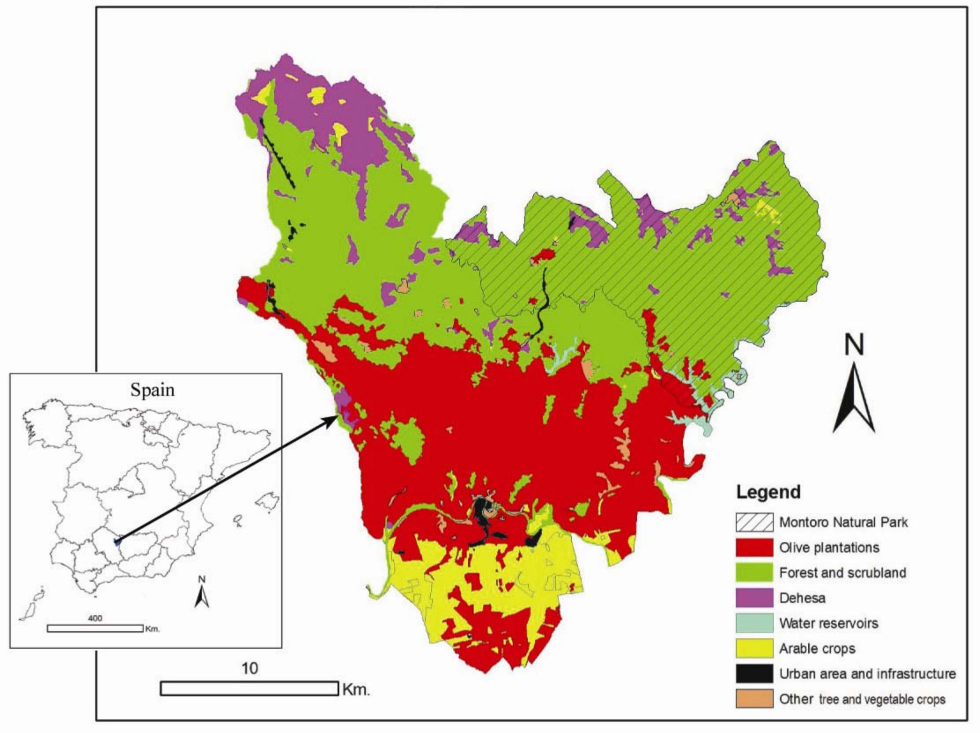


Fig. 1. **Study area map**

MATERIALS AND METHODS

1. Phases of the study

In order to assess the optimum agricultural system management (conventional, integrated, organic or restoration toward Mediterranean forest) for each pixel (the raster format of GIS analysis has been used) of the territory five phases were carried out:

1. Selection of most important socio-economic and environmental functions of these agricultural systems in mountain areas.
2. Preparation of the hierarchy structure of the study.
3. Evaluation of Society's preferences for these functions (their weightings in the general optimisation model).

4. Assessment of how each type of management contributes to achieving the selected socio-economic and environmental functions.

5. For each pixel, assessment on a 0-1 scale of its current suitability for each function. This phase produces five partial optimisation maps, one for each objective (production of olive oil, suitability for wildlife and flora habitat restoration, erosion risk, wildfire risk and visual impact).

6. Integration of the five maps into one which indicates for each pixel of the territory the optimum agricultural system management.

2. Primary data

The primary information gathered to implement the general optimisation model corresponds to the first four aforementioned phases and involves the following activities:

1. A focus group on the main functions provided by olive plantations in mountain areas. A group of experts on olive agricultural production and environmentalists ranked the main socio-economic and environmental functions of this agricultural system.

2. A survey in the province of Cordoba following a quota sampling based on sex, age and size of the municipality with quota sample size chosen by proportional allocation. Although this is a non-random sampling technique it often produces very good results in opinion surveys (Barnett, 1997).

3. A group made up of 15 experts assessed how the agricultural system management of the olive plantations (conventional, integrated and organic) or the abandonment of the agricultural activity and its restoration toward Mediterranean forest contribute to the achievement of the selected socio-economic and environmental functions. In order to attain a consensus a Delphi method was followed.

4. Three groups of experts assess the suitability for wildlife and flora habitat restoration, the wildfire risk and the erosion risk of the territory, respectively. The first two groups followed a typical Analytic Hierarchy Process (AHP) questionnaire, the last group of experts, the one assessing the erosion risk, expressed their opinions using the Analytic Network Process (ANP), a refinement of the AHP which allows for interactions among factors.

3. The AHP and ANP methods. Aggregating group opinions

Initially AHP was devised only for individual decision-making. However, after the multiple use of this method in different areas it was extended to group decision making (Aczel and Saaty, 1983; Dyer and Forman, 1992; Ramanathan and Ganesh, 1994; Gass and Rapcsák 1998; Lai *et al.,* 2002). In the present study this method is used to aggregate individual opinions of the local inhabitants and the experts' judgment upon the effects of the agricultural production systems on the selected objectives. In both cases the geometric mean was used (Forman and Peniwati, 1998).

4. The Geographical Information Systems (GIS)

The analysis of the area of study on a territorial basis involves the use of GIS, which is defined as an information system for the management and analysis of geographical information, and the geographical information as an abstraction or representation of the real world (landscape) (Georgiadou et al., 2004; Santiago, 2005).

The GIS software used as a platform for the representation, management and analysis of the spatial information was ArcGis 9.1 (ESRI) and ILWIS 3.4 Open with the SMCE module (ILWIS 3.4 and SMCE module was developed in ITC (Netherlands). This is free Software available at: www.itc.nl). The SMCE module makes it possible to manage and solve spatial multicriteria decision making problems. The input data were: land use map (1999; 1:50,000) corresponding to the study area (EGMASA, 2001); aerial monochrome orthophotos (2001-2002; 1:5000) and colour orthophotos (2005; 1:10,000); yield map of the olive plantations (2004; 1:25,000); road infrastructure map (1999; 1:25,000). The materials were provided by the Cartography Service (Junta de Andalucía, 2004, 2005). All geographical materials are represented in European Datum 1950, Zone 30N (Spain and

Portugal). Several trips to the study area were made with a GPS device, in order to check and if necessary, correct, the accuracy of the geographic information.

Empirical studies that have used multicriteria evaluation methods for the solution of spatial problems include that of Carver (1991) and later Malczewski (1999), which brought together two approaches developed much earlier: Multi-Attribute Utility Theory (MAUT) and the use of GIS as a platform for representing the spatial dimension of the problems. A large number of studies have since adopted this approach, including Hoctor et al. (2000), Store and Kangas (2001), Tseng et al. (2001), Thirumalaivasan et al. (2003), Ayalew et al. (2005), Strager and Rosenberger (2006), and Neaupane and Piantanakulchai (2006), this last dealing with different fields of the landscape assessment process.

As an example of the use of AHP for solving spatial problems, Thirumalaivasan et al. (2003) predicted areas that are more likely than others to become contaminated as a result of activities on or near the land surface. The AHP method computes the ratings and weights of each criterion on the parameters of the model. Then GIS software provides the spatial representation of the optimum solution. Similarly, Ayalew et al. (2005) deal with landslide hazard area prediction using both the AHP and logistic regression techniques. The results compare two susceptibility maps. According to these authors, the AHP map was closer to capturing the reality on the ground than the logistic regression. Strager and Rosenberger (2006) focus on the identification of high-priority areas for land conservation. For this purpose, individual stakeholders and expert judgements were combined using the AHP. A recent study by Neaupane and Piantanakulchai (2006) determined landslide hazard zonation but, unlike Ayalew et al. (2005) using the ANP method.

5. General optimisation model and territorial models

The solution of each AHP multicriteria problem involves the construction of the hierarchy of the objectives and the alternatives. Thus in the present case, a complex hierarchy was constructed (Figure 2) consisting of 5 levels.

Levels 1, 2, 3 and 5 are common to all AHP problems. Level 4 represents the inclusion of the territorial dimension of the analysis. At this level five territorial models are obtained to assess either the potential or risk of the olive plantations with respect to the functions demanded by Society: (1) Production of olive oil (the objective of keeping population in rural areas is considered as an non-territorial); (2) Provision of quality landscapes; (3) Suitability for wildlife and flora habitat restoration; (4) Soil erosion risk evaluation; and (5) Wildfire risk evaluation. The last three each required a group of experts in order to assess the effect of the landscape elements, natural and man-made, on its corresponding objective.

5.1. Visibility analysis of the study area

In the general model the visual quality of the alternative land uses is weighted depending on its visibility (Sevenant and Antrop, 2007; Hernández et al., 2004), therefore the aesthetic value of the agricultural land is increased in highly visible areas and, conversely, decreased in areas with lower visibility. The visibility analysis through an AHP questionnaire included both intrinsic and extrinsic elements (Martínez-Vega et al., 2000; Martínez-Vega et al., 2003).

5.2. Analysis of potentiality of the area for wild flora and fauna restoration

Mountainous agricultural areas with a high probability of being abandoned could be used for wildlife habitat restoration. However, there is a problem of how to evaluate agricultural land in terms of its suitability for wildlife habitat restoration. The competition between agriculture (particularly intensive agriculture) and wildlife habitats has been pointed out by several authors (Donald et al., 2006; Osinski, 2003; Santelmann et al., 2006; Waldhardt, 2003). The negative influence on wildlife habitats of agricultural activities through the use of agrochemicals and the modification of natural habitats has also been well documented (Pimentel et al., 1992; Sullivan and Sullivan, 2006).

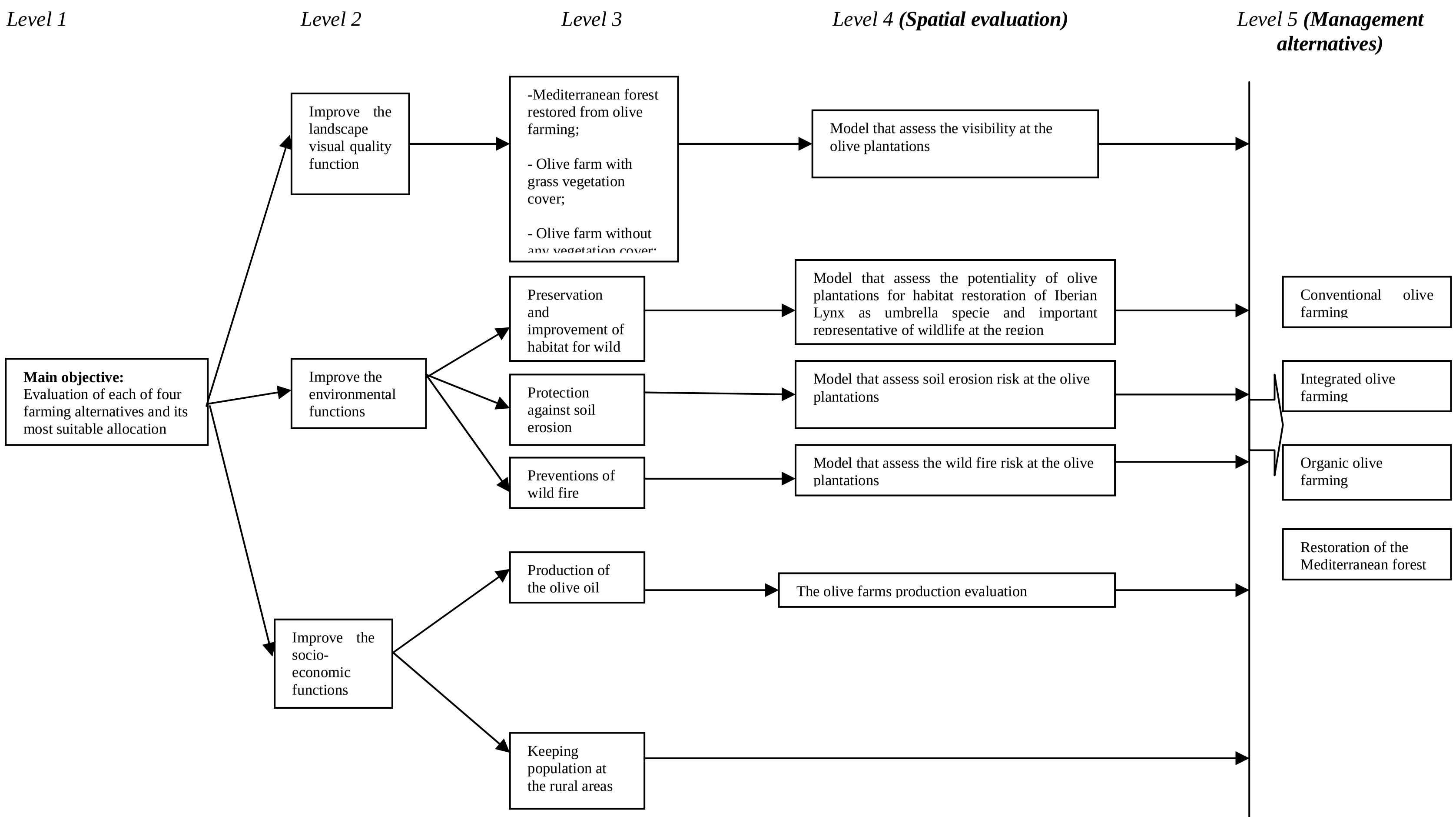


Fig. 2. **The hierarchy constructed for the study**

It is clear that some indicators are needed for ecological diversity and wildlife habitat assessments of agricultural areas. Most of the indicators that have been developed to assess biodiversity and ecological diversity refer to species richness and the habitat requirements of particular species (Büchs, 2003; Duelli and Obrist, 2003; Jeanneret et al., 2003). The approach proposed focuses on one key species or "umbrella species", the Iberian lynx (*Lynx pardinus*). The Iberian lynx is included in the Annex of the Habitat Directive 92/43/EEC as a priority species. Currently the Iberian lynx is the most seriously endangered species of all the felids, and is recognized as critically endangered by the World Conservation Union (IUCN, 2002), and as the most threatened carnivorous species in Europe (Nowell and Jackson, 1996; Delibes et al., 2000; Guzmán et al., 2004). It is on the brink of extinction due to a low total population and a highly fragmented distribution (Rodríguez and Delibes, 1992, 2002; Fernandez et al., 2003; Fernandez et al., 2006). Its distribution is restricted to the Iberian Peninsula.

The method used involved three phases (Nekhay and Arriaza, 2009):

- first, an inventory of Iberian lynx habitat requirements was drawn up;
- then, the AHP method was implemented based on ten experts' knowledge;
- finally, GIS technology was used to assess the potential of the study area for Iberian lynx's habitat restoration.

This approach is similar to used in Nekhay et al. (2009b) where four regionally important wild species was considered.

5.3. Soil erosion risk evaluation

The Revised Universal Soil Loss Equation (RUSLE) factors (Wischmeier and Smith, 1978; Renard et al., 1997) were adapted to local olive growing systems in Montoro, with the addition of the proximity factor of rivers and streams and the expertise-based ANP evaluation. In contrast to the classic USLE/ RUSLE models, which assume that the factors are independent, the model proposed here allowed us to consider possible interdependences and feedback between factors. The factors considered were (Nekhay et al., 2009a): rainfall-runoff, grass vegetation cover, soil erodibility, river and stream proximity, slope steepness and slope length.

5.4. Wildfire risk evaluation

The abandonment of the agricultural activity implies higher risk of wildfires. As the area of study is adjacent to a Protected Natural Park, home of the world most endangered feline species, the Iberian lynx, this issue is particularly important.

The approach used for wildfire risk evaluation is based on AHP method with experts' evaluations and several indexes developed in different countries: the Canadian Forest Fire Danger Index (Lee et al., 2002), the Australian Forest Fire Danger Index (CSIRO Forestry and Forest Products 2000), the New Zealand experience (Leathwick and Briggs, 2001) and the National Fire Danger Rating System of the US Forestry Service (Deeming et al., 1978). The study of Gouma and Chronopoulou-Sereli (1998) was also considered.

5.5. Olive oil production

This map is a simple reclassification of the average olive oil production of the study area. Six categories of olive oil production (≤1000; 1001-2000; 2001-3000, 3001-4000; 4001-5000; >5000 kg of olives / ha) from a four-years time-series were calculated.

5.6. General model

In the general model the public's preferences about the functions that this agricultural system should provide to Society, the contribution of each agricultural management type and current suitability/risk of the territory for each function are mathematically integrated as follows:

$$U_{n,g} = \sum_{i=1}^{6} A_{gi} \cdot P_i \cdot F_{ni}$$

Where n represents each pixel of the study area (10x10 m); g is the type of management (conventional, integrated, organic and restoration toward Mediterranean forest); A_{gi} represents the adequacy of management g with respect to the function i; P_i is the weight given by Society to the function i; F_{ni} is the value that function i takes in pixel n (Figs 3 to 9).

Finally, the recommended management type for each pixel of the olive plantations, its socio-economic and environmental optimum (O_n) corresponds with the highest utility, mathematically: $O_n = \text{Max}\ (U_{n,1}, U_{n,2}, U_{n,3}, U_{n,4})$.

RESULTS AND DISCUSSION

1. Society's opinion about the functions of the olive plantations in mountain areas

A total of 480 citizens were interviewed following a structured questionnaire with AHP pair-wise comparison of the selected functions of the olive plantations. The aggregation algorithm produced the general preferences of Table 1.

Table 1

Social preferences of the functions of the olive plantations in mountain areas

Socio-economic functions (42.5%)	Keeping population in rural areas	24.2%
	Production of olive oil	18.3%
Environmental functions (42.2%)	Wildfire prevention	17.1%
	Soil erosion prevention	16.2%
	Wildlife and flora habitats improvement	8.9%
Provision of quality agricultural landscape (15.3%)	Olive plantations with vegetal cover between trees	6.4%
	Olive plantations colonized by Mediterranean vegetation	6.2%
	Olive plantations without vegetation between lanes	2.7%
	Total	100.0%

Source: Survey on social preferences carried out in Cordoba (Spain) with 480 personal interviews.

According to these results, the socio-economic and environmental functions should have equal importance in the optimisation of the agricultural land use. Notwithstanding, the aesthetic value of the agricultural systems should be taken into account as well in the territorial analysis.

2. Contribution of each olive production system to the selected functions

Conventional production systems imply high use of agrochemicals and tillage. In organic olive plantations industrially synthesised agrochemicals are not allowed and weeds are controlled by either mechanical techniques or livestock. The integrated alternative is a technical in-between solution which aims to regulate the type and dosage of agrochemical with minimal yield reduction.

Following the iterative Delphi method and AHP questionnaire, a group of 15 experts on agricultural production, agricultural economics and environmentalists assessed the contribution of each agricultural production system or its restoration toward Mediterranean forest to the achievement of these functions. The following table 2 shows their aggregated responses.

Table 2

Contribution of alternative land uses to the achievement of the selected functions

Function / Alternative	Production of olive oil	Keeping population in rural areas	Improving wildlife and flora habitats	Prevention of soil erosion	Prevention of wildfire	Provision of quality agricultural landscapes
Restoration	0.05	0.06	0.46	0.36	0.06	0.51
Conventional	0.33	0.33	0.05	0.07	0.42	0.09
Integrated	0.35	0.29	0.13	0.20	0.27	0.15
Organic	0.27	0.32	0.36	0.37	0.25	0.26
Total	1.00	1.00	1.00	1.00	1.00	1.00

Source: Survey carried out on 15 experts using an AHP questionnaire.

4.3. General model for the agricultural land use optimization

For each alternative management of the olive plantations the five maps are aggregated, as Fig 3 shows:

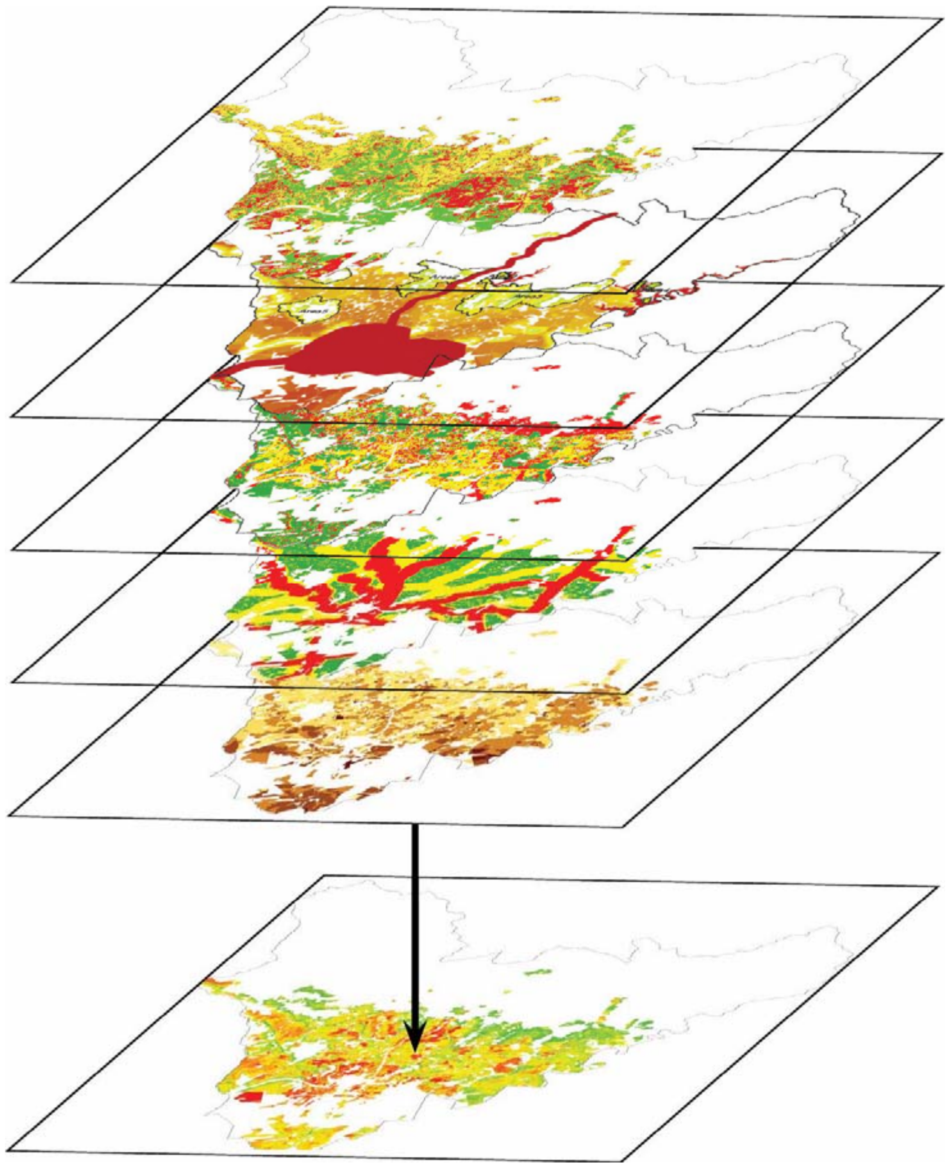


Fig. 3. **Weighed aggregation of the partial maps for each management type**

Once we have obtained the scoring of each alternative for each pixel, the highest value determines the optimum use. Fig 4 compares the current and optimum management type of the olive plantations in the study area.

The proposed changes imply a significant increase of the integrated and organic production systems to the detriment of the conventional system, as Table 3 shows.

According to these results, in order to promote a more sustainable agricultural system, taking into account Society's preferences and the experts' judgements about the effects of each agricultural management type and the suitability of the territory for the achievement of these functions, part of the conventional olive production system should be shifted toward either integrated or organic systems of production.

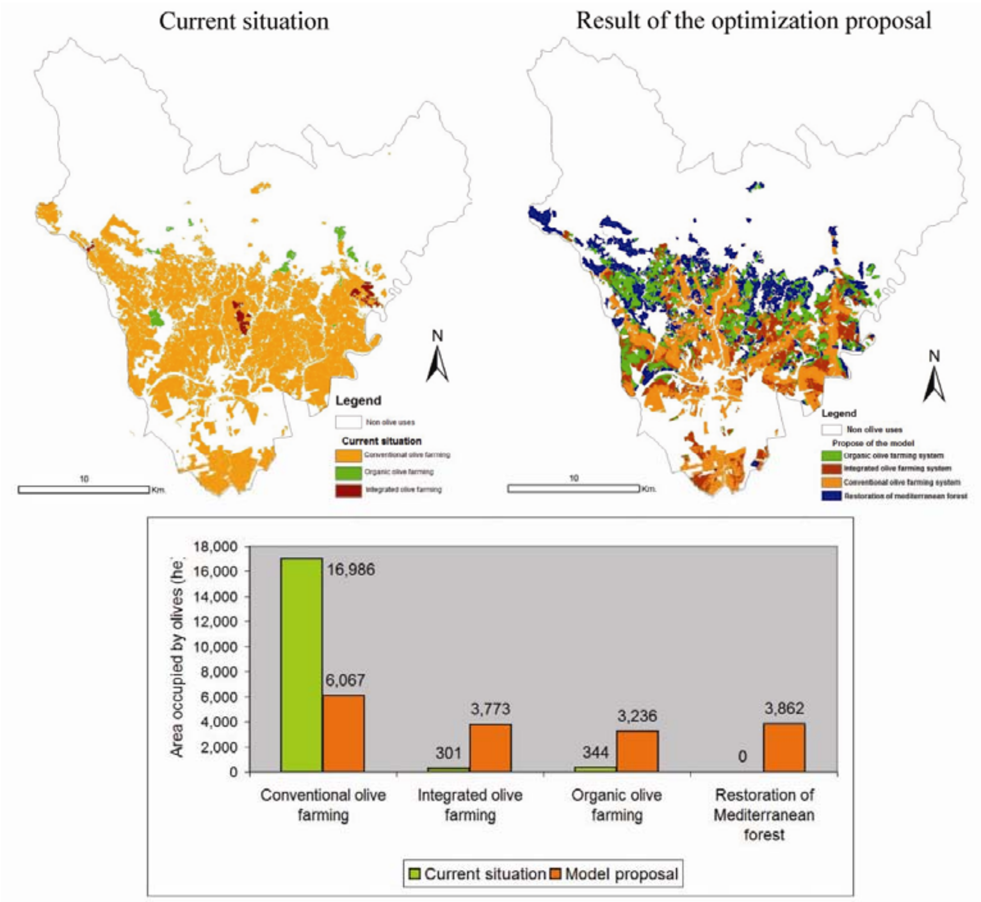


Fig. 4. **Comparison of maps of current and optimum management of the olive plantations**

Table 3

Current and optimised agricultural land use in olive plantations

Production system	Current situation (ha)	Optimised land use (ha)
Conventional	16,292	6,067
Integrated	301	3,773
Organic	344	3,236
Restoration to Mediterranean forest	0	3,862
Total	16,938	16,938

The upland olive growing systems represent a typical example of the unfavourable agricultural area that could be abandoned in the nearest future. However, these areas perform several socio-economic, environmental and landscape visual quality functions. That is why the intervention of the public administration is very important in order to prevent this uncontrolled abandonment of agricultural activities. Nevertheless, the public administration needs a scientifically sound tool that could help to support a decision to implement different agro-forestry systems in uplands areas. The study presented here shows one possible way to optimize the use of the olive growing area in agreement with the selected functions.

The main advantage of the proposed approach is the possibility of optimization of the agricultural land use embedding the opinions of the local inhabitants and the territorial dimension of the problem at low cost and in a reasonable time. The results of the optimization of the agricultural territory suggest the redistribution of the management systems currently in use in the olive plantations of Montoro toward a much more balanced situation. The use of Geographical Information Systems in conjunction with the AHP multicriteria decision making technique make it possible to locate which agricultural management is suitable in the territory.

The proposed changes in agricultural land use should have the financial support of the public administration. One example of the compensation payments is presented by Ulbrich et al. (2008) as specific software.

However, the commented advantages of this approach have several limitations. Firstly, it is highly sensitive to people's and experts' opinions. This problem could be solved through a dynamic model which updates changes in public opinion. This, however, should be done with caution since the proposed restoration measures must be planned over the long-term. Secondly, the use of the geographical boundaries in the submodels with clear limits instead of a fuzzy or soft consideration to model environmental processes represents an approximation to reality. Finally, an additional issue is the resolution of available digital layers: The land use map used is 1:50,000 spatial resolution and other digital layers used have 1:25,000 or 1:10.000 spatial resolution. This means that allowed spatial errors are from 10 to 50 m or even 100 m in some layers.

As a remark, some future research lines are being opened from this work. An obvious one is the consideration of other functions of the agricultural systems not considered in the present study. The design of a dynamic model able to include the time dimension of the problem and its influence on the ranking of the alternatives is a second one. Finally, to overcome the limitations of the AHP linear structure and its main assumption of mutual independence of elements at the same level and of different levels in the hierarchy, criticized by some researchers (Dyer, 1990; Holder, 1990; Barzilai and Golani, 1994; Leung and Cao, 2001), the Analytic Network Process could be applied instead.

CONCLUSIONS

In this paper (a) citizens' preferences for the functions that olive plantations in mountain areas should provide to Society and (b) experts' opinion about the suitability of each olive production system (conventional, integrated and organic) and the restoration of the olive plantations toward Mediterranean forest for the achievement of such functions, are integrated into a GIS to determine changes in the agricultural land use to optimise social welfare.

According to the population's responses, the groups of environmental and socio-economic functions have equal importance (42% each), leaving the provision of agricultural landscape with a weight of 15%. Individually, keeping the rural population in the villages (24%), the production of olive oil (18%), the prevention of wildfires (17%) and the reduction of soil erosion (16%) are the most valued functions.

In order to aggregate public and expert opinions we have used the AHP technique which makes pair-wise comparisons of functions and olive management, respectively. In the erosion evaluation case, the ANP method was used instead of the AHP, making it possible to consider the interactions among factors to determine the corresponding map.

The general model integrated the six functions that correspond with five partial maps (visibility analysis, habitat restoration for the Iberian lynx, soil erosion risk, wildfire risk, average olive oil production and keeping rural population, not considered as a territorial function) indicating via a GIS the either most suitable production system management or abandonment of the farming activity for each pixel of the study area. The results suggest that part of the conventional production management of the olive plantations should be changed to (a) Mediterranean forest in areas adjacent to the Natural Park, home of the Iberian lynx, and those near to rivers; (b) organic production management in steeped areas and high visibility areas; and (c) integrated production system, something in between conventional and organic systems, in steeped areas with higher yields. The conventional production system is most suitable for open plain with high yields and those near to roads to prevent wildfires.

The proposed changes would result in a higher level of social welfare due to the positive effects of the prevention of soil erosion, the expansion of endangered species' habitats and the preservation and improvement of the flora and wildlife in general. In addition, the higher ecological diversity improves the visual quality of this agricultural system.

ACKNOWLEDGEMENTS

This research has been financed by the National Institute for Agricultural and Food Research and Technology (INIA) through the project RTA2008-00022.

REFERENCES

Aczel, J., Saaty, T. L., 1983. Procedures for synthesizing ratio judgments. Journal of Mathematical Psychology 27, 93-102.

Ayalew, L., Yamagishi, H., Marui, H. Y Kanno, T., 2005. Landslides in Sado Island of Japan: Part II. GIS-based susceptibility mapping with comparisons of results from two methods and verifications. Engineering Geology 81, 432-445.

Barnett, V., 1997. Sampling survey. Principles and methods. Arnold. London.

Barzilai, J., Golani, B., 1994. AHP rank reversal, normalization and aggregation rules. INFOR 32, 57-63.

Büchs, W., 2003. Biodiversity and agri-environmental indicators- general scopes and skills with special reference to the habitat level. Agriculture Ecosystems and Environment 98, 35-78.

Carver, S.J., 1991. Integrating multi-criteria evaluation with geographical information systems. International Journal of Geographical Information Science 5 (3), 321-339.

CSIRO Forestry and Forest Products, 2000. Bushfire Behaviour and Management, http://www.ffp.csiro.au/nfm/fbm/.

Deeming, J.E.; Burgan, R.E., Cohen, J.D.,1978. The National Fire Danger Rating System. USDA Forest Service, General Technical Report INT-39.

Delibes, M., Rodriguez, A., Ferreras, P., 2000. Action plan for the conservation of the Iberian lynx (*Lynx Pardinus*) in Europe. Nature and Environment 111, 1-45.

Donald, P.F., Sanderson, F.J., Burfield, I.J., van Bommel, F.P.J., 2006. Further evidence of continent-wide impacts of agricultural intensification on European farmland birds, 1990–2000. Agriculture Ecosystems and Environment 116 (3–4), 189–196.

Duelli, P., Obrist, M., 2003. Biodiversity Indicators: the choice of values and measures. Agriculture Ecosystems and Environment 98, 87-98.

Dyer, J.S., 1990. Remarks on the analytic hierarchy process. Management Science 36, 249-258.

Dyer, R. F., Forman, E. H., 1992. Group decision support with the Analytic Hierarchy Process. Decision Support System 8, 99-124.

EEC, 1992. Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora ('The Habitats and Species Directive'), 92/43/EEC. European Economic Community.

EGMASA (Empresa de Gestión Medioambiental), 2001. Usos de Suelo de Andalucía. Consejería de Medio Ambiente, Junta de Andalucía (CD) (in Spanish).

Fernandez, N., Delibes, M., Palomares, F., Mladenoff, D.J., 2003. Identifying breeding habitat for the Iberian lynx: inferences from a fine-scale spatial analysis. Ecol Appl 13, 1310-1324.

Fernandez, N., Delibes, M., Palomares, F., 2006. Landscape evaluation in conservation: molecular sampling and habitat modeling for the Iberian lynx. Ecol Appl 16(3), 1037-1049.

Forman, E.H., Peniwati, K., 1998. Aggregating individual judgments and priorities with the Analytic Hierarchy Process. European Journal of Operational Research 108, 165-169.

Forman, E.H., Selly, M.A., 2001. Decision by Objectives. World Scientific. ISBN: 9810241437. Available in: http://www.expertchoice.com/dbo/.

Gass, S.I., Rapcsák, T., 1998. A note on synthesizing group decisions. Decision Support Systems 22, 59-63.

Georgiadou, Y., Knippers, R.A., Kraak, M.N., Sun, Y., Weir, M.J.C., Van Westen, C.J., De By, R.A. (2004). Principles of Geographical Information Systems. The International Institute for Geo-Information Science and Earth Observation (ITC), Enschede, The Netherlands. ISBN 90-6164-226-4.

Gerber, P.J., Carsjens, G.J., Pak-uthai, T., Robinson, T.P., 2008. Decision support for spatially targeted livestock policies: Diverse examples from Uganda and Thailand. Agricultural Systems 96, 37-51.

Gouma, V., Chronopoulou-Sereli, A., 1998. Wildland fire danger zoning- A methodology. International Journal of Wildland Fire 8(1), 37-43.

Guzmán-Álvarez, J.R., Navarro-Cerrillo, R.M., 2008. Modelling potential abandonment and natural restoration of marginal olive groves in Andalusia (South of Spain). Journal of Land Use Science 3(2), 113-129.

Guzmán J.N., Garcia F.J., Garrote G., Pérez De Ayala R., Iglesias C., 2004. El lince ibérico (*Lynx pardinus*) en España y Portugal. Censo-diagnóstico de sus poblaciones. Dirección General para la Biodiversidad, Ministerio de Medio Ambiente, Madrid. 184 pp. [In Spanish].

Hajkowicz, S., Perraud, J.M., Dawes, W., DeRose, R., 2005. The strategic landscape investment model: a tool for mapping optimal environmental expenditure. Environmental Modelling and Software 20(10), 1251-1262.

Hernández, J., García, L., Ayuga, F., 2004. Assessment of the visual impact made on the landscape by new buildings: a methodology for site selection. Landscape and Urban Planning 68, 15-28.

Hoctor, T.S., Carr, M.H., Zwick, P., 2000. Identifying a linked reserve system using a regional landscape approach: the Florida Ecological Network. Conservation Biology 14 (4), 984–1000.

Holder, R.D., 1990. Some comments on the analytic hierarchy process. The Journal of the Operational Research Society 41, 1073-1076.

IUCN, 2002. Updated IUCN red list of threatened species released online. Species 38, 6-7.

Jeanneret, Ph., Schupbach, B., Luka, H., 2003. Quantifying the impact of landscape and habitat features on biodiversity in cultivated landscapes. Agriculture Ecosystems and Environment 98, 311-320.

Junta de Andalucía., 2004. Ortofotografía en blanco y negro, provincia de Córdoba. Consejería de obras Públicas y Transportes, Consejería de Agricultura y Pesca, Consejería de Medio Ambiente. ISBN: 84-95083-94-9 (in Spanish).

Junta de Andalucía., 2005. Ortofotografía en color, provincia de Córdoba. Consejería de obras Públicas y Transportes, Consejería de Agricultura y Pesca, Consejería de Medio Ambiente. ISBN: 84-95083-94-9 (in Spanish).

Lai, V. S., Wong, Bo K., Chung, W., 2002. Group decision making in a multiple criteria environment: A case using the AHP in software selection. European Journal of Operational Research 137, 134-144.

Leathwick, J. R., Briggs, C.M., 2001. Spatial prediction of wildfire hazard across New Zealand. New Zealand Fire Service Commission, Research report No. 22.

Lee, B.S.; Alexander, M.E.; Hawkes, B.C.; Lynham, T.J.; Stocks, B.J. y Englefield, P., 2002. "Information systems in support of wildland fire management decision making in Canada". Computers and Electronics in Agriculture 37(1-3), 185-198.

Leung, L. C., Cao, D., 2001. On the efficacy of modelling multi-attribute decision problems using AHP and Sinarchy. European Journal of Operational Research 132, 39-49.

MacDonald, D., Crabtree, J.R., Wiesinger, G., Dax, T., Stamou, N., Fleury, P., Gutierrez-Lazpita, J., Gibon, A., 2000. Agricultural abandonment in mountain areas of Europe: Environmental consequences and policy response. Journal of Environmental Management 59, 47-69.

Malczewski, J., 1999. GIS and Multicriteria Decision Analysis. Nueva York, John Wiley & Sons.

Martínez Vega, J., Martín Isabel, M. P., Romero Calcerrado, R., 2003. Valoración del paisaje en la zona de especial protección de aves carrizales y sotos de Aranjuez (Comunidad de Madrid). Revista Internacional de Ciencia y Tecnología de la Información Geográfica 3(1), 1-21.

Martínez-Vega, J., Romero, R., García, J.A., Corrochano, P. and Martín, M.P., 2000. Application of Geographic Information Systems to the management and conservation of Protected Areas. In Lois, R., Martín-Lou, M.A., Mata, R. and Valenzuela, M. (eds): Living with Diversity. XXIX Congress of the International Geographic Union (Seoul, 2000). Madrid, 425-438.

Moreira, F., Russo, D., 2007. Modelling the impact of agricultural abandonment and wildfires on vertebrate diversity in Mediterranean Europe. Landscape Ecology (2007) 22:1461–1476. doi 10.1007/s10980-007-9125-3.

Neaupane, K.M., Piantanakulchai, M., 2006. Analytic network process model for landslide hazard zonation. Engineering Geology 85, 281-294.

Nekhay, O., Arriaza, M., 2009. Restoration of abandoned agricultural lands toward umbrella species habitats. Spanish Journal of Agricultural Research **7**(2), 375-389.

Nekhay, O., Arriaza, M., Boerboom, L., 2009a. Evaluation of erosion risk using Analytic Network Process and GIS: a case study from Spanish mountain olive plantations. Journal of Environmental Management 90(10), 3091-3104. ISSN: 0301-4797. doi:10.1016/j.jenvman.2009.04.022.

Nekhay, O., Arriaza, M., Guzmán-Álvarez, J.R., 2009b. Spatial analysis of the suitability of olive plantations for wildlife habitat restoration. Computers and Electronics in Agriculture 65, 49-64.

Nowell K., Jackson P., 1996. Wild cats: status survey and action plan. IUCN/SSC Cat Specialist Group, IUCN, Gland, Switzerland.

Osinski, E., 2003. Operationalisation of a landscape-oriented indicators. Agriculture Ecosystems and Environment 98, 371–386.

Parra Lopez, C., Calatrava Requena, J., Haro Giménez, T., 2008. A systematic comparative assessment of the multifunctional performance of alternative olive systems in Spain within an AHP-extended framework. Ecological Economics 64, 820-834.

Pedersen Å.Ø., Nyhuus S., Blindheim T., Wergeland Krong O.M., 2004. Implementation of a GIS-based management tool for conservation of biodiversity within the municipality of Oslo, Norway. Landscape Urban Plan 68, 429-438.

Pimentel, D., Acguay, H., Biltonen, M., Rice, P., Silva, M., Nelson, J., Lipner, V., Giordano, S., Harowitz, A., D'amore, M., 1992. Environmental and economic cost of pesticide use. Bioscience 42 (10), 750–760.

Ramanathan, R., Ganesh, L. S., 1994. Group preference aggregation methods employed in AHP: An evaluation and an intrinsic process for deriving members' weightages. European Journal of Operational Research 79, 249-265.

Rego, F., 1992. Land use changes and wildfires. In: Teller A, Mathy P, Jeffers JNR (eds) Responses of forest ecosystems to environmental changes. Elsevier Applied Science, London, pp 367–373.

Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K., Yoder, D.C. (Eds.), 1997. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). Agricultural Handbook No. 703. US Department of Agriculture, Agricultural Research Service, Washington, DC, USA, 404pp.

Rodrigueza., Delibes M., 1992. Current range and status of the Iberian lynx *Felis pardina* Temminck 1824, in Spain. Biol Conserv 61, 189-196. doi: 10.1016/0006- 3207(92)91115-9.

Rodriguez A., Delibes M., 2002. Internal structure and patterns of contraction in the geographic range of the Iberian lynx. Ecography 25, 314-328. doi: 10.1034/j.1600-0587.2002.250308.x.

Sadeghi, S.H.R., Jalili, Kh., Nikkami, D., 2009. Land use optimization in watershed scale. Land Use Policy 26(2), 186-193.

Santé, I., Crecente R., 2007. LUSE, a decision support system for exploration of rural land use allocation: Aplication to the Terra Chá district of Galicia (N.W. Spain). Agricultural Systems 94(2), 341-356.

Santelmann, M., Freemark, K., Sifneos, J., White, D., 2006. Assessing effects of alternative agricultural practices on wild habitat in Iowa, USA. Agriculture Ecosystems and Environment 113, 243–253.

Santé-Riveira, I., Crecente-Maseda, R., Miranda-Barrós, D., 2008. GIS-based palnning support system for rural land-use allocation. Computers and Electronics in Agriculture 63, 257-273.

Santiago, I., 2005. Fundamentos de ArcGIS versión ArcView 9.1., tutorial de lecturas. Área de Tecnologías de Información Gubernamental, oficina de Gerencia y Presupuesto. Puerto Rico.

Sevenant, M., Antrop, M., 2007. Settlement models, land use and visibility in rural landscapes : Two case studies in Greece. Landscape and urban planning 80(4), 362-374.

Sikder, I.U., 2009. Knowledge-based spatial decision support systems: An assessment of environmental adaptability of crops. Expert System with Application 36(3) part 1, 5341-5347.

Stewart, T.J., Janssen, R., Van Herwijnen, M., 2004. A genetic algorithm approach to multiobjective land use planning. Computers & Operations Research 31(14), 2293-2313.

Store, R., Kangas, J., 2001. Integrating spatial multi-criteria evaluation and expert knowledge for GIS-based habitat suitability modelling. Landscape and Urban Planning 55, 79-93.

Strager, M.P., Rosenberger, R.S., 2006. Incorporating stakeholder preferences for land conservation: Weights and measures in spatial MCA. Ecological Economics 57(4), 627-639.

Sullivan, T.P., Sullivan, D.S., 2006. Plant and small mammal diversity in orchard versus non-crop habitats. Agriculture Ecosystems and Environment 116 (3–4), 235–243.

Tait, N.G., Davison, R.M., Whittaker, J.J., Leharne, S.A., Lerner, D.N., 2004. Borehole Optimisation System (BOS) – A GIS based risk analysis tool for optimising the use of urban groundwater. Environmental Modelling and Software 19(12), 1111-1124.

Thirumalaivasan, D. Karmegam, M. Venugopal, K., 2003. AHP-Drastic: software for specific aquifer vulnerability assessment using DRASTIC model and GIS. Environmental Modelling and Software 18(4), 645-656.

Thompson, W. A., Vertinsky, I., Schreier, H. Y Blackwell, B. A., 2000. Using forest fire hazard modeling in multiple use forest management planning. Forest Ecology and Management 134, 163-176.

Tixier, P., Malézieux, E., Dorel, M., Wery, J., 2008. SIMBA, a model for deigning sustainable banana-based cropping systems. Agricultural Systems 97, 139-150.

Tseng, C.T., Chen, S.C., Huang, C.S., Liu, C.C., 2001. GIS-assisted site selection for artificial reefs. Fisheries Science 67, 1015–1022.

Ulbrich, K., Drechsler, M., Wätzold, F., Johst, K., Settele, J., 2008. A software tool for designing cost-effective compensation payments for conservation measures. Environmental Modelling and Software 23, 122-123.

Vaidya, O. S., Kumar, S., 2006. Analytic hierarchy process: An overview of applications. European Journal of Operational Research 169, 1-29.

Van der Horst, D. and Gimona, A., 2005. Where new farm woodlands support biodiversity action plans: a spatial multi-criteria analysis. Biological Conservation 123, 421-432.

Vold, A., 2005. Optimal land use and transport planning for the Greater Oslo area. Transportation Research part A: Policy and Practice 39(6), 548-565.

Waldhardt, R., 2003. Biodiversity and landscape—summary, conclusions and perspectives. Agriculture Ecosystems and Environment 98, 305–309.

Wischmeier, W.H., Smith D.D., 1978. Predicting Soil Erosion Losses: A Guide to Conservation Planning. USDA Agricultural Handbook No. 537, 58 pp.

Надійшла до редколегії 18.11.10

UDK 580.006(477.72):502.72

N. O. Havrylenko

ECOSYSTEM OF DENDROLOGICAL PARK «ASKANIA NOVA» AS A PART OF AN OBJECT OF THE NATURE PROTECTED FUND OF UKRAINE

F. E. Falz-Fein Biosphere reserve «Askania Nova», National Academy of Agrarian Sciences of Ukraine

The ecosystem of oasis type including the biocoenosis artificial created and formed spontaneously is described. A stranger element of the dendropark forced by zonal biodiversity considerably increases the sozological status of the dendropark as a structural compotent of the Biosphere reserve «Askania Nova».

Key words: irrigated park, cultivated flora, spontaneous flora, fauna, rare species.

Н. А. Гавриленко

Биосферный заповедник «Аскания-Нова» имени Ф. Э. Фальц-Фейна НААН Украины

ЭКОСИСТЕМА ДЕНДРОПАРКА «АСКАНИЯ-НОВА» КАК ЭЛЕМЕНТ ОБЪЕКТА ПРИРОДНО-ЗАПОВЕДНОГО ФОНДА УКРАИНЫ

Охарактеризована экосистема дендропарка, включающая, помимо искусственно созданных, спонтанно сформировавшиеся биоценозы. Интродуцированный элемент парка, усиленный зональным биоразнообразием, существенно повышает его созологический статус как структурного компонента Биосферного заповедника «Аскания-Нова».

Ключевые слова: орошаемый дендропарк, культивируемая флора, спонтанная флора, фауна, редкие виды.

Н. О. Гавриленко

Біосферний заповідник «Асканія-Нова» імені Ф.Е. Фальц-Фейна НААН України

ЕКОСИСТЕМА ДЕНДРОПАРКУ «АСКАНІЯ-НОВА» ЯК ЕЛЕМЕНТ ОБ'ЄКТУ ПРИРОДНО-ЗАПОВІДНОГО ФОНДУ УКРАЇНИ

Охарактеризовано екосистему дендропарку, яка включає, окрім штучно створених, спонтанно сформовані біоценози. Інтродукований елемент парку, посилений зональним біорізноманіттям, суттєво підвищує його созологічний статус як структурного компонента Біосферного заповідника «Асканія-Нова».

Ключові слова: зрошувальний дендропарк, культивована флора, спонтанна флора, фауна, рідкісні види.

Dendrological Park "Askania Nova" is unique Woodland Park of oasis type which exists over 125 years at the region with difficult climatic conditions, great changeability of the meteorological factors and intensive hot dry winds. It is largest irrigated park at the south of Ukraine with rich collection of wood plantings, which are growing in azonal conditions. Such view in estimate of this formation out of the ordinary predominated from the time of formation of its plantings and landscapes till present days. However other components and characteristics of artificial ecosystem that were formed without direct anthropogenic influence were ignored. The researches of total biodiversity have a fragmentary character and they are determined mainly by professional interests of executors.

OBJECTIVE OF RESEARCHES

The aim of this paper is to summarize the data presented the dendropark's biodiversity.

RESULTS AND DISCUSSION

The growth of woody vegetation under conditions of Askania Nova became possible due to water from artesian pumps. The Dendrological Park consists of three different age massifs: the old botanical park (founded during period 1887-1893), the forest-steppe light forest with oak-wood (laid in 1907-1962 and it was included into composition of a new part of park after its creation) and the new park (created in 1968-1972). They are differed by specific composition and phytocoenotic structure of woody planting stands, diversity of landscapes, a method of glades' formation, ratio of the open and close spaces. A soil for planting of trees and shrubs at the old park has been prepared according to system of bare fallow. The soil has been dug from 50 cm till 100 cm in deep except the plots for glades on which the soil and vegetable cover was not broken (Карасев, 1962). When the new park has been laid out, deep ploughing till 70 cm was done at all area intended for it. Later the regime of bare fallow was kept before the growing of young plants. The glades of grass mix were formed at the same time. The grass mix consisted of *Bromopsis inermis* (Leyss.) Holub, *Festuca pratensis* Huds., *Dactylis glomerata* L.; *Lolium perenne* L., *Phleum pratense* L., *Medicago* sp. and *Trifolium* sp.

Before telling about a biota of Dendrological Park we must note the changes taken place in pedosphere. At the present time glades' soil (particularly The Big Steppe Glade on area of 7 ha) is classified as dark chestnut residually alkaline (Ушачова, Моргун, 2003) and typical for the whole region. The soil of park irrigated culture is classified as dark chestnut calcareous soil improved deeply (Ушачева, 2001). The last one was formed because of three main factors: deep manual digging, long term irrigation and forest culture. Combination of annual broad-leaved tree waste with high level of moisture providing, perennial activity of soil mesofauna and impact of wood vegetation root system led hereto that more than 120 years of being the dendropark a soil profile different from the profile of original virgin dark chestnut residually alkaline soil was formed. It is typical of him an absence of residually alkalinity, humus redistribution according to profile with concentration at upper its parts (a ceiling amount of humus of the park's soil is concentrated in upper stratum 10 cm: 0-5 cm – 6.21 %; 5-10 cm – 4.09 %; its amount rapidly falls with depth in stratums 25-30 and 45-50 cm that makes up 1.86 % and 1.56 % respectively), useful increase of sum of absorbed grounds concerning with weighting of mechanical composition, supporting of relative density of a bridging part of profile in optimum range and formation of grainy water-stable structure, contributing to creation of favourable water-air regime in soil. The soils of old part of the dendropark which is under conditions of irrigated culture more than 100 years possess the largest potential productivity as compared to other soils of the biosphere reserve besides of the virgin variants, according to a set of indices: color, density, composition, structure, moisture, new formations, and character of transition between horizons (Ушачова, Моргун, 2005).

Two blocs are studied well: collection fund of aliens and spontaneous component in flora of the dendropark.

Cultivated flora includes 766 species, 265 forms and sorts (1031 taxons) belonging to 170 genera of 66 families. Pinophyta is presented by 66 species, 65 forms and sorts (131 taxons), 17 genera, 6 families; Magnoliophyta is presented by 700 species, 200 forms and sorts (900 taxons) relating to 153 genera and 60 families (Каталог…, 2003). Among Pinophyta two families dominate in taxonomic respect: Cupressaceae Bartl. – 8 genera, 21 species, 51 forms and Pinaceae Lindl. – 5 genera, 38 species, 11 forms. The most numerous genera are *Juniperus* L.– 10 species, 18 form; *Thuja* L. – 3, 22; *Pinus* L. – 16, 1; *Picea* Dietr. – 8, 6; *Chamaecyparis* Spach – 3, 7; *Abies* Mill. – 7, 1; *Larix* Mill. – 6, 1; *Taxus* L. – 3, 3. Among Magnoliophyta the most taxonomic diverse families are Rosaceae Juss. – 35 genera, 215 species, 69 form and sorts; Caprifoliaceae Juss. – 6, 58, 13; Oleaceae Hoffmgg. et Link – 7, 38, 23; Fabaceae Lindl. – 9, 24, 6; Fagaceae Dumort. – 3, 21, 10; Salicaceae Mirb. – 2, 27, 5; Betulaceae S.F. Gray – 2, 18, 2; Berberidaceae Torr. et Gray – 2, 16, 4; Celastraceae R. Br. – 2, 16, 6; Juglandaceae A. Rich. ex Kunth – 3, 16, 1, the representatives of such genera dominate: *Crataegus* L – 43 species, 2 form and sorts;. *Rosa* L. – 16, 34; *Lonicera* L. – 36, 4; *Acer* L. – 22, 10; *Cotoneaster* Medik. – 25, 2; *Syringa* L. – 15, 14; *Quercus* L. – 18, 4; *Betula* L. – 17, 1; *Populus* L. – 16, 1; *Tilia* L. – 15, 2; *Salix* L. – 11, 4; *Celtis* L. – 11, 1.

A list of alien grass plants numbers 564 species, forms and sorts relating to 194 genera of 62 families: Magnoliopsida – 160 genera, 147 families; Liliopsida – 34 genera, 15 families.

About 138 aliens have the sozological status (Каталог…, 2010): 24 of them is listed in the Red List of IUCN (Walter, Gillette, 1998), 11 – in the European Red List (Види…, 1996), 6 – in the List of Bern Convention (Конвенція…, 1998), 3 – in the Lists of CITES (Список…, 1998), 62 species are listed in the Red Book of Ukraine (2009), 65 species are rare species of Eurasia (Редкие виды…, 1983).

Spontaneous flora is unique in regional scale and numbers 484 species of vascular plants (Гавриленко, Мойсієнко, Шаповал, 2008). A flora of the core area of the Biosphere Reserve "Askania Nova" is comparable to volume – 505 species (Шаповал, 2007), but a square of the core area exceeds square of the dendropark in more than 66 times. The following families dominate: Asteraceae – 83 species (17,1%), Poaceae – 50 (10,3%), Fabaceae – 31 (6,4%), Brassicaceae – 25 (5,2%), Chenopodiaceae – 23 (4,8%), Lamiaceae – 21 (4,3%), Scrophulariaceae – 20 (4,1%), Cariophyllaceae – 18 (3,7%), Apiaceae – 16 (3,3%), Boraginaceae and Polygonaceae – in 15 (3,1%). Thus a spectrum of spontaneous flora of the dendropark is not notable for originality and practically identical with the local floras of the region and also correlates with the same spectrum of flora of the south of Ukraine. About 27 species are included in protected lists: 6 – in the Red List of IUCN, 6 – in the European Red List, 3 – in the List of Bern Convention, 2 – CITES, 14 species are listed in the Red Book of Ukraine, 7 species are listed in the Red List of Kherson Region (Бойко, Підгайний, 2002).

Fungi diversity is rather great (Гелюта та ін., 2009). About 23 species of 7 genera Erysiphales are founded at the park. Erysiphe s.l., Golovinomyces and Podosphaera s.l. genera predominate (7, 6 and 5 species respectively). The general pests of wood species for Ukraine make up more than a third. However some rare species occur in the Steppe Zone: Erysiphe lonicerae, Podosphaera ferruginea, Phyllactinia fraxini, etc; the last one was not registered on the territories of others protected objects of the Left-bank Ukraine. About 94 species of anamorphous phytotrophic micromycetes of 31 genera are founded. They cause a blotch of leaves with following their yellowing and falling, drying of sprays. The genera of Diplodia (22 species), Camarosporium (9), Phoma (9), Phomopsis (8), Septoria (6), Ascochyta (5), Cytospora (4) are presented most of all. The basidial macromycetes (87 species) are notable for specific diversity: Agaricales – 55 species, Polyporales – 21, Hymenochaetales – 4, Phallales – 4, Boletales – 2, Russulales – 1. Leucopaxillus rhodoleucus and Volvariella gloiocephala are rare, and Agaricus romagnesii is listed in the Red Book.

Lichenoflora of the dendropark and the reserve in whole is not studied enough (Кондратюк, Ходосовцев, 1997). According to the analytical review of A.Ye. Chodosovtsew (Ходосовцев, 1998) 32 species of lichen and lichenophilous fungi occur here.

The park's bryoflora includes 46 species (Бойко, 1998). The families of Pottiaceae, Brachytheciaceae, Orthotrichaceae, Bryaceae, Amblystegiaceae predominate. Some rare and endangered species grow up here: Tortula intermedia, T. papillosa, Didymodon sinuosus, Pohlia annotina, Bryum bicolor, Amblystegium saxatile, Rhynchostegium murale.

S.I. Medvedev carried out the fundamental researches on entomofauna for 25 years. He founded 121 species at the park (Медведев, 1950) and drew a conclusion that insect fauna of artificial plantation has very poor specific composition as compared with nearest natural forests in bottomland and on the sandy terrace of Dnieper. Fauna is generally formed due to species widely distributed in this area and immigrants from other more distant places at less measure. The most of insect imported with building materials or planting stock didn't take root here. Further the entomological papers were sporadic. V.N. Khomenko and Ye.H. Vakarenko had studied the specific composition and changes in structure of the reserve's carabidofauna in 1981-1987 and indicated 176 species of carabid beetles for the park (Хоменко, Вакаренко, 1993); L.A. D'yakonchyk (1998) – Coleoptera, V.P. Dumenko (2001) – Lepidoptera (the theory of the reserve in whole is considered in these publications without accent on the dendropark). Since the middle of 80-th till 2004 S.V. Kapitonenko investigated phytophages of aliens and both the independent species and non-taxonomic insect groups integrated on type of wood plants damages have been studied.

The vertebrate animals of the dendropark are presented by fishes – 2 species registered in permanent artificial ponds; amphibian – 3 species; reptiles – 5 species including steppe snake listed in Red Book of Ukraine; birds – 63 species (Гавриленко, 2000) and mammals – 13 species.

CONCLUSSIONS

Dendrological Park “Askania Nova” is the ecosystem of oasis type including the biocoenosis artificial created and formed spontaneously.

The island character of location having the natural barriers lets to keep the unique collection funds including rare and endangered species.

A stranger element of the dendropark forced by zonal biodiversity considerably increases the sozological status of the dendropark as a structural compotent of the Biosphere reserve “Askania Nova”.

REFERENCES

Бойко М. Ф. Біорізноманіття Біосферного заповідника "Асканія-Нова": Мохоподібні / М. Ф. Бойко // Актуальні питання збереження та відновлення степових екосистем : мат. міжнар. наук. конф., присвяч. 100-річчю заповідання асканійського степу (Асканія-Нова, 21–23 травня 1998р.). – Асканія-Нова, 1998. – С. 7-9.

Бойко М. Ф. Червоний список Херсонської області. Рідкісні та зникаючі види рослин, грибів та тварин / М. Ф. Бойко, М. М. Підгайний. [вид. 2-ге, переробл. та доповн.]. – Херсон, 2002. – 32 с.

Види судинних рослин флори України, які занесені до Європейського Червоного списку тварин і рослин, що знаходяться під загрозою зникнення у світовому масштабі (1991) // Червона книга України. Рослинний світ / під ред. Ю. Р. Шеляг-Сосонка. – К. : Укр.енциклопедія, 1996. – С. 590-595.

Гавриленко В. С. Гніздова орнітофауна дендропарку "Асканія-Нова" та особливості її формування / В. С. Гавриленко // Вісті Біосферного заповідника "Асканія-Нова": охорона та збереження рідкісних видів. – 2000. – С. 58-66.

Гавриленко Н. О. Спонтанна флора дендрологічного парку "Асканія-Нова" / Н. О. Гавриленко, І. І. Мойсієнко, В. В. Шаповал // Вісті Біосферного заповідника "Асканія-Нова". – 2008. – Т. 10. – С. 49-73.

Гелюта В. П. Гриби Біосферного заповідника "Асканія-Нова" ім. Ф.Е. Фальц-Фейна / В. П. Гелюта, В. П. Гайова, Т. В. Андріанова та ін. // Гриби заповідників та національних природних парків Лівобережжя України. Т. 1. [Ш.О. Дудка, В. П. Гелюта, Т.В. Андріанова та ін.]. – Київ : Арістей, 2009. – С. 104-115.

Карасев Г. М. Ботанический парк "Аскания-Нова" / Г. М. Карасев. – К.: Госсельхозиздат, 1962. – 202 с.

Каталог рослин дендрологічного парку "Асканія-Нова" / Н. О. Гавриленко, А. Ф. Рубцов, Л. О. Слепченко. – Асканія-Нова, 2003. – 116 с.

Каталог рідкісних рослин дендрологічного парку "Асканія-Нова" / Н. О. Гавриленко. – Асканія-Нова, 2010. – 37 с.

Конвенція про охорону дикої флори і фауни та природних середовищ існування в Європі (Берн, 1979 рік). – К. : Мінекобезпеки України, 1998. – 74 с.

Кондратюк С. Я. Сучасний стан вивченості лишайників на природно-заповідних територіях територіях рівнинної частини України / С. Я. Кондратюк, О. Є. Ходосовцев // Заповідна справа в Україні. – 1997. – Т. 3, вип.. 2. – С. 24-29.

Медведев С. И. К вопросу о происхождении энтомофауны парков Аскании-Нова / С. И. Медведев // Труды научн.-исслед. Ин-та биологии Харьковского гос. Ун-та им. А.М. Горького. – 1950. – Т. 14–15. – С. 67- 88.

Редкие и исчезающие виды природной флоры СССР, культивируемые в ботанических садах и других интродукционных центрах страны. – М. : Наука, 1983. – 302 с.

Список животных и растений, подпадающих под действие СИТЕС. – М., 1998. – 181 с.

Ушачова Т. І. Моніторинг важких металів в Дендрологічному парку Біосферного заповідника "Асканія-Нова" / Т. І. Ушачова, Є. М. Моргун // Состояние природных комплексов Крымского природного заповедника и других заповедных территорий Украины, их изучение и охрана : научно-практ. конф., посвящ. 80-летию Крымского природного заповедника. – Алушта, 2003. – С. 71-72.

Ушачева Т. И. Влияние лесной орошаемой культуры на свойства темно-каштановой остаточно солонцеватой почвы / Т. И. Ушачева // Вісті Біосферного заповідника "Асканія-Нова". – 2001. – Т. 3. – С. 47-50.

Ушачова Т. І. Вплив довгострокового зрошення на ґрунтовий покрив деревних насаджень дендрологічного парку "Асканія-Нова" / Т. І. Ушачова, Є. М. Моргун // Вісті Біосферного заповідника "Асканія-Нова". – 2005. – Т. 7. – С. 63-69.

Ходосовцев О. Є. Біорізноманіття Біосферного заповідника "Асканія-Нова": Лишайники та ліхенофільні гриби / О. Є. Ходосовцев // Актуальні питання збереження та відновлення степових екосистем : мат. міжнар. наук. конф., присвяч. 100-річчю заповідання асканійського степу (Асканія-Нова, 21–23 травня 1998р.). – Асканія-Нова, 1998. – С. 9-12.

Хоменко В. Н. Карабидофауна (Coleoptera, Carabidae) заповедника "Аскания-Нова": структура и тенденции изменения / В. Н. Хоменко, Е. Г. Вакаренко // Вестн. зоологи. – 1993. – № 5. – С. 26-35.

Шаповал В. В. Синантропний елемент флори асканійського степу: структура та динаміка у контексті резерватної експозиції території / В. В. Шаповал // Заповідні степи України. Сучасний стан та перспективи їх збереження : міжнар. наук. конф., 18–22 верес. 2007 р. : мат. – Армянськ, 2007. – С. 115-119.

Walter K. S. Gillette H.J. 1997 IUCN Red List of Threatened Plants / K. S. Walter, H. J. Gillette. – Compiled by the World Conservation Monitoring Centre, IUCN – The World Conservation Union. Gland, Switzerland and Cambridge, UK, 1998. – 862 p.

Надійшла до редколегії 23.12.10

UDK 574.4

M. Romanova, A. Puchilo

ENVIROMENTAL PROBLEMS OF THE BELARUS

Kuprevich Institute of Experimental Botany, National Academy of Sciences Belarus, Republic of Belarus

The most significant issues of ecological situation in Belarus are presented; among them there are the elimination of the consequences of the catastrophe at the Chernobyl nuclear power station, saving of marsh lakes, water-meadows and peatbogs in Polessje.

Key words: marsh, Polessie, Pripyatsky National Park.

М. Романова, А. Пучило

Інститут експериментальної ботаніки ім. В. Ф. Купревича Національної академії наук Білорусі, Республіка Білорусь

ПРОБЛЕМИ НАВКОЛИШНЬОГО СЕРЕДОВИЩА БІЛОРУСІ

Представлені найбільш важливі питання з проблем навколишнього середовища Білорусі, серед яких подолання наслідків катастрофи на Чорнобильській атомній станції, збереження заболочених озер та торф’яних боліт у Поліссі.

Ключові слова: болото, Полісся, Прип’ятський національний парк.

М. Романова, А. Пучило

Институт экспериментальной ботаники им. В. Ф. Купревича Национальной академии наук Беларуси, Республика Беларусь

ПРОБЛЕМЫ ОКРУЖАЮЩЕЙ СРЕДЫ БЕЛАРУСИ

Представлены наиболее важные вопросы по проблемам окружающей среды Беларуси, среди которых устранение последствий катастрофы на Чернобыльской атомной станции, сохранение заболоченных озер, заливных озер и торфяных болот в Полесье.

Ключевые слова: болото, Полесье, Припятский национальный парк.

Belarus is located on one of the largest marsh territory of Europe - known as Polessie. Belarus in a landlocked, relatively flat and covered with forest territory with smoothly dispersed over the country lakes and rivers. There are, 11,000 lakes in Belarus, but the majority of the lakes as e.g. Naroch are smaller than 0.5 square kilometers. Three major rivers run through the country, the Neman River, the Pripyat River, and the Dnepr River. Forest covers about 34 %of the total landscape, making forestry one of the most abundant natural resources in Belarus. Other natural resources to be found in Belarus include peat deposits, small quantities of oil and natural gas, granite, dolomite limestone, marl, chalk, sand, gravel, and clay. As many other countries, Belarus is facing number of ecological problems. Those include air pollution both from regional sources and as a result of transboundary transfer, declining quality of surface and ground waters, primarily ground waters. Nevertheless, the key significance for Belarus, will be the elimination of the consequences of the catastrophe at the Chernobyl nuclear power station which resulted in radioactive contamination of over 22 % of its territory. The current environmental situation in Belarus is adversely impacted in the quality of life and health of people, specifically children. Pripyatsky National Park is located near the Chernobyl in the lowland of Polesye. Crossed by numerous small rivers and spotted by 30 small lakes, the Park has unique population of mammals, birds, reptiles, and fish. Its flora includes among other about 200 moss species. Disappearance of Pripyatsky marshes that are located near the Prirytsky National Park - is threatening for the landscape on the European continent. Belarus object to drainage this biggest swamped area in Europe. We aim to save the biggest and the most valuable marsh lakes, water-meadows and peatbogs of Europe in the lowland of Polessje.

Scientists see the danger of agricultural attack on 175.000 hectares of swamped areas near the river Pripyat' that are planned to be drined to turn them into productive land. This action is supposed to compensate for the loss of useful agricultural lands that were polluted by the radio-activity. For this gigantic project the Belorussian Goverment has made already an inquiry to the World Bank for a credit that is considered in a range of billion dollars. The view of Pripyatsky marshes from the height of a bird's flight reveals a majestic picture of gigantic water reservoirs, lakes, water-meadows and swamps. Numerous species of flora and fauna, which are now rare or became extinct in other places, can be still found there. This work is proceeding in two main directions: first, they explore the places where a reed-warbler (currently in The Belorussian Red Book) lives; second, more important, they work out the conception of creation of large natural reservoirs. Finally, these areas have already been marked on the Belarus map and are currently under protection.

Надійшла до редколегії 18.11.10

UDK 574.4

A. Gadaev

THE WATER WELL CLOGGING AND REHABILITATION ISSUES

Samarkand State Architectural & Civil Engineering Institute, Uzbekistan

Water is one of the most important components of environment and its resources are limited. Especially safe and clean water resources are already in deficit. It's known, that Central Asia is an agricultural region and has only two rivers as a surface water resources, however ground waters are enough protected and theirs resources can be one of ecologically safe source for drinking, industrial and municipal needs. Water wells are the important part of the water supply system. Loosing of productivity, clogging of the filters and the gravel zone issues are common in Uzbekistan and other Central Asian countries. This article is about water well rehabilitation and some new methods and devices for cleaning filter screens and near filter (gravel) zone.

Key words: ground waters, water wells, filters, specific and decreased yield, clogging deposits, rehabilitation method.

А. Гадаєв

Самаркандський державний інститут архітектури та цивільного будівництва, Узбекистан

ПРОБЛЕМА КОЛЬМАТАЦІЇ ТА ВІДНОВЛЕННЯ ВОДОЗАБІРНИХ СВЕРДЛОВИН

Вода – один з найважливіших компонентів навколишнього середовища і її ресурси обмежені, особливо дефіцитними стали ресурси безпечної та чистої води. Відомо, що Центральна Азія є сільськогосподарським регіоном і має лише дві річки як джерело поверхневої води, однак є достатньо захищені підземні води, які можуть слугувати екологічно безпечним джерелом питного, виробничого та муніципального водозабезпечення. Свердловини є першою та найважливішою частиною системи водозабезпечення. Зниження їх продуктивності, кольматація фільтрів і прифільтрової зони є розповсюдженою проблемою в Узбекистані та інших центрально-азіатських державах. Дана стаття присвячена обробці та відновленню свердловин, а також деяким новим методам обробки та пристроям для очистки фільтрів та прифільтрової (гравійної) зони свердловин.

Ключові слова: підземні води, водозабірні свердловини, фільтри, питома та знижена продуктивність, кольматаційні речовини, спосіб відновлення.

А. Гадаев

Самаркандский государственный институт архитектуры и гражданского строительства, Узбекистан

ПРОБЛЕМА КОЛЬМАТАЦИИ И ВОССТАНОВЛЕНИЯ ВОДОЗАБОРНЫХ СКВАЖИН

Вода – один из важнейших компонентов окружающей среды и её ресурсы ограничены, особенно ресурсы безопасной и чистой воды, которая стала дефицитом. Известно, что Центральная Азия является сельскохозяйственным регионом и имеет только двух рек как источник поверхностной воды однако, имеются достаточно защищенные подземные воды и они могут служит экологически безопасным источником питьевого, производственного и муниципального водоснабжения. Скважины являются первой и самой важной частью системы водоснабжения. Снижение их производительности, кольматация фильтров и прифильровой зоны являются распространенной проблемой в Узбекистане и других Центрально Азиатских государствах. Данная статья посвящена на обработку и восстановление производительности скважин и некоторых новых методов обработки и устройств для очистки фильтров и прифильтровой (гравийной) зоны скважин.

Ключевые слова: подземные воды, водозаборные скважины, фильтры, удельная и сниженная производительность, кольматационные вещества, способ восстановления.

This article will address the need for water resource management in Central Asia with a focus on Uzbekistan. The normal vital activity of population is directly related to their stable drinking water supply. As it is known the process of society development is impossible without influence upon nature and such influence leads to change in natural balance. Solution of the problem of society development is becoming more urgent influence of improvement of social condition of population and preservation the environment. It requests modernization of water supply system, its technologies and devices. The first and very important part of the water supply system is water intake stations and lifting equipments such as water wells and it's screen. This article is about water wells issues in Central Asia and particularly in Uzbekistan where ground waters are the primary source of quality drinking water. It represents 85-90% of the general water budget. There are territories and regions where ground water is the only source. Uzbekistan is a region with a very hot and dry climate. During the long summer (from May until October) water consumption increases sharply and wells with declining productivity cannot meet the demand. Existence of a water supply source, constructions for getting and lifting water to the consumers is not always sufficient. This brings about necessity of the better founded approach to operation structure to rational use of water resources. However, some of these wells are not in a good and operable condition. It is very common for a well to have years of operation prior to experiencing loss of capacity. With age it is common to see these lost capacity problems frequently. The increased frequency of lost capacity and the need for well rehabilitation treatments is due to the incomplete removal of plugging deposits from prior rehabilitation efforts, thereby not maintaining the original pore volume of the gravel pack, well screen, or fractured formation. There are lots of deficiencies in the well pumping system ranging from the wells themselves to the equipment and switchgear installed.

Over time, it is very common for water wells to experience lost capacity as well as a variety of water quality problems requiring some form of well rehabilitation. It is common in the Aral Sea disaster zone where the quality of the ground waters and environmental conditions are worse in terms of safety. Most of these problems are a result of fouling material becoming deposited on the surfaces (rock surfaces, gravel pack, well screen) in water environments.

Effective water well rehabilitation requires the removal of all deposited material thereby allowing the specific capacity and pore volume to be restored. There are many different strategies and methods used in water well rehabilitation, some successful, others less successful. The success in using many of the physical and chemical methods is dependant on the user being able to fully identify the plugging material, or combination of plugging material and design a specific chemical treatment to dissolve that material. This becomes a daunting task due to the variability of the complex geochemical and microbiological underground environment and the reliance of the user to perfectly design a specific chemical combination required to fully remove the plugging, while not effecting well construction.

As it mentioned, 93% of drinking waters in Uzbekistan come from the aquifers and the quality commonly doesn't meet the standards. Mainly they are hard and mineralized by salts calcium, iron and magnesium.

The main reason for ineffective operation of wells is clogging of filters and filter area by salt deposits and corrosion products of metallic elements. The clogging deposits consists mainly salts calcium and iron oxides. When wells lost more than 40 % productivity they need to be rehabilitated (restoring as a cleaning up filters and gravel zone). This situation requests groundwater use management by improving efficiency existing water wells. From the economical and ecological points of view the regular water supply of the population should be based on the active structures of a system of water supply as there is a considerable potential of increasing the efficiency of use of investments which they can provide.

The new water well rehabilitation technology called combined uses solid, gaseous and liquid carbon dioxide with composition of complex acid to restore water wells. Since 1991, the offered technology has been used on more than two-handred wells in Ukraine and Uzbekistan with excellent results. A combined water well rehabilitation technology has been used on a wide variety of wells including vertical wells, drainage wells, from shallow to very deep wells, from small diameter to large diameter, screened and injection wells. Offered well restoration method is more effective at removing deposits from both inside the well screen and the formation surrounding the well because the process is impulsive and cyclic. One of the active components from the injected gas is carbonic acid, a mild acid, which under atmospheric conditions produces a pH of +/-6.0. However, there is pressure in an aquifer or a sealed well, allowing the pH values to become reduced to as low as 4.0. and more, still relatively mild. When the pressure is released the pH will return above pH 6.0 and therefore does not become a neutralization or disposal concern. There is also the effect of localized space in the well and and more importantly, agitation, as the liquid carbon dioxide is injected at approximately 0°F. The process is not an overly aggressive process, yet is capable of delivering the necessary energy required to be effective in wells constructed using PVC or HDPE wells, without problems. The success is achieved through combination of carbonic acid, agitation, and localized space resulting in superior disruption and detachment of the encrusted and plugging material. The bulk of the activity is due to phase changes. The expansion rate from a liquid to a gaseous state of the carbon dioxide is almost 700 times in volume. The agitation achieved with liquid carbon dioxide is the same action as when dry ice is placed in water by using a special continer. There is agitation as the carbon dioxide changes, in this case, from a solid to a gaseous state. The process is the controlled injection of carbon dioxide, as injection pressure and down-hole pressure are monitored to regulate the feed rate the well will comfortably accept. The rate and volume of carbon dioxide injected is regulated to assure that the pressures (and energy) going down the well can dissipate into the surrounding formations. A new and more compact continer allows to introduce chemicals and solid ice to the localized spice in the well near filter area. Gaseous and liquid carbon dioxide contain tremendous energy, described as energy of dissolution, energy of detachment and energy of agitation. This energy results in the detachment, dissolution and removal of sediments and encrustation from the surfaces within the well screen and the surrounding aquifer.

The combined well rehabilitation method by using a new designed chemical complex and device are relatively broad ranging in its ability to effectively disrupt and remove a wide variety of plugging deposits, in a wide variety of well construction types and materials, offering superior deposit removal and more complete pore volume recovery, without adversely effecting well construction.

All wells are in different state in their performance and use. The further utilization of some of the wells might be critical for various reasons, such as physical condition of the well, existing pollution or potential pollution of the water catchments area, risk for contamination, etc.

Using the new developed water well rehabilitation technology increasing of productivity of the water well achieved 90 % of original capacity.

The economic benefit of processing one well is $13500 US. The developed method is combined (blended) for water well rehabilitation by using complexions as chemicals and solid dioxide carbonic as an agent for pressing of the selective solvent into filter area and helps make a process as cyclic. The combined rehabilitation method can fully restore the water well capacity and economic value is equal 15-20% from overall value of construction of new wells.

Надійшла до редколегії 08.12.10

ЕКОЛОГІЧНІ ПРОБЛЕМИ ВОДНИХ РЕСУРСІВ

UDK 574.4

A. Gadaev[1], I. Niyazov[2]

UZBEKISTAN: ARAL SEA ECOLOGICAL DISASTER AND WATER RESOURCES MANAGEMENT ISSUES

[1]Samarkand State Architectural and Civil Engineering Institute, Uzbekistan
[2]Samarkand Agricultural Institute,Samarkand, Uzbekistan

Central Asia is a region that is rich in the natural resources. However, water resources, especially surface water resources are limited. The region's two main rivers are Syr Darya and Amu Darya. Uzbekistan, the single biggest consumer of water and is located downstream of these rivers. The region's biggest ecological disaster is shrinking of the Aral Sea which is the result of mismanagement of the water resources.

Key words: water resources, ecology, Central Asian region, Aral Sea, disaster, rational water use, management, adaptation strategy.

А. Гадаєв[1], І. Ніязов[2]
[1]Самаркандський державний інститут архітектури та цивільного будівництва, Узбекистан
[2]Самаркандський сільськогосподарський інститут, Узбекистан

УЗБЕКИСТАН: ЕКОЛОГІЧНА КАТАСТРОФА В АРАЛЬСЬКОМУ МОРІ ТА УПРАВЛІННЯ ВОДНИМИ РЕСУРСАМИ

Центральна Азія є багатим регіоном з природними ресурсами. Однак водні ресурси, а саме поверхневі води, вельми обмежені. Дві головних і великі річки – Сирдар'я та Амудар'я. Узбекистан є єдиним та найбільшим споживачем води в регіоні і він розташований у нижній частині течії цих річок. Найбільшою екологічною катастрофою даного регіону є висихання Аральського моря, що стало результатом нераціонального управління водними ресурсами.

Ключові слова: водні ресурси, екологія, регіон Центральної Азії, Аральське море, катастрофа, раціональне використання води, управління, стратегія зменшення наслідків.

А. Гадаев[1], И. Ниязов[2]
[1]Самаркандский государственный институт архитектуры и гражданского строительства, Узбекистан
[2]Самаркандский сельскохозяйственный институт, Узбекистан

УЗБЕКИСТАН: ЭКОЛОГИЧЕСКАЯ КАТАСТРОФА В АРАЛЬСКОМ МОРЕ И УПРАВЛЕНИЕ ВОДНЫМИ РЕСУРСАМИ

Центральная Азия является богатым регионом с природными ресурсами. Однако, водные ресурсы а именно поверхностные воды весьма ограничены. Две главные и крупнее реки – это Сырдарья и Амударья и Узбекистан является единственным и крупнейшим потребителем воды в регионе и он расположен в нижней части по течение этих рек. Крупнейшей экологической катастрофой данного региона является высыхание Аральского моря, что стало результатом нерационального управления водными ресурсами.

Ключевые слова: водные ресурсы, экология, регион Центральной Азии, Аральское море, катастрофа, рациональное использование воды, управление, стратегия уменьшение последствия.

The Republic of Uzbekistan is 447 km^2 and is located geographically at the northern boundary of the subtropical and temperate climate zones. To the north and west of Uzbekistan is Kazakhstan, west and south are Turkmenistan and Afghanistan, and east are Tajikistan and Kyrgyzstan. Uzbekistan is only one of two double landlocked countries in the world, making its access the ocean extremely difficult. Uzbekistan and other Central Asian countries including Kazakhstan, Kyrgyzstan, Turkmenistan, Tajikistan and Afghanistan are struggling to come to terms with an ecological disaster affecting the Aral Sea. The crisis has been brought about by the mismanagement of water resources from the Aral's main tributaries, the Amudarya and the Sirdarya rivers. The primary source of quality drinking water in Uzbekistan and Central Asia is ground water, which accounts for between 85 an 90% of the general water budget. Agricultural irrigation systems have caused high pollutions levels in the region's (unevenly distributed) surface waters. Historically water flow the Aral Sea was 56 km^3 per year, which decreased to 47 km^3 between 1966 and 1970. Water flow plummeted to 2 km^3 between 1981 and 1983, and now stands at less than 1,8 km^3.

A key question is how to balance social and economic development with natural resource protection. Central Asian Republics utilize the same watersheds and share many water management issues in common. It is clear that the region's existing multination and regional water management and environmental protection project are insufficient by themselves to meet the scale of the problem. Further multinational agreements and joint-state/joint-agency programs will undoubtedly be required. Central Asian countries are suffering from regional climate change due to the destruction of the Aral Sea as well as global climate change, which will drastically alter the environment and have vast implications for future water resource availability. The two major rivers supplying water resources to Uzbekistan are being overused for irrigation purposes, which has led to the diminishment of the once large Aral Sea. Other factors affecting Uzbekistan's water resources are the desert-like climate for most of the country, low annual rainfall (7-12 inches), extremely hot summers, and the displacement of around seventy-percent of the population living in rural areas. Newer more modern strategies to conserve water and use water more efficiently as well as farm more sustainably must be enacted soon to adapt with the region's changing climate. These adaptation strategies include smarter irrigation practices, better usage of groundwater, and possible diversion of surface waters from Russian rivers and the Caspian Sea. Drip irrigation is feasible for Uzbekistan and is better suited for the region due to its diminishing water resources.

WATER RESOURCES MANAGEMENT

Uzbekistan is an arid country that relies on irrigated farming as a major source of its economy. With around 90% of water resources used in the republic originating from the mountains of nearby countries, water resource management is a crucial role in Uzbekistan's livelihood. The problem associated with such water intensive irrigation practices is the Aral Sea is shrinking, which leads to many more environmental, economic, and social problems. Uzbekistan as well as the other Central Asian countries all share the surface water of the Aral Sea basin as their means of water resources. The sources of water in the region come from river runoff (glaciers), ground water, and lakes.

The two rivers that fuel Central Asian countries water supply are the Amudarya and Syrdarya. The Amudarya's volume is 78.5 km^3/year and the Syrdarya's volume is 37.9 km^3/year. The annual volumes are then divided at an agreed upon ratio and each country in Central Asia can then use that amount; Uzbekistan receiving an average of 43-53 km^3 annually. These two rivers flow have been diverted from their natural pathway for the use of reservoirs and irrigation. Uzbekistan contributes a little less than 10 percent of total river runoff for the two large rivers, with the majority of the contribution coming from streams in the mountainous regions of the country, and little to none coming from the plains. Infiltration of water from rivers, canals, lakes, and irrigated areas into the ground as well as from precipitation contribute to the 95 deposits of groundwater in Uzbekistan .

Previously the fourth largest inland lake in the world, the Aral Sea has been subjected to years of inflow from the Amudarya and Syrdarya rivers being diverted and used for irrigation. The original size of the Aral Sea prior to it drying up was an area of 66.1 km^2 and volume of 1064 km^3 . The loss of area and volume of the Aral Sea is caused by a decline of inflow and is causing increased salinity of the remaining water, sand and salt transfer to nearby areas, loss of fishing, loss of cargo transport, and a change in the local and regional microclimate that is effecting at least 35 million people. By 1994, the Aral's area was reduced to 31.7 thousand km^2 and salinity had risen to a level almost equal to world's oceans, 35 percent. Inflow into the Aral has changed from 1060-2090m^3 originally to between 50-500m^3 by the late 1980's.

To understand how dire water shortages is for Uzbekistan, it is important to understand the population distribution as well as the percentage of the population involved in agriculture. Around eighty percent of all population movements in the mid-nineties were from urban to more rural settings. Almost seventy percent of the population lives in rural areas of Uzbekistan and future population increases could be seeing even more people moving out of the cities. This large population group is supplying fifty percent of the work force in the agricultural sector, which supplies eighty percent of national demand for food. The other work force sectors are around twenty-five percent in industry and the remaining workers in service or other categories.

As it can be seen from the large portion of the population working the farms in Uzbekistan, agriculture is extremely important for national food demand, the economy, and for the workforce. Mostly all of the farming in this area cannot be accomplished without the assistance of irrigation, which is extremely water intensive in the hot, dry climate of Uzbekistan. Less than ten percent of the land used for farming is not irrigated; the irrigated portion going to grow mainly cotton, but also rice, potatoes, and other grains.

The current loss of the Aral Sea and the continued intensive use of water in Central Asia will eventually lead to water shortages throughout the region, but this problem coupled with climate change is extremely dangerous. Uzbekistan's need for a more sustainable usage of water resources is greatly increased with the largest natural threat, climate change. Not only is Central Asia already experiencing a changing microclimate, but also global climate change is going to intensify the changes. The current method of irrigation in Uzbekistan is called open or furrow irrigation and this is the traditional method used for hundreds of years. Water is diverted directly from a stream or water supply and is forced down the rows of crops through furrows by gravity. This method is cheap and does not require additional equipment. Furrow irrigation is basically free as long as you have a water supply, but drip irrigation requires piping throughout the entire plantation as well as a purification system to prevent saline contamination. With newer technologies being created everyday, small developing farmers may soon have the ability to create a piped irrigation infrastructure. Low cost trickle systems are much cheaper, reduce labor by one half, save water, doubled the amount of land that can be irrigated, and can be used in semi-hilly areas.

Groundwater usage in Uzbekistan is also a valid option for reclamation of water that infiltrated soils during open irrigation processes. Water tables near irrigated lands are increasing and this buildup of water is useable for town centers as well as rural areas. The problem with the usage of infiltrated groundwater is that it is contaminated with surface salts and it needs to be purified. Uzbekistan's current ground water pumping stations are from the previous decades and do not implore any electric extraction or purification (Ikramov, 2006). This is another infrastructure change that can be adapted along with trickle irrigation to be better sustainable at using the local water resources.

The most progressive, political, controversial, and difficult adaptations strategy to diminishing water resources and the loss of the Aral Sea is diverting waters from either Russian rivers and/or the Caspian Sea. This adaptation is unlike the others because it involves the cooperation of multiple countries as well as the decrease of water resources in another country to balance out the gains for the Aral Sea. The problem associated with sharing between countries of water resources is the fear that the country with the water will be adversely affected in the future. With the onset of global climate changes, countries are more reluctant to lose water resources to another country.

With the dissolution of the Soviet Union went the idea of supplying central Asia with water resources for agricultural processes with canals from the Ob and Volga rivers. A canal could be constructed from the Volga River to the Aral Sea that would require no pumping stations due to the favorable elevation gradient (Ring, 2009). The logistics of this canal is that it would be 800 km long, 200 m wide, and 16 m deep at a cost of eight billion US dollars (Ring, 2009). Another canal from the Ob and Irtysh rivers would be of similar logistics, but would require pumping stations to reach the Aral Sea. These pumping stations would bring the cost up to 22 billion US dollars. Critics to these plans say that diversion from these rivers will affect other regions of the continent, which will cause even bigger problems. Also political issues arise between Russia and central Asian countries.

The Caspian Sea is another option for a diversion project. This project is still not even in planning stages, but is possible some time in the distant future. Water rights are still being established between the five countries surrounding the Caspian Sea and until they make compromises, Uzbekistan will not receive aid. Also if a project were being established, around seventeen pumping stations would be required to make up for the extreme gradient from the Caspian to the Aral Sea making this project more expensive and unlikely.

Water resources are going to be a limiting factor in the productivity and survival of Central Asian countries in the not too distant future. Global climate change compounded with regional climate change from the loss of the Aral Sea is instilling extreme environmental impacts on the region. In order for Uzbekistan and the other Central Asian countries to continue using water like they have been, adaptations must be made. Smarter irrigation practices and groundwater pumping are two feasible and intra-country solutions to heavy water usage. Also, the usage of water from the Ob- Irtysh Rivers in Russia via canal systems as well as diversions from the Caspian Sea are possible for the future.

Надійшла до редколегії 18.11.10

СОЦІАЛЬНІ ПРОБЛЕМИ ОХОРОНИ НАВКОЛИШНЬОГО СЕРЕДОВИЩА ЛЮДИНИ

UDK 574.4

A. Gomera Martínez, M. Vaquero Abellán, A. de Toro Jordano,
J. E. Aguilar Moreno, C. Guijarro Jiménez

ENVIRONMENTAL MANAGEMENT AND EDUCATION AT THE UNIVERSITY OF CORDOBA

University of Córdoba, Spain

The main commitments and lines of action at the University of Córdoba (Spain) in environmental management and education through projects and strategies implemented by the Environmental Protection Service / Servicio de Protección Ambiental (SEPA) are presented. The SEPA was established in 2000 and began working to comply with the University's environmental policy, identifying areas for improvement in environmental management and education and developing measures to control the different environmental issues arising from university activities.

Thus, the SEPA aims to encourage among all members of the university community (workers, students and organizations), an environmental culture based on the responsibility to protect and improve the environment.

Key words: University, Environmental Protection Service (SEPA), environmental management, environmental education, sustainability, awareness, resources, waste, transport.

А. Гомера Мартинез, М. Вакуеро Абелан, А. де Торо Джордано,
Х. Е. Агуілар Морено, К. Гунджаро Ждименез

Університет Кордоби, Іспанія

ЕКОЛОГІЧНЕ УПРАВЛІННЯ ТА ОСВІТА В УНІВЕРСИТЕТІ КОРДОБИ

В роботі представлено основні обставини та напрямки діяльності Університету Кордоби (Іспанія) в екологічному управлінні та вихованні через стратегії та проекти Служби захисту навколишнього середовища (СЗНС). СЗНС була заснована та почала свою роботу згідно екологічній політиці університету, в 2000 р., встановлюючи області з покращення екологічного управління та освіти, а також за розвитком заходів контролю різноманітних питань щодо захисту навколишнього середовища, які підіймаються науково-дослідною діяльністю.

Таким чином, мета СЗНС – покращити екологічну культуру всіх членів наукового суспільства (співробітники, студенти, організації), яка основана на захисті та покращенні навколишнього середовища.

Ключові слова: університет, Служба захисту навколишнього середовища, екологічне управління, екологічне виховання, стійкість, компетентність, ресурси, відходи, транспортування.

А. Гомера Мартинез, М. Вакуеро Абеллан, А. де Торо Джордано,
Х. Э. Агуилар Морено, К. Гуиджаро Ждименез.

Служба защиты окружающей среды, Университет Кордовы

ЭКОЛОГИЧЕСКОЕ УПРАВЛЕНИЕ И ОБРАЗОВАНИЕ В УНИВЕРСИТЕТЕ КОРДОВЫ

В работе представлены основные обязательства и направления деятельности Университета Кордобы (Испания) в экологическом управлении и образовании через стратегии и проекты Службы защиты окружающей среды (СЗОС). СЗОС была основана и начала свою работу, согласно экологической политике Университета, в 2000 году, устанавливая области по улучшению экологического управления и образования, а также по развитию мер контроля различных вопросов, касающихся защиты окружающей среды, поднимаемых научно-исследовательской деятельностью.

Таким образом, цель СЗОС – улучшать экологическую культуру всех членов научного общества (сотрудники, студенты, организации), которая основана на защите и улучшении окружающей среды.

Ключевые слова: Университет, Служба защиты окружающей среды, экологическое управление, экологическое образование, устойчивость, компетентность, ресурсы, отходы, транспортирование.

Universities are increasingly aware of the environmental consequences arising from their research, teaching and administration activities. Like any other organization, a university uses a range of resources (energy, fuel, water, materials, etc.) necessary for the implementation of these activities. These activities generate, in turn, a large amount of waste products in the form of discharges, air emissions or waste. Likewise, transport used by the university community represents another important environmental aspect to take into account as for fuel consumption, gas and noise emission and associated waste generation.

The universities also are aware of their responsibility as Higher Education Institutions to transmit and extend environmental knowledge and values at a personal, social and professional level. If a framework of study that integrates environmental considerations is created, students will be more permeable and receptive to acquire environmental friendly values and habits and will be prepared to incorporate this responsible attitude in their future jobs. Therefore, the environmental protection in the university has two values: management and education.

THE UNIVERSITY OF CÓRDOBA AND THE ENVIRONMENT

The University of Córdoba is aware of this dual responsibility and is committed to act accordingly. In addition, the continued rise of interest groups that influence and put pressure in this area (companies, administration, financial institutions, media, society ...) facilitates and promotes a. suitable framework for sustainability.

In its Strategic Plan 2006-2015, the University is projected as a "Centre committed to the environment, advocate for its preservation, for its quality and for the sustainable use of natural resources as a means of improving the welfare of society and quality of life of its environment’. In order to achieve this, the University provides specific guidelines and strategies, such as the ‘Declaration of Environmental Policy’, a public document in which the chancellor as chief executive of the Institution expresses the commitment of respect and environmental responsibility in the sphere of the university. To implement actions that provide compliance with these commitments, the Environmental Protection Service (SEPA), a central organ of the university, was created. The SEPA, aiming to introduce the environmental factor in university management and to establish a culture of respect for the environment among its members, develops and promotes activities related to the environment and the sustainability in all areas and universitary units. These activities are aimed, firstly to identify and assess compliance with legal environmental requirements of the institution, and secondly, with the environmental improvement of the university activity within the various fields of competence of the SEPA.

MAIN ENVIRONMENTAL COMMITMENTS OF THE UNIVERSITY OF CÓRDOBA: SOME EXAMPLES OF HOW TO MAKE THEM EFFECTIVE

1. Studying and analysing the activities in the area of the University that are generating environmental impacts.

Any academic activity (teaching, research or administration) may be generating impacts of varying magnitude. For measuring and monitoring, the SEPA has established a system of environmental indicators that provide regular information on resource consumption, waste production and mobility rates, among others.

2. Raising awareness, educating and informing members of the university community on environmental issues and management.

It is important to provide students with the necessary academic training and environmental awareness that will allow them to develop their future work and guarantee the support of a sustainable future of our society. In this sense, the University represents an area of great interest to develop tools to measure and analyze students' environmental awareness through various indicators relating to knowledge, attitudes, perceptions and behaviour, which in turn help to identify the main social groups present around this concept. An example of one of these measures is a study to design an instrument for measuring and monitoring the environmental awareness of the students of the University of Córdoba, which reflects the four dimensions that define this term and its relations:

-*Cognitive dimension*: the degree of information and knowledge on issues related to the environment.

- *Affective dimension*: perception of the environment, values and beliefs of students in environmental matters.

- *Attitudinal dimension*: students' attitudes compared to their environmental responsibility, willingness of students to adopt pro-environmental criteria in their behavior.

- *Active dimension*: production of environmentally responsible practices and behaviors, both individual and collective.

Also, it is aimed to define the possible levels of environmental awareness present in the university population, to analyse how they are distributed among the reference population, differentiating the potential social sectors as appropriate. This will result in the identification of the needs and demands in university environmental management and education in order to propose possible suggestions and solutions.

On the other hand, it is equally important to educate and inform all employees (government bodies, teachers, researchers, technicians, administrators) on the main environmental impacts of their activities, the procedures established to control them as well as the environmental responsibility and the 'added value', ie., having this training and being able to transmit it to the students.

3. Preventing pollution, both through improved waste management, discharges and emissions and their minimization.

The SEPA has set up selective collection programs of the majority of waste (hazardous and non-hazardous) produced in the UCO. Thus, workers and students may use different containers to ensure the recycling of this waste through delivery management companies approved by the Administration. Table shows the main lines of separate collection of waste generated in the UCO.

Main types and quantities of waste collected in 2009

Waste	**Kgs. (2009)**
Hazardous waste	16.700
Ink-jet and tonner	525
Batteries	550
Electric waste and computers	10.500
Confidential Paper	2.000
Cell phones	10
Urban waste: organics	4.200
Urban waste: plastic	129.500
Urban waste: paper	34.500
Urban waste: glass	17.000

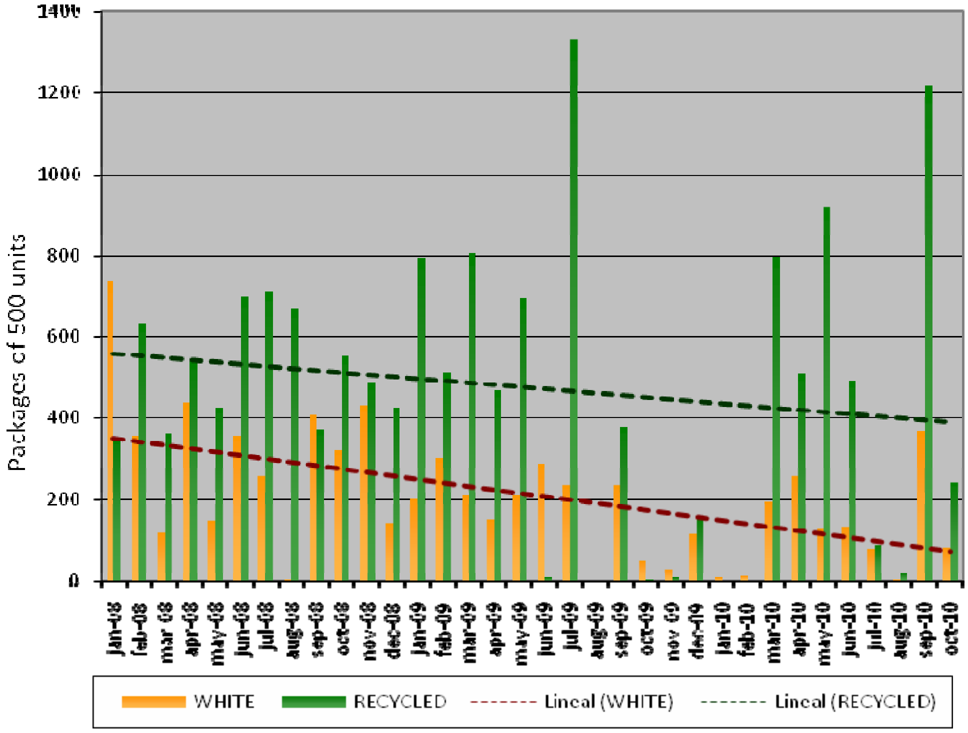
Waste production has grown from 2001 to 2009, when it has begun to stabilise. From 2011 a waste minimization plan will start in order to reduce waste generation where possible, improve environmental management and cost savings.

In addition, the UCO is beginning to analyse their carbon footprint, to assess the CO_2 equivalent emissions produced by their activities and raise awareness and management actions to reduce them.

4. Promoting energy conservation, water and raw materials.

The UCO has planned an Energy Efficiency Strategy that begins with energy and water audits, ie., revisions of the buildings that seek to detect deficiencies in electrical, lighting, air conditioning and piping systems and water supply reflecting an increase in spending, with a view to proposing measures to remedy these deficiencies and improve the efficiency and energy and water saving.

With regard to the most widely used material in the university, paper, the SEPA has developed a specific campaign to promote responsible consumption. The campaign includes both the dissemination of good practices to reduce its use whenever possible (opting for digital formats, using paper on both sides, etc…) as the introduction of recycled paper in the entire university. Recycled paper used follows all required technical and environmental specifications. As shown in Figure, the general trend of the use of paper is declining, and in almost all cases the recycled paper is consumed much more than white paper (the average is at 70% of recycled paper compared to 30% of white paper).



Evolution of white recycled paper and Consumption at the University of Cordoba (2008-2010)

5. Increasing the use of sustainable transport facilities.

Promoting more sustainable transport in the UCO is one of the biggest challenges of the SEPA. Two examples are a bicycle loan program and a website to share car journeys to college.

The bicycle loan program is a system which is available to students and workers so that they have access to a continued bike loan during the academic year both for traveling to work or study centres and for private use .Bikes are provided with a road safety kit (helmet, reflective vest, set of lights, etc.).

On the other hand, the idea of car sharing is becoming more widespread in large organizations (industrial areas, large companies, etc.). Everyday more than 7,000 university students and workers move to the different centers of the UCO in prívate vehicles, with consequent damage to the urban environment: emissions of greenhouse gases, fuel consumption, noise , jams, etc. However, in many cases people need to travel by car due to personal and working responsibilities and obligations, or, in some cases, to the limitation of public transport. In these journeys, the average occupancy of cars is very low, not reaching, according to SEPA estimates, more than two people per vehicle. For this reason, the SEPA has created the website *www.uco.es/compartetucoche*, a meeting place between people doing similar journeys by car, making the car-sharing deal easier. It is a free service for students and workers in the UCO, which aims to connect people who demand free seats in cars with those that can make them available to others in the movement to and from the different university centers.

CONCLUSIONS

Universities play a key role in the society. As Higher Education Institutions, they are responsible for transmitting knowledge, values and attitudes that contribute to students' comprehensive education, to train them for working life and to interact with the surrounding environment in an appropriate manner. This environment is damaged and is still being damaged due to human activity, the result of a social model based on the indiscriminate use of resources and generation of waste products which Nature, in many cases, is no longer able to assimilate.

The responsibility to minimize the environmental impact raises the need of appropriate environmental policies designed to implement a model of a sustainable campus. A basic mainstay of this model is environmental education. By making people aware of the environmental problems which they are part of and the possibilities for tackling them, environmental management objectives will be achieved in a much more effective way.

The University of Córdoba is strongly committed to integrating environmental criteria in its management. While there is still a long way to achieve this goal, the foundations are being layed: a institutional commitment to respect and care for the environment, creating a specific body on environmental matters, the Environmental Protection Service (SEPA), which counts on human, technical and economic resources to design and develop activities that give effect to this commitment. And last but not least, an assumed educational responsibility and some groups of interest around the institution that enable a favorable and promising framework to make an increasingly aware and sustainable university a reality.

REFERENCES

Gomera Martínez, A.: "Environmental awareness within university students: a study for its measurement, analysis and description at the University of Córdoba" (Thesis Project). Directors: Manuel Vaquero Abellán, Francisco Villamandos de la Torre. University of Córdoba, Department of Microbiology, 2010.

University of Córdoba. Environmental Policy, Córdoba (Spain), 2008.

University of Córdoba. Environmental Protection Service. Action Plan and Work procedures. Córdoba (Spain), 2001-2010.

Надійшла до редколегії 25.11.10

UDK 574.4

I. Volovyk

SOCIAL AND ECOLOGICAL ASPECTS OF RURAL DEVELOPMENT UNDER INFLUENCE OF URBANIZATION

Dnipropetrovsk State Agrarian University

Economic, social and ecology indicators of Ukrainian agriculture development were examined as well as problems of rural degradation under influence of urbanization. It was proposed to change the management approach to rural development by redistribution of responsibility between government, enterprises and institutions.

Key words: rural areas, degradation, urbanization.

І. Воловік

Дніпропетровський державний аграрний університет

СОЦІАЛЬНІ ТА ЕКОЛОГІЧНІ АСПЕКТИ РОЗВИТКУ СІЛЬСЬКИХ ТЕРИТОРІЙ В УМОВАХ УРБАНІЗАЦІЇ

Розглянуті економічні, соціальні та екологічні індикатори розвитку сільського господарства України та проблеми деградації сільських територій в умовах урбанізації. Запропоновано змінити підхід до управління розвитком сільських територій шляхом перерозподілу відповідальності між державними органами влади, підприємцями та інституціями.

Ключові слова: сільські території, деградація, урбанізація.

И. Воловик

Днепропетровский государственный аграрный университет

СОЦИАЛЬНЫЕ И ЭКОЛОГИЧЕСКИЕ АСПЕКТЫ РАЗВИТИЯ СЕЛЬСКИХ ТЕРРИТОРИЙ В УСЛОВИЯХ УРБАНИЗАЦИИ

Рассмотрены экономические, социальные и экологические индикаторы развития сельского хозяйства Украины и проблемы деградации сельских территорий в условиях урбанизации. Предложено изменить подход к управлению развитием сельских территорий путем перераспределения ответственности между государственными органами власти, предпринимателями и институциями.

Ключевые слова: сельские территории, деградация, урбанизация.

Sustainable rural development is one of the targets of the Millennium Development Goals. Accelerated rural development is essential to reducing poverty and promoting better standards of life for much of the world's population. Three spheres of development-economics, society and environment - are extremely important for rural communities all over the world and especially for countries of transitive economy such as Ukraine.

During centuries agriculture had been the strategic sector of Ukrainian economy. About one third of the total population of Ukraine lives in the countryside (to 15 ml person). The area of rural communities is more then 48.3 ml hectares. Agricultural land occupies 72 % of the country's territory, 69 % of which is arable land. In 1990 the part of agriculture in gross additional value (GAV) was 22 %; the average profitability of agribusiness was 37 . In 10 years the part in GAV reduced to 11 %, and 92 % of agrarian enterprises was unprofitable. Now figures are much better but Ukrainian agriculture has not still achieved the 1990 year's level. The core factors of such situation are:

-"freezing" the market of land in Ukraine and as a result - lack of foreign and domestic investors;

- Reduced .role of government in financing agribusiness due to membership of Ukraine in WTO since 2008.

Destruction of rural communities, reduction of villages and rural population, degradation of environment are the consequence of economic unsustainable position of agrarian enterprises. It is possible to estimate rural well-being by some indicators:

1. Demographic: rural population, age, education, birth and death rates. According to the State Committee for Statistics of Ukraine, there is a trend of reduction rural population on 165 thousand people each year (-11 per a thousand), average age of a rural inhabitant is 40, only 10% the inhabitants have diplomas about high education, the rate of death among babies is 11.2%, the total rate of death is 20.7 %. As conclusion, there is a negative tendency of reduction and aging of rural population.

2. Economic activities: employment, unemployment, the level of economic activity, level of the incomes, sources of the incomes. The level of employment is about 60 %; the most part of incomes is made by selling domestic products (vegetables, fruits, milk etc); salary in agrarian enterprises is below the middle level in economics. Additional but not the most important source of income is rent. After privatization each inhabitant of rural area if he had worked on a collective farm became the owner of land certificate and the plot of land. But there are no legal opportunities in Ukraine now to sell land so owners can use their land by themselves or hand them over in rent. But rent is very low (20-100 euro per ha for year).

3. Social infrastructure: the quantity and quality of habitation, access to water sources, communication, electricity, natural gas. Availability of medicine care, education, cultures events etc. Only 10 % of villages in Ukraine have a water pipe, about 1 % use water delivered from other places. Social infrastructure is available only in a half of the need. The worst level is in medical sphere. About 90 % of social assets are in property of rural community and need repairing and modernization.

4. Safety of environment: in Ukraine there is a difficult ecological situation. Annually 60-100 millions tons of harmful substances are thrown out to environment; about 3 billions tons of toxic industrial wastes are stored in special storehouses in the rural areas. One third of water dumped in rivers is polluted; the unorganized dumps are placed near villages and farms. In some villages there are warehouses of the delayed chemical means (fertilizers, means of protection etc).

Summing up, we can speak about degradation of the rural territory of Ukraine. To restore such as important part of social and economic life of country have using conceptual and project approach. That means:

- Develop the government program of protection policy in agribusiness using the tools approved by WTO. For example, create the ecological-economic zones as the factor of the sustainability of agriculture and development of rural territories. Ecological-economic zones are the type of free economic zones with the special regime of the investment, where organic production is achieved, the newest technologies are used, agro-park or scientific technical parks function, and the economic stimulation of rational utilization and protection of the earth which are carried out in conformity of the principles of sustainability.

- Create and stimulate green tourism as alternative incomes for rural communities; use the principles of eco-tourism promoting alternative sources of energy and implementing resources-saving technology,

- Implement the co-financing for rural development: use private, government and international financing. Thus, investment projects provided principles of sustainable development will have priority.

Further development of extension services (consulting in agribusiness) will create the opportunities to promote and implement knew sustainable technologies, develop social projects (for example, to start non-agricultural business) and attract investors for rural development.

Надійшла до редколегії 16.11.10

МАТЕМАТИЧНА ЕКОЛОГІЯ

UDK 574.4

S. V. Chernyshenko[1], V. S. Chernyshenko[2], M. O. Alekseyev[2]

NONLINEAR THEORY OF SUCCESSIONS IN FORESTRY BIOGEOCOENOSES: MATHEMATICAL ASPECTS

[1]*Khmelnitskiy National University*
[2]*State Higher Educational Institute «National Mining University»*

Systems analysis of biological phenomenon of succession has been carried out. The history of the subject and the current state of art are considered. Classification of both succession process as a whole and separate succession stages are proposed. Interaction between two main gears of succession – competition between plant species and their interaction with abiotic part of the biogeocoenose – are considered. Extreme nature of succession process and polygenetic structure of biogeocoenose, as a result of succession, are demonstrated.

Key words: biogeocoenose, succession, systems analysis, woodland, mathematical model.

С. В. Чернишенко[1], В. С. Чернишенко[2], М. О. Алексєєв[2]
[1]*Хмельницкий національний університет*
[2]*Національний гірничий університет*

НЕЛІНІЙНА ТЕОРІЯ СУКЦЕСІЙ ЛІСНИХ БІОГЕОЦЕНОЗІВ: МАТЕМАТИЧНІ АСПЕКТИ

Проведено системний аналіз біологічного феномену сукцесій. Розглянуто історію проблеми та її сучасний стан. Наведені окремі класифікаційні схеми і для сукцесій, як процесів у цілому, і для окремих сукцесійних стадій. Розглянута взаємодія двох основних механізмів сукцесії – конкуренції між продуцентами та їхня взаємодія з абіотичними компонентами біогеоценозу. Показано екстремальний характер процесу сукцесії та полігенетичний характер біогеоценозу як результат сукцесії.

Ключові слова: біогеоценоз, сукцесія, системний аналіз, ліси, математична модель.

С. В. Чернышенко[1], В. С. Чернышенко[2], М. А. Алексеев[2]
[1]*Хмельницкий национальный университет*
[2]*Национальный горный университет*

НЕЛИНЕЙНАЯ ТЕОРИЯ СУКЦЕССИЙ ЛЕСНЫХ БИОГЕОЦЕНОЗОВ: МАТЕМАТИЧЕСКИЕ АСПЕКТЫ

Выполнен системный анализ биологического феномена сукцессий. Рассмотрена история проблемы и современное состояние. Представлены отдельные классификационные схемы и для сукцессий, как процессов в целом, так и для отдельных сукцессионных стадий. Рассмотрено взаимодействие двух основных механизмов сукцессии – конкуренции между продуцентами и их взаимодействие с абиотическими компонентами биогеоценоза. Показан экстремальный характер процесса сукцессии и полигенетический характер биогеоценоза как результат сукцессии.

Ключевые слова: биогеоценоз, сукцессия, системный анализ, леса, математическая модель.

Consider issues related to biological gears of successions understanding of which is necessary for adequate mathematical models of ecosystem dynamics construction. We shall examine successions in land (uppermost forest) biogeocoenoses. Succession biological specificity issue is closely connected with emergency of succession ecological system problem (Vasilevich, 1983; Peregudov, Tarasenko, 1989; Gorelov, 1998), whereas they could be examined as specific peculiarities display of synecological systems or as simple step-by-step substitution of one plants by the others not obeying certain special laws. We shall hold to the first approach and show that succession may be examined like nontrivial process of homeostasis and ecosystem self-organization (Kolesov, Majorov, 1986; Armand, 1988; Chernyshenko S.V.,1995). Meanwhile, emergent properties of successions are, from our point of view, based on two quite clear ecological processes:

- dialectical interaction of biota and stagnant environment (against the background of evolutional fitness of species to certain ecological characteristics);
- interspecific competition for ecological resources (phased-array, biogenic elements, water, etc.).

Ecological phenomenon of successions

Succession changes have been being at the centre of attention of biogeocenologists for more than century and have been staying one of the most urgent problems of ecology. There is a huge number of publications, dealing with this subject. Short review Russian-language publications is given in the volumes (Krivolutsky, Pokarzhevsky, 1990; Berezovskaya and others, 1991; Gorelov,1998), and foreign publications (Pianka, 1994; Krebs, 1994). But until now these processes have not been interpreted and generally accepted for their complexity, diversity and long-term character. There are no integrated approaches to their practical research (Austin, 1977).

Probably the term "succession" was first used in the paper "Disappearance of pine wood of south breeds as an argument of production change tendency on the same soil existence in nature" published by American forester J.Edlam in 1806. In 1863 the other American scientist G.D.Toro used the notion "forest succession" for characterization of substitution of pine by deciduous breeds in New England. In XIX century the conception of forest succession was developed in works of T.Duglas and G.Sernander (the latter suggested the theory about dynamics of plant "formations"). Finally in 1899 American botanist G.K.Karaulz published the results of classical research of successions on sand dunes of Lake Michigan, which has not lose its urgency yet and has been examined in majority of ecology textbooks (Spurr, Barnes, 1984).

F.Klements philosophically (now we could say "systemically") generalized the results of predecessors. His theory became a remarkable phenomenon in theoretical ecology development. It had global character, the author tried to construct on the base of quite simple and clear assumptions logically proportioned model, globally explaining the diversity of observed phenomena. From this point of view the idea of self-organization of biogeocenose is quite organic in his theory. Really at succession lightening each stage of succession prepares own changing itself; as a result of such step-by-step self-development process, more determined, biogeocenose returns to its optimal for the climatic zone form – "climax".

Construction of similar global theories has become the principle direction of physical science development in the last three hundred years, has changed the period of empirical data accumulation and first shy generalizations in the time of Newton. But even at comparative simplicity of physical phenomena (as compared to biological) the theories value not always seemed evident for practice. High abstractness giving the theory depth and generality creates inevitably certain problems with its application to real, far from being abstract objects.

Studying extremely complicated, multiple-factor biological processes such problems appear particularly sharp. Refined theoretical constructions of F. Klements and his followers are checking up with difficulty in practice. For instance reveal of factors furthering the development of the following stage, or, on the opposite side, their absence conclusion is a very complicated task methodologically. Besides, any biological theory, in contrast to physical, wittingly does not describe the whole diversity of possible phenomena. Intention to describe maximum large quantity of real situations made Klements considerably complicate his theory, add there large quantity of complementary terms, why the theory had lost its orderliness and seemingly increase its practical value insignificantly.

Works of V.N.Sukachev and L.G.Remensky played a remarkable role in succession studying in domestic biogeocenology. A separate chapter (written by V.N.Sukachev) formed a part of the major work on forest biogeocenology, monograph (The basis of forest...,1964). The chapter deals with dynamical processes in BGC and contains a number of important theoretical generalizations. V.N.Sukachev regarded successions as many-sided notion, covering a wide range of dynamical processes, progressing in biogeocenoses. Following this approach, it could be considered, that fundamental forms of global dynamics of BGC, starting with seasonal fluctuations and finishing with phylocoenogenesis, have in their character many common features and could be united under the general term of successions. Nowadays such approach is supported by the majority of world ecologists (different points of view on this question could be found for instance in (Ehrlich, Roughgarden, 1987)).

Succession is a display of two the most important properties of biogeocenoses – to homeostasis and to self-development (though sometimes it is said about "conditionality" of ecosystems' self-regulation (Danilov, 1978), but it is difficult to agree with such opinion). Self-development processes (evolutional successions, phitocenogenesis) are caused by inner reasons – micro- and macroevolutional processes, progressing in the components of biogeocenose populations – and become the display of general tendency of matter to self-development.

Homeostatic and adaptation processes are activated by violation in the structure of BGC occurrence or by environmental condition change. Violation degree of equilibrium in BGC is defined by succession complexity and duration. Succession ability is a display of homeostatic and adaptation properties of biosphere, which strives for its viability preservation mutating environmental conditions. Homeostasis and successions relationship is evident; and examination of homeostasis on the ecosystem level without mentioning of successions (as it sometimes occurs (Golubets, 1982)) is presented incompletely. As I.G.Emelyanov pointed, environmental mutation "cause adequate reorganization in structure of species populations, communities, biotas" (Emelyanov, 1992). Successions are exactly these reorganizations on the level of biogeocenoses.

Successions are defined by non-linear character and come to step-by-step change of several succession stages – several dominating vegetational associations. In the paper (Chernyshenko, 1997) for such associations the term "cenoma" was suggested, meanwhile the view on the succession stage in the capacity of biogenic elements cycle will be developed. But in many cases more simple approach could be used, considering that for succession stage description it is sufficient to examine the vegetational association dynamics (and even – the dynamics of edificators' populations of these assosiations).

We should note the important relations of successions and spatial heterogeneity of biogeocenoses. The both phenomena could be connected with external against the biota factors. Vegetational associations (which could be naturally named "parcels" here) reflect heterogeneity of phytocenosis in the area, and successions reflect the same but through the time. G.Valter, for instance, wrote about similarity of temporal and spatial aspects of biogeocenoses mutability. He suggested to fix for spatial analogs of successional stages a well-known name "ecological range" (Valter, 1982).

Vegetational associations (ecological ranges) change each other in the area by the gradient of natural factors. Successional stages also change each other during the gradual mutability of one or several natural factors, but this mutability occurs not in the area but in the time. Endogenous successions deals with environment-forming properties of successional stages, which create the gradient of factors in the time.

Steppe dendrology gives illustrative examples of spatial changes, reflecting temporal changes. The boundary between steppe and forest areas are often characterized by intermediate conditions zone existence, where the ecological ranges could be observed (for example "squawbush forests – blackthorn – elm-black-maple oak-forests – elm-ash oak forests – lime-ash oak forests – lime oak forests" (Belgard, 1950)). In the conditions of restless age-old successions ecological ranges shift (to steppe or forest areas), so in every spot the successional changes of applicable vegetational associations occur.

Succession classification multistage processes

In the classification of V.N.Sucachev (The basis of forest..., 1964) the dynamics of biogeocenoses is devided into two large forms: cyclic (periodical) processes and successions. The dynamics of BGC relating with diurnal and annual rhythms (generally too significant) does not really deal with its development direction, global trend, which is the basic observable phenomenon in succession theory. A.L.Belgard calls the first form of dynamics "dynamics of phytocenosis" and the second – "dynamics of vegetational cover" (Belgard, 1950).

But to connect periodicity and reversibility directly (as well as aperiodicity and irreversibility), as it was done in mentioned definition of B.M.Mirkin and G.C.Rozenberg, to our point of view, is not quite reasonable. As V.N.Sukachev mentioned (The basis of forest..., 1964), successions, induced by external action on BGC, could be reversible, when periodical external actions could not lead to reversibility in BGC dynamics. There are forms of dynamics, when demutation (by G.N.Vygotsky, 1950) do not occur, i.e. when restoration of external ecological parameters does not lead to BGC restoration (Rabotnov, 1983). In system theory such phenomena, on the ground of physical analogies, are called hysteresis.

Phenomenon, which is similar to periodic dynamics by several features, is so-called fluctuations of vegetation (Rabotnov, 1974). Fundamental joint feature of these two types of dynamics is conservation of the main features of vegetational community in their progress. In systems approach it is more preferable to use the interpretation of vegetational grouping, changing each other in the progress of fluctuations, as different display forms of integrated plant association. The majority of phytocenologists hold this definition (Nitsenko, 1971; Rabotnov, 1974; Mirkin, 1974) and do not consider that in the case of fluctuation of environmental parameters the reversible change of plant association occurs (Vasilevich, 1983). Fluctuation and periodical dynamics, as well as succession, is a homeostatic process, but in contrast to successions at relative transience and moderate character of environmental mutability of association adaptation is reached not by radical reconstruction of system (replacement of elements and change of relationship between them), as it occurs at succession, and by condition of elements change of existing system without structure change.

Classification of successional processes (including several stages - from the beginning to the "climax") is usually based on an analysis of two indicators - the causes of succession and its duration. Such approach has certainly justified itself, especially in solving practical problems of ecology. At the same time in the theoretical study of the succession there is a necessity to develop the classification of successions by the nature of internal processes in BGC in the succession progress, which are connected with two mentioned parameters, but not one-to-one correspondence. Consider possible causes and duration of successions from the position of system analysis, using the obtained results in this area (Aleksandrova, 1964; Vasilevich, 1983), and then discuss a possible interpretation of the systemic nature of different successional processes.

We begin by considering the possible causes of succession. Following the common practice of dividing the succession to the endogenous (autogenic) and exogenous (allogenic), it should be noted that at the end, almost all successions are caused by external factors. An exception could be considered phylocenogenetic processes (which are also stimulated by instability of the environment) related to the global process of self-development of matter and micro-evolutionary population processes.

By the interpretation of V.N.Sukachev we should refer phylocenogenesis to endogenous succession processes. In this case, we should refer to successions only "coherent" phases of phylogenesis (Zherikhin, 1987), which occur under conditions of relative stability of native environment. Abrupt and global climate changes (or other catastrophic events) can destroy biogeocenosis, after that a mass extinction of the old and the intensive formation of new species occurs (Zherikhin, 1987) - a process that can also be refered to adaptation, but which by its nature has few common features with classic succession.

Exogenous successions are divided into two categories (according to the character of causing them external influences):

- autonomous succession, if the influence was nonrecurrent and relatively short-term (the appearance of island on the river sediments, BGC destruction by fire, etc.);

- non-autonomous succession, in the case of a constant destabilizing external influences (global climate change, industrial pollution, moderate economic use of man, etc.)

Notion of "autonomous " and "non-autonomous" system are widely used in system theory (Kalman and others, 1971; Mesarovich, Takahara, 1978; Van-Gig, 1981). Autonomous call system, impact of the environment on which does not change through the time (or changes spontaneously, at random), and non-autonomous - a system the dynamics description of which requires taking into account the parameters of the environment depending on the time. Applying these terms to the dynamics of biogeocoenoses, we can unite under the term "autonomous succession" the types of succession, the course of which is determined by internal processes in BGC, with no significant effect of changes in external to BGC environment. These are primary successions, syngenesis, exogenous catastrophical (by V.D.Aleksandrova, 1964 - "postcatastrophical) successions. V.I.Vasilevich (1983) proposes to unite all the successions of this kind under the notion postcatastrophical, however, the term " autonomous successions" seems to us more appropriate, firstly because the beginning of such successions do not always associated with catastrophic events (for example, in the case of syngenesis), and secondly, following the common terminology of systems theory makes this term more transparent for specialists-systemologists.

For successions, caused by permanent and having a tendency to change in the external environment, V.I.Vasilevich uses the term "permanent" or "continuous" succession. Concepts of continuity and permanence in mathematical systems theory have somewhat different shades of meaning. We suggest, in consideration of unsettled character of terminology, to call such succession with term understood in the framework of systems analysis - "non-autonomous" succession.

To the reasons causing the non-autonomous succession we can refer solar variability, which have periodicity, but to which there are no special adaptive devices in biogecenosis (the mentioned restriction of T.A.Rabotnov is connected with taking into account the possibility of such factors on a long period of "periodic" processes).

Thus, on the basis of their causes, we can divide the successions into three categories:

- phylocenogenesis (the only in the full sense of the endogenous process);
- autonomous successions - caused by a nonrecurrent and short-term external influence (by this feature - exogenous), but then progressing under the influence of internal biogeocenotic processes (in this sense - endogenous);
- non-autonomous successions - caused by constantly progressing changes in the external environment (in the full sense of an exogenous process).

For autonomous successions it is naturally to define three main types of violation, "launching" the succession (they can be often combined):

- the environmental parameters change (for example, change in water regime as a result of a reservoir creation);
- the change of the number biocoenosis species - a violation of equilibrium, a balance of species (for example, the destruction of undergrowth and most of the plants of the lower tiers as a result of ground fire);
- changes in species composition of biogeocenosis as a result of extinction or introduction of species (for example, delivery of rabbits in Australia).

Autonomous succession caused by the first type of violations, wesuggest to call autonomous parametric, the second - autonomous balanced, the third - syngenesis (in accordance to the established terminology). To call the dynamic process, caused by any of the mentioned reason, a succession (in accordance with the definition of the latter), changes in BGC must be radical enough. The violation must be in such degree that the return of biogeocenosis in the initial state could not be possible within the existing structure, and requires step-by-stepits modification. Maintaining and restoring the balance processes without structural rearrangements progress constantly in BGC and can also be reffered to the forms of dynamics. They can be reffered to the mentioned fluctuation dynamics (if we understand the fluctuations in extended sense).

Now we shall consider the issues related to the duration of succession. The division of the succession into short-term and age-old reflects the nature of the processes within an ecosystem in a less degree, as related primarily to the characteristics of the external factors causing succession or ecological features of the dominant species in BGC.

Apparently, autonomous successions are always relatively short, but even they, if among the edificators of successional stages long-lived tree species are presented, could last for centuries. At the literal meaning of the term we could refeer such succession to "age-old", but now the scale of age-old succession is considered to be of thousands or millions of years.

Duration of non-autonomous succession depends primarily on the duration of the external factors causing them. Non-autonomous successions reflect BGC tendency to adapt to changing environmental conditions, so the usual succession of this kind may be called adaptive. Among the non-autonomous successions are usually distinguished hologenesis – an age-old succession, which is caused by global climate change, "development of river valleys, epeirogenetic fluctuations of land and the evolution of soil types" (Belgard, 1950). To our point of view, age-old successions of this kind do not differ fundamentally from other non-autonomous successions, as based on the same mechanisms of homeostasis of biogeocenosis. The exception is the micro-and macroevolutional BGC processes, which in the case of hologenesis may complement a more adaptive processes. In this case, we believe that parallel to hologenesis the other process progresses, which is also commonly referred to age-old successions - phylocoenogenesis.

Microevolution, which is manifested in a change of some population characteristics of the species-edificators, can occur at fairly short intervals of time and play an important role during the succession (Becking, 1968). Microevolutional component in phylocoenogenesis is relatively short, while a more global macroevolutional process on its own time scale even greater than that which is usually attributed to age-old succession.

As stated in the book (Gorelov, 1998), "one of the major achievements of ecology was the discovery that not only the organisms and species develop, but also ecosystems do." Between the evolution of individual species and biogeocenosis generally there are dialectical relationships. On the one hand, natural selection carries out on cenotic level, and in this sense biogeocoenosis "controls" evolution. On the other hand - the emergence of BGC of new life forms (species, subspecies, races - have arisen on-site or migrated from the outside) can cause rearrangements in BGC ("flashes", by V.D.Fedorov (1970)), which are also agreed to classify as successions. If we exclude the introduction or accidental entry of new species by man (unfortunately, getting a colossal scale in the last century) - these phenomena we refer to the reasons of syngenesis - processes of self-development of BGC progress very slow, even compared to other types of successions that are traditionally related to the age-old ones. For suth successions we suggest the term "evolutionary successions", which underlines their difference from short-term and age-old ones as in the time and the inner nature (the system not only keeps or restores its structure, but changes, "improves" it).

The proposed classification of dynamic processes in forest biogeocenoses is presented in the table.

The proposed classification is convenient for system analysis and succession modeling. Selection of phylocoenogenesis in a separate category is justified, since the processes of self-organization (Levitin, 1975), consisting of the fact that the system can themselves change their structure, represent a special category of systems theory yet not well studied models. As a simple example of this approach in the article (Chernyshenko, 1996) a model of successional shifts based on the hypercycle model of M. Eigen is considered, in which biogeocoenosis itself "chooses" the level of its complexity.

Non-autonomous successions compose a special group in the analysis of dynamic processes. Non-autonomous (or nonstationary) models with time-dependent coefficients correspond to these successions. If the time variable tends to infinity, these coefficients do not tend to some constant values, the ecosystem is also not likely to move in a certain state, and its dynamics will be determined, ultimately, the dynamics of the coefficients. To study such systems there are not developed universal methods, although some of their properties (for instanse, sensitivity, and inertia with respect to a change in the coefficients) can be investigated.

Classification of dynamical processes in forest BGC

<table>
<tr><th>Type of dynamics</th><th>External influances</th><th colspan="2">Type of succession</th><th>Duration</th></tr>
<tr><td rowspan="2">Endogenous successions</td><td rowspan="2">—</td><td rowspan="2">phylocoenogenesis</td><td>evolutional succession</td><td>"age-old"</td></tr>
<tr><td>microevolution</td><td>"age-old", medium</td></tr>
<tr><td rowspan="5">Exogenous successios</td><td rowspan="2">constant, with certain tendency</td><td rowspan="2">non-autonomous successions</td><td>hologenesis</td><td>"age-old"</td></tr>
<tr><td>adaptation</td><td>small, medium</td></tr>
<tr><td rowspan="3">nonrecurrent</td><td rowspan="3">autonomous (postcatastrophic) successions</td><td>parametric</td><td rowspan="3">small, medium</td></tr>
<tr><td>balanced</td></tr>
<tr><td>syngenesis</td></tr>
<tr><td>Periodic dynamics</td><td>constant periodic with small period</td><td colspan="2"></td><td>small</td></tr>
<tr><td>Fluctuation</td><td>constant with accidental dispersion</td><td colspan="2"></td><td>small</td></tr>
</table>

In the case of autonomous successions for the mathematical description of the process the nature of the initial disturbance is significant. In the case of changes in the number of species (balance autonomous succession) the disturbance of the system state (with no change in itself) occurs. In this case, the stability of the system "in the initial conditions” is interesting, the qualitative behavior of the system can be studied on the basis of the theory of Lyapunov (Liapunov, 1950; Bautin, Leontovich, 1990).

At the system parameters change (parametric autonomous succession) the system in terms of systems analysis, changes its properties. The "structural stability" of the system should be researched, and as a well-developed mathematical apparatus the bifurcation theory may be used (Yoss, Joseph, 1983).

The case of changing the structure of the system (syngenesis) is the most difficult methodologically because it is difficult to describe quantitatively the relationship between a system, in which there are new elements or old disappeared, and the initial system. The study of the structural stability of this kind is naturally carried, bringing this case to the previous. For example, when modeling the appearance of a new type of model introduced a new element with some weighting factors that define the extent of its connection with other species, which then can be changed from zero to determine the critical values associated with qualitative changes in the dynamics of the system.

Volterra systems (Volterra, 1976; Maynard Smith, 1974; Svirezhev, 1983) provide a convenient way to reduce the latter case is not to the more complicated the second, and the first case. These models have the property that the population with a zero number can not be developed, so simply "zeroing" population size, we exclude it from BGC. Similarly, when the introduction we "includes" the species at BGC just giving it the number of non-zero value. Below at the modeling of successions, we shall use this technique.

When balanced autonomous successions change population size is not going beyond the boundary of the attraction of the current equilibrium point corresponds to the fluctuation dynamics. We can talk about succession, if the violations are so large that they lead to a change in the equilibrium position (structure of BGC changes and the succession process begins).

When parametric autonomous successions we are dealing with fluctuations, until the change of parameters does not lead to a bifurcation (a catastrophe). Bifurcation, meaning a radical change in the dynamic properties of the system, means the beginning of a new successional stage.

If we consider the model of not only the biotic part of BGC, but also include in it biostagnant parts and the part of stagnant components, changes in the environment, which is an essential part of succession, is expressed by the change of the system, rather than its external parameters. Those effects, that were associated with bifurcations of the system, become the result of "internal bifurcation" (Chernyshenko, 1995a). So restructuring of the system is the result of its internal development, rather than external influences. Not all the abiotic factors may be included in such a way to the model of BGC (for example, in the constructions of F.Clements BGC detects even a relief, but beyond its borders of BGC climatic conditions still remain), but some of them - such as the parameters of soil, litter, the nature of wetting etc. should preferably not be seen as external, but as internal parameters of BGC.

Finally, we should note the importance of the territorial aspects of succession. Succession in the ecosystem do not and can not progress regardless of ecosystems, surrounding it. Except start-up island in the ocean, the relationship of primary succession in which other ecosystems are mediated (but which exists, and without which these successions are impossible! "); the actual succession passes in the territory, surrounded by other biogeocenoses, and in most cases - in which can be considered as part of some of the existing ecosystem. A classic example of a primary succession - the formation of a new biogeocoenose on the river flats - can be interpreted (perhaps more correctly) and as an extension of the territory of the existing floodplain BGC. Destruction of forest BGC in a fire can be considered not starting the process of syngenesis on the affected area, which disappeared most of the species, but the beginning of the balanced autonomous succession in BGC, in which the density distribution of many species turned into zero. Restoring of an ecosystem will be progress not only by successional processes in the territory, violated by fire, but also by the diffusion occupation of it from the surrounding undisturbed parts of BGC.

Mechanisms of succession. The role of competition of populations of producers-edificators and their interactions with the abiotic environment

As mentioned at the beginning of this article, the change of the dominant association in succession process occurs under the influence of two driving mechanisms: interspecific competition between plants-edificators and their dialectical interaction with the stagnant environment.

Consider in the beginning the first process - the competition of the associations for the major environmental resources, which has a number of specific features (such as forest successions its course is largely determined by the properties of the soil block – as L.O.Karpachevsky writes (1995) "Soil is the basis of competition").

The role of competition in the successions was highlighted by many researchers. So, in a monograph (Fundamentals of forest ..., 1964), which gives a classic description of the forest biogeocenology, appears the following statement. "In development of the forest biogeocenotic cover the main role played by successions of phytocenosises; mechanism of any phytocenosises change, and the change biogeocenoses in general is the displacement of some other species in the process of inter-species fighting for survival and competition. ... In the process of ecosystem change of one another ... the main leadership role played by inter-species relationships." Around this the same idea is expressed in the monograph devoted to the cybernetic analysis of biological systems. "Succession ... is ... the process of logical sequential change of competing with each other ... communities." (Biological Cybernetics, 1977).

Competition between species-producers (edificators of plant associations, relevant successional stages) is the main (or, if you ignore the minor details - the only) mechanism for actuating the succession of inhibition and tolerance. However, in the case of "relief" when the previous cenoma in a sense, "promotes" the development of the next, there is always competition between edificators for resources, i.e. observed the effect of "inhibition". As noted by the TA Rabotnov, "should not be forgotten ... that the change occurs phytocenosises while continuing influence of plants on each other, primarily because of competitive interactions (Rabotnov, 1983).

The fact that competition plays an important role in the functioning of biological communities, is a universally recognized fact. The interest in the competition, especially increased after the triumph of the ideas of Darwin, in which "the struggle for existence" is considered as the main driving force behind the evolutionary process. Numerous studies have demonstrated the fruitfulness of this approach, particularly when considering the dynamic processes in Biogeocenoses (Budyko, 1977; Basics forest ..., 1964; Gall, 1976;

Gilyarov, 1990; Holubec, 1982; Dylis, 1973; Krivolutsky, Pokarzhevsky, 1990 ; Nomokanov, 1989; Rabotnov, 1983; spurrite, Barnes, 1984).

The most important stage in the development of competition began in the early twentieth century work of Lotka (Lotka, 1925) and Volterra (Volterra, 1931; Volterra, 1976), containing the fundamental mathematical description of the competition. Using these models, G. Gause based on extensive experimental material has formulated a well-known principle of competitive exclusion - "the principle of Gause» (Gause, 1934). The latter is sometimes considered very broadly, assuming that it operates at different levels of ecological systems, up to the scale of the noosphere (Gorelov, 1998) (although sometimes its universality is questioned, even for phytocenosises (Bigon et al, 1989)).

The interest to the problem is not reduced nowadays. On the one hand, reached ever deeper understanding of the internal mechanisms of competition, but on the other hand, all the more deeply we study the role of competition in real ecosystems, Biogeocenoses. In particular, many studies have been devoted to constructing models of competition for forest BGTS (Rosenberg, 1984, Berezovsky and others, 1991). Many works are devoted to studying the role of competition in the formation of plant associations in successional processes (Biological Mechanisms of ..., 1964). A significant development was the doctrine of life forms and environmental policies as a result of competitive interactions of different types (Forest Principles ..., 1964; MacArthur, Wilson, 1967; Pianka, 1994).

Regarding the second mechanism - the interaction of populations of producers with inert environment and their mutual influence - note that it plays an important role when these two components BGTS not balanced (or, in other words, when there existed a dialectical contradiction.) This contradiction is resolved by changes in both components, which changes the biogeocoenosis, leading to the formation of a new successional stage. Previous stage is not "programmed" to self-depression or training environment for the next stage. A process of harmonization of biotic and abiotic components BGTS, resulting in biocaenosis changes its structure - replacing one plant association comes another. It is in this sense (in his non-compliance with the inert medium), one prepares the next stage of succession, "facilitates" its development.

Famous examples of chemical "self-depression" of explerents at early successional stages (Whitteker, 1981) can hardly be regarded as genetically programmed "facilitation" of succession, as a manifestation of overorganism regulating its flow. Correct to speak about genetically fixed "doom" of these species in competition with the energetically more powerful species. Their strategy is to generate 1-2 produce sufficient for the survival of a population of seeds. Energy as the cost of establishing and supporting the physiological mechanisms (or a service population of the consorts, decomposers), aimed at the possibility of long-term coexistence with the products of its own metabolism, are presented in this meaningless. Another possible explanation "samougneteniya" contained in the paper (Rabotnov, 1983).

Successions of facilitation play a major role in the early stages of primary succession, where the discrepancy of biota and environment is particularly high. To some extent the effects of "harmonizing with the environmental conditions" must be manifested at all stages of succession, but in the latter stages of their influence in comparison with the competition is much weaker.

To account for the effect of facilitation it should be entered into the model the dynamics of abiotic factors, which significantly complicates the construction of a methodological part. Sometimes this can be avoided by introducing a special nonlinear relationships between the populations of plant-edificators that allow implicitly consider the impact of the effects of facilitation on interpopulation interactions.

BGC as polygenetic system. Biogeocenosis compatibility of associations

Conventional progressive succession are a gradual change in the dominant populations edificators - from simpler to more specialized species with more power. In this case, the fate of the previous stage may be different. There are two main possibilities.

The first of them occurs when the previous dominant completely disappears as a structural whole, after the environmental conditions become favorable for the development of the next stage of succession. Most of its constituent species fall out of the forming of ecosystem (as a result of changing environmental conditions of habitat and / or interspecific competition with species belonging to the new stage) and turn into a "virtual" form. They are stored in a seed bank as a result of the influx of seeds and / or individuals from neighboring biogeocoenoses, in the form of relict groups tied to specific areas of relief, etc. If conditions change, they tend to be fast enough to return to biogeocoenosis, and create a certain "energy pressure" on the dominant association, forcing it to expend energy on a constant struggle with the return. At the same time they play a minor role in the transformation of matter and energy prevailing of BGC. An example of this kind of stage can serve as a grouping ruderants arising on post-fire known as the temporal association, which does not leave a noticeable trace in the emerging after it biogeocenoses.

In the second case, the earlier association, albeit in a modified standing, becomes a part of a new stage of BGC, and species, its components, occupy a position in consorts of the new dominant. In this case we can speak of "*biogeocenosis compatibility*" of the two associations. Such an outcome is very real, especially in the later stages of succession. Types of previous stages may be presented in BGC long enough, and some of them (especially soil decomposers) can even play an important role in the functioning of new communities. Real BGC is always a combination of several associations. This is especially true for amphicenoses (Belgard, 1950) - biogeocenoses in border environmental conditions.

The number of associations, "overlapping" one by one in the progress of succession (or, equivalently, the amount passed successional stages) we shall call the dimension of BGC. Of course, this conditional value largely depends on the subjective understanding of what should be counted as successional stage, and what - intermediate amphicenose (Belgard, 1950). However, with the same approach to multiple BGC, the dimension may be used to estimate the relative complexity of these ecosystems.

More favorable conditions (in terms of the number of available for the photo-synthetic assimilation of energy) create preconditions for more successional stages changing each other, and thus for higher dimension (and complexity) level of climax community. In severe conditions the flow of available energy does not allow BGC pass more than a few initial steps of succession.

Overlapping of successional stages is one of the factors promoting the biodiversity enrichment in biogeocenoses. The relationship between biodiversity and informational and entropic indices is universally recognized. We emphasize that a certain degree of conditionality of biodiversity level by evolutional effects (Emelyanov, 1992) is associated with progressive evolution of the energy-producing capabilities of producers-edificators. The latter is a result of competition and pressure of the populations of heterotrophs (Chernyshenko, 1997a). The expanding power base creates the conditions for "proliferation" of ecological niches at all levels of the trophic net.

REFERENCES

Александрова В. Д. Изучение смен растительного покрова / В. Д. Александрова // Полевая геоботаника. – Л. : Наука, 1964. – Т. 3. – С. 300-447.

Арманд А. Д. Информационные модели природных комплексов / А. Д. Арманд. – М. : Наука, 1975. – 126 с.

Арманд А. Д. Самоорганизация земной поверхности (географическая синергетика) / А. Д. Арманд // Математическое моделирование сложных биологических систем. – М. : Наука, 1988. – С. 33-49.

Багоцкий С. В. Различные механизмы упрощения водных экосистем при росте поступления органических загрязнений и биогенных элементов / С. В. Багоцкий, В. А. Вавилин // Математическое моделирование сложных биологических систем. – М. : Наука, 1988. – С. 128-133.

Баутин Н. Н. Методы и приемы качественного исследованияя динамических систем на плоскости / Н. Н. Баутин, Е. А. Леонтович. – М. : Наука, 1990. – 488 с.

Бельгард А. Л. Лесная растительность юго-востока УССР / А. Л. Бельгард. – К. : Из-во КГУ, 1950. – 264 с.

Березовская Ф. С. Моделирование динамики древостоев: эколого-физиологический подход / Ф. С. Березовская, Г. П. Карев, А. З. Швиденко. – М. : Из-во ВНИИЦлесресурс, 1991. – 84 с.

Бигон М. Экология. Особи, популяции и сообщества / М. Бигон, Дж. Харпер, К. Таунсенд. – М. : Мир, 1989. – Т. 1. – 668 с.

Биологическая кибернетика / Под. ред. А. Б. Когана. – М. : Высшая школа, 1977. – 408 с.

Будыко М. И. Глобальная экология / М. И. Будыко. – М. : Мысль, 1977. – 415 с.

Вальтер Г. Общая геоботаника / Г. Вальтер. – М. : Мир, 1982. – 264 с.

Ван-Гиг Дж. Прикладная общая теория систем / Дж. Ван-Гиг. – М. : Мир, 1981. – 350 с.

Василевич В. И. Очерки теоретической фитоценологии / В. И. Василевич. – Л. : Наука, 1983. – 248 с.

Вольтерра В. Математическая теория борьбы за существование / В. Вольтерра. – М. : Наука, 1976. – 264 с.

Высоцкий Г. Н. Учение о влиянии леса на изменение среды его произрастания и на окружающее пространство / Г. Н. Высоцкий. – М. : Изд-во АН СССР, 1950.

Галл Я. М. Борьба за существование как фактор эволюции / Я. М. Галл. – Л. : Наука, 1976. – 156 с.

Гиляров А. М. Популяционная экология / А. М. Гиляров. – М. : МГУ, 1990. – 184 с.

Голубец М. А. Актуальные вопросы экологии / М. А. Голубец. – К. : Наукова думка, 1982. – 158 с.

Голубець М. А. Загальна схема механізмів саморегуляції в живих системах біосфери / М. А. Голубець // Вісник АН УРСР. – 1978. – № 1. – С. 76-85.

Горелов А. А. Экология / А. А. Горелов. – М. : Центр, 1998. – 238 с.

Горстко А. Б. Введение в моделирование эколого-экономических систем / А. Б. Горстко, Г. А. Угольницкий. – Ростов : РГУ, 1990. – 110 с.

Губанов В. А. Введение в системный анализ / В. А. Губанов, В. В. Захаров, А. Н. Коваленко. – Л. : ЛГУ, 1988. – 268 с.

Данилов Н. Н. Равновесное состояние биогеоценозов / Н. Н. Данилов // Биогеоценология, антропогенные изменения растительного покрова и их прогнозирование. – К. : Наукова думка, 1978. – С. 13-14.

Дылис Н. В. Основы биогеоценологии / Н. В. Дылис. – М. : МГУ, 1973. – 152 с.

Емельянов И. Г. Роль разнообразия в функционировании биологических систем / И. Г. Емельянов. – К. : Ин-т зоологии АН Украины, 1992. – 64 с.

Жерихин В. В. Биоценологическая регуляция эволюции / В. В. Жерихин // Палеонтол. журн. – 1987. – № 1. – С. 3-12.

Зонн С. В. Географо-генетические аспекты почвообразования, эволюции и охраны почв / С. В. Зонн, А. П. Травлеев. – К. : Наукова думка, 1989. – 216 с.

Йосс Ж. Элементарная теория устойчивости и бифуркаций / Ж. Йосс, Д. Джозеф. – М. : Мир, 1983. – 302 с.

Казенс Д. Введение в лесную экологию / Д. Казенс. – М. : Лесная пром-ть, 1982. – 142 с.

Калман Р. Очерки по математической теории систем / Ф. Калман, П. Фалб, М. Арбиб. – М. : Мир, 1971. – 400 с.

Карпачевский Л. О. Проблемы экологического почвоведения / Л. О. Карпачевский // Екологія та ноосферологія. – 1995. – Т. 1, № 1-2. – С. 48-55.

Колесов Ю. С. Пространственная и временная самоорганизация в одновидовом биоценозе / Ю. С. Колесов, В. В. Майоров // Динамика биологических популяций. – Горький: ГГУ, 1986. – С. 3-13.

Криволуцкий Д. А. Введение в биогеоценологию / Д. А. Криволуцкий, А. Д. Покаржевский. – М. : МГУ, 1990. – 104 с.

Левитин К. Все, наверное, проще / К. Левитин. – М. : Знание, 1975. – 176 с.

Ляпунов А. А. Кибернетический подход к теоретической биологии / А. А. Ляпунов // Биология и информация. – М. : Наука, 1984. – С. 38-45.

Ляпунов А. М. Общая задача об устойчивости движения / А. М. Ляпунов. – М. : Гостехиздат, 1950. – 412 с.

Месарович М. Общая теория систем: математические основы / М. Месарович, Я. Такахара. – М. : Мир, 1978. – 312 с.

Механизмы биологической конкуренции. – М. : Мир, 1964 – 317 с.

Миркин Б. М. Закономерности развития растительности речных пойм / Б. М. Маркин. – М. : Наука, 1974. – 174 с.

Миркин Б. М. Толковый словарь современной фитоценологии / Б. М. Миркин, Г. С. Розенберг. – М. : Наука, 1983. – 134 с.

Моисеев Н. Н. Экология человечества глазами математика / Н. Н. Моисеев. – М. : Молодая гвардия, 1988. – 256 с.

Мэйнард Смит Дж. Модели в экологии / Дж. Мэйнард Смит. – М. : Мир, 1974. – 184 с.

Ниценко А. А. Растительная ассоциация и растительное сообщество как первичные объекты геоботанического исследования / А. А. Ниценко. – Л. : Наука, 1971. – 184 с.

Номоконов Л. И. Общая биогеоценология / Л. И. Номоконов. – Ростов-на-Дону : РГУ, 1989. – 455 с.

Одум Ю. Основы экологии / Ю. Одум. – М. : Мир, 1975. – 740 с.

Основы лесной биогеоценологии // Под ред. В. Н. Сукачева и Н. В. Дылиса. – М. : Наука, 1964. – 576 с.

Пасеков В. Н. Экстремальные свойства и эволюционная оптимальность в модели биологического сообщества, учитывающей энергетику жизнедеятельности / В. Н. Пасеков, Л. Л. Овсянников // Математическое моделирование сложных биологических систем. – М. : Наука, 1988. – С. 133-140.

Перегудов Ф. И. Введение в системный анализ / Ф. И. Перегудов, Ф. П. Тарасенко. – М. : Высшая школа, 1989. – 368 с.

Плотников В. В. Эволюция структуры растительного сообщества / В. В. Плотниов. – М. : Наука, 1979. – 276 с.

Работнов Т. А. Луговедение / Т. А. Работнов. – М. : МГУ, 1974. – 384 с.

Работнов Т. А. Фитоценология / Т. А. Работнов. – М. : МГУ, 1983. – 294 с.

Раменский Л. Г. Введение в комплексное почвенно-геоботаническое исследование земель / Л. Г. Раменский. – М., 1938.

Реймерс Н. Ф. Азбука природы. Микроэнциклопедия биосферы / Н. Ф. Реймерс. – М. : Знание, 1980. – 208 с.

Розенберг Г. С. Модели в фитоценологии / Г. С. Розенберг. – М. : Наука, 1984. – 266 с.

Свирежев Ю. М. Математические модели в экологии / Ю. М. Свирежев // Математические методы в биологии. – К. : Наукова думка, 1983. – С. 97-106.

Свирежев Ю. М. Нелинейные волны, диссипативные структуры и катастрофы в экологии / Ю. М. Свирежев. – М. : Наука, 1987. – 368 с.

Свирежев Ю. М. Устойчивость биологических сообществ / Ю. М. Свирежев, Д. О. Логофет. – М. : Наука, 1978. – 352 с.

Спурр С. Г. Лесная экология / С. Г. Спурр, Б. В. Барнес. – М.: Лесная пром-ть, 1984. – 480 с.

Травлеев А. П. Лес и почва в условиях степи / А. П. Травлеев, Л. П. Травлеев. – Д. : ДГУ, 1988. – 85 с.

Тринчер К. С. Биология и информация / К. С. Тринчер. – М. : Наука, 1964. – 100 с.

Уиттекер Р. Сообщества и экосистемы / Р. Уиттекер. – М. : Прогресс, 1981. – 328 с.

Федоров В. Д. Особенности организации биологических систем и гипотеза "вспышки" вида в сообществе / В. Д. Федоров // Вестн. МГУ. Сер. биол., почвовед. – 1970. – № 2. – С. 71-81.

Ханин М. А. Экстремальные принципы в биологии и физиологии / М. А. Ханин, Н. Л. Дорфман, Н. Б. Бухаров и др. – М. : Наука, 1978. – 256 с.

Чернышенко С. В. Качественное исследование двумерной модификации гиперцикла Эйгена и внутренние катастрофы / С. В. Чернышенко // Вопросы прикладной математики и математического моделирования. – Д. : ДГУ, 1995a. – С. 129-134.

Чернышенко С. В. Термин "информация" и математическое описание информационных процессов в экологических системах / С. В. Чернышенко // Екологія та ноосферологія. – 1995b. – Т. 1, № 1-2. – С. 137-150.

Чернышенко С. В. Системный подход к задаче моделирования сукцессионных процессов в фитоценозах / С. В. Чернышенко // Вопросы степного лесоразведения и лесной рекультивации земель. – Д. : ДГУ, 1996. – С. 71-77.

Чернышенко С. В. О математическом моделировании динамической структуры биогеоценозов / С. В. Чернышенко // Екологія та ноосферологія. – 1997a. – Т. 3, № 1-2. – С. 65-86.

Чернышенко С. В. Системный анализ динамической структуры биогеоценоза / С. В. Чернышенко // Вопросы степного лесоведения и лесной рекультивации земель. – Д. : ДГУ, 1997b. – С. 18-31.

Шредингер Э. Что такое жизнь? / Э. Шредингер. – М. : Атомиздат, 1972. – 88 с.

Эйген М., Гиперцикл / М. Эйген, П. Шустер. – М. : Мир, 1982. – 272 с.

Эрроусмит Д. Обыкновенные дифференциальные уравнения. Качественная теория с приложениями / Д. Эрроусмит, К. Плейс. – М. : Мир, 1986. – 244 с.

Austin M.P. Use of ordination and other multivariate descriptive methods to study succession // Vegetatio. – 1977. – V. 35, N 3. – P. 165-175.

Becking R.W. Vegetational response to change in environment and change in species tolerance with time // Vegetatio. – 1968. – V. 16, N 1-4. – P. 135-158.

Brooks D.R., Wiley E.O. Evolution as entropy: toward a unified theory of biology. – Chicago & London: The University of Chicago Press, 1988. – 416 p.

Chernyshenko S.V. The open Eigen Hypercycle and selforganization of ecological systems //

Sustainable Development: environmental pollution and ecological safety. – Dniepropetrovsk: Dniepropetrovsk University Press, 1995. – P. 42-43.

Clements F.E. Plant succession: Analysis of the development of vegetation. – Washington: Carnegie Institute of Washington Publications, 1916.

Drury W.H., Nisbet I.C.T. Succession // J. Arnold Arboretum. – 1973. – V. 54, N 3. – P. 331-368.

Dunbar M.J. The ecosystem as unit of natural selection // Growth by intussusception. – N.Y.: Trans. Conn. Acad. Arts Sci., 1972. – T. 44. – P. 113-130.

Ehrlich P., Roughgarden J. The science of ecology. – N.Y.: McMillan, 1987.

Fox J.F. Alternation and coexistance of tree species // Amer. Natur. – 1977. – V. 111, N 977. – P. 69-89.

Gause G.F. The struggle for existence. – Baltimore: Williams and Wilkins, 1934.

Hart A., Begon M. The status of general reproductive-strategy theories, illustrated in winkles // Oecologie. – 1982. – V. 52. – P. 37-52.

Kershaw K.A. Quantitative and dynamics plant ecology. – L. : Assley, 1973. – 308 p.

Krebs C.J. Ecology. – N.Y. & Harlow: Addison Wesley, 1994. – 802 p.

Lawton J.H. Are the assembly rules for successional communities? // Colonization, succession and stability. – Oxford: Blackwell, 1987. – P. 225-244.

Lotka A.G. Elements of Physical Biology. – Baltimore: Williams and Wilkens, 1925.

MacArthur R.H., Wilson E.O. The theory of island biogeography. – Princeton & New Jersey: Princeton University Press, 1967.

Margalef R. On certain unifying principles in ecology // Amer. Natur. – 1963. – V. 97, N 897. – P. 357-374.

Margalef R. Perspectives of ecological theory. – Chicago: Chicago University Press, 1968. – 102 p.

Noble I.R., Slatyer R.O. Concepts and models of succession in vascular plant communities subject to recurrent fire // Fire and the Australian biota. – Canberra: Australian Academy of Science, 1981.

Odum E.P. Fundamentals of ecology. – Philadelphia: Saunders, 1971.

Odum H.T. Environment, power, and society. – N.Y. Wiley, 1971.

Pianka E.R. Evolutionary ecology. – N.Y.: Harper Collins, 1994. – 486 p.

Volterra V. Lecons sur la theorie mathematique de la lutte pour la vie. – Paris: Gauthier-Villars, 1931.

Woods K.D. Reciprocal replacement and maintenance of codominance in a beech–maple forest // Oikos – 1979 – V. 33, N 1 – P. 31-39.

Надійшла до редколегії 08.12.10

ЕКОЛОГІЧНІ ПРОБЛЕМИ КОСМОСУ

УДК 629.21

М. Г. Головко, В. А. Безуглый, С. Г. Бондаренко

АНАЛИЗ СОСТОЯНИЯ ТЕХНОГЕННОГО ЗАСОРЕНИЯ ОКОЛОЗЕМНОГО КОСМИЧЕСКОГО ПРОСТРАНСТВА И СПОСОБЫ ЕГО УМЕНЬШЕНИЯ

Днепропетровский национальный университет им. О. Гончара

В работе рассмотрена проблема техногенного загрязнения околоземного космического пространства, которая стала актуальной в последние десятилетия. Проанализировано экологическое состояние космической окружающей среды, приведено некоторые концептуальные мероприятия для уменьшения загрязнения космоса.

Ключевые слова: техногенное засорение, околоземное космическое пространство, экологическое состояние.

М. Г. Головко, В. А. Безуглий, С. Г. Бондаренко

Дніпропетровський національний університет ім. О. Гончара

АНАЛІЗ СТАНУ ТЕХНОГЕННОГО ЗАБРУДНЕННЯ НАВКОЛОЗЕМНОГО КОСМІЧНОГО ПРОСТОРУ ТА СПОСОБИ ЙОГО ЗМЕНШЕННЯ

В роботі розглянута проблема техногенного засмічення навколоземного простору, яка стала актуальною в останні десятиріччя. Проаналізовано екологічний стан космічного навколишнього середовища, приведено деякі концептуальні заходи для зменшення засмічення космосу.

Ключові слова: техногенне засмічення, навколоземний космічний простір, екологічний стан.

M. G. Golovko, V. A. Bezugly, S. G. Bondarenko

O. Gonchar Dniepropetrovsk National University

ANALYSIS OF ANTHROPOGENIC POLLUTION STATE OF CIRCUMTERRESTRIAL SPACE AND WAYS TO DECREASE IT

In the work was considering problem of technogenic pollution of space what become topical last ten years. Was analyzed ecological situation of environment, adduced several conceptual measures by diminution of space pollution.

Keywords: anthropogenic pollution, circumterrestrial space, ecological situation.

Космический мусор (КМ) – это все антропогенные объекты, которые находятся на околоземной орбите, включая фрагменты или части тех объектов, которые прекратили свое активное существование.

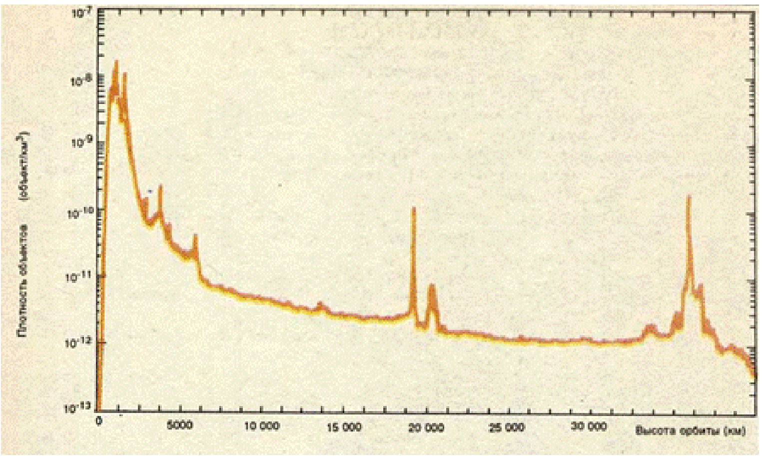
Проблема засорения околоземного космического пространства «космическим мусором», как чисто теоретическая, возникла по существу сразу после запусков первых искусственных спутников Земли в конце пятидесятых годов. Официальный статус на международном уровне она получила 10 декабря 1993 года после доклада Генерального секретаря ООН под названием «Воздействие космической деятельности на окружающую среду», где особо отмечено, что проблема имеет международный, глобальный характер. Нет засорения национального околоземного космического пространства, есть засорение космического пространства Земли, одинаково негативно влияющее на все страны, прямо или косвенно участвующие в его освоении (http:// rnd. cnews.ru/; http:// www.anafor.ru/).

Необходимость мер по уменьшению интенсивности техногенного засорения космоса становится понятной при рассмотрении возможных сценариев освоения космоса в будущем. Так, существующие оценки показывают, что так называемый «каскадный эффект», который в среднесрочной перспективе может возникнуть от взаимного столкновения объектов и частиц КМ, при экстраполяции существующих условий засорения низких околоземных орбит (НОО), даже с учетом мер по снижению в будущем числа орбитальных взрывов (42 % всего КМ) и других мероприятий по уменьшению техногенного засорения, может в долгосрочной перспективе привести к катастрофическому росту количества объектов орбитального мусора на НОО и, как следствие, к практической невозможности дальнейшего освоения космоса. Предполагается, что после 2055 года процесс саморазмножения остатков космической деятельности человечества станет серьезной проблемой (http:// rnd. cnews.ru/; http:// www.anafor.ru/).

Околоземное космическое пространство будет заполнено сплошным слоем КМ, если не предпринимать активных действий по его удалению (http:// www.anafor.ru/)

В настоящее время по разным оценкам в районе НОО вплоть до высот около 2000 км находится до 5000 тонн техногенных объектов. На основе статистических оценок делаются выводы, что общее число объектов подобного рода (поперечником более 1 см) достаточно неопределенно и может достигать 60 000 − 100 000. Из них только порядка 10 % (около 15000 объектов) обнаруживаются, отслеживаются и каталогизируются наземными радиолокационными и оптическими средствами, причём, только около 6 % отслеживаемых объектов — действующие. Около 22 % объектов прекратили функционирование, 17 % представляют собой отработанные верхние ступени и разгонные блоки ракет-носителей (РН), и около 55 % — отходы, технологические элементы, сопутствующие запускам, обломки взрывов и фрагментации. Большинство этих объектов находится на орбитах с высоким наклонением, плоскости которых пересекаются, поэтому средняя относительная скорость их взаимного пролета составляет около 10 км/с. В следствие огромного запаса кинетической энергии столкновение любого из этих объектов с действующим космическим аппаратом (КА) может повредить его или даже вывести из строя. Эффективных мер защиты от объектов КМ размером более 1 см в поперечнике на сегодня практически нет (http:// rnd. cnews.ru/; http:// www.anafor.ru/).

Степень влияния загрязненности космического пространства на функционирование КА определяется четырьмя факторами: временем нахождения на орбите, районами по предположению нахождения объектов, высотой орбиты, наклоном плоскости орбиты. Для представления об объектах загрязнения космического пространства разрабатывают математические модели его засоренности. Они описывают распределение загрязняющих объектов в пространстве, траектории их движения, физические характеристики. Разрабатываемые модели бывают двух видов: краткосрочные (период до 10 лет) и долгосрочные (период до 100 лет) (http:// rnd. cnews.ru/; http:// www.anafor.ru/).



Пространственная плотность распределения космических объектов (Рыхлова, 1993)

Наиболее широко используемыми моделями являются:

– ORDEM-96, -2000, -2008 – инженерные модели, используемые NASA для оценки вероятности столкновения КА с КМ размерами от 10 мкм до 10 см, а также для определения концентрации КМ на различных орбитах и ее прогноз на будущее (Liou et al., 2002).

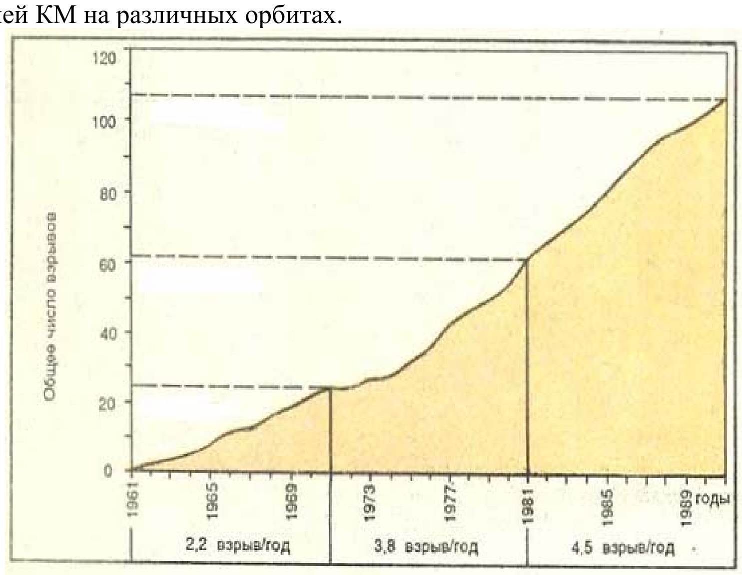
– MASTER-99, -2001, -2008 – инженерные модели, используемые ESA для оценки столкновения КА с КМ и метеороидами (Sdunnus, 2001).

– EVOLVE – модель эволюции движения КМ, используемая NASA (Krisko, 2000, 2001).

– LEGEND – модель эволюции движения КМ, в том числе и на геостационарной орбите (ГСО), используемая NASA (Liou, 2004).

– DELTA – модель эволюции движения КМ, используемая ESA (Robotic Geostationary orbit Restorer, 2003).

Цель настоящей работы заключается в проведении анализа существующего состояния техногенного загрязнения околоземного космического пространства (ОКП) и концептуальное обоснование применения ракетно-космических аппаратов и некоторых технических мероприятий для борьбы с образованием, а также сбором и утилизацией КМ на различных орбитах.



Рост числа взрывов КА (Рыхлова, 1993)

Фрагменты КМ, образовавшиеся после взрывов, могут стать одним из главных источников загрязнения. Фрагменты КМ, образовавшиеся в результате столкновений, могут порождать следующие загрязнения, что приведет к росту загрязненности в геометрической прогрессии.

Эффективных практических мер по уничтожению КМ на орбитах более 600 км (где не сказывается очищающий эффект от торможения об атмосферу) на настоящем уровне технического развития человечества не существует. Вместе с тем актуальность задачи обеспечения безопасности космических полетов в условиях техногенного загрязнения ОКП и снижения опасности для объектов на Земле при неконтролируемом вхождении космических объектов в плотные слои атмосферы и их падении на Землю стремительно растет. Поэтому в обеспечение решения этой проблемы международное сотрудничество по проблематике КМ развивается по следующим приоритетным направлениям ((http:// rnd. cnews.ru/; http:// www.anafor.ru/):

– Экологический мониторинг ОКП, включая область ГСО: наблюдение за КМ и ведение каталога объектов КМ.

– Математическое моделирование КМ и создание международных информационных систем для прогноза засоренности ОКП и ее опасности для космических полетов, а также информационного сопровождения событий опасного сближения космических объектов (КО) и их неконтролируемого входа в плотные слои атмосферы.

– Разработка способов и средств защиты КА от воздействия высокоскоростных частиц КМ.

– Разработка и внедрение мероприятий, направленных на снижение засоренности ОКП.

Эти мероприятия можно определить в два глобальных направления:

А. Уменьшение количества вновь образующегося КМ.

Предотвращение появления нового КМ заключается в проведение следующих мероприятий (UNCOPUOS, 1999; NASA, 2007):

1) Пассивации компонентов ракетного топлива и газов наддува, оставшихся на последних ступенях РН, разгонных блоках (РБ) и КА, которые завершили своё функционирование. Она заключается в стравливании этих компонентов топлива и газов наддува за борт; консервации химических источников тока; деактивации пиротехнических устройств. Данное мероприятие позволяет свести к минимуму вероятность взрыва, который может привести к образованию большого количества мелкого КМ.

2) Ограничения количества операционных элементов, (заглушки, пиротехнические устройства и т.д.) отделяемых от последних ступеней РН, РБ и КА в процессе их штатной работы.

3) Ограничения срока баллистического существования последних ступеней РН, РБ и КА 25 годами. Данное мероприятие осуществляется путём выбора орбиты или размещения на борту средств увода с целевой орбиты.

4) Увода последних ступеней РН, РБ и КА в плотные слои атмосферы Земли либо на орбиты захоронения. Для низкоорбитальных объектов орбита захоронения расположена выше 2000 км. Для геостационарных объектов – выше ГСО на 200 км.

5) Исключения столкновений крупногабаритных объектов между собой. Реализуется либо путём выбора целевой орбиты либо путём маневрирования средствами функционирующих объектов.

6) Использование космического ремонтного модуля (КРМ) для захвата и проведения ремонтных работ на внепланово вышедших из эксплуатации КА.

Все вышеперечисленные мероприятия необходимо планировать ещё на этапе проектирования ракетно-космической техники. Космические агентства США, Европы и России уже начали внедрять указанные мероприятия не только на этапе проектирования, но и на законодательном уровне. К сожалению, пока не спешат с этим другие страны мирового космического клуба.

Б. Удаление уже существующего КМ.

Существуют следующие предложения по удалению существующего КМ:

1) Использование космического мусоросборщика (КМС) для захвата КМ и перевода его на орбиту захоронения либо его управляемого сведения в плотные слои атмосферы Земли. Для маневрирования могут быть использованы различные средства:

– химические двигатели (Robotic Geostationary orbit Restorer, 2003);

– «солнечный парус»;

– аэродинамическая система;

– электродинамическая система (Dardini, 2006).

2) Использование многоразовых транспортных космических кораблей (МТКК) типа «Спейс Шаттл». Позволяет эффективно осуществить захват КМ, в том числе и вышедший досрочно с эксплуатации КА, производить мелкий его ремонт и даже доставку ценного КА на Землю. Недостатком является высокая стоимость и ограничения по орбите. Кроме того, после 2010 года эксплуатация МТКК «Спейс Шаттл» не предполагается.

3) Использование тонкостенных конструкций, при нештатном столкновении с которыми происходит разрушение КМ с последующим сгоранием части его фрагментов в атмосфере Земли (Патент 2092409 РФ, 1997). Однако, часть фрагментов разрушения останется на орбите, что приведёт к увеличению количества мелкого КМ и является не совсем приемлемо.

4) Использование лазера (Патент 2092408 РФ, 1997), с помощью которого предлагается сводить крупный КМ в плотные слои атмосферы за счёт создания реактивной силы при сублимации вещества КМ под воздействием лазерного излучения. Возможно, использование лазера как наземного базирования, так и космического. На сегодняшний день существует экспериментальный образец наземного лазера.

5) Использование солнечного концентратора (Патент 5120008 США, 1992). С его помощью предлагается сводить крупный КМ в плотные слои атмосферы за счёт создания реактивной силы при сублимации вещества КМ под воздействием концентрированного солнечного излучения.

Также проблема состоит в возращении в атмосферу Земли космических объектов. За последние 40 лет их отмечено более 16000. В течение последних 5-ти лет примерно раз в неделю происходит попадание в атмосферу объекта с площадью поперечного сечения около 1 $м^2$. Вхождение того или иного объекта в атмосферу связано не только с опасностью механического удара, но и с возможностью химического либо радиологического заражения окружающей среды.

Объект КМ, упавший на Землю (Англия) (http://news.siteua.org/**)**

Дальнейшие наши исследования будут направлены на разработку конструктивных схем РН, РБ и КА, предусматривающих не допущения образования КМ, а также аппаратов типа КРМ и КМС для сбора, ремонта или утилизации КМ.

В заключении следует отметить, что любые работы в этом направлении являются весьма актуальными даже с той точки зрения, что освоение космоса даёт огромную пользу и значительный прогресс человечеству, но дальнейшая эксплуатация нашего космоса существующими методами, без принятия указанных выше мероприятий, не позволит его дальнейшее безопасное освоение уже после 2055 года.

СПИСОК ИСПОЛЬЗОВАННОЙ ЛИТЕРАТУРЫ

http:// rnd. cnews.ru/

Liou J.- C., et al. The New NASA Orbital Debris Engineering Model ORDEM2000 // NASA TP - 2002-210780, May 2002.

Sdunnus, H., J. Bendish, H. Klinkrad, The ESA MASTER 2001 Space Debris and Meteoroid Reference Model // Proccedings of the3rd European Conference on Space Debris, ESA SP – 473, Darmstadt, Germany, October 2001.

Krisko, P. H et al. EVOLVE 4.0 User's Guide and Handbook // LMSMSS-33020, 2000.

Krisko, P. H., N. L. Johnson, J. N. Opiela EVOLVE 4.0 Orbital Debris Mitigation Studies Adv. // Space Research, 28(9) pp. 1385 – 1390, 2001.

Liou J.- C., D.T. Hall, P.H. Krisko, and J.N. Opiela, LEGEND – A Three Dimensional Leo-to-GEO Debris Evolutionary Model Adv. // Space Research, 34(5), pp. 981-986, 2004.

Robotic Geostationary orbit Restorer (ROGER) Executive Summary ESA/ESTEC Contract No. 15678/01/NL/WK, 2003.

Dardini C, T. Hanada, P.H. Krisko, Benefits and Risks of Using Electrodinamic Tethers to De-orbit Spacecraft, 2006.

Патент 2092409 РФ, МКИ B64G9/00, Способ очистки околоземного космического пространства от космических объектов и мелких частиц путём их разрушения и устройство для его осуществления, Ю.В. Корягин, В.Н. Долгих, В.И. Савин, В.П. Сенкевич, Э.Г. Семененко, №93052084/11, заяв. 16.11.1993, опубл. 10.10.1997.

Патент 2092408 РФ, МКИ B64G9/00, Космический аппарат для очитски космического пространства от мусора, А.А. Масленников, В.В. Синявский, №93050919/11, заяв. 09.11.1993, опубл. 10.10.1997.

Патент 5120008 США, МКИ B64G 1/10, B64G 1/44, F24J 2/02, F24J 2/38, Orbital Debris Processor and Method Therefor, K. Ramohall, №387583, filed Jul. 28, 1989, publ. Jim. 9, 1992.

UNCOPUOS Scientific and Technical Subcommittee // Technical Report on Space Debris, A/AC. 105/720, May 1999.

NASA Technical Standart // NASA STD-8719.14, 2007.

http://Lenta. ru/

http://news.siteua.org/

Рыхлова Л. В. Проблемы космического мусора // Земля и Вселенная. – 1993. – № 6.

http:// www.anafor.ru/

Надійшла до редколегії 12.11.10

РЕЦЕНЗІЇ

Монченко В. И. Свободноживущие циклопообразные копеподы Понто-Каспийского бассейна. – К. : Наукова думка, 2003. – 351 с.

Монография академика НАН Украины В. И. Монченко посвящена одной из наиболее распространенных групп веслоногих ракообразных – свободноживущим циклопообразным.

Исследования автора охватывают все моря Понто-Каспийского бассейна (Черное, Азовское, Каспийское, Аральское), а также и пресные воды водосборного бассейна этих морей. Наиболее полно также исследованы пресные воды Украины.

В монографии рассматриваются пути решения общих вопросов эволюции и биологии циклопообразных. Разработаны представления о регрессивной олигомеризации конечностей веслоногих раков, как основном направлении их морфологической эволюции. Излагается гипотетическая картина эволюционного формирования видов у циклопообразных, существенный момент которой – наличие двух последовательных этапов видообразования. Первый из них – образование криптического вида при становлении барьера нескрещиваемости на основе изменения одного или немногих аллелей, контролирующих в основном тот или иной фермент. Лишь вторым этапом является формирование морфологического вида с генетически сложно контролируемыми пластическими признаками. Автор предлагает разработанную гипотезу частотно-вероятностной экологической детерминированности в связи с частотами естественной встречаемости циклопов. Исследована своеобразная особенность пресноводных циклопов и их способность впадать в диапаузу на период воздействия неблагоприятных сезонных факторов. Обоснован вывод о полифакторной обусловленности действия механизмов переключения физиологических процессов с равномерного индивидуального развития на сезонное состояние покоя и обратно. Внесен существенный вклад и в проблему зоогеографии.

Установлен также видовой состав морской и пресноводной фауны циклопообразных Понто-Каспийского бассейна. Собственные и литературные данные свидетельствуют о том, что 50 видов циклопообразных являются промежуточными хозяевами 172 видов гельминтов.

В главе 1 автор подчеркивает, что для исследований был собран материал в количестве 5550 проб, переданный другими лицами – 808 проб, также использованы материалы фонда ЗИН РАН в количестве 846 проб.

Материалы на побережье Черного моря собирались в заливах Ягорлыцком, Тендровском, Новороссийском, Геленджикском в течение 1969–1974 гг., на побережье Азовского моря – с 1968 до 1980 г. в 30 пунктах. Из миксогалинных вод Азово-Черноморского бассейна было отобрано 867 проб, 137 – из разносоленых вод, из Днепровско-Бугского лимана было обработано 119 проб, из низовьев Дуная – 440 проб. По лиманам и устьям рек Азовского моря собрано 83 пробы. Были отобраны пробы в устьях рек Обиточная, Берда, Кальмиус. Из Черного и Азовского морей вместе с их лиманами и приустьевыми пространствами обработано 1386 проб.

Материалы, собранные по внутренним континентальным водам Азово-Черноморского бассейна, составляют 3782 пробы, материалы по фауне Украинских Карпат составляют 250 проб, по Крыму – 103 пробы. На Кавказе собран материал в районах: Талыш и Малый Кавказ, Карабахский, Зангезурский, Аджаро-Имеретинский, Хеттский, Арсеанский хребты, северные склоны и южные склоны Большого Кавказа. В центральной части Грузии – окрестности Коджори, Сагареджо, в Ленкоранской низменности, оз. Рица и многие другие регионы и объекты.

Глава 2 посвящена анализу серьезных недостатков номенклатурных проблем, которые накопились в процессе многолетних исследований ученых, работающих в области выявления и познания циклопообразных представителей энтомофауны.

Указанная глава, на наш взгляд, является образцом пристального многолетнего труда, посвященного уточнению и выявлению ошибочных определений и неверного номенклатурного присвоения наименования видам и подвидам, которое часто не соответствует действительности.

Для уточнения многих видов представителей циклопообразной фауны автор обнаружил огромный поток неточностей и заблуждений, причиной которых явились сложные морфологические динамические процессы, протекающие в пространстве и во времени, что приводит к выявлению желаемого за действительное. Такая высокопродуктивная работа с морфологической полиморфностью может дать шанс только выдающемуся, талантливому, тонкому аналитику-исследователю, замечательному естествоиспытателю и терпеливому специалисту, переопределить и выявить промахи предшествующих специалистов, внести ясность, уточнения, исправления и придать отдельным видам и подвидам истинную номенклатурную принадлежность и экологическое соответствие вида условиям обитания.

Здесь автор успешно использовал и находки многих других исследователей, которые внесли свой вклад в научно обоснованную номенклатуру и классификационную принадлежность представителей циклопообразных. Глава является образцом аналитико-синтетического подхода к подобным сложным и запутанным материалам, с которыми приходится часто встречаться систематикам, исследующим флору и фауну нашей многоликой планеты. Как отмечалось выше, автор задался целью переопределить и исправить целый ряд ошибочных определений как отечественных, так и зарубежных ученых, которые работали преимущественно во второй половине XIX в.

В главе 3 излагается фаунистический состав циклопообразных Понто-Каспийского бассейна, южных морей СНГ, изученность группы в Черном и Азовском морях.

Здесь приводятся данные собранных проб в Черном и Азовском морях и подробные обзорные материалы в соответствующих таблицах № 4 и № 5, а также материалы 347 обработанных проб, в которых циклопообразные обнаружены в 136 пробах.

Видовой состав циклопообразных полигалинных вод Черного моря оказался более чем в полтора раза разнообразнее, чем данные, приведенные в литературных сводках. Здесь проанализированы мезогалинные воды Азовского моря, миксогалинные воды Азово-Черноморского бассейна, эколого-фаунистические группы циклопообразных миксогалинных вод и Каспийского моря. В многочисленных таблицах излагается видовой состав, а также встречаемость и фаунистическая новизна, их систематическое положение. Интересные данные приводятся по циклопообразным Аральского моря. Эти материалы в настоящее время, когда Аральское море исчезло, имеют, безусловно, неизмеримую научную ценность как свидетели прошлого фаунистического разнообразия, хранящего в себе множество научных тайн.

Далее автор акцентирует внимание читателей на разнообразии морских циклопообразных в южных морях СНГ и других частей Мирового океана и во внутренних континентальных водоемах. Особый интерес вызывают открытые водоемы Азово-Черноморского бассейна, водоемы бассейна Каспийского моря, колодцы и родники равнинных районов. Обработан материал, собранный в восточных Карпатах и Закарпатье, а также на Крымском полуострове и на Кавказских горных массивах. Все материалы документированы 29 многоинформативными таблицами и подробным аналитическим текстом.

Глава 4 посвящается зоогеографическому анализу циклопообразных Понто-Каспийского бассейна.

Автор подчеркивает, что геологическая история Азово-Черноморского бассейна связана с историей Каспийского моря и вместе с тем отличается собственными особенностями. И теперь, когда видовой состав циклопообразных Черного и Азовского морей увеличен автором от 12 до 31 полигалинного и миксогалинного вида, не встречающегося в пресных континентальных водах, а в Каспии обнаружено с 6 до 122 таких же видов, автор совершенно верно считает возможным дать собственную первую зоогеографическую характеристику группы на основании хорологического анализа.

Далее излагаются зоогеографические комплексы циклопообразных Каспийского моря, Черного и Азовского морей, Понто-Каспийского автохтонного комплекса циклопообразных как единого понятия, зоогеографического комплекса циклопид внутренних (континентальных) водоемов.

В главе 5 решаются самые интересные и ответственные задачи, посвященные систематике циклопообразных:

- циклопообразные в системе копепод;
- система копепод;
- место циклопообразных в системе родственных таксонов сходного ранга;
- морфологические закономерности эволюции циклопообразных;

В итоге анализа огромного морфолого-эволюционного материала установлено, что у циклопообразных выявлено наличие корреляционных зависимостей между размерами тела и степенью олигомеризации таракальных конечностей. Процесс уменьшения размеров является ведущим. Олигомеризация эволюционно необратима, ее дальнейшее развитие канализировано и сама она должна рассматриваться как одна из форм ортогенетической эволюции в животном мире. Невольно приходит мысль о том, что в условиях земного гравитационного поля каждый тип животных имеет наиболее удобные для него размеры, изменения которых повлекло бы изменение и формы. Соотношение объемов, размеров и масс определяет, например, парусность пыльцы и семян растений и способы их перенесения. Известно, что если длину, высоту и ширину животного увеличить в 10 раз, то масса его изменится в 1000 раз, а поверхность в 100 раз. Понятно, что при этом должно перестроиться все тело.

Вот на такие размышления наталкивают великолепные исключительно интересные открытия, которые приводит автор в свих классических исследованиях.

Глава 6 посвящена заметкам по систематике и составу родов. Автор логично рассуждает о том, что если существует олигомеризация как основное морфоэволюционное направление в развитии группы, то вполне логично предположение об исходно 3-членистых ветвях торакальных ног у циклопообразных.

Автор раскрывает родственные отношения между свободноживущими семействами – семейство Cyclopinidae sars, 1913, семейство Oithonidae, 1852, семейство Cyclopidea claus, 1863, целый ряд подсемейств.

В главе 7 автор рассматривает криптические виды и особенности видообразования у циклопообразных. Изучаются трудно объяснимые вопросы заражения и незаражения в эксперименте циклопов одного и того же вида определенным видом гельминта или эвгленоидиды. Предлагается информативная таблица-сводка противоречивых данных о заражаемости циклопообразных гельминтами в эксперименте. Далее приводятся данные экспериментальных исследований криптических видов с использованием генетических приемов; исследование криптических видов вне условий эксперимента; основные предпосылки криптического видообразования циклопообразных. Вызывает интерес подраздел, посвященный популяционным особенностям циклопообразных и последовательность их специации.

В главе 8 освещаются проблемы симбиотических аспектов взаимодействий циклопообразных со средой. Обращается внимание на факты, что циклопы являются промежуточными хозяевами гельминтов и объектов зоофагии паразитирования для эвгленовых (euglenoidida), как хозяева паразитических грибов, как носители симфорионтных инфузорий (peritricha, sessilina, suctoria).

Глава 9 посвящена полифакторной обусловленности перехода циклопов в состояние покоя. Изменение численности биомассы пресноводного планктона отмечены осенью и весной. Однако истинной причины этого явления пока неустановленно. В связи с этим, попытка анализа причин такого явления, сопоставление фактов и привлечение новых данных могут способствовать решению этого интересного биологического свойства.

Автор считает, что наиболее широкое распространение этого явления присуще Cyclopidae.Так, например, из 950 известных видов, подвидов и форм этого семейства для 34 уже установлена способность впадать в состояние покоя. В результате собственных экспериментов автора установлено, что в большинстве случаев в активное состояние из состояния покоя возвращались особи 4 и 5 копеподитных стадий. Конкретные факторы, которые способствуют переходу циклопов в состояние покоя и возвращение в активное состояние этого процесса до настоящего времени полностью не выяснены. Автором подтверждено тормозящее влияние комнатной температуры на развитие Acanthocyclops vernalis (Fisch.). Этот факт был подтвержден наблюдениями над сезонной динамикой циклопов в пойме Днепра под Киевом. Изложенный материал документируется таблицей № 64, в которой перечислены виды и температурные пороги наличия в планктоне активных популяций ряда видов циклопов.

Одни авторы придают большое значение количественным показателям наличия кислорода, другие объясняют переход в состояние покоя увеличением солености, зависимостью от динамики светового фактора, продолжительности светового дня и др. Однако, по мнению автора монографии В. И. Монченко, биологически более оправданным является наличие способности у организмов реагировать на одновременное воздействие этих факторов. Речь идет о комплексном влиянии факторов при их взаимодействии. Состояние покоя не является, по-видимому, обязательной непосредственной спонтанной реакцией на определенные неблагоприятные внешние воздействия.

Необходимо подчеркнуть о целом ряде открытий автором, который в результате многолетних и пристальных исследований вносят в проблему полифакторной обусловленности перехода циклопов в состояние покоя много нового, оригинального.

Методологически совершенно правильно утверждение автора о необходимости системного комплексного подхода для получения наиболее обоснованных результатов. Эти исследования имеют колоссальное значение для биосферных процессов, в которых обитает человек с заботой о своем здоровье и скрытых, утаенных факторах среды, часто являющихся причиной его плохого состояния.

Таким образом, циклопообразные, насчитывающие около 1000 видов, обитающих во всех типах водоемов Земли, в донных и зарослевых биогидроценозах пресных и морских вод планеты играют разнообразную метаболическую роль в их экосистемах и часто приобретают решающее значение в сохранении устойчивости их функционирования. Вместе с тем, до настоящего времени функциональная роль копепод изучена недостаточно. В имеющейся отечественной и зарубежной литературе сведения по веслоногим ракообразным посвящены исследованиям морфологии, систематики и филогении данной группы. Они в основном содержат фауно-морфологический материал с обоснованием тех или иных таксономических систем или дополнениями к уже существующим классификациям.

В данной монографии, в отличие от указанных выше, автором рассмотрены пути решения общих вопросов эволюции и биологии циклопообразных. Им, в частности, разработаны представления о регрессивной олигомеризации конечностей веслоногих рачков как основном направлении их морфологической эволюции, которые носят несомненную научную новизну.

В монографии академика В. И. Монченко подведены итоги почти 30-летнего изучения автором циклопообразных копепод, рассмотрены пути решения общих вопросов эволюции и биологии этой систематической группы. Фаунистические исследования автора охватывают все моря Понто-Каспийского бассейна и пресные воды значительной части водосборного бассейна этих морей. Несмотря на то, что автором наиболее полно исследованы пресные воды Украины, материал монографии в большинстве глав не является региональным и рассматривает проблему в глобальном масштабе. В этом плане полностью выходит за рамки указанного региона содержание глав, посвященных морфоэволюционным основам систематики копепод, филогенетическим отношением их надвидовых таксонов, особенностям видообразования, симбиотическим аспектам их взаимодействия со средой обитания, ряда экологических проблем.

В одной из глав автором работы представлена гипотетическая картина двух последовательных этапов эволюционного образования видов у циклопообразных. В главе о симбиотических отношениях этой группы веслоногих разработана гипотеза частотно-вероятностной экологической детерминированности.

Новизной отличается материал в разделах, посвященных зоогеографии. И даже в традиционных для ракообразных направлениях исследований автором получены весомые новые результаты. Им установлен видовой состав пресноводной и морской фауны циклопообразных Понто-Каспийского бассейна, среди которого из 125 обнаруженных видов более половины впервые указаны для исследуемого региона, 55 видов являются новыми для бывшего СССР и 29 видов описаны как новые для науки. Автором выделены 5 новых родов, одно новое подсемейство, а для исследованных паразитов и зоофагов – 3 новых вида и 2 новых рода, составлен первый определитель мировой фауны.

Определенный интерес монография представляет и в практическом отношении. Материалы автора монографии и литературные данные свидетельствуют о том, что часть (50 видов) циклопообразных являются промежуточными хозяевами 172 видов гельминтов. В работе предложено ряд мероприятий, ограничивающих инвазию этих паразитов через трофические цепи. В числе одного из них рекомендуется использовать зоофагов (эвгленовые и некоторые грибы), поражающих яйца и личинки копепод. Автором впервые количественно оценена роль зоофагов в регуляции численности копепод в водоемах. Собранный автором материал может рассматриваться в качестве эталона, к которому следует стремиться при реализации природоохранных и восстановительных мероприятий.

Приведенные в работе В. И. Монченко материалы многолетних исследований, несомненно, являются актуальными, имеют большое теоретическое и практическое значение.

Книга написана хорошим литературным языком, прекрасно оформлена, мастерски выполнены рисунки, схемы и табличный материал, привлекательный, с эстетическим вкусом изготовлен переплет.

Книга рекомендуется для зоологов, паразитологов, гидробиологов, экологов, студентов вузов. Она будет полезна и для почвоведов, которые работают в области рекультивации подтопленных подработанных территорий, в результате промышленных разработок в долинах рек, специалистов санитарии и гигиены окружающей среды, а также для ученых, работающих в сфере охраны окружающей среды человека.

Настоящая фундаментальная энциклопедическая монография, посвященная свободноживущим циклопообразным копеподам Понто-Каспийского бассейна, по своему содержанию, новизне, объему материала, тщательности отработанных выводов и открытий может быть приравнена к классическому труду, который имеет огромное теоретическое и практическое значение.

А. П. Травлеев,
доктор биологических наук, профессор,
член-корреспондент НАН Украины

А. М. Сумароков,
доктор биологических наук,
главный научный сотрудник отдела энтомологии
Института зернового хозяйства НААН Украины

Кармазиненко С. П. Мікроморфологічні дослідження викопних і сучасних ґрунтів України / Відп. ред. д-р геогр. наук Ж. М. Матвіїшина. – К. : Наукова думка, 2010. – 120 с.

Сама назва монографії свідчить про широкий підхід автора до результатів мікроморфологічних досліджень ґрунтів України.

Після виходу в світ монографії Ж. М. Матвіїшиної в 1982 р. «Мікроморфологія плейстоценових ґрунтів України», монографія С. П. Кармазиненка розвиває далі ідеї свого вчителя і властиві наукові традиції мікроморфологів інституту географії НАН України.

Монографія С. П. Кармазиненка присвячена не тільки викопним, але і сучасним генетичним типам ґрунтів, що природно пов'язує минулий характер розвитку ґрунтотворних процесів з сучасними антропогенно навантаженими ґрунтами України.

В монографії виділяються три розділи і 14 підрозділів відповідної підпорядкованості, висновків та списку літератури.

В передмові автор аналізує різні підходи до оцінки місця мікроморфології ґрунтів в системі наук і, на наш погляд, правильно узагальнює думку що «Мікроморфологія ґрунтів – це і особливий метод, і особлива галузь ґрунтознавства, що належить відразу двом великим розділам: традиційному – морфології і новітньому – мікроґрунтознавству.

Розділ 1 присвячений історії розвитку і сучасному стану досліджень мікро морфології ґрунтів. Автор віддає належне мікроморфології як розділу ґрунтознавства і підкреслює пріоритетне значення наукових праць Б. Б. Полинова, В. Кубієни, Р. Брюера, J. B.Jamagne, J. B. Dalrimple, A. Bronger,L, Smolikova, T. Madeyska, К. А. Ярилової, О. І. Парфьонової, Ж. М. Матвіїшиної, Н. А. Білової, А. П. Травлєєва, В. М. Яковенко, Н. Г. Мінашиної, Т. Д. Морозової, Т. Н. Чурсіної, К. М. Фьодорова, С, О. Шоби, С. В. Зонна, М. І. Горбунова, В. О. Таргульяна, Г. В. Добровольського, М. І. Герасимової та багатьом іншим дослідникам, які внесли значний вклад в розвиток мікроморфології ґрунтів.

Автор виділяє основні завдання морфології ґрунтів (мезо-, мікро-, субмікроморфології).

Розділ 2 присвячений методикам мікроморфологічних досліджень ґрунтів. Визначаються методологічні аспекти мікроморфологічного аналізу, послідовність мікроморфологічних досліджень, пропонується таблиця загальної ієрархії компонентів мікробудови ґрунтів. Всі викладені багаточисельні матеріали підтверджуються прекрасними мікрофотографіями, які безпосередньо відповідають тому чи іншому положенню методам оцінки мікробудови окремих морфологічних ознак ґрунту. Ця клопітлива і корисна робота додає монографії краси мінерального складу ґрунтів та дисциплінує дослідника для отримання об'єктивних матеріалів при складних мікроморфологічних синтетичних дослідженнях.

На стор. 32 дається ілюстрований приклад морфологічної організації ґрунту на прикладі чорнозему типового на рівнях ґрунтового профілю і горизонтів, морфонів і мікробудови ґрунту. Додаються типи забарвлення в вигляді трикутника С. О. Захарова та найголовніші типи і види структури, типи елементарної мікробудови плейстоценових ґрунтів.

Слідуючі рисунки розкривають порядковість і форми структурних відокремлень, форми порожнин, види органічної речовини, форми оптичного орієнтування, складові мінерального скелету, види новоутворень, види намивів, типи ґрунтової мікроструктури. Всі ці показники віддзеркалюють особливості як сучасних так і плейстоценових ґрунтів. Автором відтворена карта розрізів плейстоценових відкладів і сучасних ґрунтів басейну Дніпра та території України. Фотоматеріали мікроморфологічної організації плейстоценових і сучасних ґрунтів викладені в рисунках 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29. Мікробудова викопних ґрунтів показана на рисунках 30–50 з ілюстрованими 182-ма добре виконаними фотодокументами. Рисунки 52, 53, 54 (понад 30 фотоматеріалів) присвячені мікроморфологічним ознакам будови чорноземних типових розрізів. У заключенні автор підкреслює, що вивчення мікроморфології ґрунтів не виключає застосування інших методів. Навпаки мікроморфологічний метод необхідно застосовувати у комплексі з іншими методами, що дає змогу глибше проникнути в різні складові процесу ґрунтотворення.

В розділі 3 «Мікроморфологічні дослідження ґрунтів конкретних регіонів України» розкриваються наступні особливості: зони мішаних (хвойно-широколистих) лісів, степової зони, мікроморфологія викопних ґрунтів, Кадацький, Прилуцький, Витачівський, Дофінівський палеогеографічні етапи. Заключна частина розкриває палеогеографічні етапи формування лесів і лесоподібних суглинків.

Підрозділ 3.3 присвячений мікроморфологічній характеристиці і особливостям мікробудови сучасних ґрунтів: дерново-підзолистих, сірих лісових ґрунтів лісостепової зони, чорноземних ґрунтів лісостепової та степової зон.

В цілому, викладені в монографії матеріали є дійсним внеском в розвиток ідей В. В. Докучаєва, А. П. Виноградова, Б. Б. Полинова, В. Кубієни, Г. В. Добровольського, С. В. Зонна, К. А. Ярилової, О. І. Парфьонової, В. О. Таргульяна та інших добре відомих дослідників, які виявили процеси, що відбуваються в ґрунті як підсумковому компоненті біогеоценозів. Ці процеси грандіозні за масштабами в біосфері. Монографія С. П. Кармазиненка змістовно і прекрасно ілюстрована. В книжці дається значний експериментальний матеріал. У сучасних екологів-мікроморфологів, ґрунтознавців монографія безумовно має значний інтерес.

Монографія буде корисна для природознавців, ґрунтознавців, екологів-біогеоценологів і всім тим, хто працює в галузі сучасної біосферології.

Нажаль монографія видана малим тиражем і не всі бажаючі зможуть її придбати.

Н. А. Білова,
доктор біологічних наук, професор,
науковий керівник лабораторії мікроморфології ґрунтів
Дніпропетровського національного університету ім. О. Гончара

Червона книга Дніпропетровської області (рослинний світ) / Гол. ред. А. П. Травлєєв. – Д. : ВВК Баланс-Клуб, 2010. – 500 с.

Червона книга Дніпропетровської області увінчує кропіткі, багаторічні дослідження флористів, геоботаніків і екологів декількох поколінь. Вона завершена в плані реалізації світової та національної тенденцій і програм збереження біологічного різноманіття та, зокрема, рослинного світу.

Визначальні основоположні флористичні, екологічні дослідження І. Я. Акінфієва, О. М. Бекетова, О. Л. Бельгарда, О. О. Гросгейма, М. І. Котова, Ю. М. Прокудіна знайшли подальший розвиток в роботах М. О. Альбицької, Т. Ф. Кириченко, М. А. Сидельника, А. П. Травлєєва і були логічно продовжені В. В. Тарасовим та Б. О. Барановським (основними укладачами книги), В. В. Кучеревським та іншими вченими.

Створення Червоної книги є свідченням започаткованого нового етапу розвитку діяльності широких кіл науковців різних спеціальностей і громадськості в розв'язанні актуальних проблем охорони рослинного світу Дніпропетровщини.

Червона книга спрямована на закріплення в масовій свідомості необхідності заходів зі збереження рослинного світу загалом і окремих видів рослин як неперехідних національних цінностей. Охорона генофонду дикої флори Дніпропетровщини у вигляді окремих неповторних рослинних видів, як носіїв унікальних генів, є актуальним та невідкладним завданням всіх рівнів організованості соціального життя.

Матеріальною основою створення Червоної книги була природна флора Дніпропетровщини та створений на кафедрі геоботаніки, екології, ґрунтознавства Дніпропетровського національного університету ім. О. Гончара науковий гербарій, об'ємом 100 тис. аркушів, який включено до Міжнародної організації гербаріїв і зберігає неповторні збори флори Дніпропетровщини, започатковані І. Я. Акінфієвим, О. О. Гросгеймом, О. Л. Бельгардом, Ю. М. Прокудіним та іншими вченими.

В Червоній книзі Дніпропетровської області описано 451 вид рідкісних і зникаючих видів, в тому числі 16 з яких занесено до Світової Червоної книги, 27 видів – до Європейського червоного списку, 82 види – до Червоної книги України. На території Дніпропетровщини збереглися 80 видів, що зникли з території СНГ і 83 види, які крім Дніпропетровської області не зустрічаються більше ніде. Занесення до Червоної книги видів є результатом критичного огляду попередніх списків рідкісних та зникаючих видів області, вивчення літературних джерел та гербарних зразків.

Такий системний підхід до складання видового списку забезпечив об'єктивність, репрезентативність та достовірність опублікованих матеріалів, які безсумнівно визначають високий рівень науковості видання. Опис виду, наведення латинської, української та російської назви таксонів за останнім виданням номенклатури видів рослин є уніфікованими з останніми (1996, 2009) виданнями Червоної книги України та унеможливлює плутанину, покращує сприйняття наукової інформації. В описах усіх видів виділяються природоохоронний статус, наукове та практичне значення, біоекологічна характеристика, ареал, чисельність виду та причини зміни, стан популяцій, заходи охорони. Цілком доречним є посилання на місце того чи іншого виду в Червоній книзі України, Європейському та Світовому Червоних списках. Місця знаходження видів на території області подаються за літературними даними, гербарними зборами, фотографіями з відповідною хронологією, що засвідчує необхідність збереження рослин, популяцій та є вихідною інформацією для моніторингу стану фітобіоти Дніпропетровщини.

Структурованість Червоної книги Дніпропетровської області дозволяє провести певні паралелі та порівняння з Червоною книгою України, щодо видового складу провідних родин покритонасінних рослин флори України.

Порівняльний аналіз провідних родин флори України та Дніпропетровської області виявив (табл. 1) сутнісну різницю у відносному числі видів, що охороняються, за винятком родини Brassicaceae. Вагомим доказом антропогенної трансформації флори Дніпропетровщини є значно вищий, порівняно з флорою України, відсоток видів усіх родин, які потребують охорони.

Достатньо контрастними є види родин Scrophulariaceae, з яких у флорі України охороняється тільки 2,92 %, а у флорі Дніпропетровщини – 27,87; Rosaceae – у флорі України – 3,11, а у флорі Дніпропетровщини – 35,21 %, Ranunculaceae відповідно 17,39 % і 43,75 %, Asteraceae – 7,3% і 20,83 %. Найбільш вразливими у флорі України є родини Ranunculaceae (17,39 %), Fabaceae (15,45 %), Poaceae (14,41 %), а у флорі Дніпропетровської області Ranunculaceae (43,75 %), Rosaceae (35,21 %), Fabaceae (27,68 %), Scrophulariaceae (27,87 %). За найменшим абсолютним числом видів, які охороняються у флорі України є родини Scrophulariaceae (5 видів), Rosaceae (9 видів), а у флорі Дніпропетровщини Apiaceae (9 видів), Brassicaceae (10 видів), Lamiaceae (11 видів). Характерним є те, що абсолютні числа видів, які охороняються, однакові у родини Caryophyllaceae (21 вид) як у флорі України, так і у флорі Дніпропетровської області, близькими є показники родини Ranunculaceae – у флорі України охороняється 24 види, в Дніпропетровській області – 21 вид. Такий формалізований підхід підкріплений багатьма червонокнижними видами, що є спільними для обох флор.

Таблиця 1

Порівняльний таксономічний аналіз флор України та Дніпропетровської області за видами, що потребують охорони

№	Родина	Флора України			Флора Дніпропетровської області		
		всього видів, абс. число	видів, які охороняються		всього видів, абс. число	видів, які охороняються	
			абс. число	%		абс. число	%
1	Asteraceae	706	52	7,37	240	50	20,83
2	Poaceae	333	48	14,41	139	23	16,55
3	Fabaceae	330	51	15,45	112	31	27,68
4	Rosaceae	289	9	3,11	71	25	35,21
5	Brassicaceae	229	30	13,10	94	10	10,64
6	Caryophyllaceae	210	21	10,00	98	21	21,43
7	Scrophulariaceae	171	5	2,92	61	17	27,87
8	Lamiaceae	170	13	7,65	76	11	14,47
9	Apiaceae	156	15	9,62	57	9	15,79
10	Ranunculaceae	138	24	17,39	48	21	43,75

Червона книга складена так, що дозволяє достатньо широко біоекологічно характеризувати види, що охороняються, узагальнювати та співставляти різні характеристики. Особливо плідним є використання системи екоморф О. Л. Бельгарда (1950), що відкриває можливості прогнозування стану та розвитку рослинних видів на фоні екологічних умов.

Така деталізація дає можливість оцінити здатність існування та відновлення рослин, популяцій в певних екологічних умовах, визначаючи багатоаспектність використання Червоної книги Дніпропетровської області науковцями біологами, екологами, вчителями, дослідниками природи, екологічною громадськістю.

Взявши до уваги, що кожний біологічний вид може займати різні положення в системі екоморф О. Л. Бельгарда ми проаналізували з таких позицій ряд провідних родин покритонасінних рослин Червоної книги Дніпропетровської області, виявивши різні екоморфічні спектри та ємності у межах тих чи інших екоморф. Попередній екоморфічний аналіз червонокнижних видів Дніпропетровської області показав, що більшість їх належить до такого клімаморфічного класу як гемікриптофіти, бруньки відновлення яких знаходяться неглибоко під землею та які здатні модифікувати життєдіяльність, існування на фоні аномальних умов клімату.

Червона книга Дніпропетровської області загалом відкриває широкі можливості деталізації та узагальнень біоекологічного характеру, щодо занесених до неї видів. Абстрагуючись від перехідних форм деяких екоморф і ценоморф (табл. 2, 3) ми проаналізували в якості таких прикладів провідні родини та виявили їхні специфічні особливості щодо насичення тими чи іншими екоморфами.

Так, у гігроморфічному відношенні найбільше число ксерофітів включають родини Fabaceae, Rosaceae. Найбільше число мезофітів включають родини Asteraceae, Caryophyllaceae, Scrophulariaceae, Ranunculaceae. Серед трофоморф у всіх родинах переважають мезотрофи. Серед ценоморф (табл. 3) в усіх родинах переважають степанти, крім родин Scrophulariaceae і Ranunculaceae, де загальним є більше число сільвантів.

Група палюдантів представлена невеликим числом видів, а група рудерантів – дуже обмеженим. Гігро-, трофо-, ценоморфічні спектри родин за співвідношенням форм є специфічними. Все це потребує поглибленого аналізу. В такому підході інформативність Червоної книги Дніпропетровської області відзначається високою ємністю та може слугувати основою подальшої поглибленої розробки.

Приймаючи до уваги загальну тенденцію підсилення синантропізації флори, ми звернули увагу на те, що до Червону книгу Дніпропетровської області занесено такі синантропні види (за В. В. Протопоповою, 1991) з родини Rosaceae, як Geum aleppicum Jacq., ксерофіт, бур’яновий вид, Potentilla orientalis Juz., ксерофіт, бур’яновий вид, Potentilla thyrsiflora Huels. et Zimmeter – ксеромезофіт, бур’яновий вид, Sanguisorba officinalis L. – мезофіт, кормовий вид. З родини Asteraceae – Artemisia pontica L. – ксеромезофіт, степант, кормовий вид, Gnaphalium uliginosum L. – пратант, лікарський і бур'яновий вид, Phalacrachena inuloides Iljin. – пратант, мезофіт, бур'яновий вид, з родини Lamiaceae – Lamium album L. – сільвант, мезофіт, лікарський, технічний вид, Salvia austriaca Jacg. – степант, ксеромезофіт, декоративний вид, з родини Boraginaceae – Symphytum tauricum Willd. – сільвант, мезофіт, з родини Scrophulariaceae – Linaria biebersteinii Bess. – степант, мезоксерофіт, бур'яновий вид, Linaria macroura Bieb. – степант, мезоксерофіт, Melampyrum arvense L. – степант, мезофіт, отруйний вид.

Таблиця 2

Гігроморфічність і трофоморфічність видів Червоної книги Дніпропетровської області

№	Родини	Число видів	Кількість гігроморф			Кількість трофоморф		
			Ks	Ms	Hg	OgTr	MsTr	Mg
1	Asteraceae	50	19	24	7	6	34	10
2	Poaceae	23	9	7	7	7	10	6
3	Fabaceae	31	18	11	2	6	18	7
4	Rosaceae	25	13	11	1	2	19	4
5	Brassicaceae	10	2	5	3	4	5	1
6	Caryophyllaceae	21	6	11	4	9	11	1
7	Scrophulariaceae	17	2	12	3	1	12	4
8	Lamiaceae	11	5	5	1	1	6	3
9	Apiaceae	9	1	6	2	1	5	3
10	Ranunculaceae	21	6	13	2	3	11	7

Наведені синантропні види та бур'яни логічно привертають увагу до створення відповідної Червоної книги, тому що такі бур'янові види, як Agrosthema githago L., Avena fatua L. та інші майже зникли з рослинного покриву, який у степу має сутнісну різницю в площах, яку займає фрагментарно дика флора та культурна рослинність разом з бур'янами.

Таблиця 3

Ценоморфічність видів Червоної книги Дніпропетровської області

№	Родини	Число видів	Кількість ценоморф				
			St	Pr	Sil	Pal	Ru
1	Asteraceae	50	18	15	14	3	–
2	Poaceae	23	12	1	7	1	–
3	Fabaceae	31	22	2	6	1	–
4	Rosaceae	25	12	3	8	–	2
5	Brassicaceae	10	5	2	1	2	–
6	Caryophyllaceae	21	11	1	7	2	–
7	Scrophulariaceae	17	2	5	9	1	–
8	Lamiaceae	11	3	4	4	–	–
9	Apiaceae	9	2	3	3	1	–
10	Ranunculaceae	21	4	7	8	2	–

Створена Червона книга Дніпропетровської області містить розв'язання невідкладної, актуальної задачі інвентаризації рослинних видів, які потребують заходів збереження, охорони та розмноження. Фундаментальність цієї Книги, створеної на основі зусиль багатьох науковців, потребує її подальшої розробки в напрямку уточнення та поповнення видового складу, поглибленого бачення особливостей видового поліморфізму та генетичної гетерогенності рослинних популяцій на основі вчення М. І. Вавілова про біологічний вид, залучення і виокремлення в її складі певних флористичних і екологічних груп.

В. І. Шанда
професор, кафедра ботаніки та екології
Криворізького педагогічного університету

Е. О. Євтушенко
доцент, кафедра ботаніки та екології
Криворізького педагогічного університету

ДО УВАГИ АВТОРІВ !

При оформленні статті до надсилання в редакцію просимо дотримуватися таких правил:

1. Слід надіслати на адресу редакційної колегії два екземпляри статті і дискету з текстом, таблицями та ілюстраціями.

Обсяг статті – не більше 10 сторінок машинопису (одна сторінка у форматі журналу містить до 4500 знаків, включаючи пропуски).

Обсяг ілюстрацій і таблиць не повинен перевищувати 30 % обсягу статті.

2. Усі текстові матеріали роздрукувати через 1,5 інтервала, залишаючи з кожного краю сторінки відступи 2 см, шрифт – Times New Roman 12 пунктів, абзацний відступ – 0,8 см. При наборі статті необхідно розрізняти дефіс і тире, а також застосовувати поліграфічні «ялинки». Між ініціалами та прізвищем обов'язково залишати пропуск. Текстові матеріали повинні бути підготовлені в редакторі MS Word 97, 2000, XP як текст у форматі RTF (*.rtf) або документ Word (*.doc). Математичні формули і рівняння готуйте в редакторі рівнянь Microsoft Equation 3.0, а хімічні – у редакторі ISIS Draw v. 2.4.

3. Використовуйте одиниці Міжнародної системи вимірювань.

4. ***Назва статті*** повинна коротко інформувати про її зміст і містити не більше 13 слів. Більш довші назви скорочуються у процесі редагування. Назву статті подати трьома мовами – українською, російською та англійською.

5. ***Наявність УДК*** обов'язкова.

6. ***Анотація*** подається трьома мовами – українською, російською, англійською і повинна коротко описувати результати і головні висновки проведених досліджень.

7. ***Ключові слова*** можна брати з назви статті. Подаються українською, російською та англійською мовами.

8. ***Адресу і назву організації***, у якій виконувалися дослідження, подати українською, російською та англійською мовами, а також указати e-mail, телефон для оперативного зв'язку з автором.

Укажіть повне ім'я та по батькові кожного автора публікації українською, російською, англійською мовами.

9. Стаття повинна містити такі розділи: Вступ; Матеріали та методи досліджень; Результати та їх обговорення; Висновки; Список використаної літератури.

10. ***Посилання*** на літературні джерела слід подавати в напівкруглих дужках із зазначенням прізвища цитованого автора (або назви джерела, якщо авторів більш ніж три) та року видання.

11. ***Подяки*** подаються наприкінці статті перед списком використаної літератури.

12. ***Список використаної літератури***. Слід ретельно звірити відповідність літературних джерел у тексті та у списку. Перевірте правильність усіх назв періодичних видань.

Слід наводити прізвище редактора та місце і дату проведення при цитуванні матеріалів симпозіумів і конференцій, прізвище відповідального редактора – при цитуванні видання колективу авторів.

13. ***Таблиці*** повинні бути пронумеровані відповідно до змісту статті. Дати назву до кожної таблиці. Статистична та інша деталізація наводяться під таблицею. Табличні матеріали підготувати у табличному редакторі Word 97, 2000, XP.

14. ***Рисунки*** нумерують у порядку їх обговорення в тексті. Унизу рисунка указати його назву. Рисунки до статті повинні мати копію на дискеті. Діаграми та графіки слід виконувати у пакетах Excel, Statistica, схеми – у пакеті Visio 2000 та зберігати у форматах цих програм окремими файлами (наприклад, petrov_ris1). Найкращими для сканованих зображень є формати файлів BMP, JPEG, EMF. Усі елементи тексту у зображеннях (графіках, діаграмах, схемах), якщо це можливо, повинні мати гарнітуру Times New Roman або Times New Roman Cyr (в окремих випадках Courier). Кожне зображення зберігайте в окремому об'єкті. Зображення після сканування при роздрукуванні повинно бути чітким, не гіршим за чіткість основного тексту.

15. При поверненні статті на доопрацювання автор зобов'язаний урахувати всі зауваження редактора і надіслати виправлені та передруковані матеріали на адресу редакційної колегії в указаний термін. Статті, повернуті після доопрацювання пізніше ніж через 3 місяці, розглядаються як нові надходження.

Подані матеріали не повертаються. Редакція зберігає за собою право виправляти та скорочувати текст.

Відповідальність за зміст поданих матеріалів несуть автори.

Рукописи, оформлені без дотримання наведених вище правил, прийматися не будуть.

TO AUTHORS' ATTENTION

The colleague of editors invite scientists, specialists who study all the spectrum of ecological problems that have to do with soils science for the cooperation.

The journal «Ecology and Noospherology» takes articles in the Ukrainian, the Russian and the English languages.

An article mustn't exceed 10 pages, including tables and pictures. Illustrations and tables together mustn't exceed 30 % of the whole volume of the article.

Selection of materials and a previous review: materials for publication should be sent to the address of the colleague of editors (it is given on the second page of each edition). Two copies of materials, a diskette with a text, materials of tables and illustrations should be sent. In addition on the diskette tables and illustrations should be located in separate files. Also a copy of the article should be sent to the e-mail: bnaitap@a-teleport.com

Working at the revision an author should take into account all the notes, retype and send all the materials to the address of the colleague of editors up to the date, noted by an editor. Articles that come after the revision later than in 3 months will be considered as new ones.

Preparation of materials: all the materials (text, references, signatures to pictures etc.) are given in 1,5 intervals. From each edge of the page 2 cm. should be left, shrift – Times New Roman Cyr 12 points,

Notes: notes in the text are not permitted.

Units: use units of measuring of International System SI.

Name of the article: name of the article should be given in three languages – Ukrainian, Russian and English. It should inform about the contest of the article briefly – maximum 13 words. Larger names will be shortened while editing.

Address and name of organization: indicate the address and the name of the organization where research was conducted (in Ukrainian, Russian and English), e-mail, fax and other information that can make the communication with the author easier.

Summary and key words: should be given in three languages – Ukrainian, Russian and English. Summary should briefly describe conducted researches, including aims, methods, results and main conclusions.

References of used literature: Check every reference in the text of the article with the list of used literature. All the names of periodicals should be checked thoroughly. The list of literature should be given without a numeration. Only the author's surname and the year of edition should be mentioned in the reference of used literature in the text of the article.

Tables: every table is prepared on a separate sheet of paper. Tables should be numerated according to their mentioning in the text. Give a brief name at the top of each table. Statistical and other detailed information is given as a note below. Don't double the contest of tables with illustrations. Among all the other equal characteristics illustrations (graphics) are preferable. Don't mention the information that wasn't discussed in the text of the article.

Illustrations: every copy of the article should contain one copy of illustrations. Number illustrations according to their order in the text. Symbols and marks should be readable. Don't use big points of shrifts and styles of decorating that give very thin elements of letters. Point at the top of the back of the illustration its number and the name of the article.

Formats of files on the diskette: texts should be prepared in the text editor MS Word 97. Don't hyphen words. Formulas and equations should be prepared in inbuilt editors of equations and should be saved as separate files (Windows metafile, *.wmf).

Illustrations should have two copies on the diskette. Formats of files Tiff- 4.0 or 5.0 (*.tif). Paint (*.bmp), Photoshop (*.psd) are most suitable. The final form of illustrations should be minimum 250-300 points per inch. Using of specific programs (statistical packets, programs of visualization etc.) for saving graphics are not permitted.

Sent materials are not returned back.

Authors take the responsibility for the contest of the materials.