DR. SCI. VALERIY K. TOKHTAR’

Director of the Botanical Garden, Belgorod State University, Belgorod

Study Of Biodiversity In Europe: Perspective Directions, Innovative Approaches And Methods Of Researches
Some facts about biodiversity

1. Biodiversity (or biological diversity) is a collective term meaning: the totality and variety of life on Earth. Biodiversity includes genetic diversity within species; the variety among species; and the range of ecosystems within which life exists and interacts.

2. According to the United Nations Environment Programme's 1995 Global Biodiversity Assessment (GBA), species extinction since the year 1600 has occurred at 50 to 100 times the natural rate, and is expected to accelerate to between 1,000 and 10,000 times the natural rate by 2020.

3. At least 784 species have become extinct since the year 1500, according to the 2004 Red List of Threatened Species published by the World Conservation Union. The majority of documented extinctions have been to terrestrial species (582), followed by freshwater species (226) and marine species (15).

4. Every minute 20 hectares of the fertile grounds turn in desert as a result of anthropogenous impact in the world. Therefore about 7 % of ground fund of a planet occupy anthropogenous deserts. That is a real treat to biodiversity.
The most problem of different regions are allocated on a map by multi-coloured circles, according to a problem:

brown - forest fires; light green – decrease in productivity; dark blue - lack of fresh water; green - rising of sea level; violet - decrease in efficiency of ocean; dark brown - droughts; blue - thawing of glaciers; dark green - tropical hurricanes; red - especially sharp rise in temperature
The modern basic threats to a biodiversity in Europe are:

1. Global climate changes

2. The microclimatic changes caused by direct anthropogenous influence of European industrial enterprises on a regional environment

3. Large-scale drift and alien plant species migrations from different parts and directions of Europe and Asia
It leads to:

1. Habitat loss, including natural reserves territories,

2. To disappearance of rare, endangered plant species,

3. Unifications, simplification and vulgarizations of flora and vegetation, fragmentation ecosystems, modification by alien species tolerant to anthropogenous impact

To prevent these consequences the assessment and prognosis of vegetative cover changes in response to anthropogenous impact has to be done.

It can be reached by creation of a reliable model which describes relationships of plant species and environmental factors.
To prevent these consequences the assessment and prognosis of vegetative cover changes formation in response to anthropogenous impact has to be done.

The most difficult problems for monitoring and prognosis of plant biodiversity are:

1. Assessment of a local biodiversity state at different regions,
2. Creation of a reliable prognosis and plant cover changes models describing their reactions to anthropogenous impact

Traditional approaches and methods assessing biodiversity have a descriptive character.

They are not suitable for modern requirements which usually take into consideration many factors, their interactions and possible future plant cover changes caused by climatic or environmental factors.

Species richness, Shannon's diversity index, Berger-Parker index, Gini index, Renyi entropy, index Simpson's diversity, Alpha, Beta, Gamma diversity etc.
Traditional assessment of *taxonomic biodiversity (species richness)* – spectrum of leading families in floras

<table>
<thead>
<tr>
<th>Families</th>
<th>Regional flora</th>
<th>Local flora</th>
<th>Elements of local floras</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stable element of flora</td>
<td>Apophytes</td>
<td>Hemiapophytes</td>
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<tr>
<td>Fabaceae</td>
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<td>Caryophyllaceae</td>
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<td>7</td>
<td>7-8</td>
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*Figure 21.3(2)*

- **Order**: Rosales (roses and their allies) ±18,000 species
- **Family**: Rosaceae ±3,500 species
- **Genus**: *Rosa* ±500 species
- **Species**: *Rosa gallica* Moss rose
Assessment of a local biodiversity state and forming of a reliable prognosis for plant biodiversity development can be reached by creation of a model which describes relationships of plant species and environmental factors.

For the goals new methods and the most powerful package of statistic programs to analyze enormous quantity of data are necessary.

_The approaches allow us to make a visualization of any biodiversity units interrelations_

Visualization give an opportunity:

1. To establish interrelations and exact statistical distances among units of a biodiversity (floras, vegetation types etc.)

2. To reveal ordination axes, gradients, factors along which units of a biodiversity are distributed.

In this case creation of a plant cover changes prognosis in response to influence of any factors is possible.
The basic steps for creation of algorithm to make a vegetative cover changes prognosis in response to an anthropogenous impact:

1. Inventarization of species and analysis of flora or types of vegetation of concrete territories (any characteristics of flora and vegetation can be used by researchers).
2. **Visualization** of interrelations of floras or types of vegetation by means of multivariate statistics methods: the factor, discriminant analysis, the canonical correspondence correlations analysis, etc.
3. Revealing of the statistical distances among floras within multivariate space,
4. Determination of the equations by which various types of anthropogenously transformed and natural floras are connected,

The data were processed by means of modern computer programs **Microsoft Excel XP, Statistica 4.7, Statistica 6.0, Canoco for Windows 4.02, CanoDraw 3.1., CanoPost 1.0.**
The main tasks of our study were:

1. To assess the changes in floras caused by an anthropogenous impact
2. To reveal the main factors impacting biodiversity
3. To determine the regularities of floras’ distribution along main factors or gradients
4. To create a reliable model of plant cover development describing its changes caused by an external anthropogenous influence

The main goal of the study was to determinate the statistic interrelations among different floras to create reliable models of plant cover formation in response to intensification of anthropogenous impact
The floristic species lists were studied at different anthropogenously transformed territories of Europe along wide latitudinal gradient: Great Britain (Black Country Region), Germany (Ruhr land), Poland (Upper Silesia), Ukraine and Russia.
Some of the Ecotopes Studied
“Consolidation” coal mining, Gelzenkirchen, Germany
Ecotopes studied

“Duisburg-North” landscape park, Duisburg, Germany
«Reichwalde» mining, Lausitz, Germany, Rurhland
Ash dump of the Kurahov hydroelectric power station (Ukraine, Donetsk Reg.)
Old ash dump, Lugansk region, Ukraine
New ash dump, Lugansk Reg., Ukraine
Correlation matrix created on the basis of the Zhakkar’s coefficients. It reflects similarity among floras in anthropogenously transformed floras

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FACTOR ANALYSIS
Plant cover units of different anthropogenous ecotopes of Europe in factor space
Distribution of anthropogenous floras forming in Europe within multidimensional space of third factors
Dynamics of floras relationships forming under the anthropogenous conditions in factor space: historical floras (upper part) and modern floras (below)
CLASSIFICATION OF PLANT COVER UNITS
BY FACTOR ANALYSIS
Senecio inaequidens is an adventitious plant in wool introduced to Europe from South Africa. Five primary centers of dispersal (sites having wool processing industry) have been reported: Mazamet (southern France), Calais, Verona, Liège and Bremen (cf. Werner et al. 1991). Its first occurrence in Germany was detected at an area near a wool factory in Hannover-Döhren (Brennenstuhl 1995), and a little later it was found at the overseas port of Bremen (specimen 1896, Bremer Überseemuseum; Kühbier 1977, 1996). First occurrences in other countries were 1922 in Belgium, 1928 in Scotland, 1935 in France and 1947 in Italy (EPPO 2006). In Denmark S. inaequidens was registered first in 1988 (Skovgaard 1993), and in 1995 it was found on railway tracks in Oslo.

First record of Lactuca saligna L. in Frankfurt-on-Main

**INVASIVE SPECIES IN THE MIDDLE E (GERMANY)**

Epilobium brachycarpum C. Presl widespread in North America, where it is a resident of varied open and woodland habitats.
The most powerful and recent invasive *Oenothera fallax* species in Germany (Duisburg) has a hybrid nature and much more invasive potential than its parental species.
Cenchrus longispinus (Hack.) Fernald – hedgehog-grass

Ambrosia artemisiifolia L.

INVASIVE SPECIES IN STEPPE ZONE MIGRATING TO THE WEST EUROPE

The threat for plant cover of the West Europe

STEPPE AND ASIAN SPECIES INVADING THE EUROPE

Artemisia annua L.
in Germany
(Dietmar Brandes data)

Bromus tectorum L.
By means of multidimensional statistics methods it has been determined that adventive fractions of technogenous ecotope floras form in a factor space three separate groups which are formed in: non-toxic primary and secondary technogenous ecotopes; toxic secondary ecotopes (by-product coke industry, chemical, metallurgical works); toxic primary ecotopes (ash-, slag and sludge dumps, ferromanganese dumps, zirconium quarries).

Spontaneous separation of all migrating species into various groups in factor space is explained by the fact that they are colonizing technogenous ecotopes of different extent of anthropogenic transformation and they have different anthropogenous tolerance.
## Distribution of loadings among adventive (alien) elements of floras at different anthropogenous habitats

<table>
<thead>
<tr>
<th>Adventive elements of floras at different anthropogenous habitats</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
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<tr>
<td>Slag dumps</td>
<td>-0.58829</td>
<td>-0.217544</td>
<td>0.496234</td>
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<tr>
<td>Territories of by-product coke-industry</td>
<td>-0.12490</td>
<td>-0.824997</td>
<td>0.121570</td>
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<tr>
<td>Sludge dumps of metallurgical factories</td>
<td>-0.15950</td>
<td>-0.063630</td>
<td>0.797347</td>
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<tr>
<td>Ferro-manganese dumps</td>
<td>-0.43538</td>
<td>0.044323</td>
<td>0.666956</td>
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<tr>
<td>Ash dumps</td>
<td>-0.73621</td>
<td>-0.086244</td>
<td>0.496343</td>
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<tr>
<td>Black coal dumps</td>
<td>-0.856646</td>
<td>0.05967</td>
<td>-0.232787</td>
</tr>
<tr>
<td>Territories of metallurgical factories</td>
<td>0.11117</td>
<td>-0.860923</td>
<td>-0.197862</td>
</tr>
<tr>
<td>Salt mines</td>
<td>-0.97669</td>
<td>-0.002698</td>
<td>-0.110461</td>
</tr>
<tr>
<td>Sandy quarries</td>
<td>-0.96910</td>
<td>-0.057678</td>
<td>-0.189993</td>
</tr>
<tr>
<td>Dolomite dumps</td>
<td>-0.97474</td>
<td>-0.015464</td>
<td>-0.188029</td>
</tr>
<tr>
<td>Calcareous quarries</td>
<td>-0.94990</td>
<td>0.094894</td>
<td>-0.071069</td>
</tr>
</tbody>
</table>
Ordination diagram of interaction between the factors which are present in technogenous ecotopes: Ph – acidity of environment, Na – natrium content, Hu – organic substances content, Mg – magnesium content, Ca – calcium content. №№ 1-16 – technogenous ecotopes, • – centroids of the species ecological niches.

The factors of ecological niches differentiation of plant species may also be climate factors or any others.
CLASSIFICATION OF PLANT COVER UNITS
FROM DIFFERENT ECOSYSTEM BY DISCRIMINANT ANALYSIS
Any different plant cover characteristics may be brought into the blue points in scatter-plot
MODEL
OF PLANT COVER UNITS DEVELOPMENT
BASED ON STATISTICAL VIZUALIZATION METHODS IN ANTHROPOGENOUS ECOTOPES
MODEL
OF PLANT COVER UNITS
DEVELOPMENT
BASED ON STATISTICAL
VIZUALIZATION METHODS
IN ANTHROPOGENOUS
ECOTOPES
MODEL
OF PLANT COVER UNITS DEVELOPMENT
BASED ON STATISTICAL VISUALIZATION METHODS IN ANTHROPOGENOUS ECOTOPES
Created models use the hemeroby coefficients which reflect anthropogenous impact on plants.
Conclusions

1. Proposed statistical methods may give us new possibilities to reach very important goals modeling reactions of plant ecosystems to any affected factors,

2. We can create an assessment and the reliable prognosis of plant cover development in response to any influence due to the model,

3. It is possible to use any characteristics of plants and environment to find the most suitable model which successfully describe all the data. The study give us an opportunity to ordinate plant characteristics along many different environmental gradients,

4. All the statistic methods allow us to reveal internal regularities in the plant ecosystems organization, to determine trends of their dynamics, to understand what plant groups can be able to form a modified neoecosystem prototype adopted to a new environment,

5. The main factors affected to plant cover can be revealed,

6. A simple analysis of structure of floras give us an opportunity to determine a degree of their anthropogenous transformation
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Some of my collaborators

Prof. Rudiger Wittig
J.W. Goethe University,
Francfurt-on-Main, Germany

Prof. Oliver Tackenberg
J.W. Goethe University,
Francfurt-on-Main, Germany

Andreas König
Francfurt-on-Main,
Germany
THANK YOU VERY MUCH FOR YOUR ATTENTION!

Valerie K. TOKHTAR’

Director of the Botanical Garden, Belgorod State University,
Belgorod

tokhtar@bsu.edu.ru

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