Using Geodatabase for Ecological Networks in the Czech Republic

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Abstract

The theory of ecological networks (bio-centers, bio-corridors) and its practical realization give a powerful conceptual tool for nature protection, specifically for long-term requirements in spatial and functional layout of present landscape. With the support of ecological networks, we are able to specify the spatial requirements for nature and landscape protection not only in the environmentally unimpaired, wild parts of landscape but also in the "nature-free" parts of cultural landscape, thus focusing on the progressive improvement of the landscape bio-diversity. Concept, methods, planning, and realization of ecological networks within the Czech Republic reflect the most up-to-date ways of landscape planning in various European countries and certain U.S. states. Vast quantity of spatial data and the necessity to follow many spatial rules (relations between network elements, network density, area of bio-centers, length of bio-corridors) call for efficient utilization of GIS technology tools.

Ecological networks in the Czech Republic

Ecological networks represent relatively new tool used for nature conservation and protection in the Czech Republic since the beginning of 90s. Unlike usual (rooted) ways of nature conservation they do not deal only with existing ecologically valuable landscape parts but they try to recover also other grounds and bring them to a "natural state". Ecological network consists of areas with natural (indigenous) or nature close structure of flora nad fauna that are large enough and reasonably arranged and interconnected in the landscape so that they can satisfy the elemental purpose - maintenance of the natural gene pool of the landscape. Ecological networks are composed of **biocentres and biocorridors**. Biocentre allows permanent existence of natural or nature close flora and fauna. Biocorridor allows migration of flora and fauna among biocentres.

At present time there exist several thousand documents in the Czech Republic containing delimitations of ecological networks in various levels of detail. These documents specify about 50.000 biocentres and 85.000 biocorridors on the territory of the Czech Republic. Experience from the last years shows clearly that actual ways of storage, update, and distribution of data are absolutely insufficient, and that the level of discrepancies in delimitation of the ecological network parts (biocentres and biocorridors) is growing in many localities of the Czech Republic. To a certain extent we can blame the ambiguous legal and methodological support in drafting the ecological networks, but the main reason seems to be a large variability in creation and distribution of ecological network data.

Knowing the detailed state of ecological network documentation in the Czech Republic we can say that the main reasons of factual and formal discrepancies in delimitation of ecological networks are:

- large amount of space oriented and interconnected data (biocentres and biocorridors are parts of space and functionally specified system)
- numerous processes that are used for creation and updating of ecological networks data
- numerous bodies of state administration system at all levels participating in the delimitation and assessment of ecological networks
- so far not unified ways of ecological networks data storage, update, and distribution

We believe that the most appropriate solution of ecological networks data integration would be

creation of an information system realized on the basis of object-oriented GIS technology together with unambiguous and binding definition of principles for its organization and run (data inputs, updates, user access etc.). There has been already created a data model for this information system enabling very accurate description of the actual state of its parts space layout (biocentres and biocorridors). This model further creates, keeping in mind the conceptual nature of ecological networks, environment for continuous support of accurate and correct delimitation, fine-tuning, and updates. Data model content "describes" the parts of ecological networks in the following data sets:

- Actually decisive delimitation of the ecological network parts (biocentres and biocorridors) taken from the source (original) documentations for individual localities. This kind of information is a part of so called **source data set** in the proposed information system.
- Seamless interpretation of actually decisive delimitation of ecological networks with a unified classification in an united map of the territory for which the information system is built. This interpretation of ecological networks still preserves possible factual mistakes in delimitations or locations because the actual valid delimitation is the first priority in this case. This kind of information is a part of so called **reference data set** in the proposed information system.
- Concept of the factually and formally accurate seamless interpretation of the ecological network parts in an environment of unified comparative base that is built on their actually decisive delimitation, continuously updated in accordance with the methodological rules for ecological networks delimitation. This kind of information is a part of so called **conceptual data set** in the proposed information system.

Data model

The previous basic specification of data sets suggests that one of the most important aims of the information system is the permanent support for the process of convergency of the actual decisive delimitation to the conceptual, formally and factually accurate, ecological network delimitation (gradual convergency of the reference and conceptual data sets). This state may be achieved by the means of updated data sets maintenance.

Existing data on ecological networks in the Czech Republic is characterised by a large variety in data formats, data structures, details, dates of origin, accuracy, and legal validity. Data on ecological networks is spatially overlapping and neither biocentres nor biocorridors create homogeneous map layers. Taking into account the data amount and its heterogeneity the data model does not focus on creation of data structures for complete transfer of all this information but rather on providing a platform for its integration using the spatial context. Data model allows qualitative comparisons of ecological networks data by various criteria which is particularly handy in areas of data overlapping.

As already explained, the data model consists of three data sets - **source**, **reference**, and **conceptual**. Each data set contains objects representing biocentres and biocorridors, their geometries and relationships. Data sets are interconnected by relations between representations of corresponding biocentres and biocorridors.

The data model allows to look at of biocentres and biocorridors as polygons for their location and delimitation and for spatial analysis; the topology validation checks use topological rules. The model provides also objects for network representation of biocentres and biocorridors thus enabling network analysis.

The fundamental object of the **source data set** is a **documentation** that one can imagine as a data container. This documentation has been procured within the frame of one order or project. It means usually digital data in various formats and structures however we can meet a paper documentation sometimes. Documentation is in fact a partially metadata object describing order or project data.

Each documentation has an orderer, an elaborator, and a responsible planner, date of origin, documentation type and a map that serves as a basis for geometry of biocentres and biocorridors. Documentation itself has no geometry, its spatial context is defined by its drawings.

Documentation contains one or more **drawings** represented by paper drawings or by electronic map layers. **Polygon of the investigated area** is defined for each drawing and this polygon represents the area described in the drawing. Polygons of the investigated areas may be used as spatial metadata and it is possible e.g. to find documentations which drawings cover the given area, or to search areas that are or that are not covered with the selected documentation type. The mere visualization of the polygons of investigated areas by a documentation type or by a map basis used provides information on coverage of the territory by documentation and allows to find out quickly whether the locations with missing biocentres and biocorridors have been mapped at all.

The drawing contain **biocentres** and **biocorridors**. Biocentres have a multiple polygon geometry, their geometry may consist of one or several polygons. The reason is that a biocentre may have different properties in its individual parts. There are numerous documentation where a biocentre's area is not fully contained in the polygon of the investigated area. In such case one polygon represents the part inside the biocentre, the second represents the part outside it. Internal part is usually delimited in a correct manner. The outer part has often just an orientation meaning. In cases of neighbouring or overlapping documentations one can identify "more accurate" delimitation of a biocentre or a biocorridor then. Geometry of biocorridors may consist of one or several polygons, or of one or several lines. The reason is that some documentations show biocorridors as lines while some others as areas. Multiple geometries may be used advantageously in cases where a biocorridor has different properties in its different parts. A unified legend of basic attributes has been built for biocentres and biocorridors, the data set contains these basic attributes only. Documentation may contain also references to other attribute related data of biocentres and biocorridors. Since individual documentations contain attribute related data in various formats and structures it is necessary to store also the definition of key items together with the link. It is possible then to join the said attribute related data for biocentres and biocorridors of the given documentation using join or relate functions in ArcMap. Creation of geometry for biocentres, biocorridors, and polygons of the investigated areas is validated using defined topological rules.

In cases of overlapping documentations there is often not necessary to include "low quality" biocentres and biocorridors in the database. It is sufficient to include "indicative" information on a documentation and its drawings and to add the data on biocentres and biocorridors later if needed.

Reference data set contains "reference" biocentres and biocorridors. Biocentres have multiple polygon geometry, biocorridors have multiple line geometry. Reference data set serves primarily for integration and comparisons of data from the source data set. One biocentre from the reference data set may be connected to one or several biocentres from the source data set. The same biocentre may be described in various documentations and the relation makes possible to define that it is always the same biocentre but in different documentations or drawings. Similarly one biocorridor from the reference data set may be connected to one or several biocorridors from the source data set. Using these relations it is possible to find a documentation or drawings describing identical biocentres or biocorridors.

The reference data set makes it possible to define a network topology. Biocentres resp. their centroids are nodes and biocorridors resp. their line representations are edges of the network. It is necessary to introduce auxiliary nodes representing a contact of a biocorridor with a biocenter border, or a contact of two biocorridors, and auxiliary edges between contact points and biocenter centroids.

Conceptual data set contains "concept" biocentres and biocorridors. Biocentres have multiple polygon geometry, biocorridors have multiple line geometry. One biocentre from the conceptual data set may be connected to one biocentre from the reference data set. Similarly one biocorridor

from the conceptual data set may be connected to one biocorridor from the reference data set. Using these relations it is possible to find corresponding biocentres or biocorridors in the remaining data sets. The network topology of biocentres and biocorridors is defined analogously to the reference data set.

Testing of the designed database took place within the general environment of ArcMap and ArcCatalog. Enhanced efficiency in editing attribute data and relations is possible thanks to special user interface created as a VBA extension in ArcMap.

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