

SPATIAL DATA VISUALISATION IN THEMATIC MAPS II

Tomáš Janata, PhD | CTU in Prague – FCE, Dept. of Geomatics

Ein ware Erschredliche vnd Erbarmliche Neue zeitung / Von den sieben Stetten so
 Gott der Allmechtich durch ein vnerhöret Grausamen Erdbeben alles in grund verdröbt / Vnd vil vmb liggende Stett zerstört / Also wüst
 vnd verumadelt / Das die menschen sich fürchten da zu wenen / Jampt andern erschredtlichen wunderzeichen / Darob sich ein yliche Christliche berg mag erweisen / In Italia nahe
 bei Viallanca vnd Diamore. im 1564. jar. Den 20. Julij. geschicht. wie zu erden vndt / Coitico aus dem Westich in das Ostlich geschrit / vnd allen in einer zeitung. vnd bepredigt für sich.

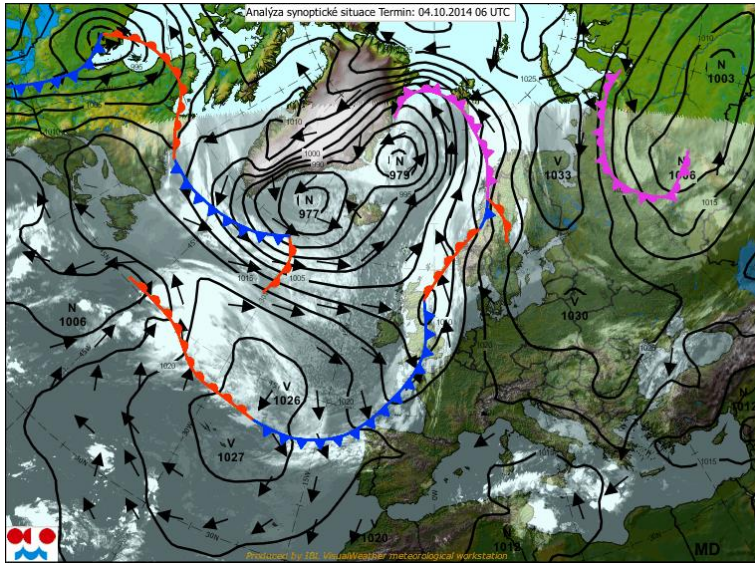


Macro seismic map, 16th century.
 (Nice earthquake)

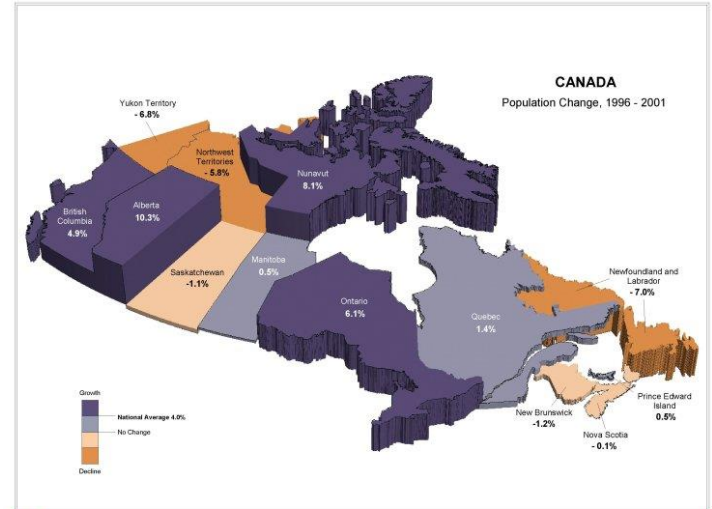
Map of magnetic declination,
 Edmond Halley, 1701

Old thematic maps

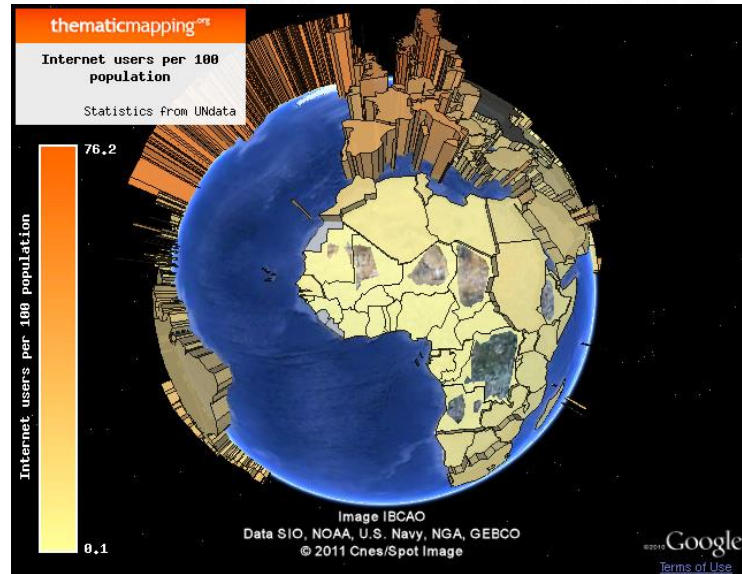
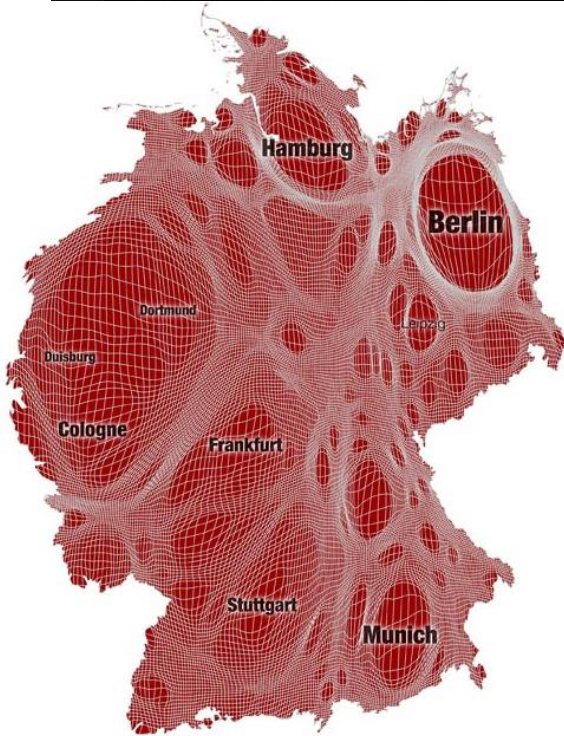




.... 21st century



Canada



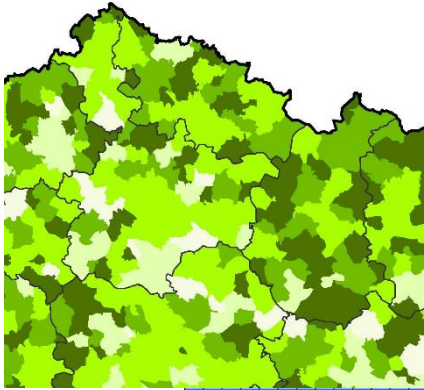
TYPES OF THEMATIC MAPS

according to the concept of thematic content

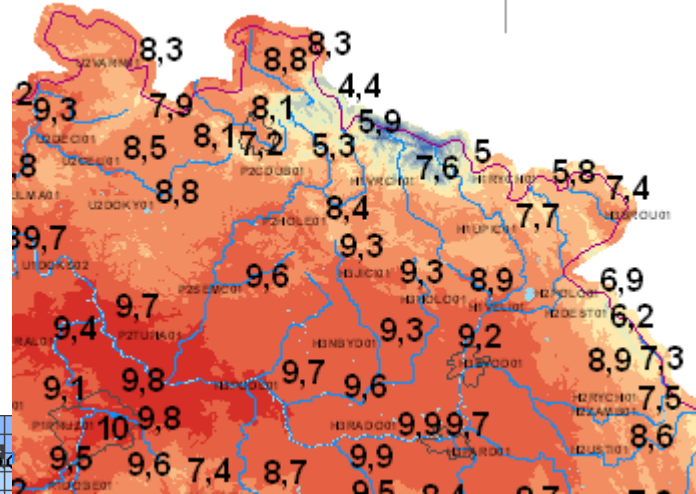
- **analytical thematic maps** – simple methods of representation, a phenomenon detected in the field or by analytical investigation, usually with no connection to other phenomena
- **complex thematic maps** – phenomena of a related topic forming a logical whole (sometimes also referred to as component maps), combination of several simple representation methods
- **synthetic thematic maps** – generalized thematic content (most often from complex maps), display of multiple phenomena to show connections and relationships, more complex thought processes used (abstraction, generalisation, synthesis)

Analytical thematic maps – examples of themes

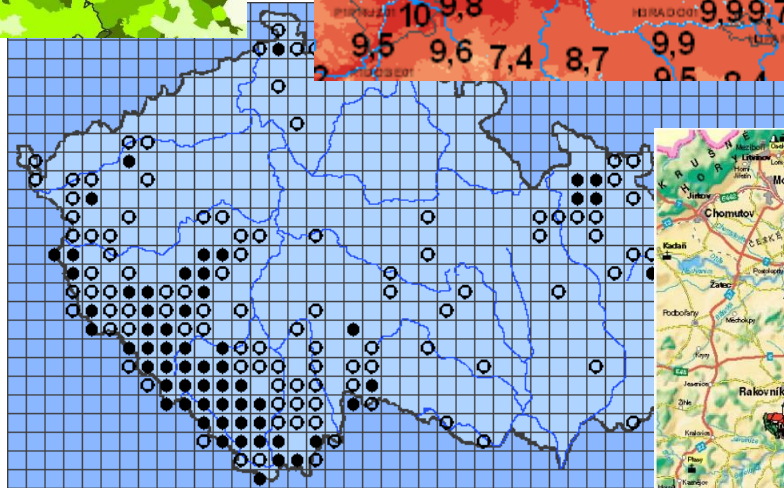
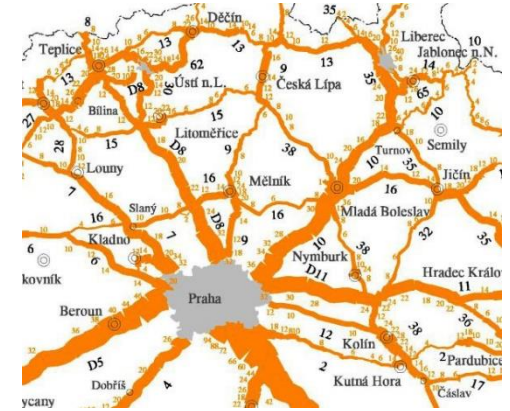
voter turnout



air temperature



traffic intensity



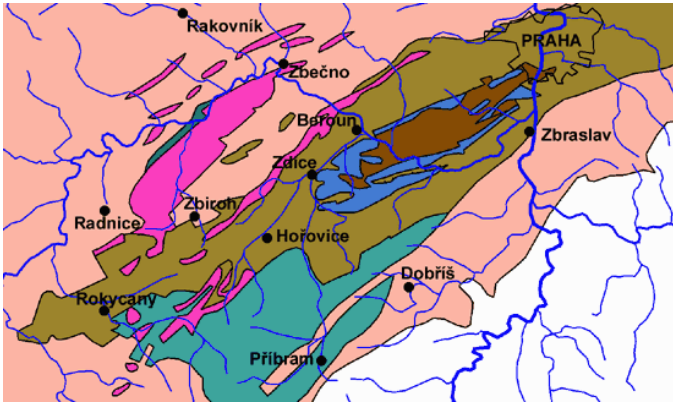
appearance of lynx

cultural monuments



Complex thematic maps – examples of themes

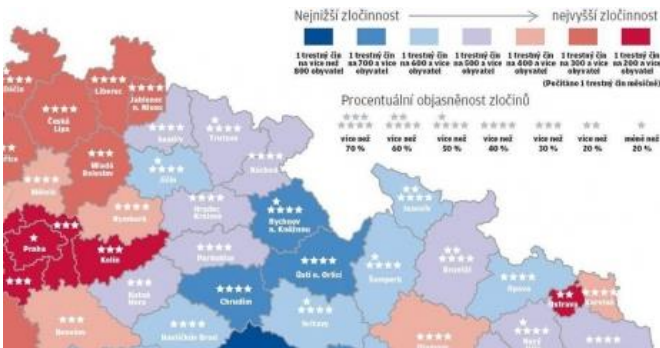
Geology



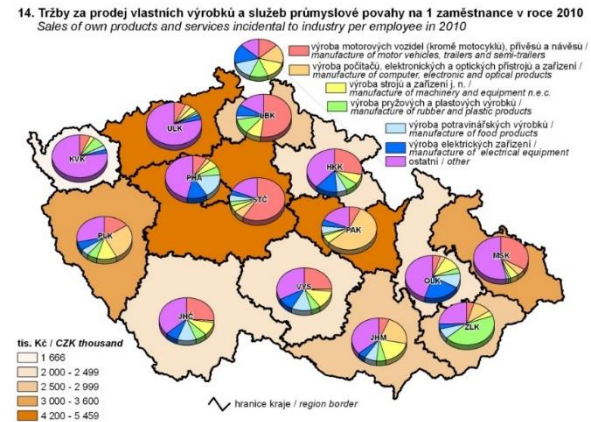
Tourism



Crime



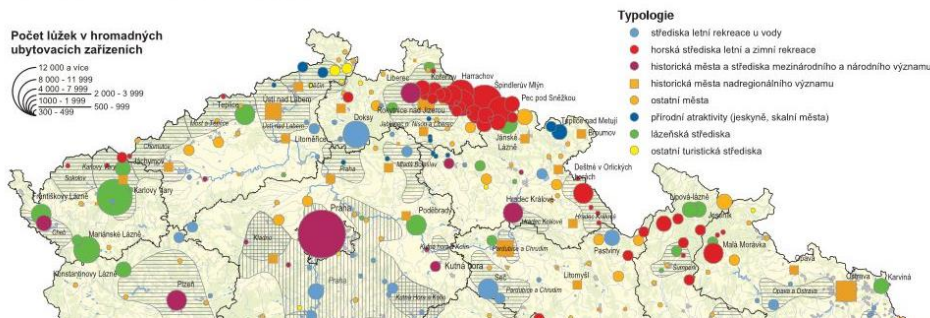
Economics



Synthetic thematic maps – examples of topics

tourist resorts

HLAVNÍ OBLASTI A CENTRA VÍKENDOVÉ A POBYTOVÉ REKREACE A CESTOVNÍHO RUCHU

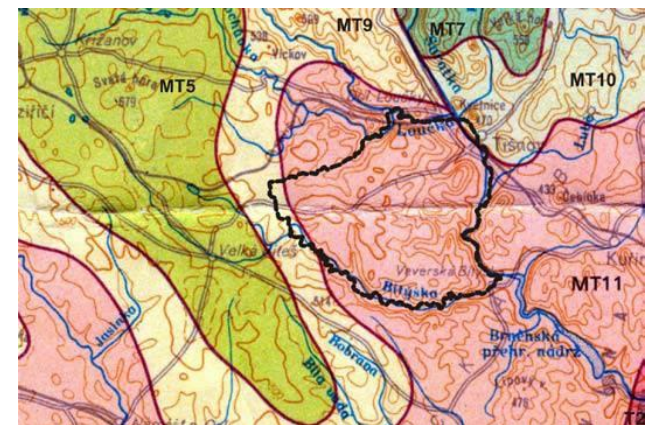
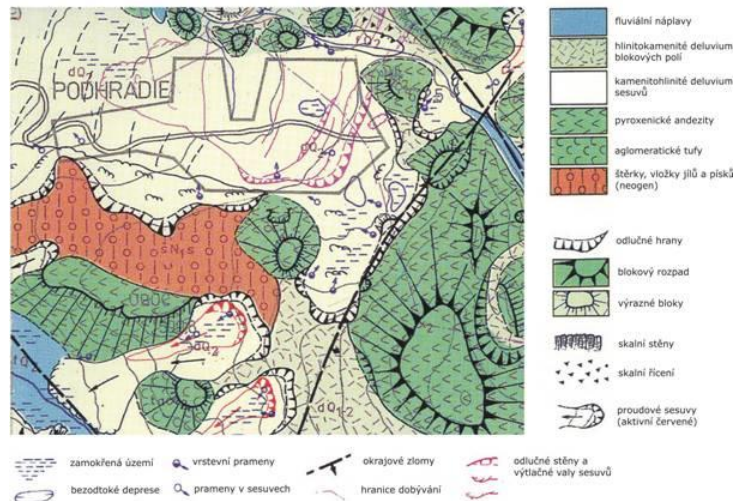


spatial planning



geology – slope failures

Obr. 4.1 Příklad mapy svahových poruch Vtáčnicka (Malgot a kol., 1983 in Matula, 1995)

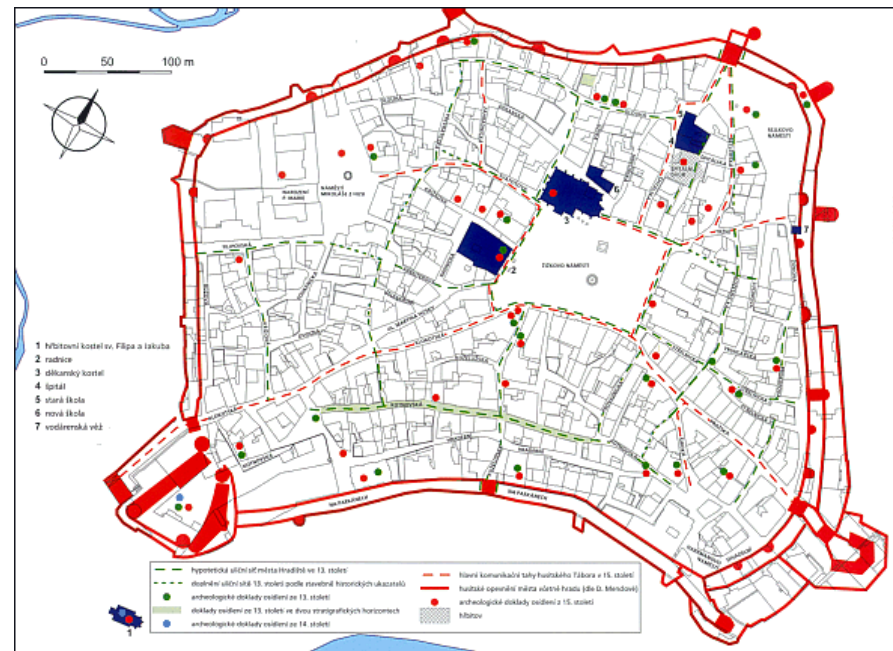


climatic regions

TYPES OF THEMATIC MAPS

according to the temporal aspect of the phenomenon depicted

- static maps
- dynamic maps
- genetic maps
- retrospective maps
- prognostic maps



old maps × historical maps

necessary to distinguish, to know the difference

Reconstruction map

Semotanová (2007)

- illustrates the results of research using modern cartographic means of expression on the basis of general geographical and other cartographic works, mostly contemporary, but also old
- it is a reconstruction of a phenomenon or a process that took place in the past, using cartographic means of expression
- **it is used mainly in social sciences** (archaeology, history, historical geography, ethnology, monument preservation, ...) **and in other fields** (geobotany, urban planning, landscape ecology, ...) etc.

- the term **reconstruction map (RM)** – it **covers types of thematic maps, dedicated to issues that took place in the past** – in relation to the "historical map" it is a broader term (it can also refer to other disciplines than history)
- RM usually illustrates new research findings
 - as a synthetic body of knowledge on a selected topic
 - as a detailed analytical probe on the selected topic
 - as a comprehensive view of a certain epoch
 - as a comparison of individual themes or periods
- RM as outputs of scientific work:
 - usually digital maps and their analogue variants
 - use of digital cartography and GIS tools and methods
 - cooperation of the expert/topic specialist with the geoinformatician/cartographer

Cartographic expression on thematic maps

different authors = different approaches

Methods (prof. Veverka):

points (dots)

motion lines (vectors)

isolines

tables, charts

diagram maps

choropleths

cartographic anamorphosis

network mapping method

Methods (prof. Voženílek):

dot signs

line signs

area signs

dot method

method of isolines

dasymetric method

diagram maps

choropleths

cartographic anamorphosis

cartotypograms

methods for expressing the dynamics of spatial phenomena

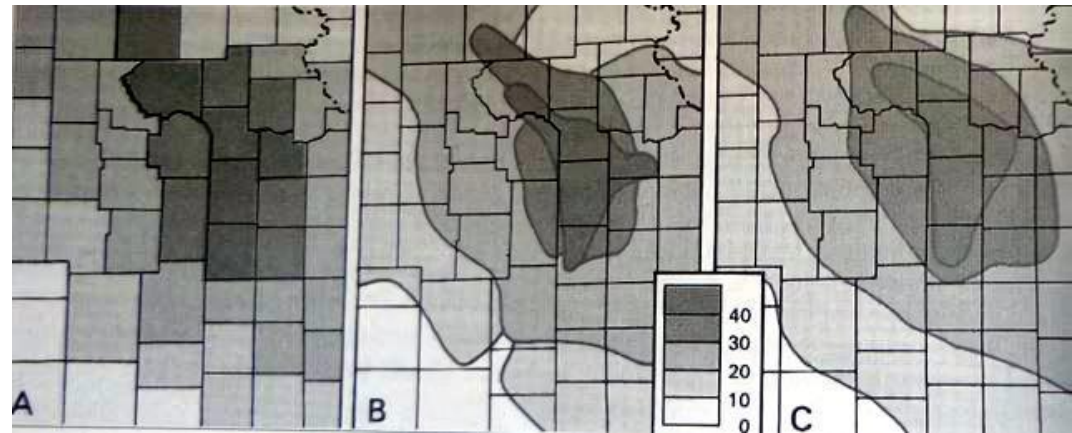
Choosing a method for creating a thematic map

Selection criteria

- **map target**
- **map functions** – orientation, topological, classification, information, (educational, planning, navigation, advertising, promotional, ...)
- **target group of users** – education, age, experience...
- **the volume of information communicated** – content and graphic filling
- **the nature of the input spatial data**
 - positional determination of data (relation to a point, line or area)
 - quantitative (relative or absolute) or qualitative properties of the phenomenon

DASYMETRIC METHOD

- for representing areas with the same intensity of the phenomenon (density)
- **the territorial units to which the phenomenon relates are not predetermined – they are defined on the basis of the geographical distribution of the phenomenon**
- more natural boundaries of the values of the displayed phenomenon – more accurate presentation of the variability of the phenomenon (compared to a choropleth)
- less used method – but often used for demographic maps (population density)



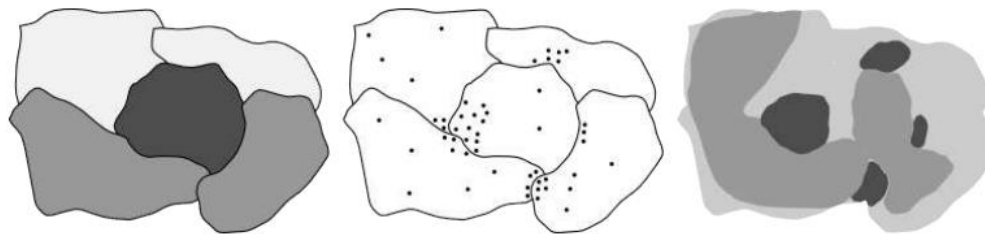
A choropleth

B dasymetric method

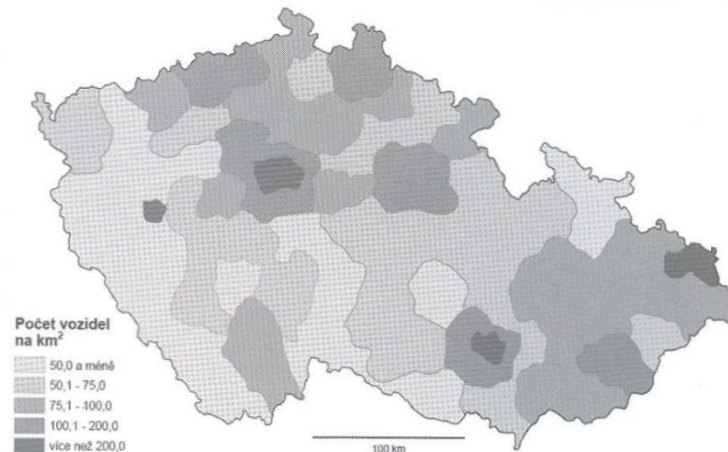
C isoline method

Creating a dasymetric map

- a) **from the dot method** – analysis of a map with topographic localization of dots: delineation of areas of equal dot density (analysis of dot distance d)



- b) **from the choropleth** – merging of territorial units in the choropleth



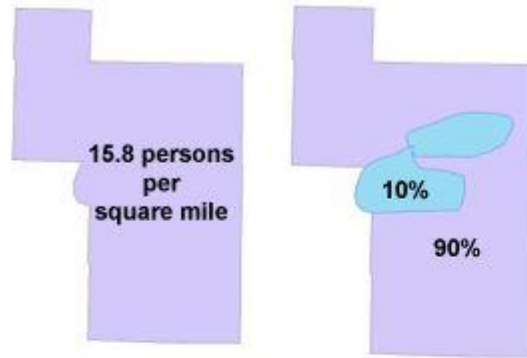
Creating a dasymetric map

c) using auxiliary data/information (e.g. remote sensing data)

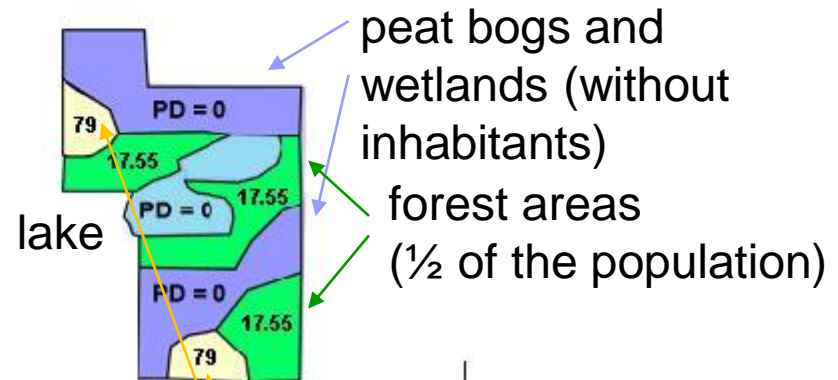
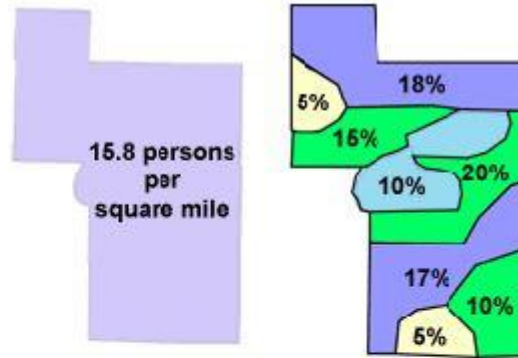
Auxiliary data

- **limiting variables**
 - define places where the phenomenon does not occur
 - are essential for the refinement of the dasymetric method
 - e.g. watercourses and water bodies (for population density)
- **related variables**
 - additional information
 - information about a related phenomenon with a proven correlation to the phenomenon depicted

The principle of using auxiliary data



limiting variable



related variables

→ calculation of new population densities

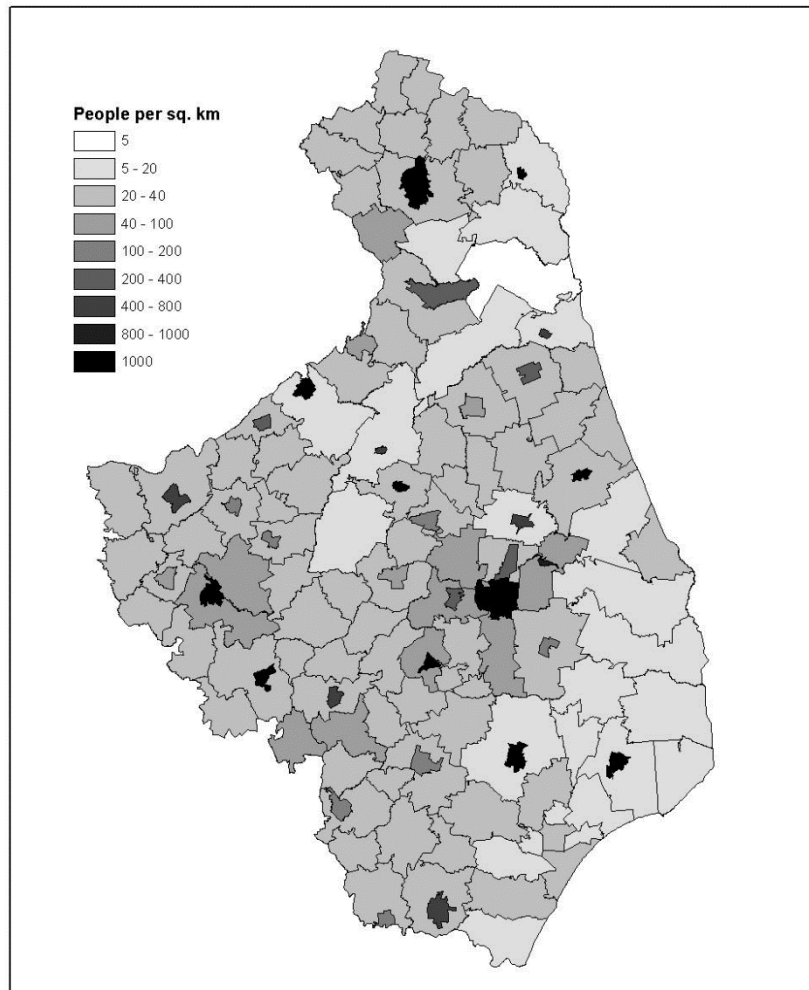
Ways of using auxiliary data (dasymetric method)

- **binary method**
 - division into areas with and without the occurrence of the phenomenon
 - recalculation of the density of the phenomenon to the area of the area of occurrence
- **three-class method**
 - division of the mapped area into three categories with different weights for occurrence of the phenomenon

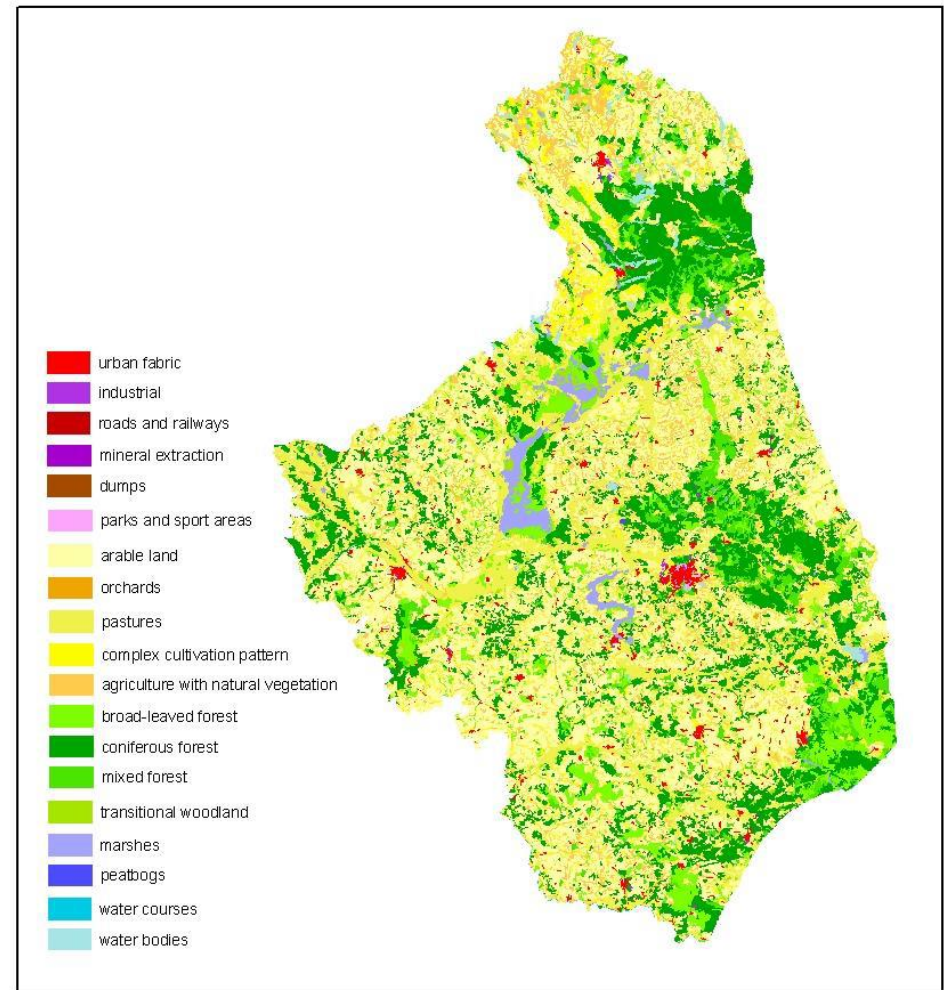
+ many other ways

Application of the dasymetric method – example 1

(Bielecka A., 2005)



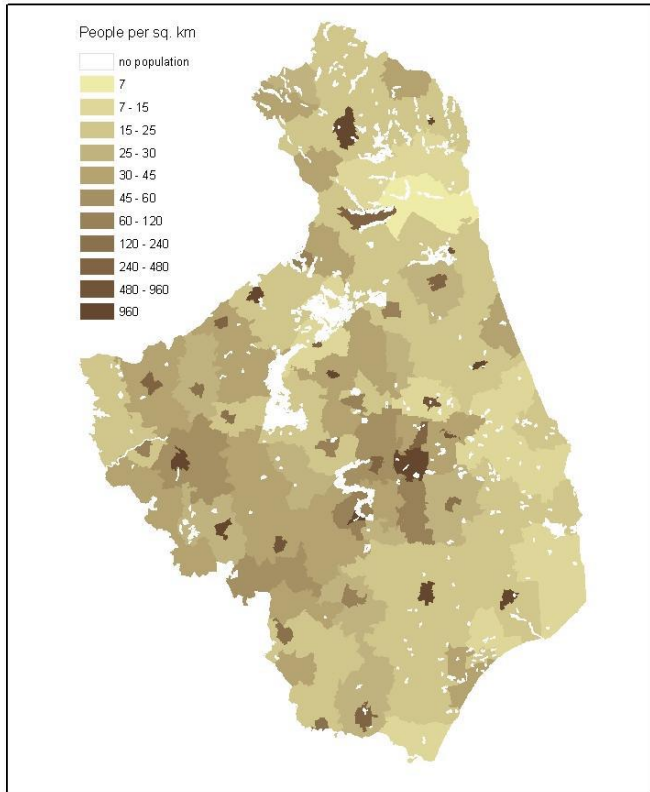
population density
– choropleth method



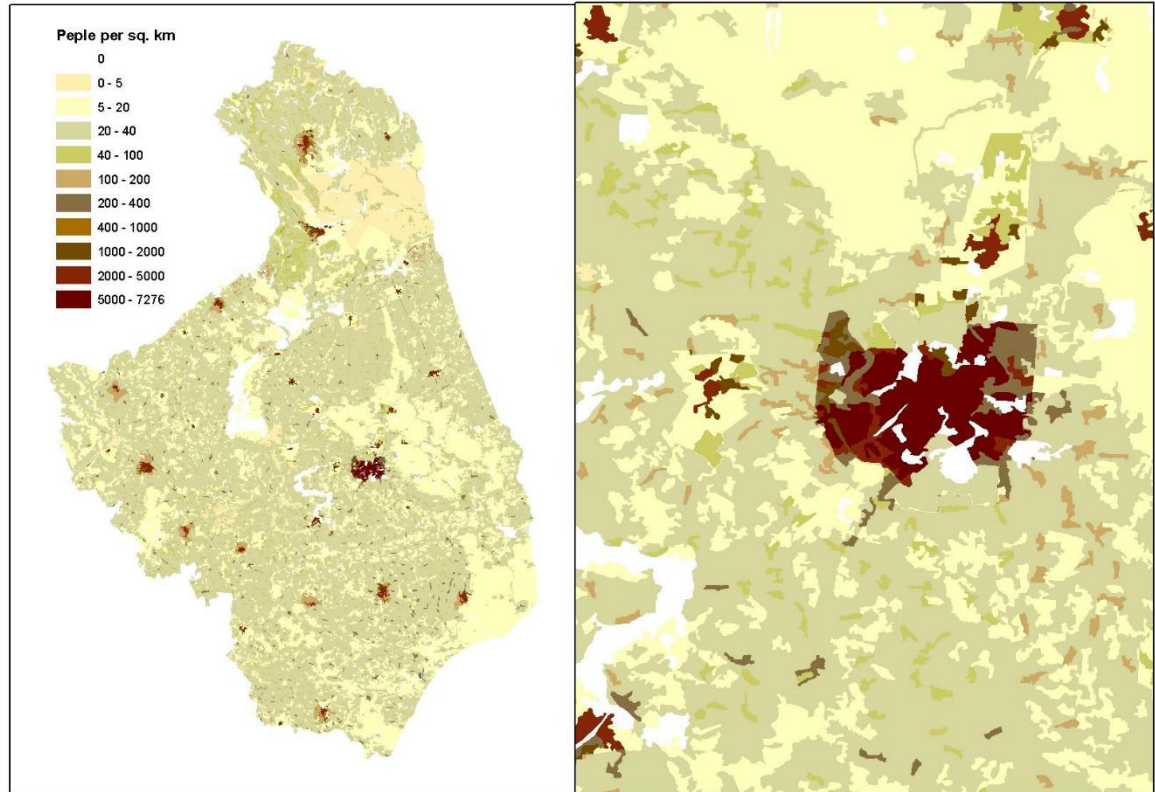
CORINE Land Cover classes
– additional information

Application of the dasymetric method – example 1

(Bielecka A., 2005)



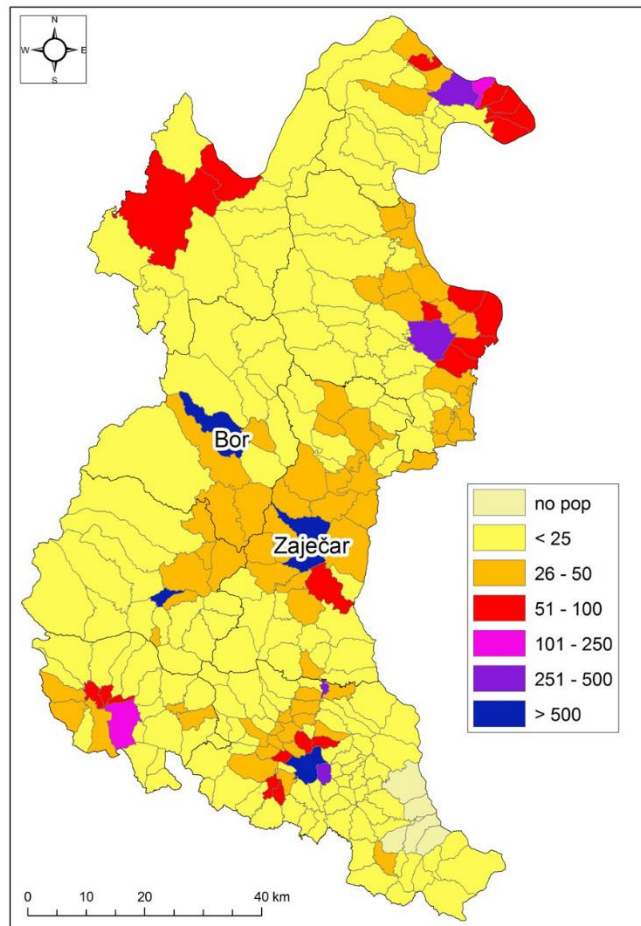
– binary method



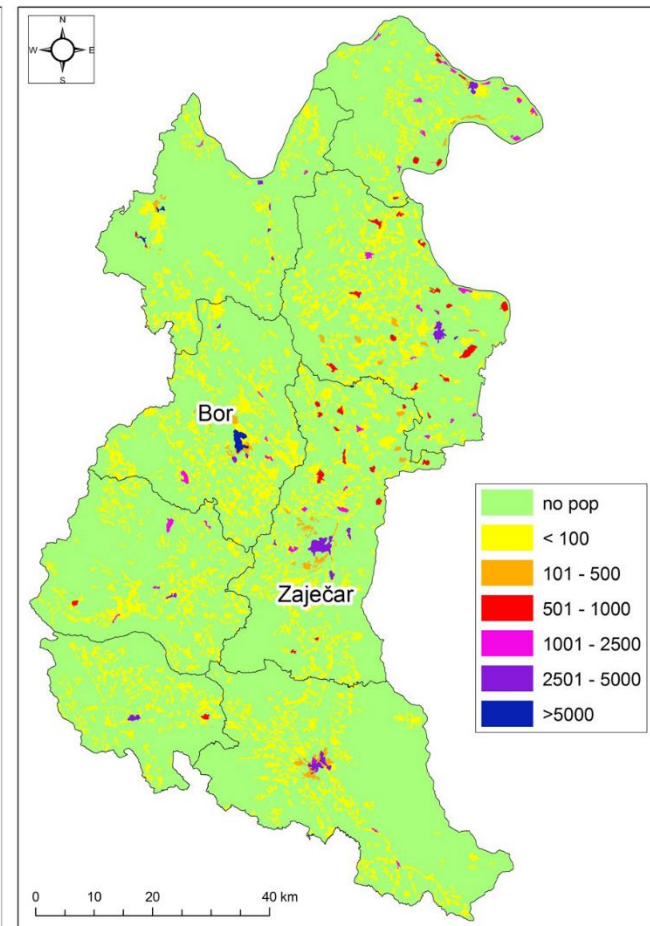
– modification of areas by introducing weighs

Application of the dasymetric method – example 2

(Bajat et al., 2011)



choropleth map



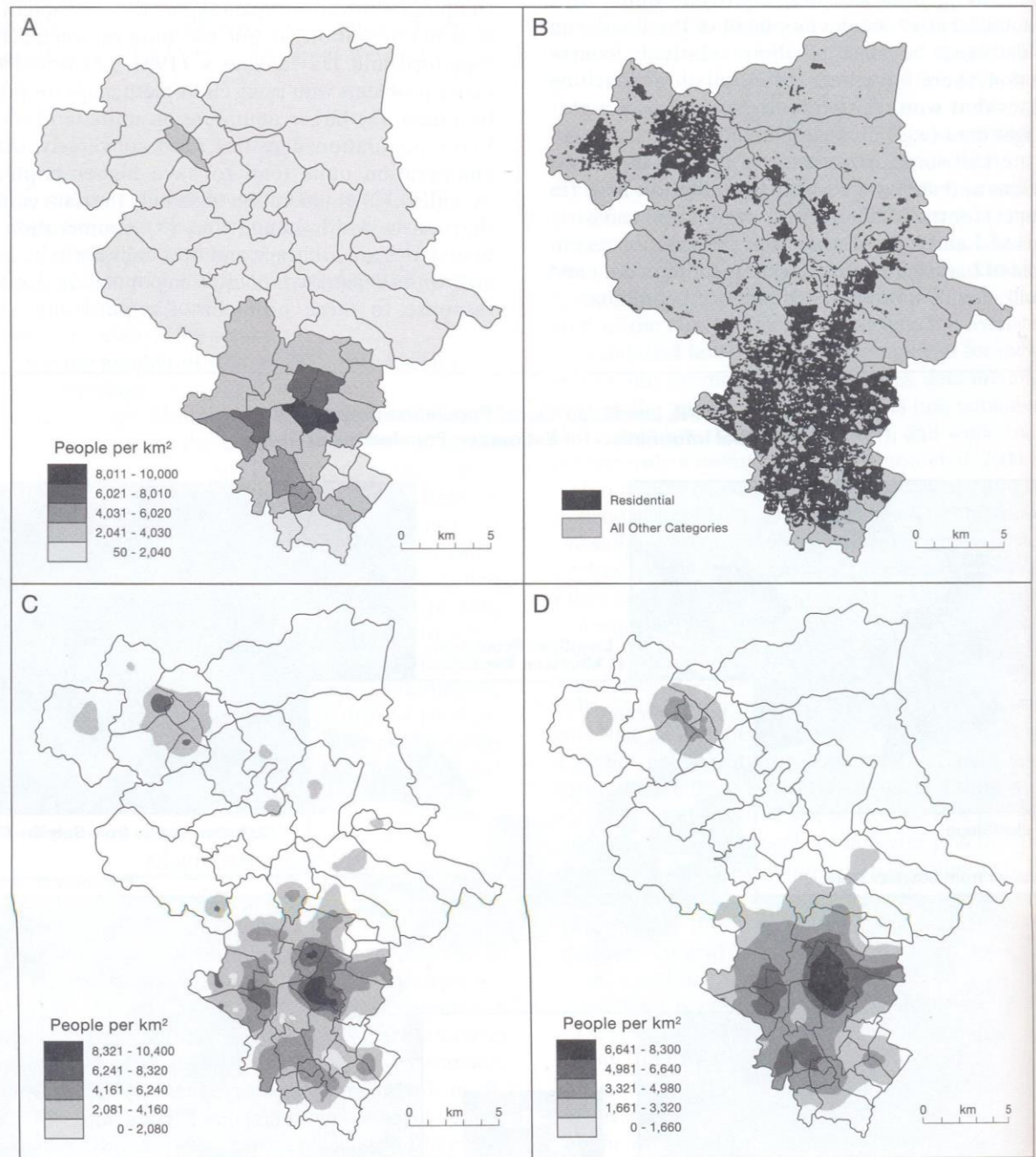
dasymetric map (land cover data)

Population density maps of Timočka Krajina

Application dasymetric methods – example 3

(Slocum et al., 2009)

binary method +
generalisation
of different degrees



CARTOTYPOGRAM METHOD

- a special method – placement of so-called typograms in the map
- **typogram** expresses relative values, most often %
- plotting the values on the axis system, always from the intersection
- comparison of the shape of individual typograms

multi-sided typograms

- **Centrogram**
 - expresses absolute values

Cartotypograms – examples (Voženílek, Kaňok, 2011)

structural cartotypogram

summation cartotypogram

NETWORK METHOD

(network mapping method)

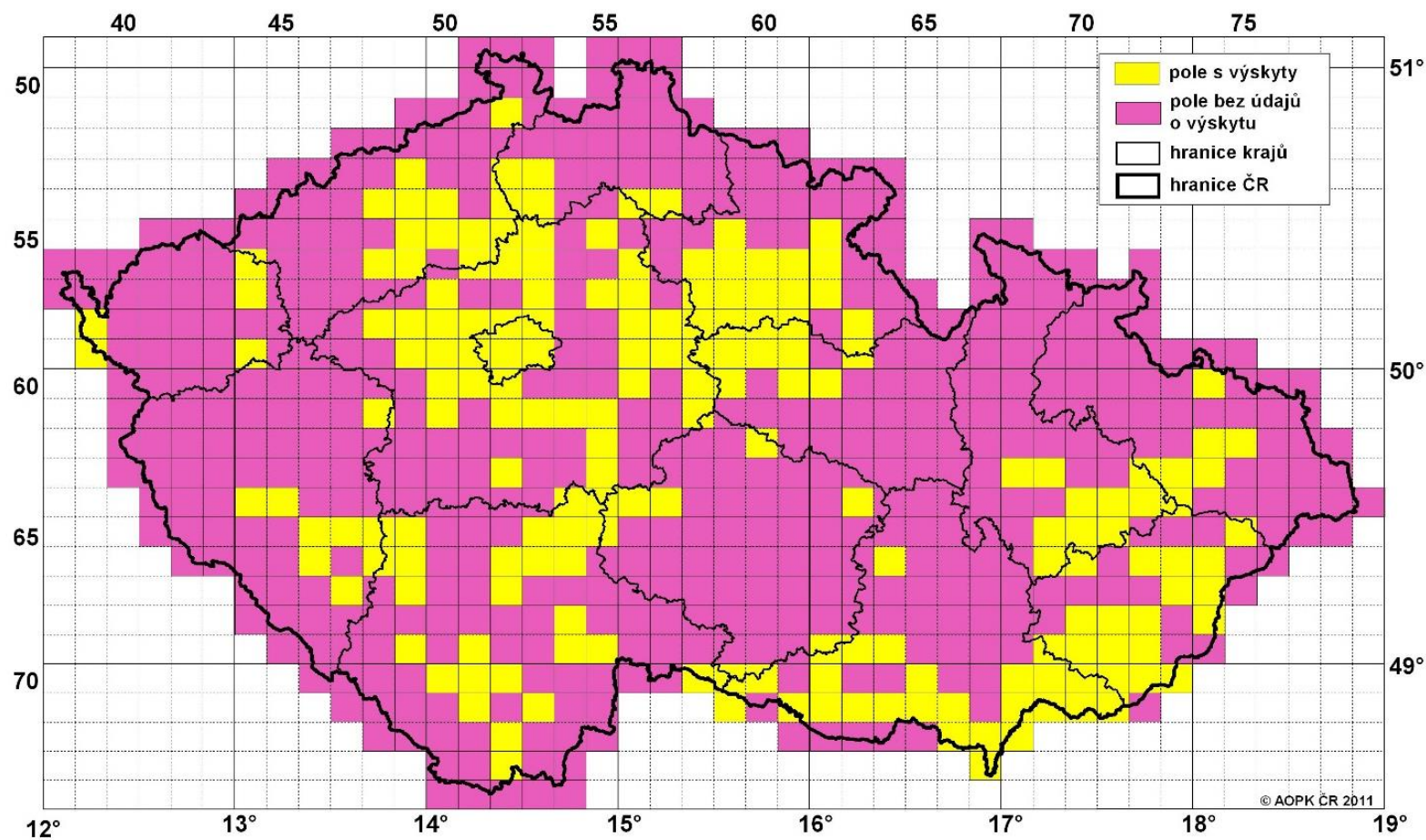
mainly used for biomonitoring (mapping the presence of animals or plants)

principle:

- the territory of the Czech Republic (or the whole of Europe) is divided into a network of squares with dimensions of approximately 11×12 km, which are derived from geographical coordinates (a total of 628 squares, including the outer 678 squares for the Czech Republic)
- when a single record of a species is found in a square, the square is considered "populated"
- the occurrence is indicated by a colour or symbol placed in a square
- colour + sign combination to compare changes in occurrence
- quantitative colour scale for a synthetic map of the occurrence of multiple species of the monitored bio-features

Network method – examples

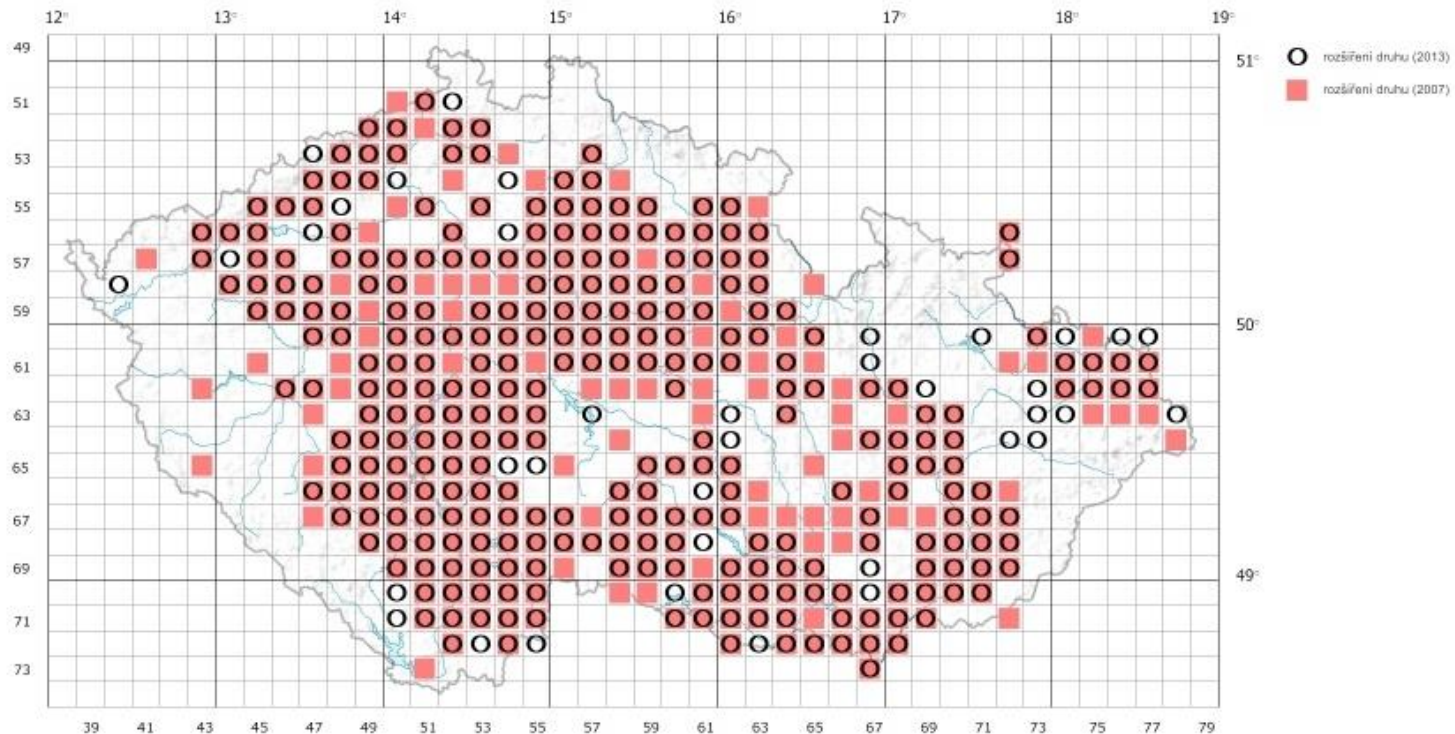
Occurrence of molluscs in the Czech Republic in 2012



Network method – examples

Comparison of the occurrence of the common marten
(*Bombina bombina*) in the Czech Republic in 2013 and 2007

Rozšíření druhu *Bombina bombina* podle zdroje: AOPK ČR, 2013

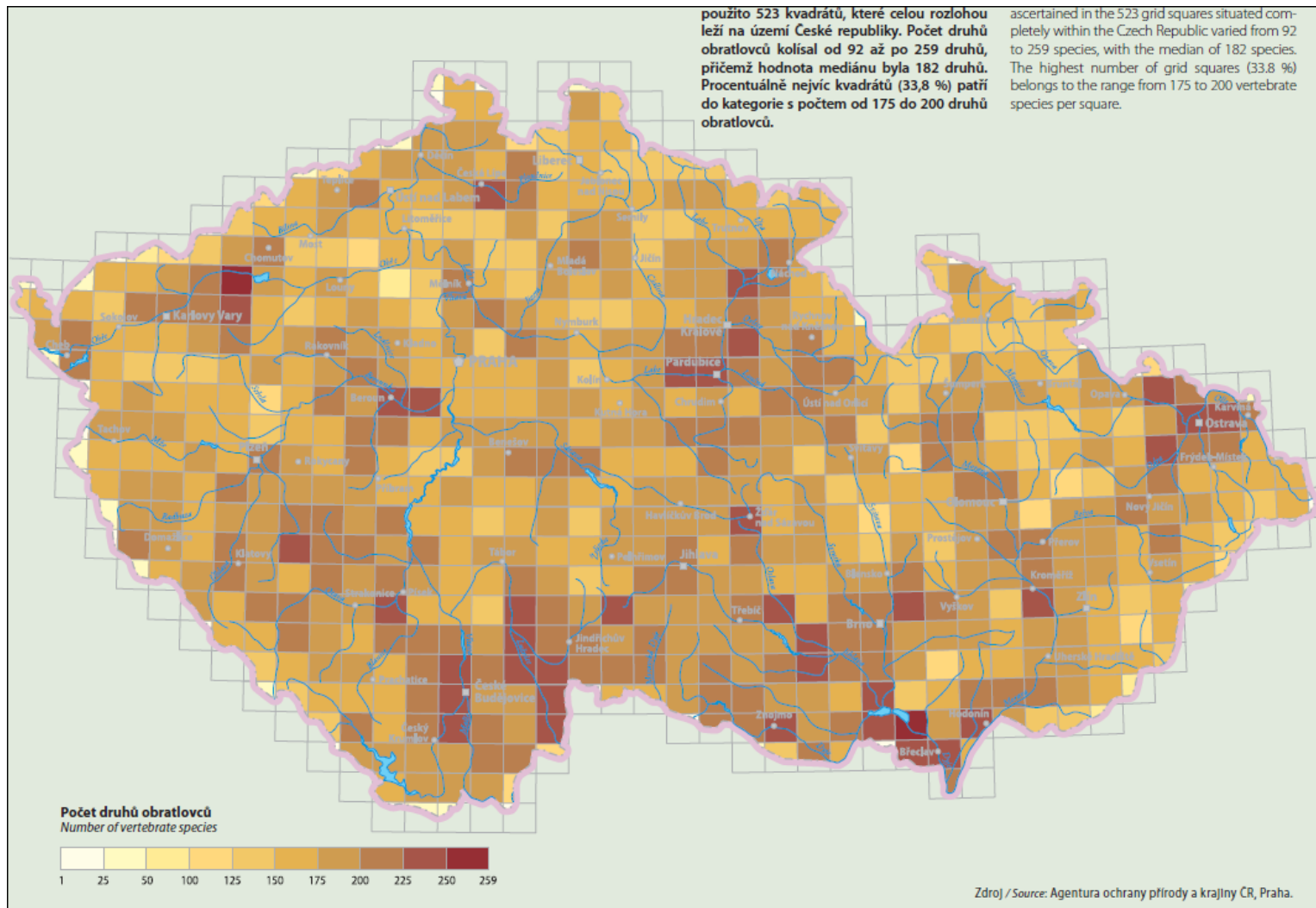


kartografická prezentace © AOPK ČR 2014, datový podklad MŽP



Network method – examples

Number of vertebrate species in the Czech Republic in 2010



SCALES IN CARTOGRAPHY

- a tool to quantify the phenomenon
- important for creating a good thematic map
- affects the clarity of the map
- input data analysis
(qualitative × quantitative, relative × absolute, statistical methods)
- **the scale must always be shown on the map!**

What is important

- scale type selection
- the procedure for creating the width of the scale intervals
- final graphic design (choice of colours, etc.)
- a correctly formed legend

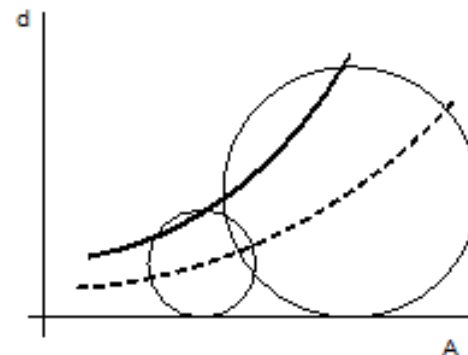
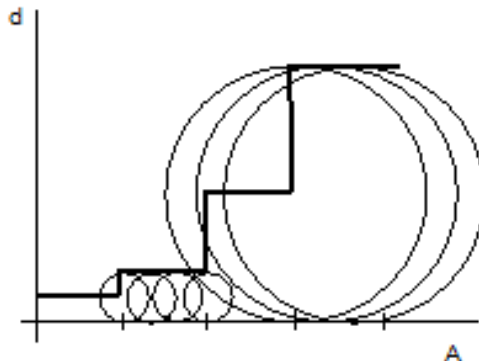
Division of scales

SCALE			
A. INTERVAL		B. FUNCTIONAL	
smoothly following	incremental	continuous	incremental
constant	without hiatus	----	with hiatus
regularly increasing or decreasing	with hiatus	----	as a result of changes in the formula
irregular	----	----	----

hiatus ... gap, interruption

... deletion of one or more intervals (containing no values)

... for the functional scale: part of the scale is omitted (the phenomenon does not occur)



Functional scales

- mainly for the diagram map method
- precisely defined mathematical relationship between the value of the represented phenomenon and a parameter of the graphic feature
- it is possible to get the specific size from the character parameter
- diagrams – mostly geometric shapes with easily measurable parameters (column, square, circle)

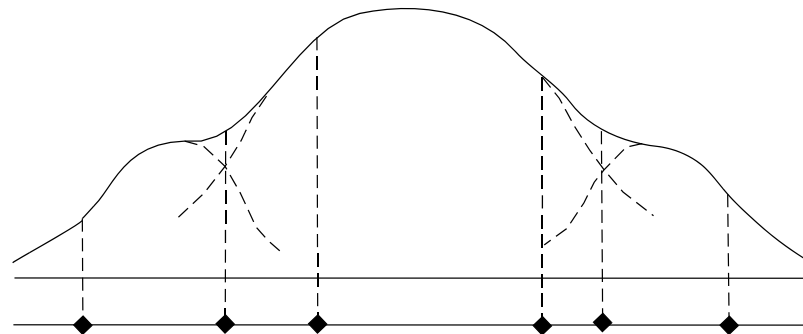
Functions for creating diagram maps

Diagram	Relationship	Functions
column	linear	
square	quadratic	
circle	quadratic	
cubes	cubic	

H – actual numerical value of the phenomenon; h – unit measure used in the diagram
a, r, v – diagram parameters (side, edge, radius height)

Interval scales

- in methods of choropleths, diagram maps, isolines, in the method of dots (topographic approach)
- **number of intervals of the resulting scale: 4 to 6** (rarely up to 10)
- **definition of intervals according to the statistical evaluation of the population – in particular according to the frequency distribution of the phenomenon**
- in software for creating thematic maps (e.g. ArcGIS) – data classification (*Classification*)



Data set classification

- **statistical parameters to be measured** (baseline or sample):
sample size; sample boundaries; range of variation; arithmetic mean; median; variance and standard deviation, ...
- **division of the population into equal-sized intervals:** calculation of the approximate number of intervals - different approaches

$$m \approx \sqrt{n} \quad m \leq 5 \log n \quad m \approx 1 + 3,3 \log n$$

where m is the number of intervals and n is the number of statistical units in the set

- **finding absolute frequencies** in these intervals + histogram
(frequency graph)
- **selection of intervals (classes) according to the frequency distribution of the phenomenon**

(normal, multilevel, exponential, U-shaped distribution, distribution of Pearson-type-III curve, ...)

Data set classification

- **statistical parameters**

sample range (number of elements) n

sample boundaries $X_{max} ; X_{min}$

variation range $R = X_{max} - X_{min}$

arithmetic mean X_{mean}

median med

variance $s^2 = 1 / n \sum_i^n (X_i - X_{mean})^2$

standard deviation $s \dots$ square root of the variance

Frequency distribution and choice of interval boundaries

Normal distribution

- phenomenon most often around the average, decreases significantly towards the extremes (Gaussian curve)
- use of the mean and standard deviation or its multiple

normal

normal flat

Incorrect

right

Frequency distribution and choice of interval boundaries

Multivariate distribution

- disparate data set
- the most common case
- each peak area and its surroundings represent a typical attribute of the phenomenon under study
- frequent use of the natural fracture method

Incorrect right

Frequency distribution and choice of interval boundaries

Exponential distribution

- most frequent occurrence – low values
- distribution of the most frequent values exponentially
- minimum occurrences (high values) – within one or two intervals

Incorrect

right

Frequency distribution and choice of interval boundaries

U-shaped division

- division of two higher frequency sections by regular intervals
- area of small occurrences of the phenomenon – in a smaller number of intervals

Incorrect

right

Frequency distribution and choice of interval boundaries

Distribution of Pearson type-III curve

- division of the higher frequency section by regular intervals
- the area of small occurrences of the phenomenon and the area approximately parallel to the x-axis (the middle part of the curve) – into a smaller number of intervals

Incorrect

right

Different methods of determining intervals (classes)

- equal intervals – equally distributed
- quantiles ... quartiles, quintiles, deciles – intervals with the same number of phenomena using quantiles and average values
e.g. 3 quartiles divide the statistical population into quarters, each of which contains 25 % elements
- mean and standard deviation – intervals by mean and standard deviation
- maximum breaks (maximum breaks) ... isolated occurrence of a phenomenon value
- natural breaks (Jenks) – division into intervals according to groups with similar values, empty spaces or inflection points are chosen as boundaries
- optimization methods (various algorithms...)

+ many others (yielding from statistics)

Comparison of data classification methods for scale development

(Slocum et al., 2009)

Interval scales – applications

- not suitable for expressing small sets
- the values from the scale intervals should be represented graphically on the map (an interval usually contains more than one value)
- for a diagram map with an interval scale, the parameters of the resulting diagrams are calculated from the values of the phenomena corresponding to the centres of the individual intervals
- attention to the notation of the continuous scale in the legend: the **principle of clearly chosen non-overlapping intervals**, i.e.
10,1–20,0 | 20,1–30,0 | 30,1–40,0 | 40,1–50,0
- **choropleth: the intensity of a phenomenon usually expressed in colour** – preferably shades of one colour or the transition of two adjacent colours in the spectrum
- **the lightest shade means the least intensity of the phenomenon, the darker the shade, the greater the intensity of the phenomenon**

Thematic maps – interesting links

- <http://www.datavis.ca/milestones/>
Milestones in the History of Thematic Cartography, Statistical Graphics and Data Visualization
- <http://www.worldmapper.org/>
thematic maps created by the method of cartographic anamorphosis
- <http://www.mapsofworld.com/thematic-maps/>
- <http://www.indexmundi.com/map/?v=21000&r=eu&l=en>

Literature

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