Monitoring and Experiments

Field Survey in Eastern-Morocco (Debdou)

Carl Beierkuhnlein

Ecological Monitoring

Ecological Monitoring can be applied

- for the detection of spatial patterns and
- for the detection of spatial trends

The design of the sampling has to relate to either spatial or temporal foci.

Sampling

As it is not possible to cover a target unit (e.g. ecosystem) *completely*, the selection of a sample is required. This has to follow certain prerequisites.

Sampling has to be:

- Representative for the data set
- Non-redundant and not autocorrelated
- Efficient in time, space and money
- Independent from observer bias
- Repeatable within relevant time scales
- Adequate to the problem

Sample Size

A sample is number of observations (measurements, records, plots) that is related to a certain phenomenon under investigation or survey.

The sampling is aiming to represent the whole unit (e.g. landscape, ecosystem, catchment).

Sampling can be based on experience and knowledge but also on probability theory and statistics, depending on the invidual case.

Grain and Extent

In Ecology, scale is mostly adressed in two hierarchical ways (following Allen & Hoekstra 1991).

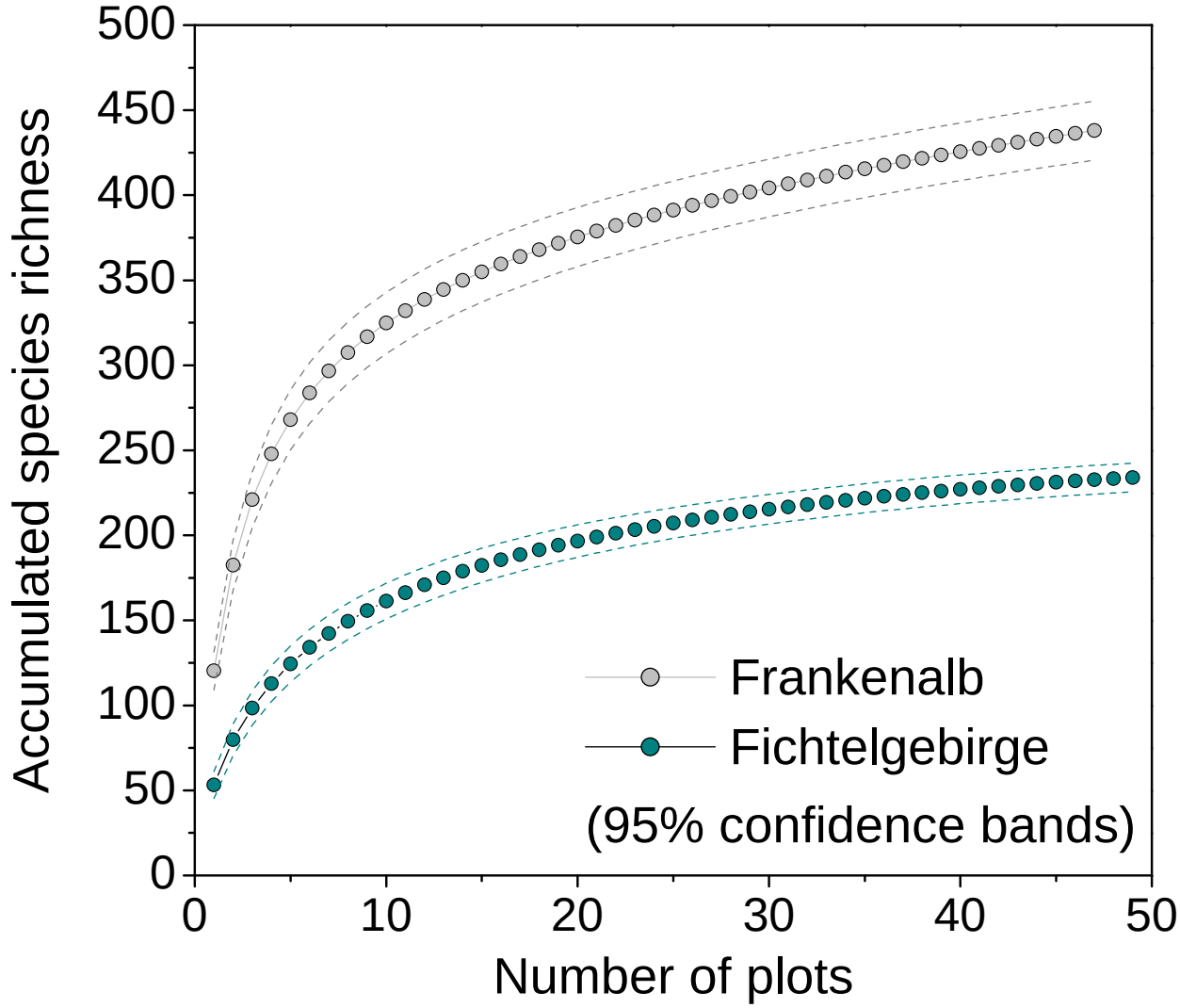
„grain“ (resolution, support, sub-unit)

a) specific plot (observation) area
b) point in time of a record (observation)

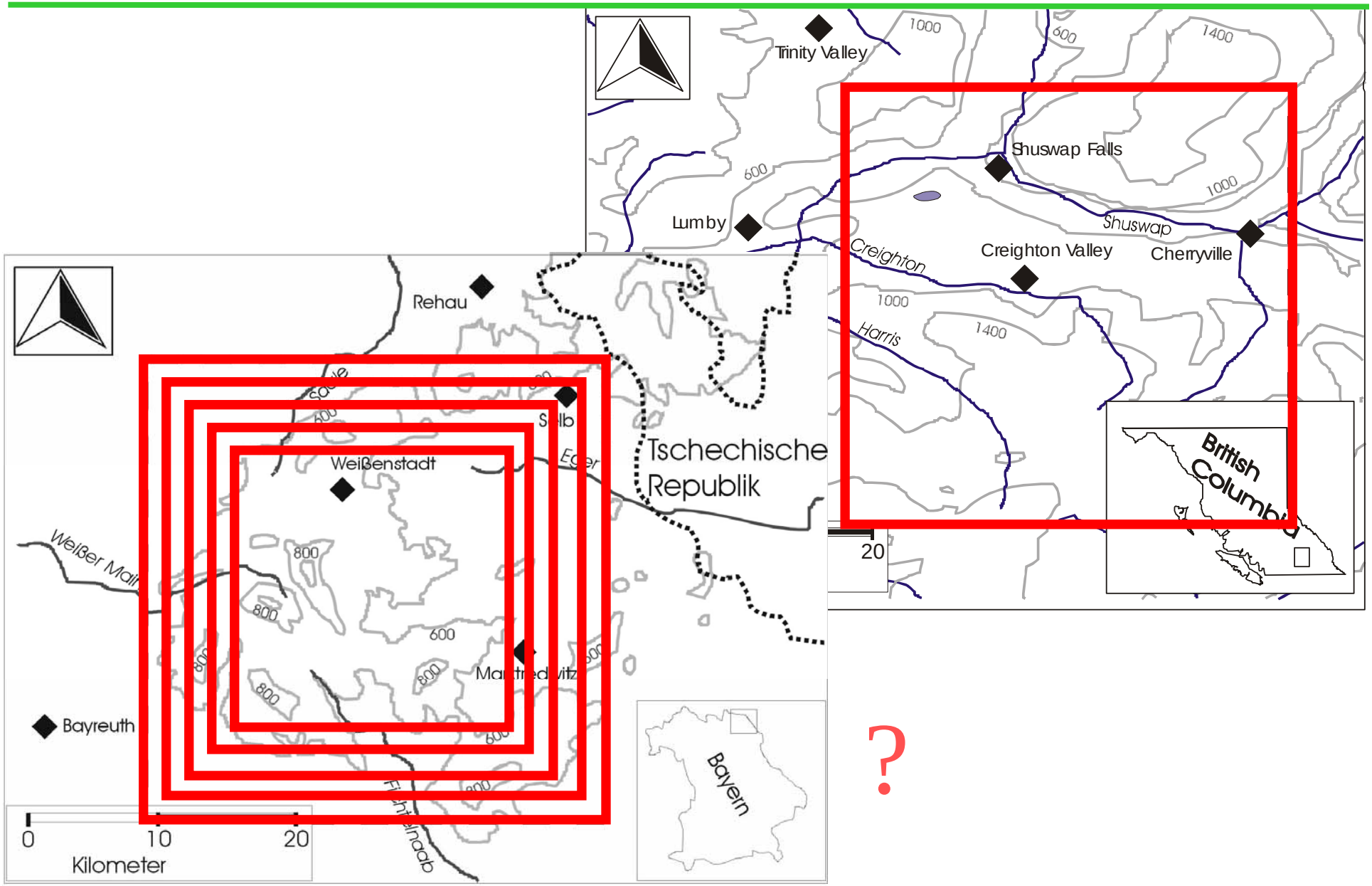
„extent“ (whole unit, entirety, range)

a) complete investigation area
b) duration of a time series

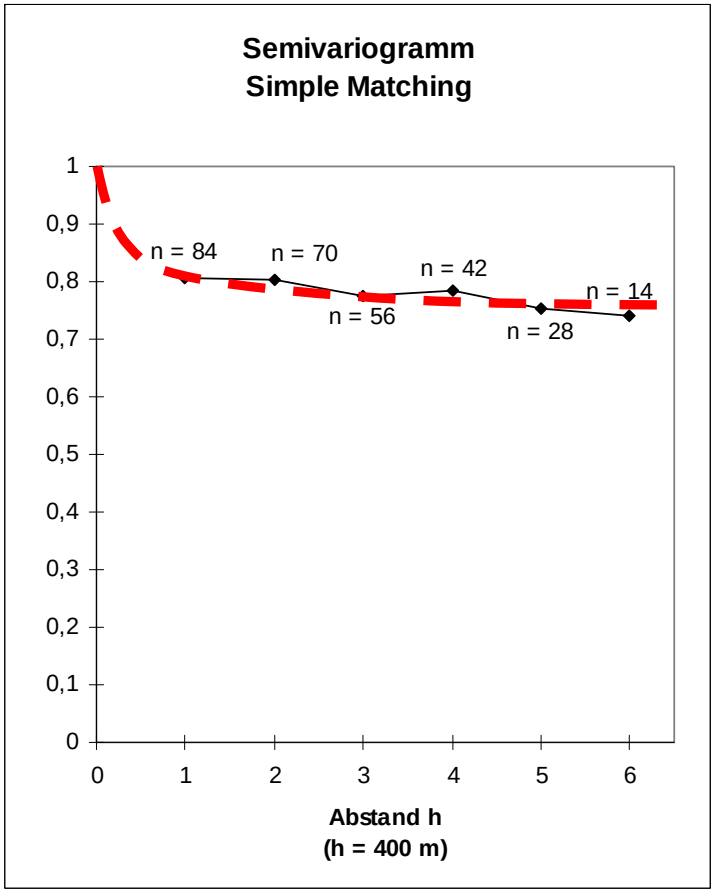
Grain and Extent

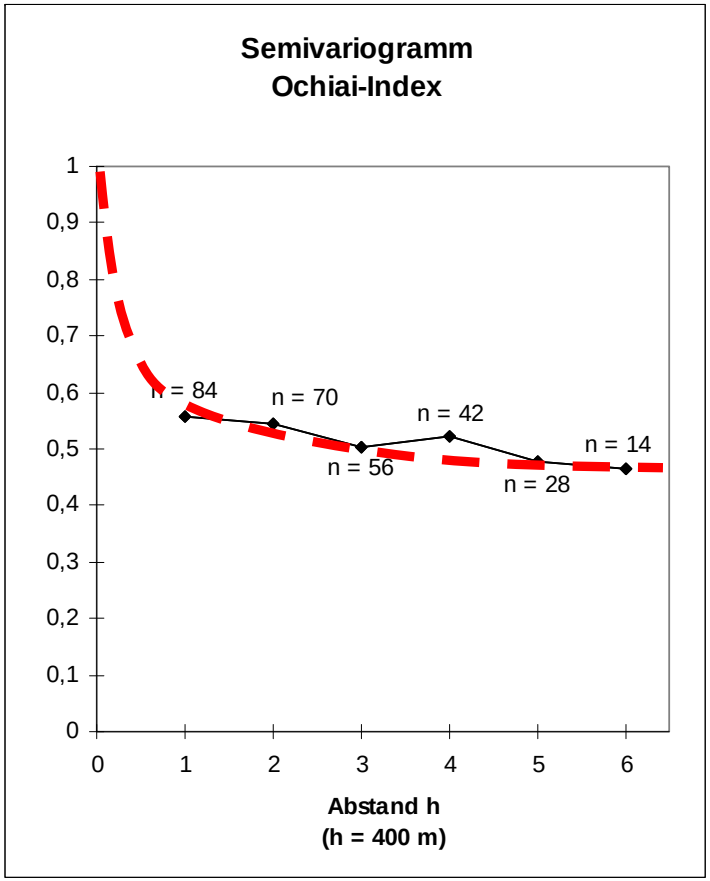


Grain and Extent

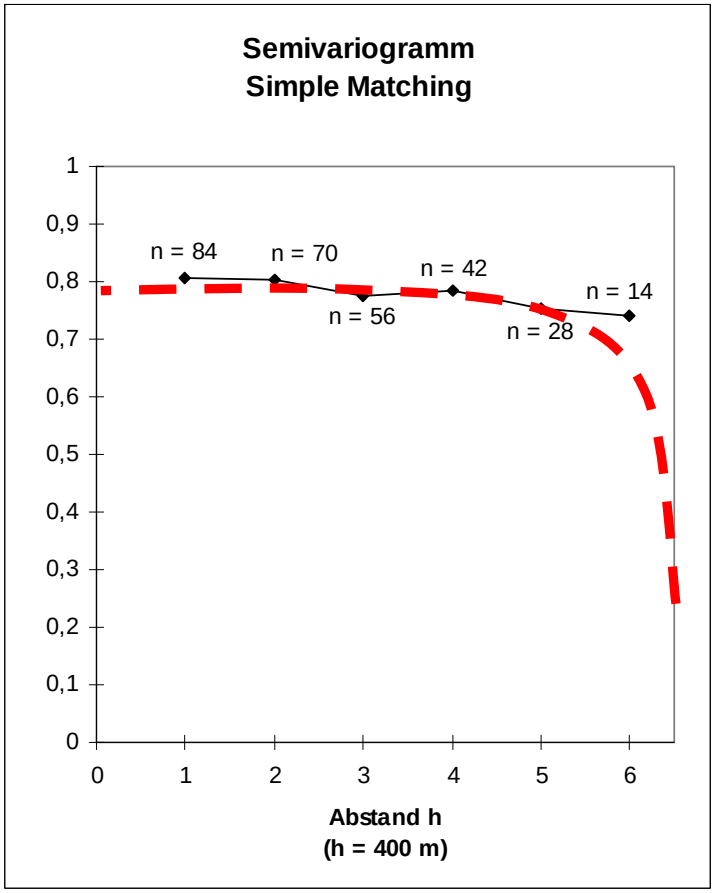


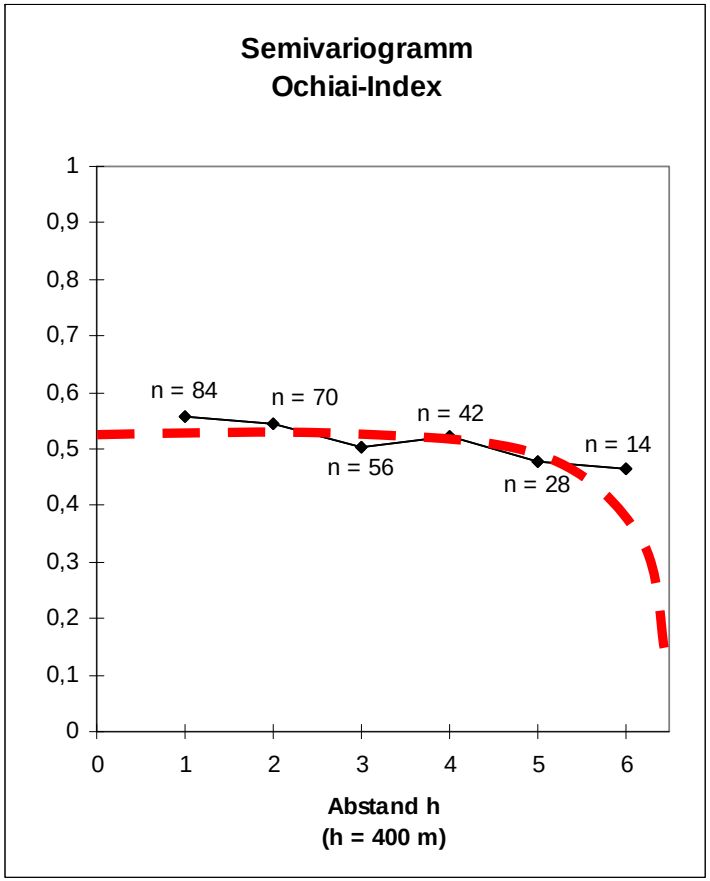
Grain and Extent





Grain and Extent





Sample Quality

Each single observation may be a composite of different qualities. These can be defined as „**variables**“ (e.g. species, compounds, temperature).

Variables can be differentiated into dependent (e.g. ANPP) and independent ones (e.g. species diversity). ANPP may be found to depend on species diversity.

A „**parameter**“ relates functions and variables.

If species composition (or fertilisation, or temperature, or moisture) is changing for instance, ANPP may increase even if species diversity remains the same.

Choice of Objects

Investigation areas, plots, transects, time series etc. are performing a certain variability.

This may be seen as the background or stochastic „noise“, which has to be identified but is not related to the target question.

However, variability may follow certain rules and causes that refer to the problem or research question (e.g. „changes“).

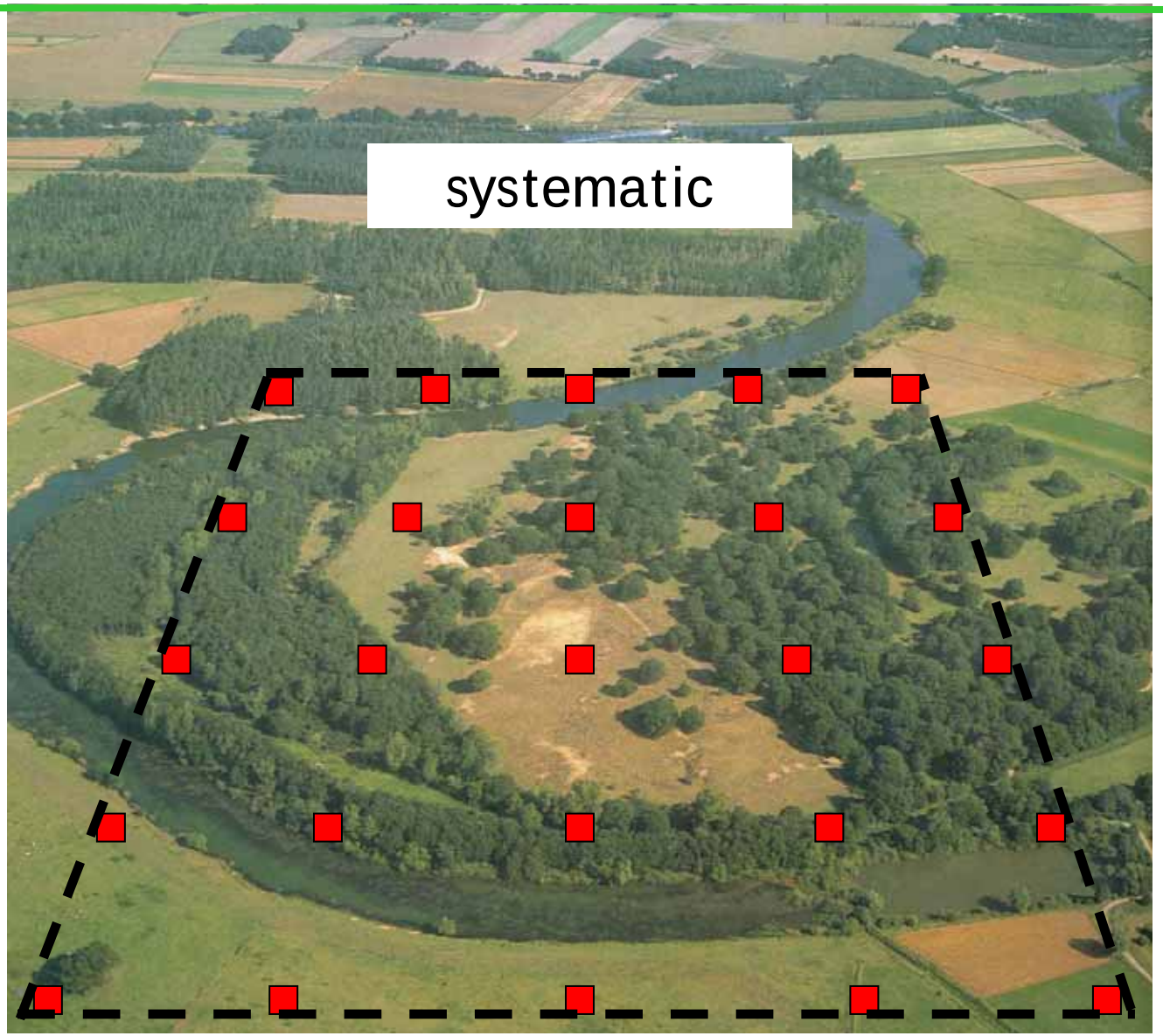
Ecological Monitoring

For both sampling approaches – temporal and spatial – three major categories of options exist:

- Random (stochastic)
- Systematic (regular)
- Preferential (pre-defined, expert knowledge)

The choice of an approach depends on research question and on temporal as well as spatial scales.

Spatial Sampling



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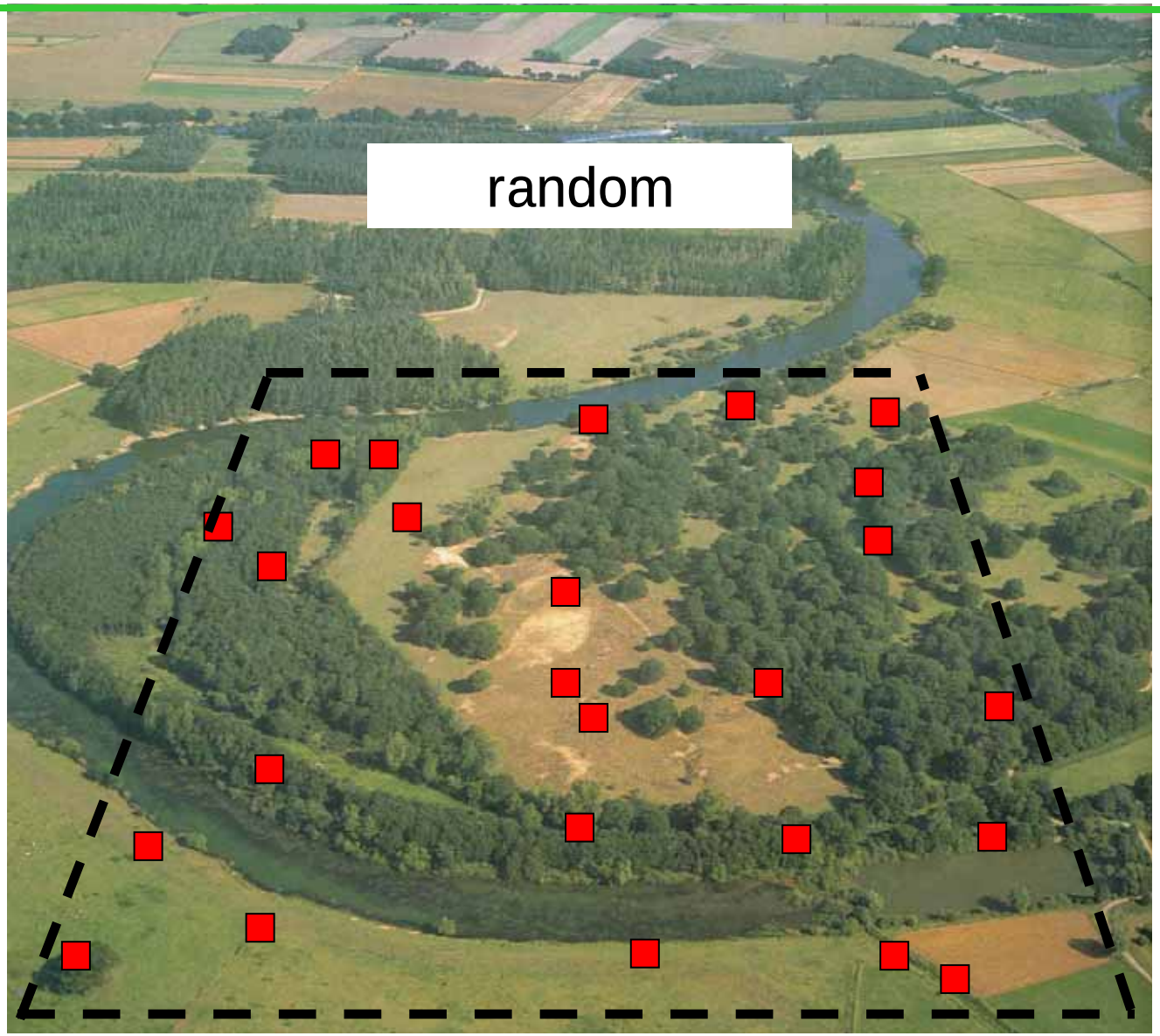

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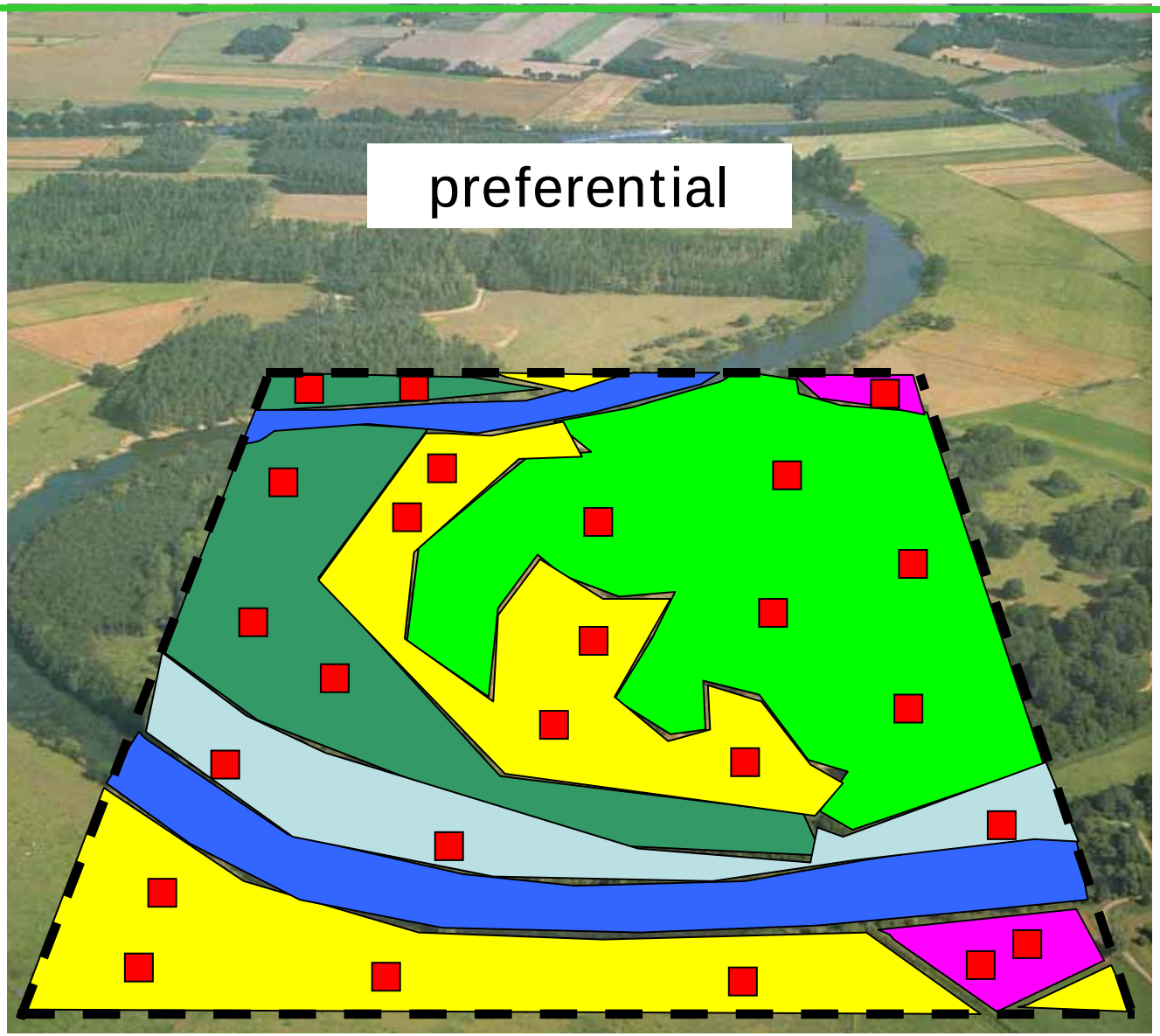
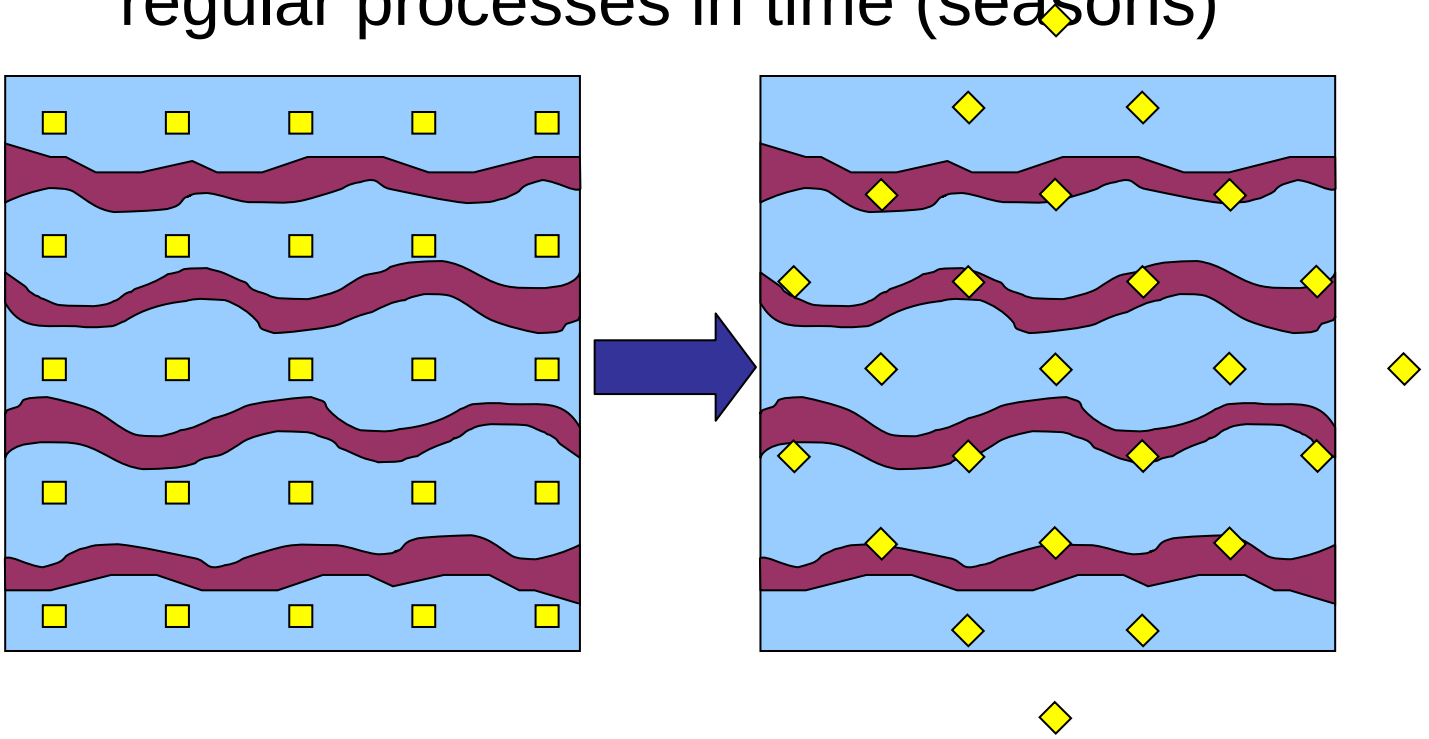


Spatial Sampling

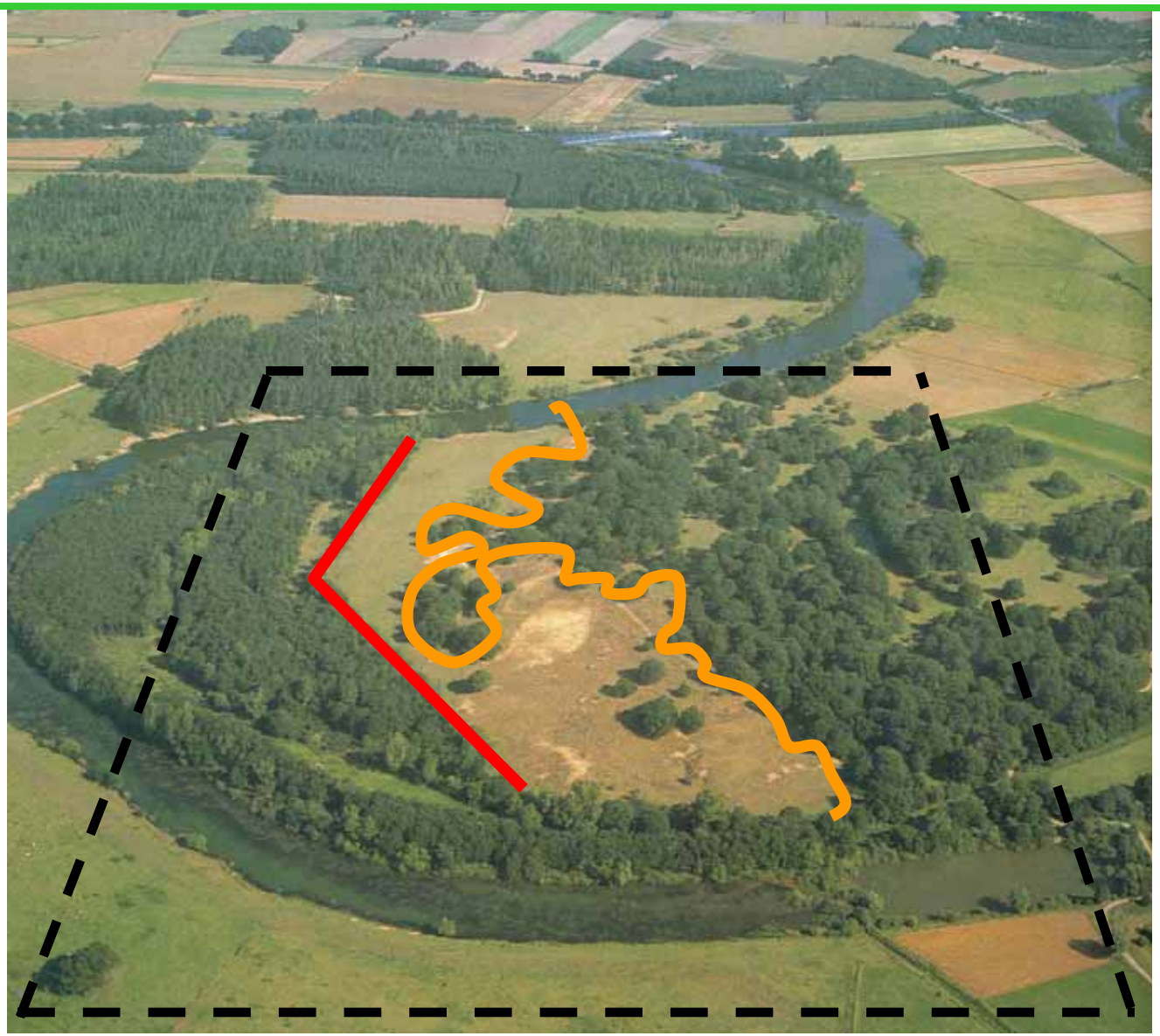
Systematic Mistake

– Underlying gradients may not be recorded

– Causes may be regularities in space or regular processes in time (seasons)



Spatial Sampling



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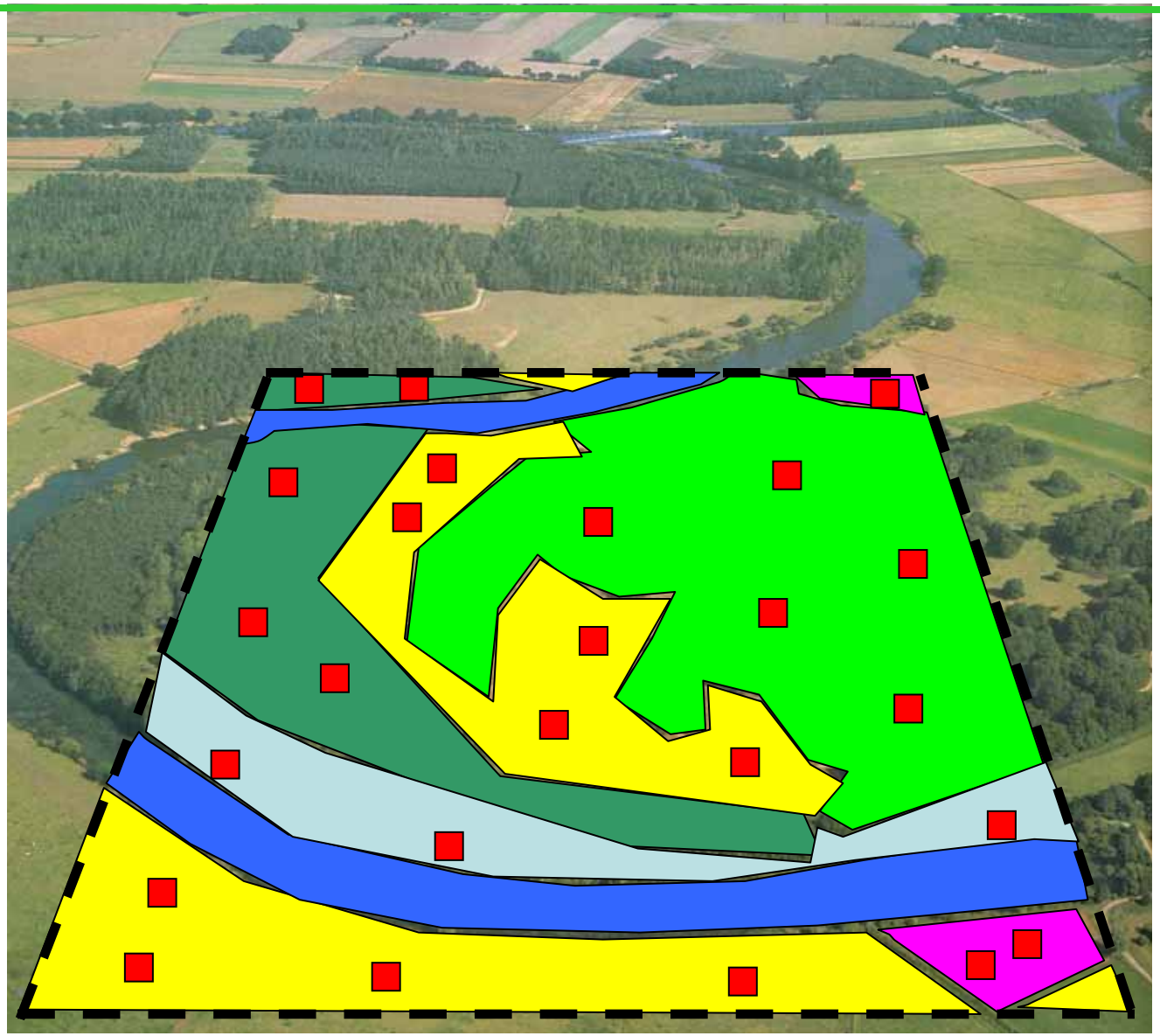

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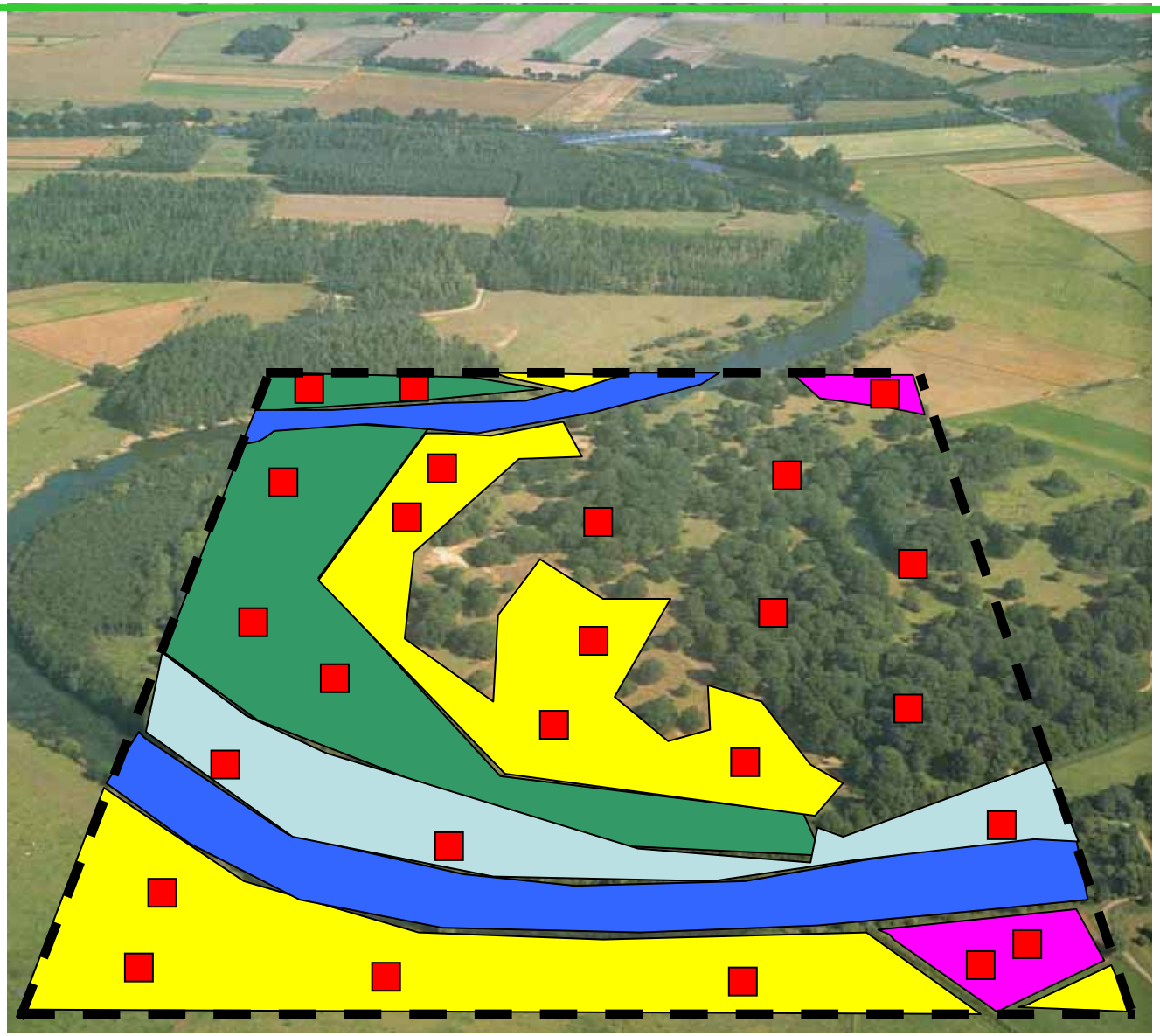

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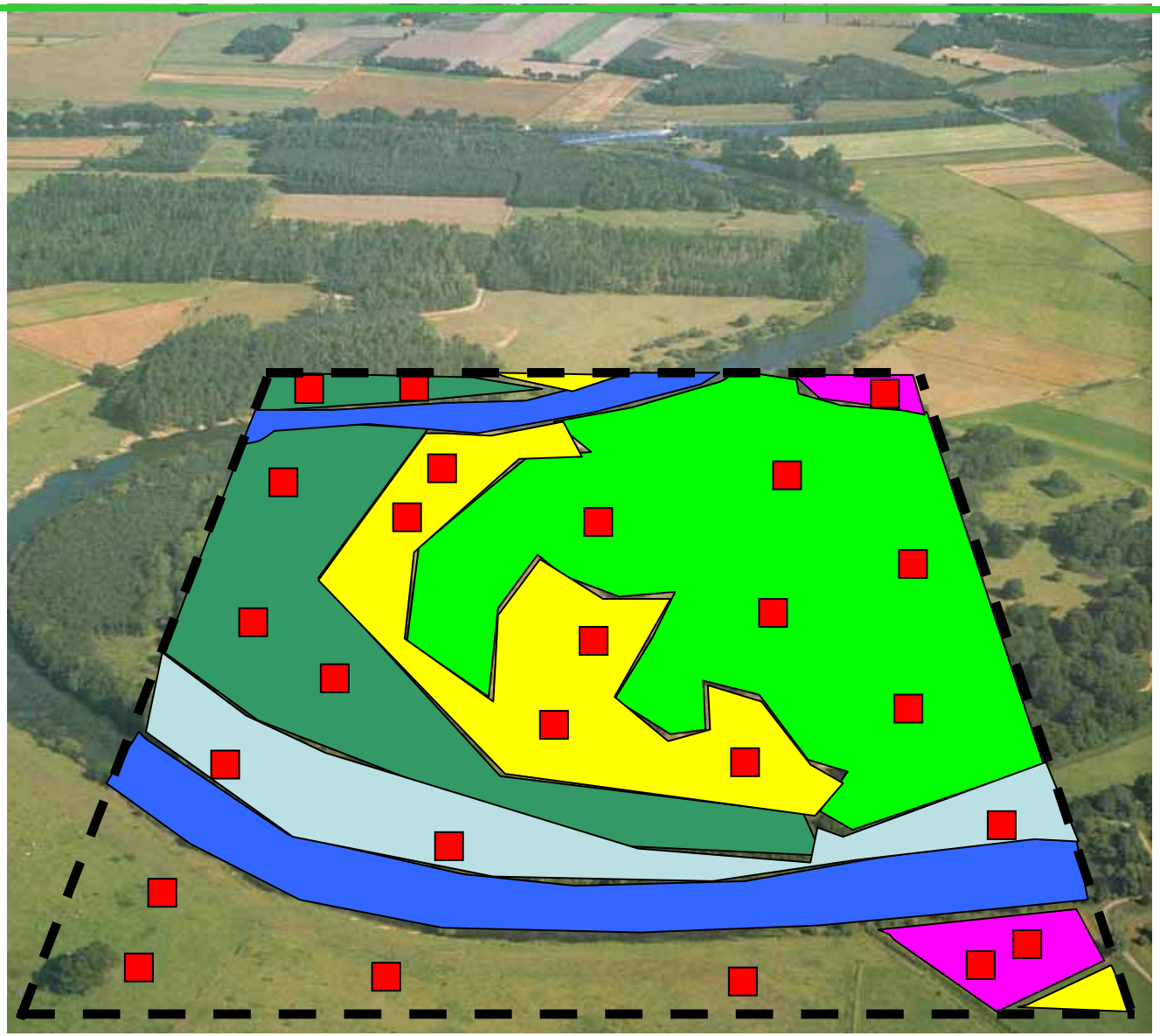
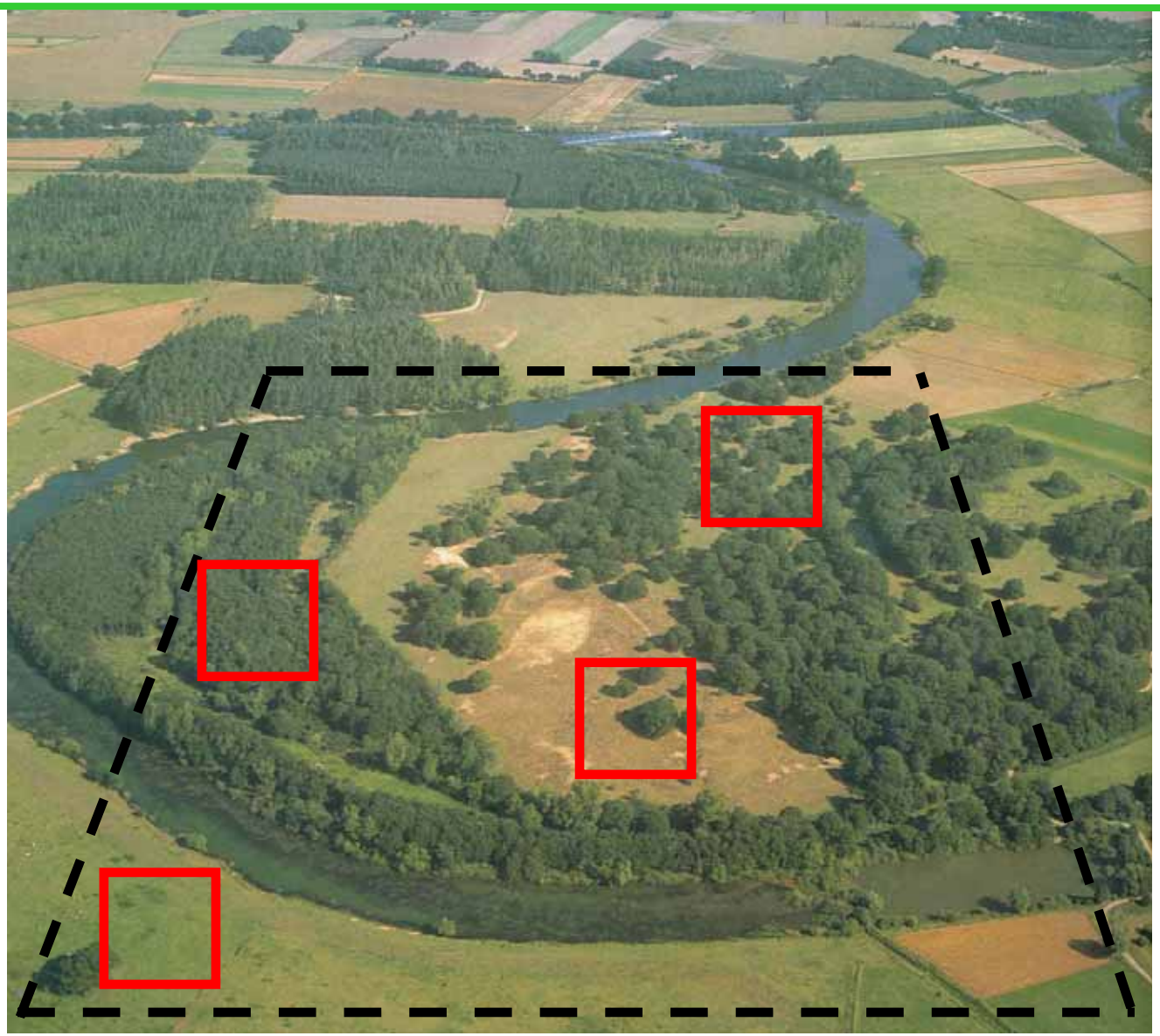


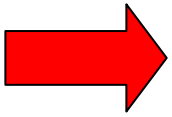
Spatial Sampling



Spatial Sampling

Sampling

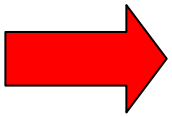
- systematic
- random



objective

but perhaps ignorant

- preferential



biased

but perhaps based on expert experience and knowledge

Heterogeneity

Heterogenity refers to a specific dataset (e.g. area, time). Considering this dataset as one unit, we may analyse the variability (range of data) within this unit.

Scales differ. We may relate heterogeneity to

a‘) one **specific plot**

b‘) one **area of investigation**

a‘‘) one **point in time**

b‘‘) one **time series**

Spatial Heterogeneity

Heterogeneity

„**Range** of dissimilarity between units within a dataset “

„Texture of objects“

Dissimilarity

„Variability (Difference) between **two** units (beta-Diversity)“

„Contrast between objects“

Pattern

„**Non-random** spatial or temporal organisation within a heterogeneous set of data “

„Arrangement of objects“

Distance Decay

„Everything is related to everything else, but nearby things are more related than distant things“

Waldo R. Tobler, 1970

Distance Decay

In functional geography (e.g. economic geography) **distance decay** is used as a term that may be quantified to indicate accessibility or the intensity of interaction between units or locations.

Distance Decay

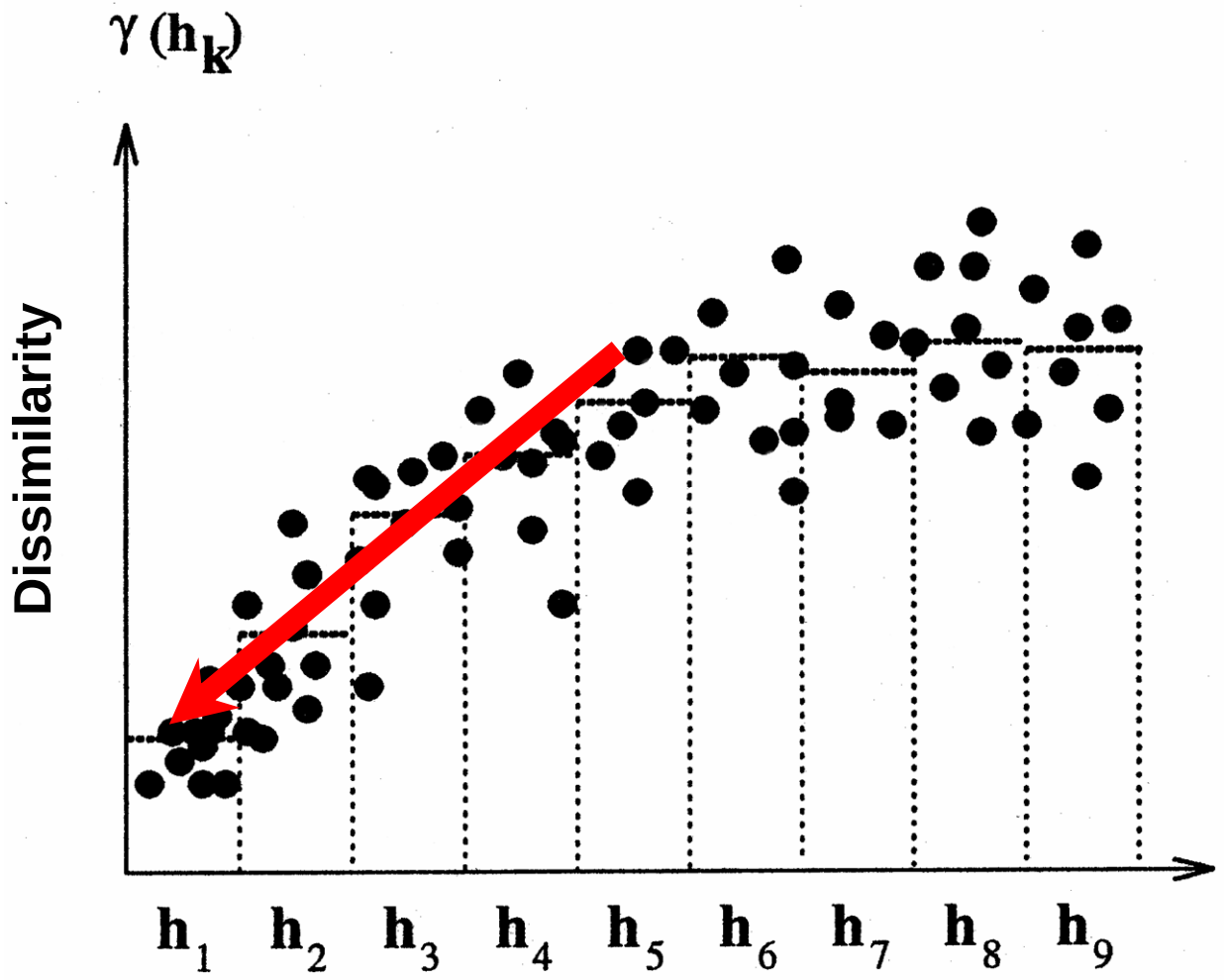
Thünen‘sche Kreise

Thuenen‘s Circles

Johann Heinrich von Thünen (1783 - 1850)

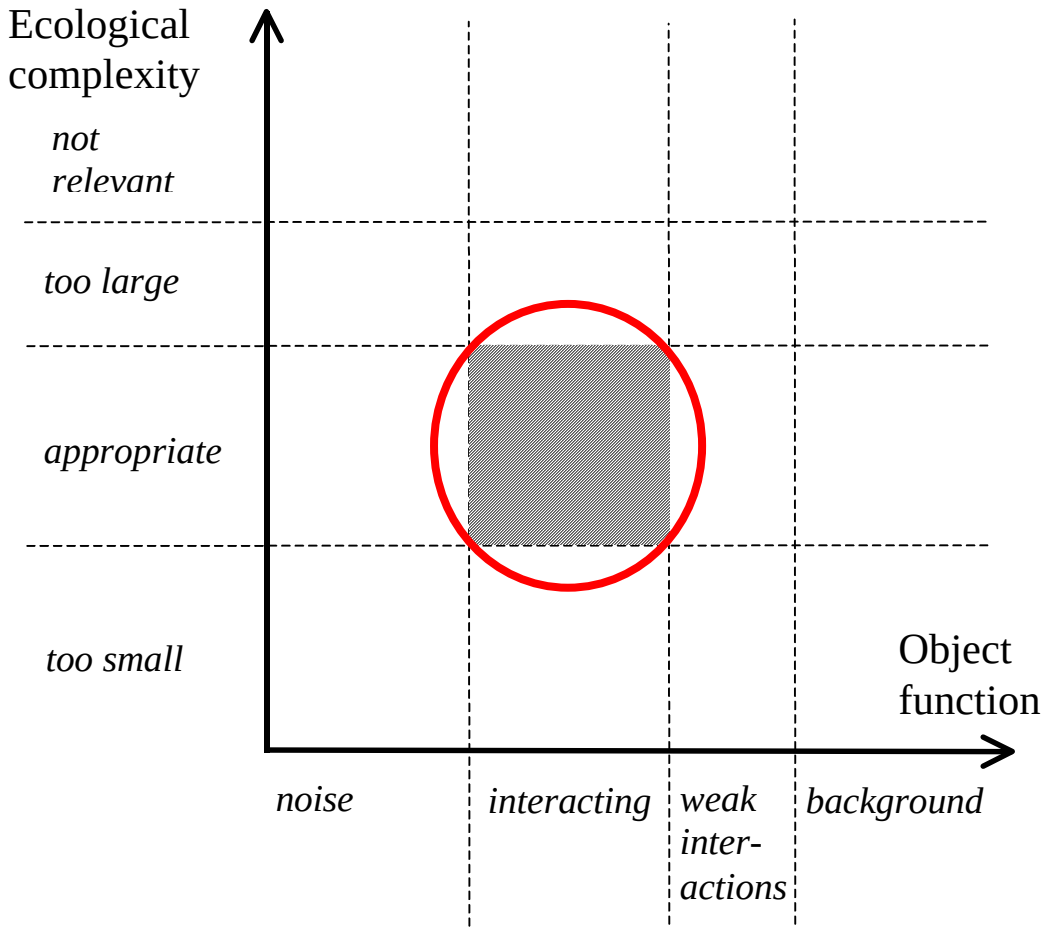
Developed the theory on spatial differentiation due to increasing distance (originally for agriculture and gardening). His concepts were adapted during the 20th century in spatial planning (eg. „Konzept der zentralen Orte“) and in economic geography.

Distance Decay

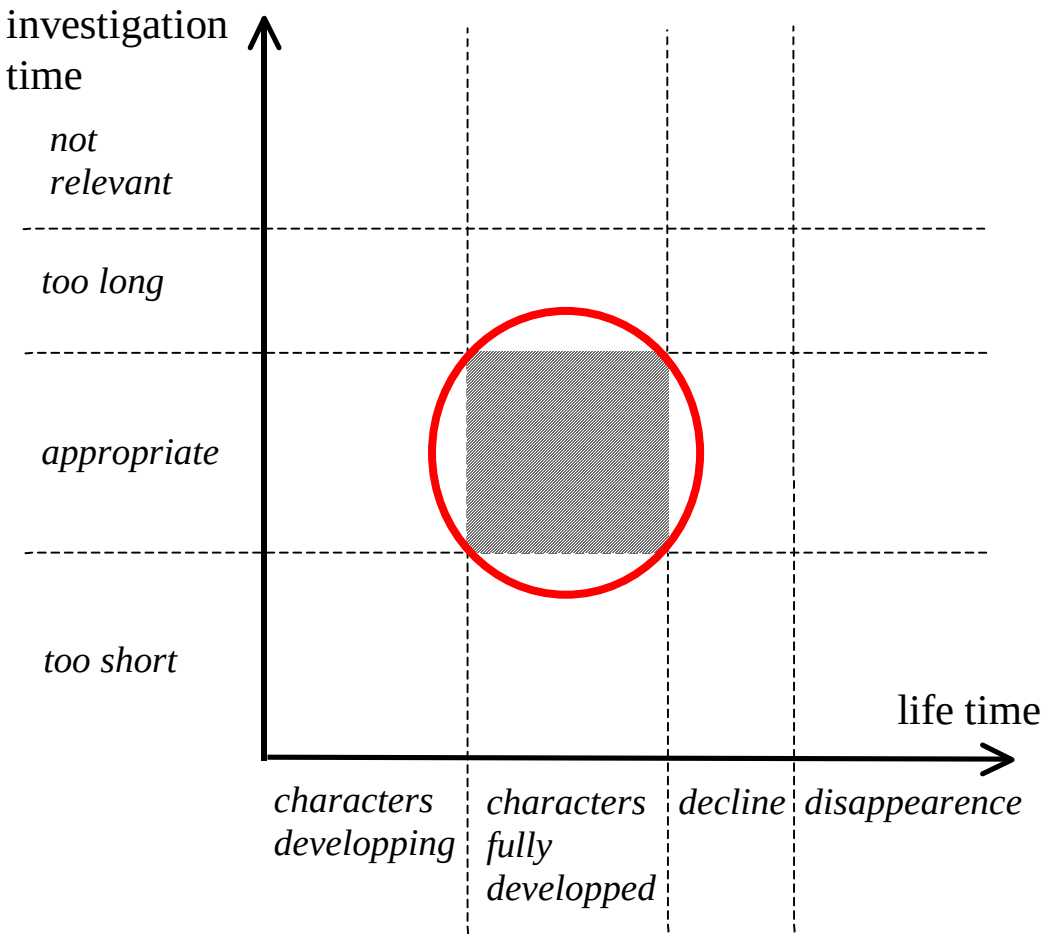


Wackernagel, H. (1995): Multivariate Geostatistics. An Introduction with Applications. Berlin, Springer.

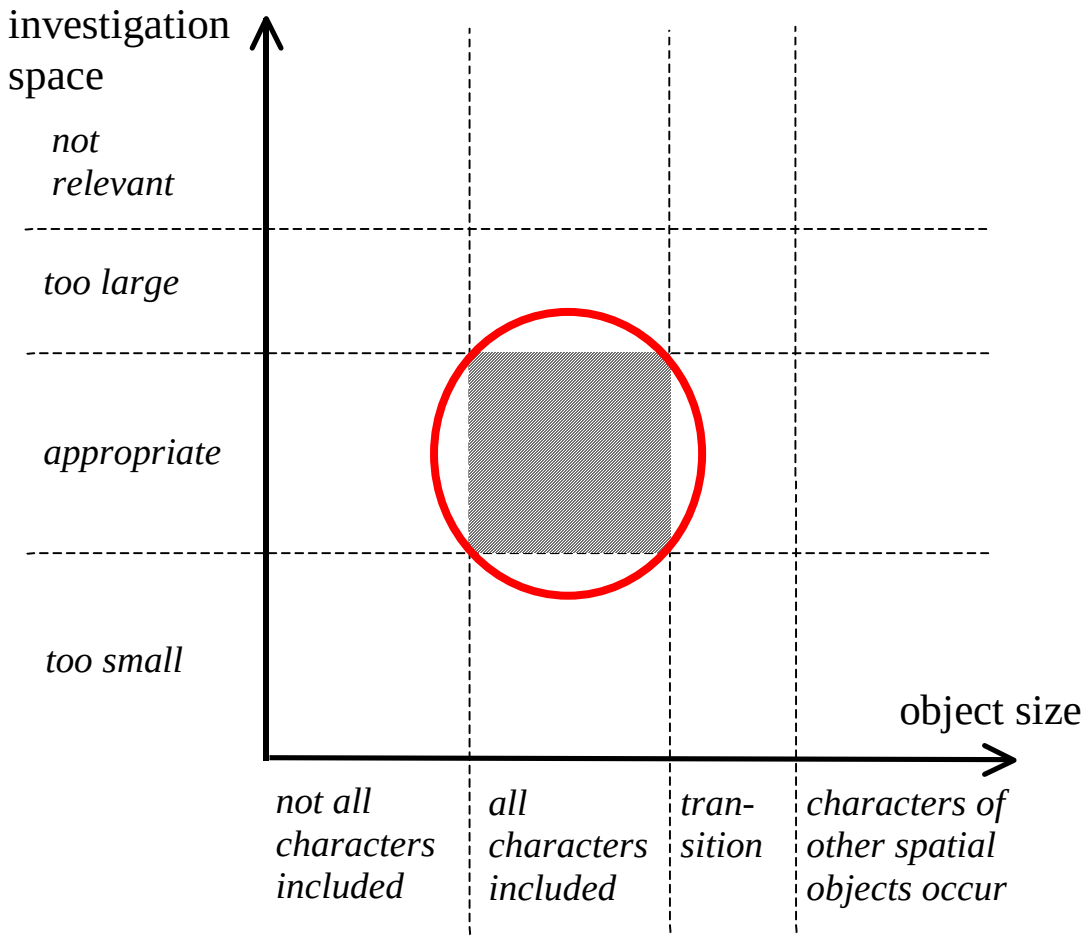
Ecological Scales



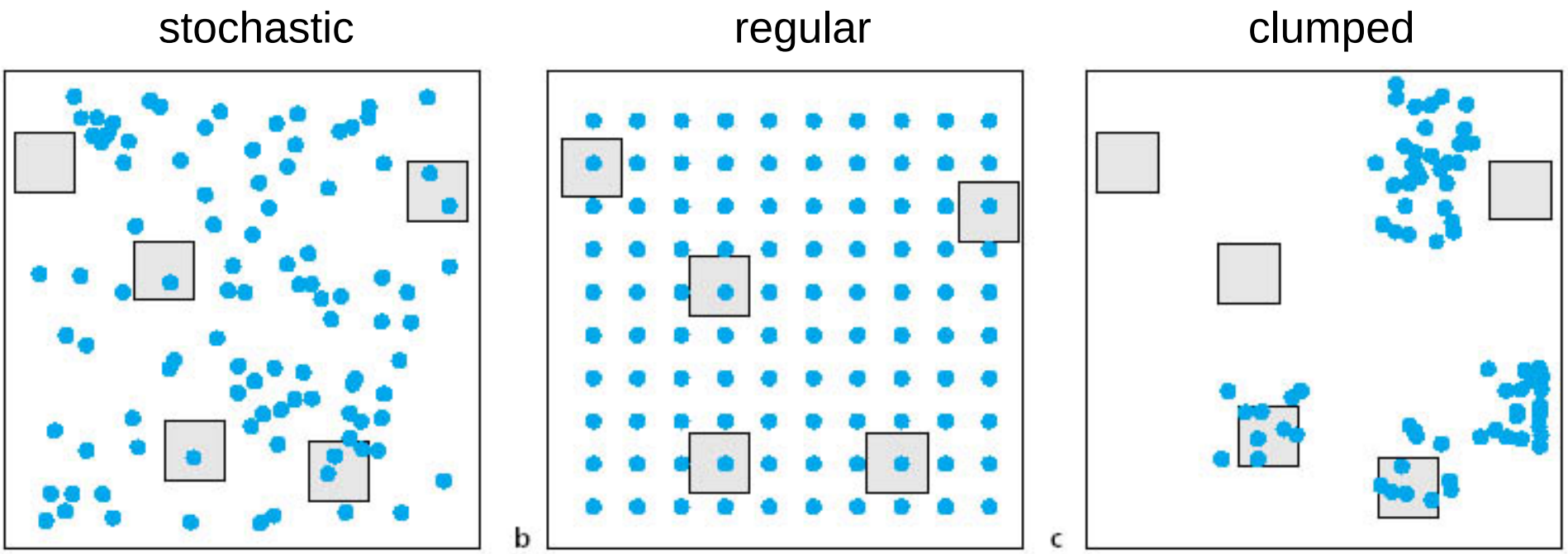
Temporal Scales



Spatial Scales



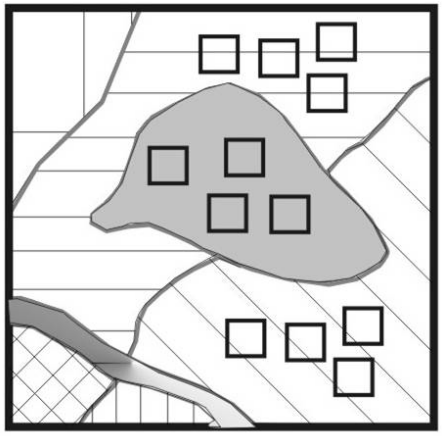
Distribution



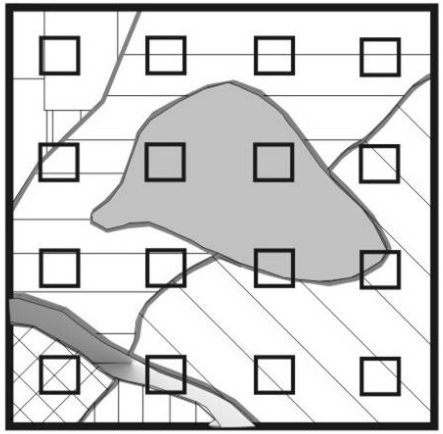
Clumped aggregates of units (species) may cause high variance in the data set.

Nentwig, W., Bacher, S., Beierkuhnlein, C., Brandl, R., Grabherr, G. (2003): Ökologie. Spektrum/Elsevier, Heidelberg.

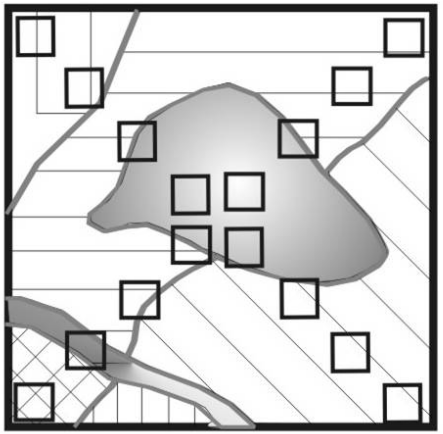
Distribution



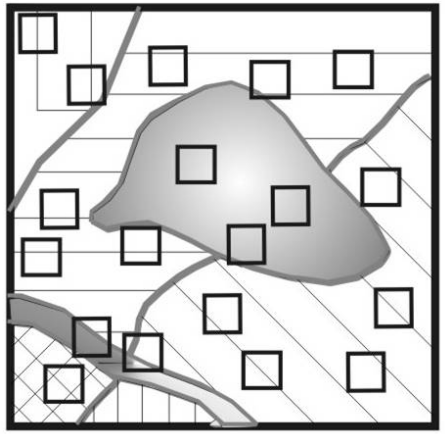
preferential



systematic



systematic

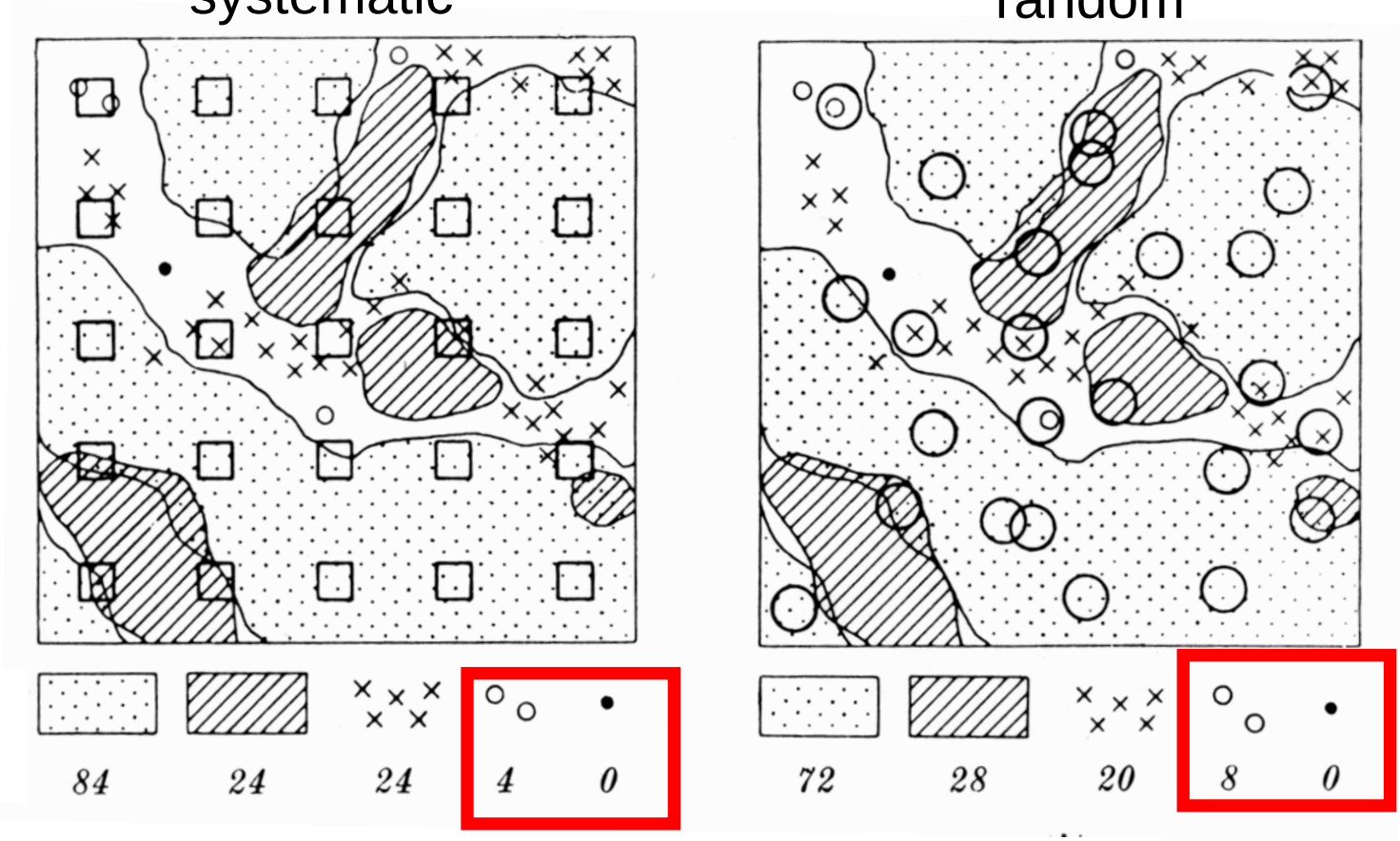


random

Distribution

systematic

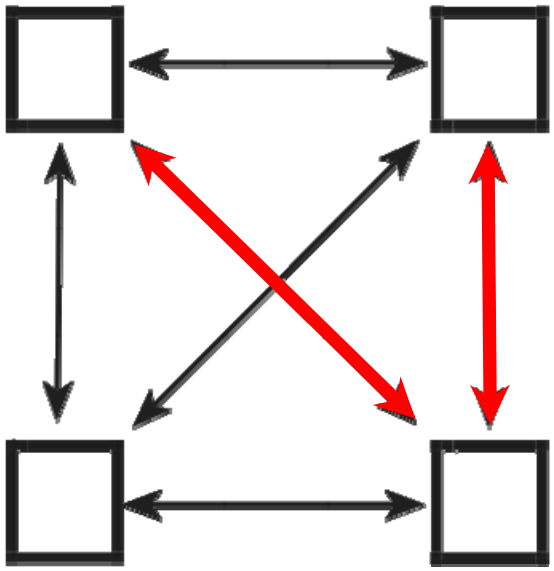
random



in %
of plots

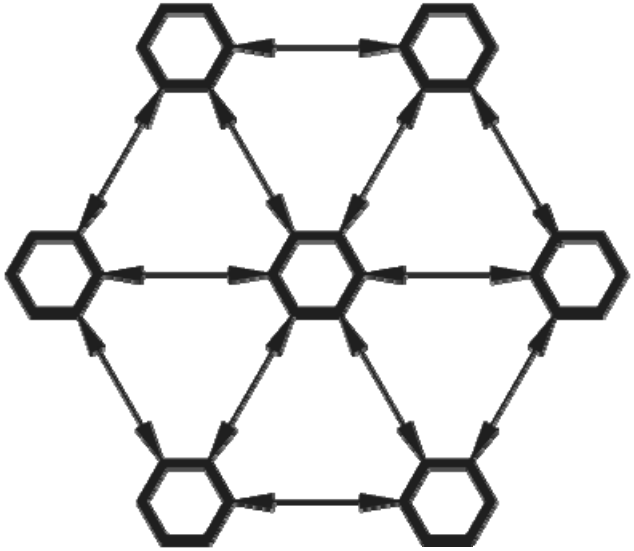
Small units show high variance in the data set

Distribution



- simple approach
- traditional

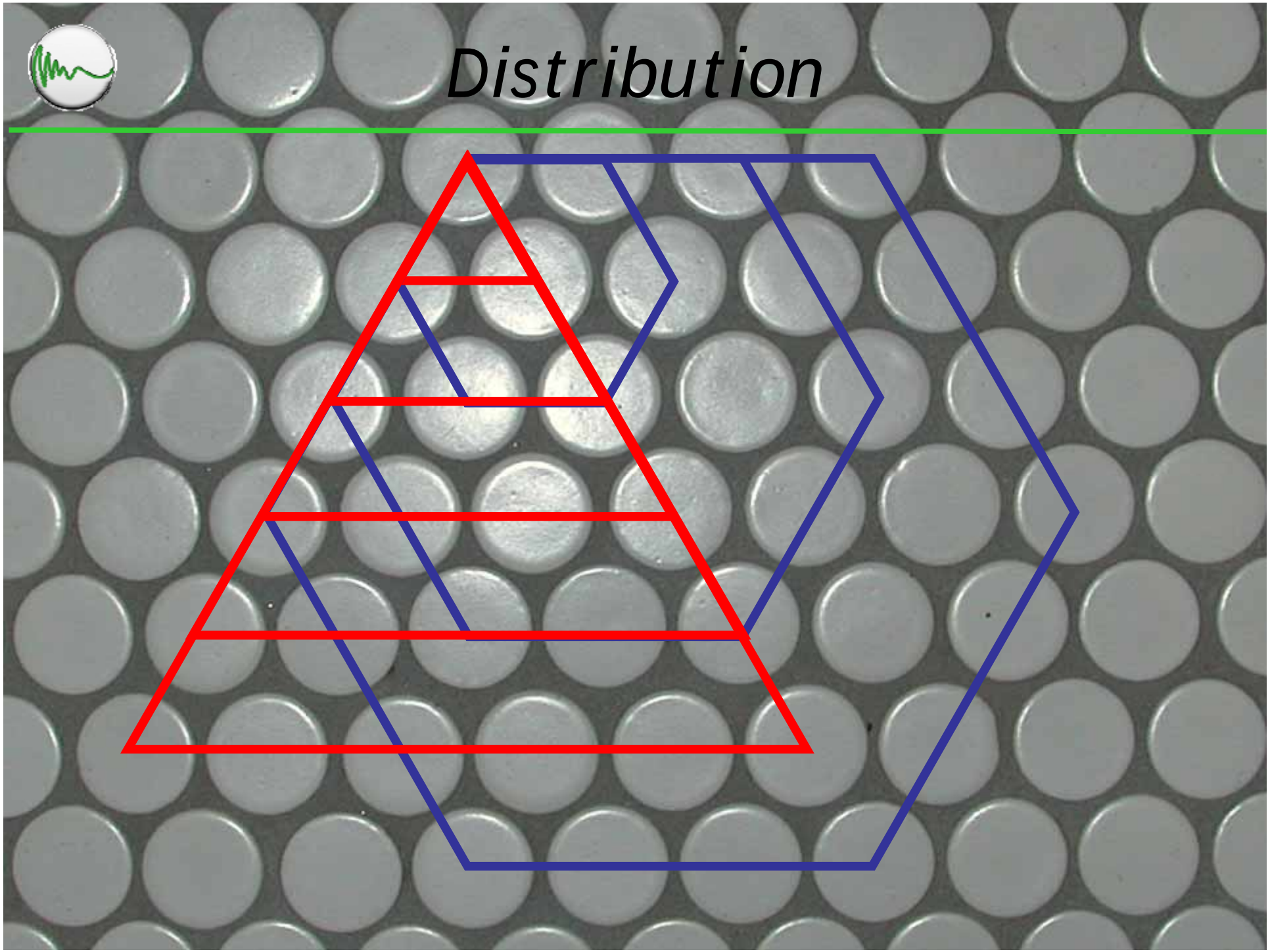
Good for assessments of **alpha-diversity** patterns and **gamma-diversity**



- equidistant neighbours
- no cross-similarities

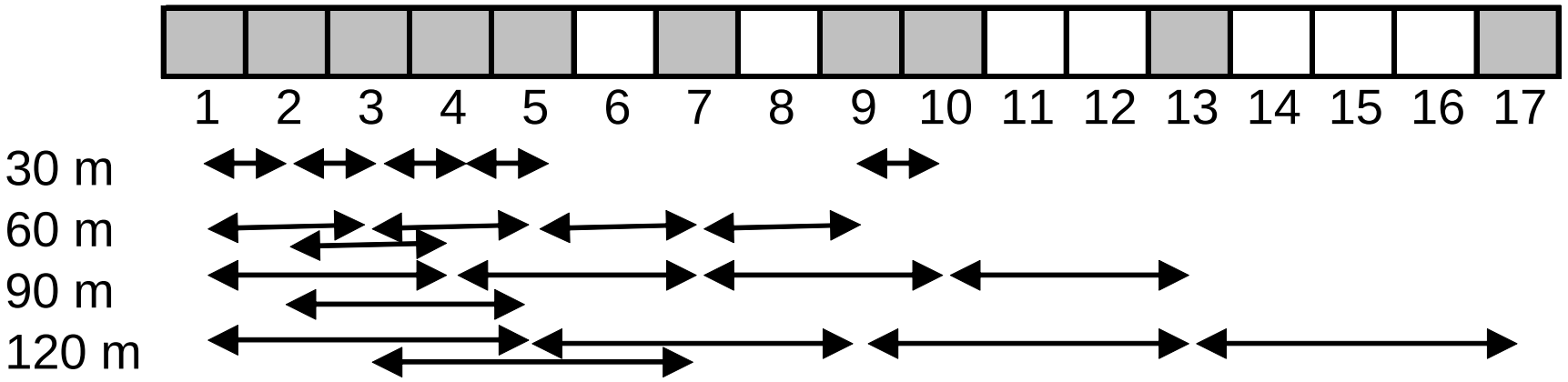
Good for assessments of **alpha-diversity** and **beta-diversity** patterns and **gamma-diversity**

Distribution



Cyclic Sampling

Case study of a „pre-investigation“



Target: Identifying minimum distances

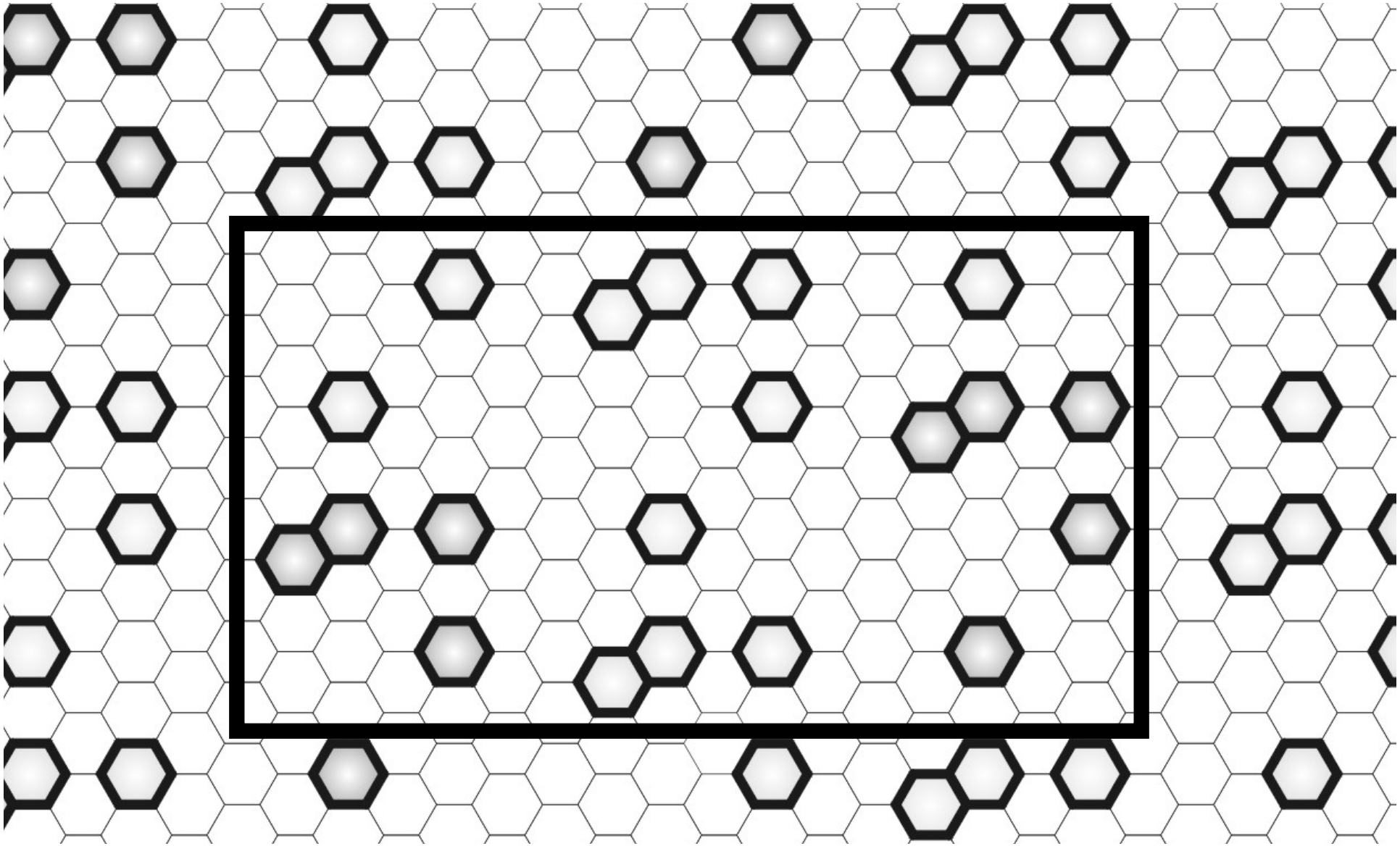
Hypothesis: Distance decay of similarity

Amount: 10 records

Groups: 5 pairs in 30, 60, 90 and 120 m distance

Result: 90 m most appropriate

Cyclic Sampling



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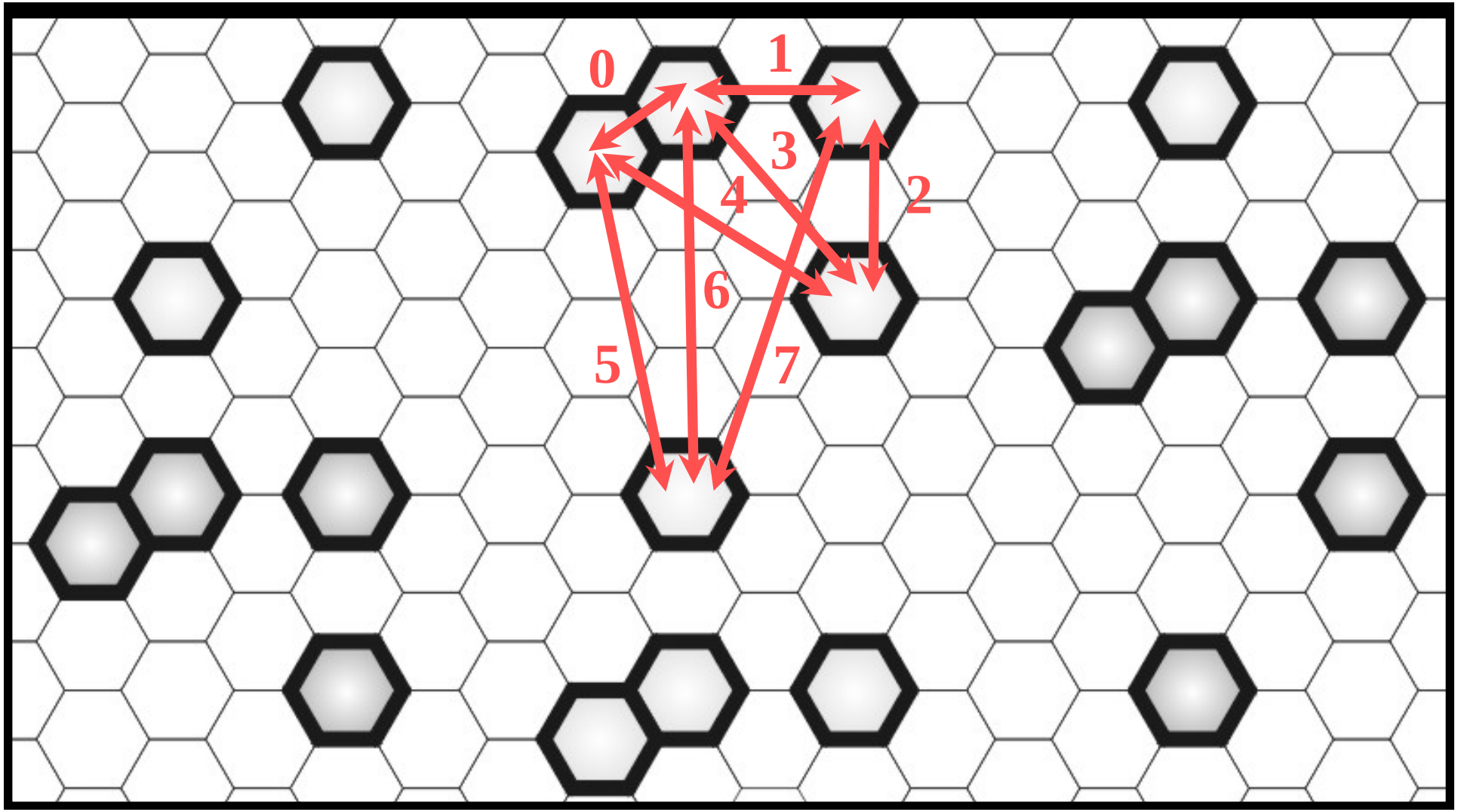

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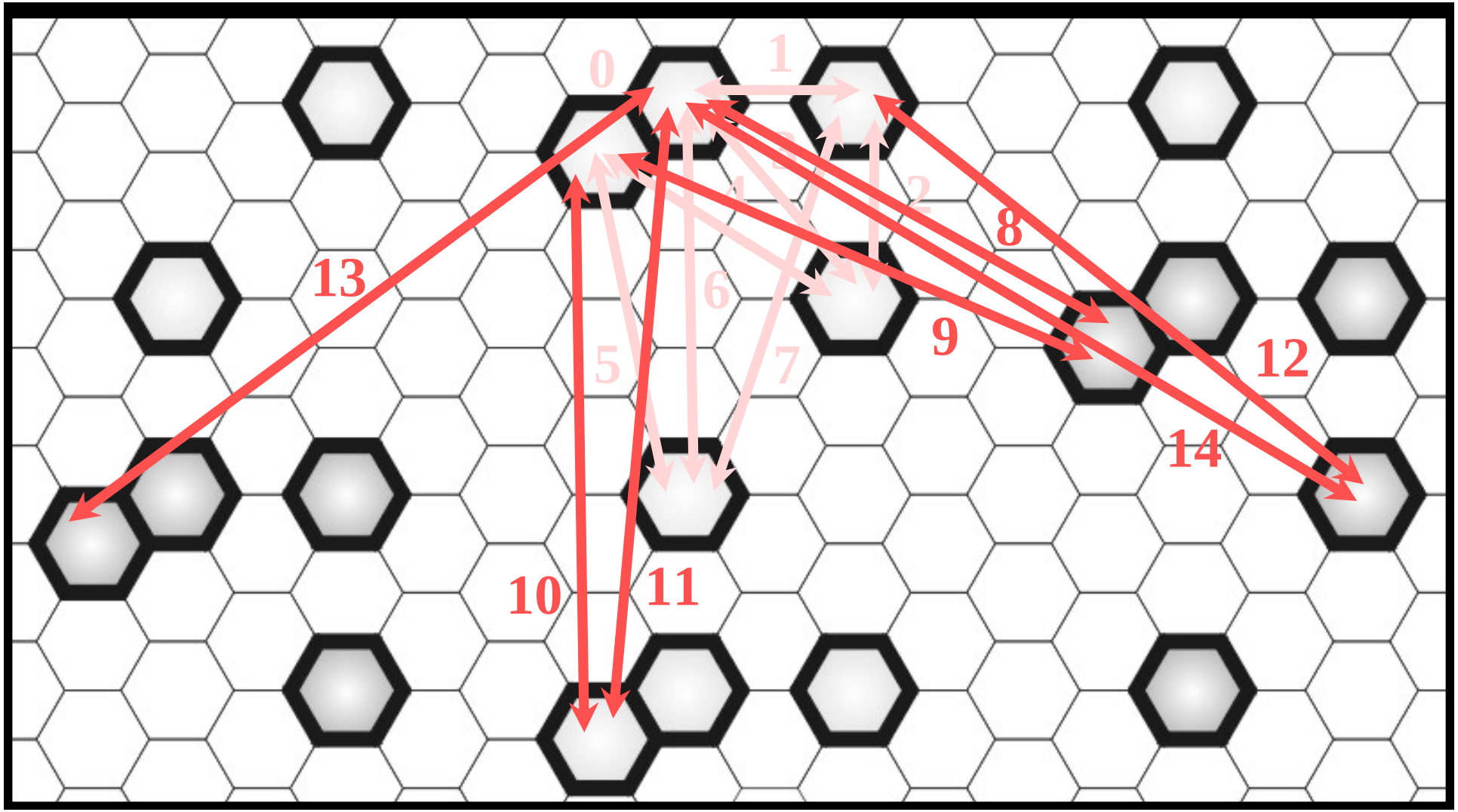
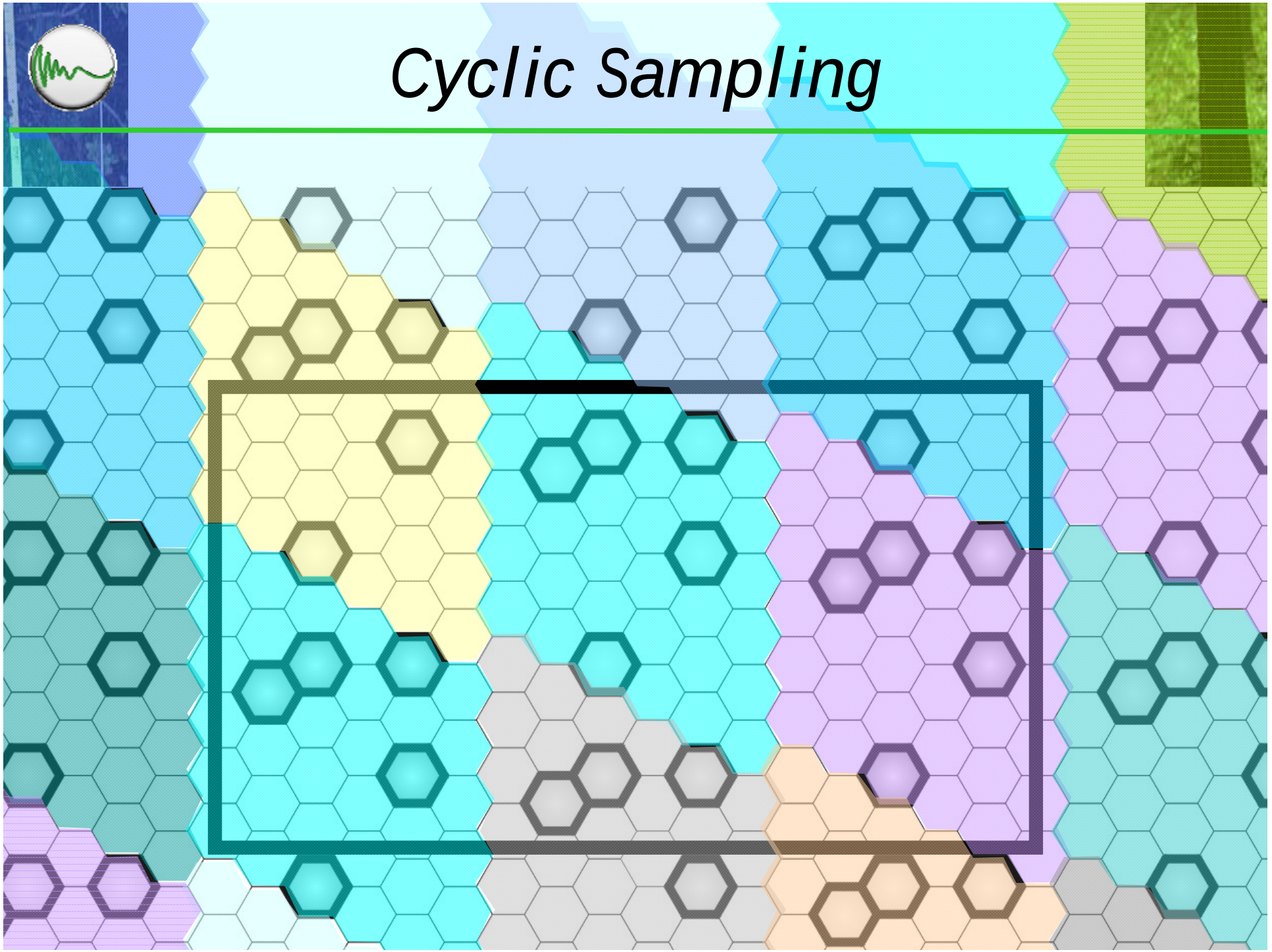
Cyclic Sampling