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Brandt, Jesper

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SMALL-BIOTOPE STRUCTURES AS A SYNTHETIZING FEATURE IN AGRICULTURAL LANDSCAPES

by Jesper Brandt

Institute of Geography, Socio-economic analysis and Computer Science, Roskilde Universitycentre, Roskilde, Denmark.

ABSTRACT

The amount, composition and pattern of small biotopes in the agricultural landscape (such as hedgerows, drainage dykes, marlpits and other uncultivated areas situated in the boundaries between the fields) can be seen both as a measure of the 'natural content' of the landscape, and at the same time as a mirror of the historical developed agricultural structure. So the study of small-biotope structures could contain an interesting possibility of using such structures as a synthesizing feature of agricultural landscapes for various purposes.

A regionalization of supposed small-biotope-related variables in Eastern Denmark has been tested by multivariate statistical analysies of 249 squares (of 1 km^2) of agricultural land evenly distributed in Eastern Denmark. The regionalization is only to a minor degree verified, and a typification of small-biotope-structures can hardly be drawn out of the material. Further studies remains to be done.

SCOPE

During the last years a lot of "hedgerow-studies" have occurred simultaneously in many countries. The main reasons for this development are different, but generally related to the growing need for and scientifically and technically better possibility of nature protection in agricultural landscapes e.g. by use of practical application of bio-geographical knowledge.

Drastical changes in the agricultural land use have reduced the extension of a lot of different types of small biotopes considerably, and the spread of other modern agricultural functionally related biotope types have only to a minor degree replaced the loss.

Allthough it might be possible and desirable for certain special types to try to conservate the single historically developed small-biotopes, the dynamics of the agricultural development makes it an unrealistic policy as a generel way of landscape management.

In Denmark, the principle has been introduced and accepted to landscape planners, that a solution might be a conservation not of the single biotopes, but of small-biotope structures as complex feature. Different types of patterns might be defined and descriped e.g. through certain area-densities of the relevant types of biotopes, defined expressions for the overall-connectivity etc., and a flexible administration is supposed to leave room for continued agricultural adjustment without destroying the principle structures.

Allthough modified, this perspective is fundamentally based on a biological conservationalist point of view.

Such small-biotope structures might however also be given a more production-related geographical interpretation: To a large extent, this pattern reflects the historically developed agricultural structure, and can in fact be seen as a mirror, or a sort of 'photographical negative' of the agricultural areal structure. How does this 'negative' relate to the development of agricultural areal structures? And does it really leave room for even this more flexible conservationist point of view just mentioned?

Within this complementarity the study of small-biotope structures could contain an interesting possibility of being used as a synthesizing feature of agricultural landscapes.

THE PROBLEM

A fundamental question in this context is, however, how far a historical developed relation between landscape classification (and regionalization) and small-biotope structures can be recognized at all. From a geographical point of view, the small-biotope structure can surely not nessessarily be seen as a historical developed integreted entity as far as it consists of qualitatively very different biotope types with their own structural and dynamical features, rather seldom

directly interrelated to each other. But if a landscape conservation strategy should integrate such principles, this strategy would in fact rely upon the supposed existance of such geographical extended small-biotope structures.

PREVIOUS WORK

Experience in this field can be drawn out of a comprehensive study of small-biotopes in Eastern Denmark, which has been carried through during the last years. The study cover a detailed survey of biotopes, their historical development and their relation to agricultural practise, carried through in 13 areas of 4 square km each . Methodologically the study has focused on classification of biotopes and the development of a relevant integreted database. So, the 13 areas selected are now used as test-areas for other sorts of landscape studies carried though at the Institute of Geography, Socio-economic Analysis and Computer Science, at RUC.

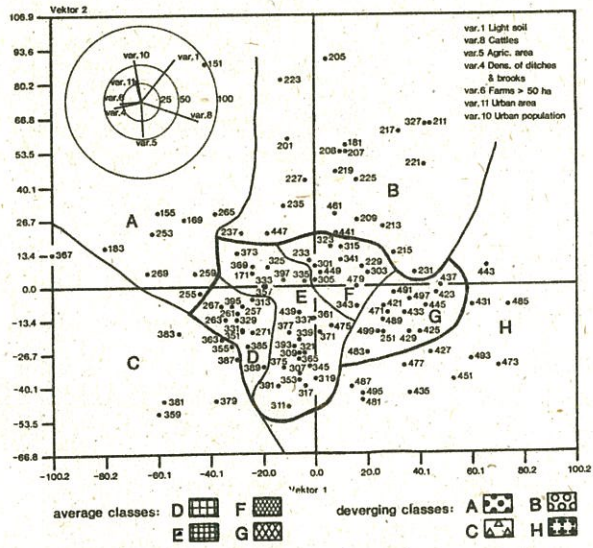
All this shall not be elaborated upon here. But a fundamental problem in these detailed studies has however been the selection of field study areas, and the problem of generalizing the results of the investigation. This part of the study is central for the scope of this contribution, and shall be elaborated further in the following.

Fundamentally, the development of
1) agricultural technology and structure is seen as the main force behind the development of the small-biotopes in the agricultural landscape. This is applied to a concrete landscape, say modified by
2) physical geographical components and
3) influenced by urbanization.

Within these 3 groups of conditions, already available statistical data on a municipal level has been selected to classify the involved 115 municipalities (with a total areal of 12722 km^2) concerning supposed equal in the general conditions for the development of small-biotopes. The data cover the percentage of cultivated area, holding size distribution, percentage of permanent grassland, cattle pr. km^2, distribution of soil types and accumulated lengh of brooks and ditches , density of rural and urban population and percentage of urban area.

A classification of the 115 municipalities was made by different multivariate statistical methods (principal component analysis and clusteranalysis). The final classification based on a projection on the plane given by the two first principal components is shown on fig. 1.

Fig. 1. Classification of municipalities in Eastern Denmark concerning supposed small-biotope-related variables, based on a PCA-vector 1-vector 2-plane, discribing 68.6% of the total variance. For interpretation purposes the projection of the variables best correlated (>0.25) with this plane, has been indicated in the figure.



– with signatures for the corresponding regions (see fig. 2)

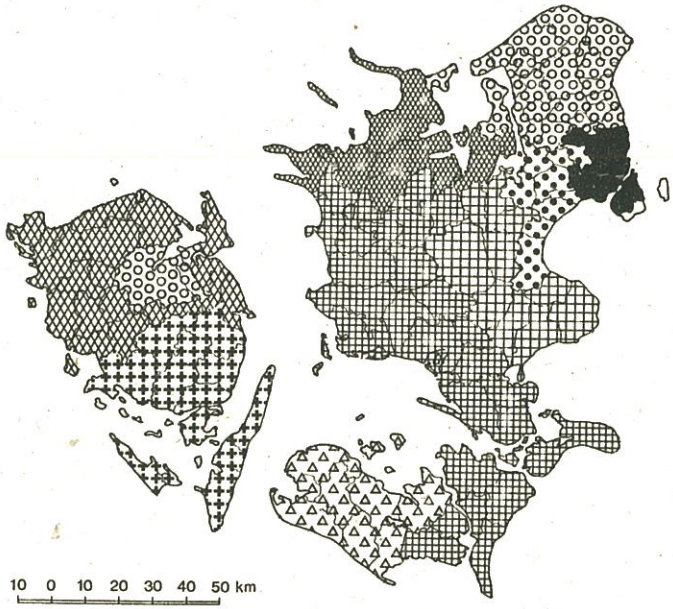
Of the eight classes recognized on fig. 1, four classes were discribed as variants of the average picture of all the municipalities ('average classes') and the rest represented more marked deviations ('deverging classes'). The geographical relevance of the classification was judged well-founded since a rather clear correspondence between the classification and a regionalization could be obtained, as shown in table 1.

The final regionalization is shown in fig. 2.

Table 1: Correspondence between classification and regionalization of municipalities in Eastern Denmark concerning supposed small-biotope-related variables. The classes correspond to fig. 1, the regions to fig. 2.

Region \ Class	A	B	C	D	E	F	G	H	Coverage (%)
1	9				1				90
2		22		1					96
3			10						100
4				7				1	86
5			2	1	24				88
6						8			100
7				1	1		10		84
8				1	1		2	13	76

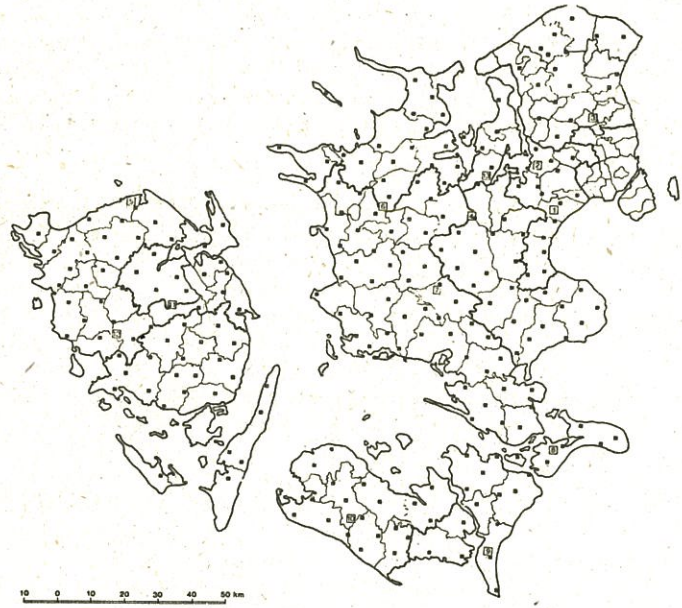
Fig. 2. Regionalization of municipalities in Eastern Denmark concerning supposed small-biotope-related variables.



For the following selection of field study areas, marked representative municipalities were selected within the deverging regions, and within the average regions average municipalities were selected. Within these municipalities field study areas has been selected by mapstudies as 'average representatives' for the regions. Those areas has been supplemented with selected representatives of landscape types at a large-scale level (such as rivervalley-buttoms, embanked areas, and dead-ice-landscapes) which was not yet included because the selection procedure was based on information on a regional scale.

Thus the field area selection procedure was guided by two probably conflicting purposes; first to secure a sample of

Fig. 3. 1 km^2-areas selected for testing the existence of different types of small-biotope-structures in Eastern denmark. 4 km^2-areas selected for detailed studies are also shown.



field areas, that according to supposed small-biotope-influencing conditions could be seen as representatives for Eastern Denmark, and second to secure that some main types of agricultural landscapes and landscape-developments would be represented.

Naturally a total overview of the amount and composition of small-biotopes in Eastern Denmark can only be extrapolated from this source in a very gross way. Neither can it be used for at statistical based typification of small-biotope structures.

THE MAP-BASED INFORMATION

So for that purpose, a sample of 249 square kilometer pixels evenly distributed over agricultural areas in Eastern Denmark has been used for a 4-cm-map-based registration of small-biotope signatures within the pixels. Their distribution is shown in fig. 3, together with the location of the areas for detailed field studies.

This has given an opportunity not only to test the regionalization of supposed small-biotope influencial conditions, but also to verify to which extent an autoclassification of small-biotope-structures can be drawn out of this source of information.

The 29 types of small biotopes recorded are shown in table 2. As in the detailed study they are devided into line-biotopes, quantitatively given by their length, and small patch--biotopes (defined as those less than 2 ha.), here given only by their numbers, within the squarekilometer of agricultural land.

In the search for an autoclassification they have been generalized on two levels; level 1 into 18 types, level 2 into 4 types.

A similarity-matrix for level 2 is given in table 3. It shows that the ingoing variables are allmost uncorrelated. The same goes for the similarity between the 18 variables described at generalization level 1: Here, the best, 0.46, is given between the lengh of covered and noncovered ditches. The second to best correlation is only 0.26.

Table 2. Basic data and generalization levels of the map-based registration of small-biotopes

BASIC DATA	GENERALIZATION	
	Level 1	Level 2
ditches, uncovered	ditches, uncovered	
brooks, uncovered	brooks, uncovered	
treerow by ditches	ditches, covered	wet line-biotopes
hedgerow by ditches		
treerow by brooks	brooks, covered	
hedgerow by brooks		
hedgerows		
treerow on dikes	hedgerows	
hedgerow on dikes		
slopes, uncovered		
treerow on slopes	slopes	
hedgerow on slopes		
constructions of raiway, uncov.	constructions of railway	dry line-biotopes
treerow on constr. of railway		
hedgerow on constr. of railway		
hedgerow by field roads		
hedgerow by other roads	roads, covered	
treerow by roads		
field roads, uncovered	field roads, unc.	
other roads, uncovered	other roads, unc.	
dikes, uncovered	dikes, uncovered	
small ponds (<0.5 ha)	small ponds	
small lakes (>0.5 ha)	small lakes	wet patch-biotopes
bogs	bogs	
woodlots (deciduous)	woodlots	
small plantations (coniferous)		
small pits	small pits	dry patch-biotopes
solidary trees	solidary trees	
grave-mounds	grave-mounds	

Table 3. Similarity matrix. Generalization level 2

		Line-biotopes wet	Line-biotopes dry	Patch-biotopes wet	Patch-biotopes dry
Line-biotopes	wet	1.00	-.26	-.04	-.10
	dry	-.26	1.00	-.09	-.01
Patch-biotopes	wet	-.04	-.09	1.00	-.01
	dry	-.10	-.01	-.01	1.00

First, principal component analysies has been tried. They have unveiled a high degree of disorder of the material by the fact, that the first principal component traces a very low part of the total variance: In the level 1-PCA (18 variables) 9.4%, in the level 2-PCA (4 variables) 32.2%.

So, the PCA has not been useful for the classification. This has been done entirely by clusteranalysies. Here, the ingoing variables has first been ranked equally by relating all values to the highest score of each variable, which has been given the value of 100. So, as a figure of speech, all the squares are placed in a sort of "hypercube" with the variables as edges.

As similarity measure both distance and the angle given by the correlation has been used, with only slightly different results. The clusters based on the correlation measure are easiest to interpret, since they express qualitatively equally compounded biotope structures. Certain structures, such as areas with a generel very low content of small-biotopes can, however, be seperated out better by using distance as similarity measure.

The investigation is not yet finished, but until now, the results has not been very convincing concerning a verification of the existence of reasonable welldefined types of small-biotope structures in the Danish agricultural landscape, not to mention a regional extension of such structures. The regionalization of supposed small-biotope influential variables has no more been confirmed, allthough some of the clusters are almost exclusively represented in the most 'deverging' regions (the area SW of Copenhagen, and Western Lolland).

It has to be stressed that a hypothesis of correlation between landscape units and small-biotope-structure has not been thoroughly tested through this procedure: E.g. would it be important - and also rather easy - to analyze how changes in the size of the squares could influence the result. Fundamentally those more detailed forms of test would however presuppose a rather lange-scaled landscape surveying of chorological units, and such surveys has not yet been carried out in Denmark.

The study has however convinced me, that it would be a very

difficult task to try to create a typification of small--scale-biotope-structures for conservation purpose. But it will still be an important question to answer how different optimization principles (agricultural, conservational, aesthetic, recreational) can be related to the density and composition of small-scale biotopes in the rural landscape.

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