LAND USE DEVELOPMENT IN GREATER COPENHAGEN

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Magnussen, Jan and Wichmann Matthiessen, Chr.: Land Use Development in Greater Copenhagen. Geografisk Tidsskrift 75: 65-69. København, juni 1, 1976.

The paper attempts to elucidate the land use development within Greater Copenhagen during this century. Sequences expressing the intensification of use and the process of urban renewal are the objects of the analysis.

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One of the radical changes in man's environment during these decades is brought about by urban development. Urban growth is no longer only a result of the concentration of the population in towns but to a much greater extent it is caused by the still growing demand for urban land per inhabitant. Due to our increased mobility and the increase in land prices we are today willing and have to accept greater distances than before, which again makes the land requirements for many urban purposes a less critical value than before. Dense quarters with 200 pers./hectare are history now; instead the newly developed land shows multi-storey buildings with about 100 pers./hectare or single-family houses with 30-35 pers./hectare; resulting in a 7-fold increase in land requirements. Industry prefers one-storey plants, companies and institutions are built in open, green surroundings, our leisure activities demand sporting grounds, parks and recreational land, and the many cars need parking space near the home, working-place and shopping centre. It is therefore obvious that the requirements for urban land per inhabitant are a function of the growth of the GNP as demonstrated by Godlund (Sweden, 1965).

Until the fifties land for urban purposes was largely considered to be an unlimited resource. Rural land might be changed to urban purposes with increasing demand. An intensified use would also give a profit which was not questionned by anyone.

Today the situation has changed due to two things: the land requirements are now at a level that makes it necessary to save the open land and to plan even for farming purposes, as it has also been considered by the legislation (1969, 1973, 1975, and 1975). When new land is changed into urban purposes, it goes through a legislative, economic, and physical development which apparently has only one goal: intensification. As a restoration to the original stage is extremely difficult and expensive, the demand for appropriate planning is very high. This paper attempts to elucidate the land use development within Greater Copenhagen during this century.

The coding system

The American Albert Z. Guttenberg has advocated a theory on urban structure and uses it to explain how an abstract world of economic and legal relationships is translated into an actual world of physical structures and sense impressions (Gutenberg USA, 1959 and 1965).

What we try to elucidate here is the part of urban growth which is actually manifested in physical structures, i.e. part of the material effect of urban growth and only the one registered on topographical maps. The classification system is designated partly to describe the kind and quantity of available land at different times and partly to be applicable in practice. The main groups in the code system are shown in table 1. The system distinguishes between rural and urban environment. The urban one is divided according to the degree of development in the way that one group describes land without permanent structures and the remaining four describe land with buildings of different kinds. The built-up areas are then described more specifically and grouped into land with buildings for dwellings and with buildings for special purposes. The residential land is split up into two classes, one with low and one with tall buildings (both again sub-classified into dense and dispersed use. The land with specialized buildings is also classified into two groups, one with institutional buildings and one with production buildings. Although the class descriptions apply terms which do not directly describe physical conditions, the distinguishing is conceived as describing real differences in physical structures.

Table 1. Land Use in Greater Copenhagen (%).
Arealbenyttelsen i Storkøbenhavn (%).

Code	1900	World War I	World War II	Late Sixties
1. Rural (incl. undeveloped land)	91	85	74	60
2. Urban, without permanent sturcture	4	7	8	9
3. Urban, with low residential buildings	3	5	13	18
4. Urban, with tall residential buildings	1	2	3	8
5. Urban, with specialized buildings (institutions)	1	1	2	2
6. Urban, with specialized buildings (production)	0	0	1	3
Total	100	100	101	100

The sample

The study area, named by local authorities, Greater Copenhagen, comprises 762 km² and correspond to the area within which much of the urban growth has taken place. The 1 × 1 km cells of the Danish national grid have been used for the random sampling of 7% of the area. This sample is stratified by division of the area into 4 × 4 km blocks with one cell drawn from each block. The sample cells are regularly distributed between blocks but fully random within each block (after Haggett, USA 1963). Each cell of the sample has been subdivided into 100 hectares and the hectare has been chosen as the operational taxonomic unit. The sample consists of 4631 hectares.

Basis for the analysis

As a basis for the analysis, four periods were chosen: the turn of the century, World War I, World War II, and the late sixties. For each period the land use pattern has been registered by analysing the topographical maps from the period. As Greater Copenhagen comprises about 25 map sheets at a scale of 1:20.000, they are not contemporary. In practice no map series exist with all sheets surveyed simultaneously, but the here applied maps are from series made within an acceptable period of years. The turn of the century is thus shown by maps from 1897-1901, World War I from 1913-15, World War II by maps from 1945-51, and the late sixties by maps from 1966-68. Examples of the last three map series are shown in black-white reproduction in fig. 1. By describing the urban development by means of four map series, one gets four static pictures of the land use pattern and the course of development for each of the 4631 described hectares.

Main results

Table 1 shows the relative distribution of the land use classes for the four analysis periods. At the turn of the century only 9% of the analysis area was occupied by urban uses, against 49% in the late sixties, or — to put it in another way — at the end of the sixties we have used one third of the area reserves which were available c. 1900. To this should be added that the vigorous area expansion experienced during the last decade has not been included due to the lack of maps for the period. Furthermore, it deserves notice that the residual, here called »rural use« a.o. comprises all land that is not used for urban purposes.

Table 2. Urban Use in Greater Copenhagen (%, (ha)).
Urban arealbenyttelse i Storkøbenhavn (%, (ha)).

Code	1900	World War I	World War II	late Sixties
2. Without structure	41 (2929)	44 (4953)	29 (5710)	23 (6796)
3. Residential with low buildings	33 (2337)	35 (3900)	48 (9445)	44 (13022)
4. Residential, with tall buildings	16 (1102)	12 (1316)	13 (2633)	19 (5710)
5. Specialized buildings, (institutions)	7 (461)	6 (728)	6 (1152)	5 (1497)
6. Specialized buildings, (production)	3 (214)	3 (362)	4 (708)	8 (2468)
Total	100% (7043)	100% (11259)	100% (19648)	100% (29493)

Especially housing is a rapidly increasing land use category. Table 1 shows that at the turn of the century housing occupied about 4% of the area and not less than 26% in the late sixties. From table 2 it further appears that about World War I and World War II the growth was the greatest for low residential use which also shows an increase towards the end of the sixties, whereas the area with multi-storey houses more than doubled during this period. This matches with the well-known boom in one-family houses experienced during the sixties, although some of the urbanization occurred outside Greater Copenhagen and has been excluded of this analysis.

World War I | World War II | Late sixties

Fig. 1. The Glostrup example. The development for a selected square kilometer approximately 10 km from the centre of Copenhagen. First map: mainly farmland and gardens. Second map: half of the land has changed into urban use with one-family houses. Third map: almost all land is now occupied by one-family houses.

Fig. 1. Glostrup eksemplet. Her er urbaniseringsforløbet vist ved tre sort-hvide gengivelser af en enkelt kvadratkilometers udvikling fra ruralt miljø til forstad.

About the year 1900, land for specializes use only occupied 1% of the analysed area. Of this 1%, two thirds were occupied by institutional land use and one third by production land use (industry). Towards both World War I and II the space requirements by the two categories increased, but at the end of the sixties we see a heavy growth of land for specialized production purposes. From table 2 it appears that this type showed the highest relative growth, an increase of 12 times from 1900 until the end of the sixties, i.e. that relatively the growth of industrial areas was twice as great as the increase in residential areas. Furthermore, it should be noticed that in the sixties industrial land occupied twice as much area as institutions, — of the urban land with specialized buildings — whereas the opposite was the case at the turn of the century.

The slowest growing land use category has been urban land without buildings i.e. parks, allotment gardens etc. even though this category has doubled since 1900. Simultaneously, urban use has increased more than 4 times however, so the share of the total urban land is almost halved (23% at the end af the sixties against 41% at about 1900). This relative decrease in the extent of unbuilt urban land corresponds to a minor growth of urban land with specialized buildings for institutions and industry (from 10-13%) and the vigorous growth in residential land (from 49 to 63%).

To summarize, with a 4-fold increase of the urban land of Greater Copenhagen from 1900 till the end of the sixties, a situation has arisen where land reserves for urban purposes must be considered exhausted, if the open character between the different urban units should be preserved. At the same time the growing habitation and specialization of the existing urban land influence the flexibility within the town and deteriorate the quality of life.

Together this means that changing and increasing land requirements in the Copenhagen area will only be possible to fulfill by planning new urban areas outside the analysis area, and/or through change and renewal of already built-up areas. The first possibility has been considered by the regional planners (Copenhagen, 1971-74), who are now working with a much larger area, 2853 km² against the 762 km² of the analysis area.

The second possibility, urban renewal rewuires additional research, as a change in land use often means expensive clearings and rebuildings. By investigating one single area it will here be attempted to elucidate to what extent the land use changes can be identified which have taken place from the turn of the century up to the end of the sixties. The rough classification which can be established on the basis of topographical maps will be used.

The Glostrup example

In fig. 1 the land use development is shown for a selected square kilometer which has undergone a development from agricultural land with a few houses along a main road to one-family house quarters almost everywhere. In the intermediate time a large part of the area has been used for gardens and horticulture. To illustrate the sequences the selected square kilometer will be described in detail, fig. 2.

The term 'development sequence' describes an evolution of land uses. A certain plot was originally agricultural land, then allotment gardens; after that it was parcelled out, lain first as vacant plots which were

later occupied by one-family houses. Here the development sequence was: agriculture; allotment gardens; vacant plots; family houses. When describing a development of this kind, the utility of the description depends on the available data and on the coding system. Both have been discussed above. It will then be a practical problem whether the available data are able to represent reality and the coding system can describe the development sequence. Only if each stage of development correspond with one of the map series, will it be described, and only if the differentiations in the classification system are precise, will the changes be recorded.

The sequence agriculture; allotment garden;vacant plot; family house was coded 1; 2; 2; 4. The Glostrup-example contains 20 different development sequences out of 1246 possible. The first 12 of these sequences comprise only one hectare each, whereas the last 8 sequences occur more frequently. In fig. 2 the development is shown for each hectare of the example. Since the turn of the century and op to the late sixties rural land has developed into an urban environment. During the interwar period, 10 hectares of agricultural land have been occupied by low family houses and similarly for other 39 hectares after World War II. The same development is seen for an additional 7 hectares (although they had an intermediate stage); 3 of the 7 hectares developed from agricultural land into urban developed land at the time of world War I and into low residential use at World War II, whereas 4 hectares developed as first described, only in a somewhat later time period. Other land developed from agricultural land into specialized purposes; this is due for 2 hectares circa World War I and 4 circa World War II, whereas 2 hectares were developed from rural land into urban land at World War I and were further developed with production buildings after World War II. Five hectares showed more complicated developments i.e. from low houses to a more intensive use: 3 hectares got multi-storey blocks and 2 hectares production buildings.

The Glostrup example is given to illustrate how the quantification of the development sequences were made. The sequences have not been submitted to data processing as a number of test problems can only be solved by proper land use investigations in the field, and these have not yet been initiated. Especially the representation problem of seldom occurring sequences demands comprehensive tests.

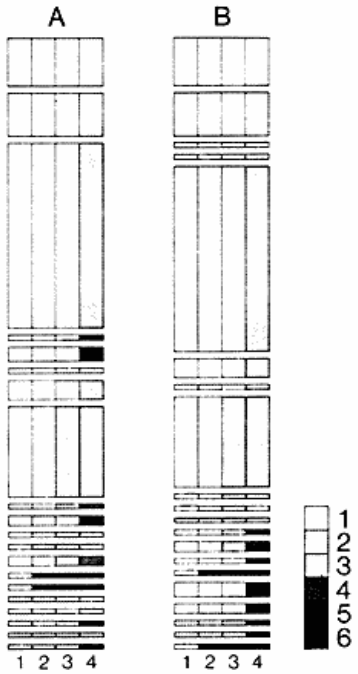

Fig. 2. Land use development in the Glostrup example. The two diagrams show the same, namely the development for each hectare since the turn of the century until the late sixties. Similarly developed hectares are grouped together.

Diagram A shows the groups classified according to land use about the year 1900, and in diagram B at the end of the sixties. The columns show the periods: 1 = turn of the century, 2 = World War I, 3 = World War II and 4 = late sixties. Signature numbers 1-6 correspond to the land use categories in table 1.

Fig. 2. Arealudviklingen i Glostrup eksemplet, se fig. 1. De to diagrammer viser det samme, nemlig udviklingen for hver enkelt hektar fra århundredskiftet til slutningen af tresserne. Ens udviklede hektarer er samlet i grupper. Diagram A ordner grupperne efter arealbenyttelse ved århundredskiftet, diagram B efter arealbenyttelsen i slutningen af tresserne. Kolonnerne svarer til perioderne: 1= århundredskiftet, 2= 1. verdenskrig, 3 = 2. verdenskrig og 4 = slutningen af tresserne. Signaturnumrene 1-6 svarer til arealbenyttelsesklasserne i tabel 1.

Development sequences in Greater Copenhagen

By summation of all sequences some of them appear to be common for Greater Copenhagen. The more seldom of them are often the most interesting ones, but the preliminary character of the material means that only the most common sequences have been included.

When examining the most frequent sequences, i.e. those occuring more than 10 times, cf. table 3, it appears that these comprise all the stable sequences, plus 22 showing a development and/or an intensification. However the last of the frequent sequences (family house; family house; family house; multi-storey blocks) illustrates an intensification which is based upon a foregoing clearing of already existing houses and construction of residential blocks on the cleared land. This sequence occurs in 11 cases. If this is representative, it means that 176 hectares of residential quarters or almost 2000 one-family houses have been cleared since the turn of the century until the end of the sixties to give room for approximately 8-10.000 flats.

Table 3. Important Use Sequences
Vigtige udviklingsforløb

	Hectares
1-1-1-1	2127*
1-1-1-2	143
1-1-1-3	203
1-1-1-4	132
1-1-1-5	16
1-1-1-6	98
1-1-2-2	74
1-1-2-3	39
1-1-2-6	13
1-1-3-3	269
1-1-4-4	32
1-1-5-5	16
1-1-6-6	10
1-2-2-2	59
1-2-2-3	44
1-2-2-4	10
1-2-3-3	45
1-3-3-3	71
1-5-5-5	12
2-2-2-2	95*
2-2-2-4	12
2-2-4-4	18
2-3-3-3	14
3-3-3-3	113*
3-3-3-4	11
4-4-4-4	63*
5-5-5-5	27*
6-6-6-6	12*

*) No change

Numrene 1-6 svarer til arealbenyttelsesklasserne i tabel 1.

To investigate other town renewal sequences, the total number of sequences were examined. It appeared that 79 hectares showed town renewal sequences, namely 35 different ones. These 79 hectares represent 2% of the analysis area, but 8% of the area urbanized with buildings at the end of the sixties. At the present time only the 100 hectares from the Glostrup example have been examined in greater detail and 5 hectares represented town renewal.

ACKNOWLEDGEMENTS

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RESUME

Urbaniseringsforløbets fysiske konsekvens er søgt dokumenteret for Storkøbenhavn. Arealbenyttelsesudviklingen fra ruralt miljø til urbant miljø med intensiveret benyttelse til følge, er derfor analyseret og de vigtigste udviklingssekvenser er beskrevet.

Analysens resultater findes i tabellerne. Analysen er gennemført ved at gøre arealbenyttelsen op til fire forskellige tidspunkter ud fra topografiske kort, se fig. 1. Tidspunkterne er: århundredeskiftet, 1. verdenskrig, 2. verdenskrig og slutningen af tresserne.

Opgørelserne er baseret på en 7% stikprøve, hvilket vil sige, at 4631 hektar er registrerede. Herved fås dels 4 statiske billeder af arealbenyttelsen i Storkøbenhavn, se tabel 1 og 2, dels 4631 udviklingsforløb, et eksempel er vist i figur 2, og de vigtigste sekvenser findes i tabel 3. Undersøgelsen, som ikke er afsluttet, tænkes at danne baggrund for studier af byvækst og byfornyelse.

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