

Work Session on Geographical Information Systems
(Ottawa, Canada, 5-7 October 1998)

Item 5 of the provisional agenda

**THE STRUCTURE OF A GEOGRAPHICAL INFORMATION SYSTEM
AT THE AUSTRIAN CENTRAL STATISTICAL OFFICE**

Submitted by Austrian Central Statistical Office ¹

CONTRIBUTED PAPER

¹ Prepared by Martin Weber.

ABSTRACT

For the **Combined Censuses** 1981 and 1991 it is possible by means of special outputs to create optional territorial aggregates based on the **smallest statistical survey unit, the building**. These aggregates are called **Project Areas** by the Austrian Central Statistical Office (ÖSTAT). At present, the formation of these areas is very time-consuming for the external user since, on the buildings level, no digitally available reference geometry exists. Only if each **building address** has a **co-ordinate value** as point of localization is the formation of individual reference units quickly and easily realized. In future, in collaboration with the Federal Office of Metrology and Surveying, it is planned to introduce co-ordinates for each building at ÖSTAT. As the data of the Combined Census and others are attached to the buildings, this is an economical solution for the creation of optional statistical output units.

I. INTRODUCTION

1. Geographical information systems (GIS) are ADP-programmes which deal with digital maps. All data banks stored within this information system therefore have a geographical reference. A GIS at ÖSTAT will naturally rely on statistical data. The options of these spacial references for statistical data are manifold. They range from administrative or statistical units to grid squares. Localization of data material on smallest areas as wards, blocks of houses, sides of blocks or even houses is necessary, particularly for detailed territorial inquiries.

2. At ÖSTAT preparations for the **Combined Census 2001** are going ahead (*the Combined Census consists of the Population Census, the Housing Census and the Census of Non-Agricultural Units of Employment*). There should be a great improvement concerning the output of data for small areas in comparison to the last census. The massive demand from the spacial sciences for data from the statistical offices also permitting regional small area analyses dates back to the sixties. The Scandinavian countries were amongst the first in Europe to begin the geographical localization of their census data on the basis of addresses. Also within ÖSTAT there was a discussion about introducing the storage of data on the basis of co-ordinates. But this was too expensive. Only during the last few years has the GIS software become so powerful and inexpensive that it can be used for regional statistics on a larger scale; this has resulted in an increasingly greater demand from many public and private institutions for statistical data for small areas.

3. For the Combined Censuses of 1981 and 1991 it is now possible to obtain spacial aggregates of optional size as special output based on the addresses of buildings. These areas of optional size are generally called **Project Areas** by ÖSTAT. At present, the formation of these Project Areas is somewhat time-consuming. Only if each address of a building has a co-ordinate value as point of localization is the formation of individual reference units quickly and easily realized by means of adequate GIS programs. The **buildings addresses** of the **Register of Buildings of ÖSTAT** therefore have to be **geocoded**.

II. GEOCODING OF BUILDINGS ADDRESSES

4. The data of the Combined Census of 1991 in Austria are stored according to buildings addresses but there exists no value for co-ordinates as points of localization for these addresses. The buildings addresses have only a geographical relation to the administrative or statistical areas. In Austria the simplest method is to take the point of localization from the Digital Cadastral Map (*Digitale Katastralmappe = DKM*) of the **Federal Office of Metrology and Surveying** (*Bundesamt für Eich- und Vermessungswesen = BEV*). Within ÖSTAT it is planned, with the support of the BEV, to **allocate co-ordinates to the buildings addresses** and thus also to the data of the Combined Census which are attached to the buildings. Preparation along these lines is under way for several selected communes.

II.1 Register of Buildings of ÖSTAT

5. The **Register of Buildings of ÖSTAT** offers itself as a **basis of a GIS** for statistical analyses since there exists not only access to the data of the Combined Census but the addresses are also maintained (see Fig. 1).

Fig.1: Extract from the Register of Buildings of ÖSTAT

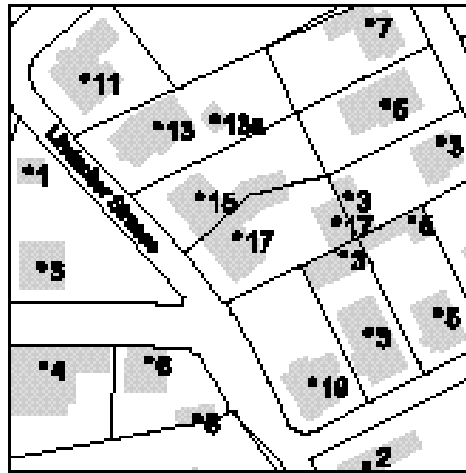
Object Number	Postcode	Streetname	House Number	Buildings	Dwellings	Inhabitants	Non-Agricultural Local Units of Employment
645001001	2800	Burgstr.	14	1	2	8	0
645021001	2800	Burgstr.	19	1	3	10	1

*Each building has an **Object Number** with 10 digits. It consists of an **Address Number** with 7 digits running through Austria from 1 to n and a **subnumber** for a building with 3 digits. From the data of the Combined Ccnsus only the number of dwellings, inhabitants (residential population) and Non-Agricultural Local Units of Employment is available for each building. To obtain other data from the Combined Census is only possible by means of the Object Number (see chapter III.2).*

II.2 Digital Cadastral Map (DKM)

6. The BEV started with DKM in 1987. The contents of this Cadastral Map are broken down into essential levels of information, e.g. boundaries of real estate, numbers of real estate, building areas, land use, fixed points and limit points. For geocoding it is important that these DKM-data have a **building area point** for each building area which lies within it (see Fig. 2).

Fig. 2: Part of a sheet of the DKM with building area, building area point and building address



II.3 Extension of the Register of Buildings to the building center co-ordinates of the DKM

7. The methodology for bringing together the addresses of the ÖSTAT Register of Buildings with the addresses of the DKM of the BEV is being worked out now. Only when this adjustment of addresses has been finalised will it be possible to complete the buildings addresses within the Register of Buildings with the values of the co-ordinates of the building area points (which correspond approximately to the center of the building area) (see Fig. 3).

Fig. 3: ÖSTAT Register of Buildings enlarged by the co-ordinates of the building area point

Object Number	Postcode	Streetname	House Number	Buildings	Dwellings	Inhabitants	Non-Agricultural Local Units of Employment	X-Co-ordinates	Y-Co-ordinates
1006033001	5110	Lindacher Str.	1	1	1	3	0	-28984.9	311344.5
1006034001	5110	Lindacher Str.	3	1	2	3	0	-28982.1	311324.1

If the X- and Y-co-ordinates of the building area points from the DKM are stored with the ÖSTAT buildings addresses, their geographical position is definitely fixed.

III. THE EVALUATION OF THE CO-ORDINATE FIXED COMBINED CENSUS DATA WITH GIS

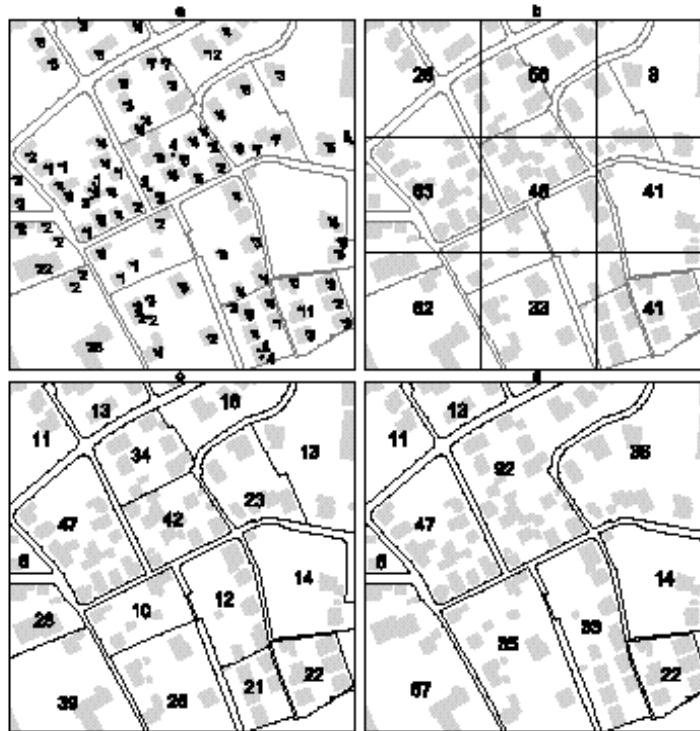
8. If an external user wants to make a statistical evaluation for Project Areas he has to order from ÖSTAT a diskette containing the Register of Buildings with geocoded addresses (see Fig. 3).

III.1 GIS evaluation of data contained in the Register of Buildings

9. As the addresses within the Register of Buildings are geocoded and connected to the number of dwellings, inhabitants and Non-Agricultural Units of Employment, the external user of a data bank is able to relate these data directly in the form of numbers (Fig. 4a) or in the form of signatures (Fig. 5a) to the respective building by means of GIS. There are no other statistical data from the Combined Census contained on this diskette for data protection and

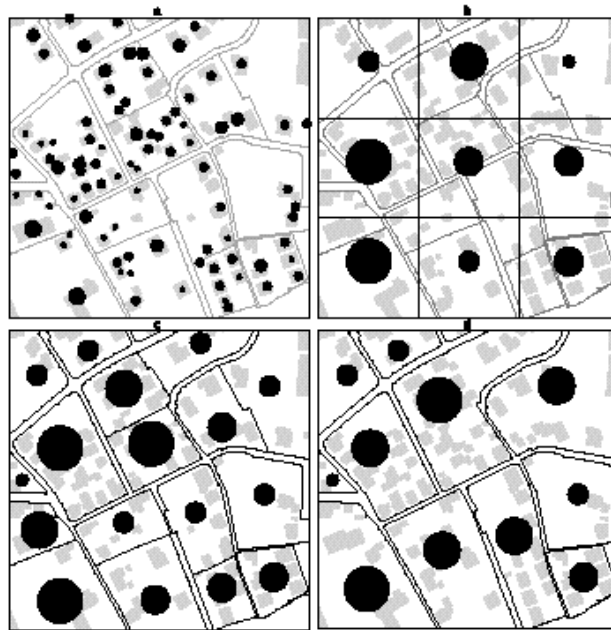
statistical confidentiality reasons (see chapter III.2).

Fig. 4: Number of inhabitants related to (a) buildings), (b) grid squares of 100 m side length, (c) parts of building blocks and (d) building blocks.



10. For many regional studies it is necessary to aggregate the buildings addresses and thus the statistical data to larger territorial units. Only those characteristics which are already contained in the Register of Buildings can be aggregated to Project Areas and presented cartographically by the external user (see Figs. 4b - 4d and 5b - 5d). The creation of Project Areas in the form of grid squares is relatively simple; the allocation of addresses to grid squares is performed automatically using GIS programs. Substantially more effort is required for the formation of the remaining breakdowns of Project Areas, e.g. blocks of houses or wards.

Fig. 5: Inhabitants related to (a) buildings, (b) grid squares of 100m side length, (c) parts of building blocks and (d) building blocks. In contrast to Fig. 4 the statistical data were not written into the map but presented in form of graduated circles.



III.2 GIS evaluation of the remaining data of the Combined Census

11. All data which are not contained in the Register of Buildings can be aggregated to the requested Project Area Units only by the detour of the Object number. Further steps of treatment are necessary. The data not contained in the Register of Buildings must be aggregated for data protection purposes. This means that such large areas have to be created by the external user that several buildings, inhabitants or Non-Agricultural Units of Employment are situated within them. To obtain data from the Population Census, the Project Areas have to contain at least 30 inhabitants. For data from the Housing Census, the Project Area has to contain at least 4 buildings, and for data from the Survey of Non-Agricultural Units of Employment, at least 4 of these units.

12. As the addresses in the Register of Buildings are geocoded, the delimitation of optional areas by means of GIS is realized comparatively quickly. At first, the external user has to delimitate the Project Areas on the basis of the DKM according to his imagination and under the restrictions of data protection. After the delimitation of the areas follows the allocation of the buildings addresses to the Project Areas. All buildings addresses situated within a Project Area are allocated to this Project Area by receiving the same **Project Area Number** (= *code for the Project Areas*). The external user then has to enter the Project Area Number into the first column in the Register of Buildings delivered by ÖSTAT (see Fig. 6). The diskette with the Register of Buildings with the Project Area Numbers added is then sent back to ÖSTAT. The external user then receives the statistical data for each Project Area Number but not for the single building addresses.

IV. GIS EVALUATIONS ON THE BASIS OF COORDINATES IN ÖSTAT

13. As owner of those statistical data which are attached to geocoded buildings addresses, ÖSTAT must produce small area statistical evaluations for external customers. The formation

of Project Areas in the form of grid squares is comparatively easy. The creation of other types of Project Areas (e.g. wards, blocks of houses) will, as a rule, have to be performed by the external user and not by ÖSTAT.

14. Apart from this small area, statistical evaluations are also needed for the whole country or, at least, for large parts of it. For a study concerning the whole country, grid squares of different size are most appropriate. The grid squares contain no gaps, are homogenous, cover the whole area and may be divided regularly and so are also independent of scale. ÖSTAT will have to offer certain standard maps for selected statistical data on the basis of grid squares (e.g. the distribution of population). Some digital bases for maps, e.g. streets, railways and areas of water, already exist in ÖSTAT.

V. CONNECTION OF THE REGISTER OF BUILDINGS WITH OTHER FILES

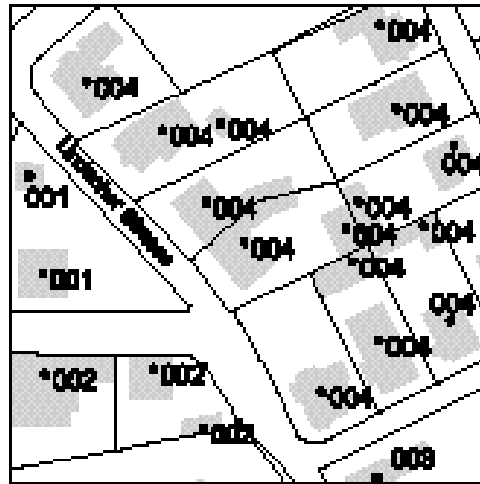
15. If one intends to connect the Register of Buildings with other data banks, it is necessary to store the Object number from the ÖSTAT Register of Buildings into the respective data bank.

16. The connection of the Object numbers of the ÖSTAT Register of Buildings with the corresponding addresses of the DKM, which is performed in the course of geocoding, is therefore of particular importance for regional statistics. Among other things, it is possible to obtain access to the areas of buildings. Since July 1995 there exists within the ÖSTAT the **Register of Non-agricultural Enterprises** (*Unternehmens- und Betriebsregister = UBR*) which is connected to the Register of Buildings by means of the Object number. In this way it is possible to obtain, for instance, the current positions of food stores, pharmacies or hotels. In the same way, the **Register of Agricultural and Forestry Holdings (Enterprises)** (*Landwirtschaftliches Betriebs- <Unternehmens-> Register*) is connected to the Object number. It is thus possible to obtain data from the **Agricultural Census and other agricultural surveys**.

Fig. 6: Register of Buildings enlarged by the column for the Project Area Number

In this example, at first on the basis of DKM, a breakdown for blocks of houses was made. Next all Object numbers situated in a certain Project Area (blocks of houses in this instance) were allocated to this Project Area by applying the same Project Area Number (block number 001). These Project Area Numbers are then entered through the corresponding addresses of buildings into the Register of Buildings (see column 1).

Section from the Digital Cadastral Map



Register of Buildings enlarged for the column of the Project Area Number

Project Area Number	Object Number	Postcode	Streetname	House Number	Buildings	Dwellings	Inhabitants	Non-Agricultural Local Units	X-Co-ordinates	Y-Co-ordinates
001	1006033001	5110	Lindacher St	1	1	1	3	0	-28984.9	311344.5
001	1006034001	5110	Lindacher St	3	1	2	3	0	-28982.1	311324.1