

The Use of Geographic Information Systems for Property Valuation and Tax Assessment

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SUMMARY

In Sweden geographic information systems (GIS) have been used for property valuation in connection with tax assessment for real property since the 1996 general taxation of single-family housing units. The use of GIS has increased concurrently with the introduction of improved methods and the availability of more accurate digital maps and is now a standard and valuable tool for both the technical valuation preparatory work and for the assessment itself. Other important factors that have contributed to the positive development include the increased availability of spatial data, easily accessible information on real property transactions and improved and customized working procedures. Above all, the use of GIS has contributed to improvements to the tax assessment of single-family housing units.

The main aim of this paper is to describe how GIS is used to increase the efficiency of some of the basic processes in the Swedish real property tax assessment system. Hopefully, this information will encourage other organisations to use similar applications.

In the preparatory work for tax assessment GIS is used for: Examination and sorting out of unwanted property transactions; purchases are presented in a GIS to facilitate checking of classification data and geographic location.

Description of the standard single-family house; statistical reports complemented by GIS showing classification data for value factors for each unit facilitate description of a standard unit in each value zone.

Overview of the division into value zones; the relationship between the sale prices for single-family housing units and their value factors is examined and the results are presented in a GIS. The results are used as the basis for evaluating the geographic location factor and to determine the optimum location of zone boundaries.

Test assessment; GIS is used to modify given standard assessed values and the results can be visualized with the help of colour coding, histograms and computed average values. Value zones can be merged to create test value zones to expand the data for determining area-related property prices and provide better support for setting levels.

Checking and quality assurance; GIS is used to show differences in value levels between adjacent value zones and can result in adjustments of levels if the differences are unjustified or too large.

Presentation of the results and decisions taken; on the National Tax Board's website property owners can view the adopted division into value zones, the standard assessed values that have been set and some information about the purchases that have been used for the test evaluation.

1. THE SWEDISH SYSTEM

Sweden has a long tradition of real property taxation. The present system, which was introduced in 2003, implies, in short, that all real properties are subject to a general real property tax assessment every sixth year, followed by a simplified assessment three years later. Assessed values are equivalent to 75 % of the market value for the reference-level year (two years prior to the tax year) and thus apply for three years before the next assessment is carried out, when every property is assigned a new value. A division into the following different types of real property has been made in order that all 3.2 million real properties will not be assessed during the same year.

Different parts of the real property stock are assigned new assessed values in different years. General real property assessment is carried out every second year and is broken down into different categories based on the following six-year cycle:

Year	Type of real property unit	Number of units (2005)
2007	Apartment building units, industrial and other units	265 000
2009	Single-family housing units	2 267 000
2011	Agricultural units	362 000

Between these general assessments a simplified assessment is carried out three years after the general assessment according to the following schedule:

Year	Type of real property unit	Number of units (2005)
2006	Single-family housing units	2 267 000
2008	Agricultural units	362 000
2010	Apartment building units	125 000

It should be noted that industrial units are excepted from the simplified assessment and are only subject to a general assessment. The simplified tax assessment is mainly carried out in the same way as the general assessment. Simplification implies that no tax assessment forms normally need to be submitted as assessment is based on information that is already available in the real property taxation register, and that there is some simplification of the preparatory work, such as that, in principle, no division into value zones is made. For the simplified tax assessment the division into value zones, which was done for the most recent general assessment, is used for the various property types.

A special assessment is carried out every year for those categories that are not, for the same year, the subject of general or simplified assessment. Special assessment implies that new assessed values are calculated for those units which, based on given criteria, have been the subject of change. New or re-formed properties are also assigned new assessed values in connection with simplified assessment. The assessed values that are set in connection with a simplified assessment are calculated based on the rules which applied when the value of the specific category was last assessed.

1.1 Legislation and organisation

Real property taxation is regulated by The Property Assessment Act and The Property Assessment Ordinance. The National Tax Board is the Swedish authority that is responsible for the taxation of real property. As a complement to the legislation, The National Tax Board publishes instructions and general advice to support taxation activities. Lantmäteriet provides important assistance to The National Tax Board by being responsible for most of the technical part of the preparatory assessment work.

1.2 The technical preparatory work for real property taxation

Every general and simplified tax assessment programme is preceded by comprehensive technical preparations. The work involves analyses of the property market, the creation or review of valuation models, the construction of tables or functions, the collection and analysis of area-related property prices and, finally, the implementation of the so-called test assessment during which the proposed assessment models and suggested assessment levels in the different value zones are tested against the collected area-related price compilations. The market comparison method is the main method used for developing assessment models and for determining assessment levels in different parts of Sweden.

A major part of the preparatory work thus comprises analyses of purchases that have been made during the reference level year and during the nearest years immediately before the reference level year for the specific assessment. The reference level year is the year two years prior to the specific tax assessment. For example, for the 2006 simplified assessment, 2004 is the reference level year. The preparatory work normally begins three years prior to a general assessment and involves analyses of the property market, an evaluation of the results of the previous assessment of a particular type of property, a review of the assessment model and more. The test assessment is carried out during the spring of the year before the tax year and all preparatory work must have been completed before September 1st of the same year by which time a decision concerning the division into value zones, proposed value levels and value tables, which steer real property taxation must have been taken by The National Tax Board.

During the autumn of the same year, proposed assessed values or real property taxation forms are sent to property owners. The forms must be completed and returned to The National Tax Board by November 1st at the latest following which the assessment work begins. By, at the latest, June 15th of the tax year The National Tax Board must have taken decisions concerning assessed values etc. and property owners must have been informed of the new values before June 30th. The new assessed values apply from the beginning of the tax year. Thus it is The National Tax Board that formally sets assessed values. Should a property owner wish to appeal against the National Tax Board's decision the case is referred to the county administrative court. An appeal against a judgment by the county administrative court can be lodged with the administrative court of appeal. The highest instance for an appeal is the Supreme Administrative Court which, however, only handles cases concerning fundamental issues.

2. GIS APPLICATIONS FOR ASSESSMENT AND TAXATION OF SINGLE-FAMILY HOUSING

Since the first general taxation of single-family houses in 1996, Lantmäteriet has, on behalf of The National Tax Board, used GIS in the preparatory work for several processes. The reason for this relatively early start was that Lantmäteriet had built up competence in GIS and had long held a leading position in Sweden in this field.

The development and use of GIS applications for real property taxation has moved forward although there have been several obstacles to overcome on the way. Today, just over ten years since the first application for test assessment was developed, GIS has become a standard and valuable tool for use with real property taxation. Initially there were problems with slow response times when plotting small-scale, background digital maps on a computer screen but, today, the focus has changed and a source of irritation can now be an occasional lack of agreement between boundaries of value zones and intended boundaries such as roads and real property boundaries. The teething problems that always seem to dog new techniques have been minimised or eliminated. Today, it is not the technology that sets limits for development, instead it is more a case of small deficiencies in carefully developed work processes. Another obstacle which must be surmounted is the reluctance of some users to accept and learn how to use the system. As a result of long experience of the use of GIS for real property assessment Lantmäteriet has accumulated valuable knowledge of when different applications will give the best results. The basic reasons for investing in new techniques and GIS have been to increase efficiency and improve the quality of the different processes that form the preparatory work.

The total cost of carrying out the preparatory work has decreased from EURO 10 million to EURO 4.25 million between 1990 and 2006. The improved IT systems, which include a computer-based test assessment system combined with GIS, have made significant contributions to reducing costs. Lantmäteriet and The National Tax Board together have responsibility for carrying out the preparatory work for real property taxation. In addition to a number of centrally placed experts and regional specialists from both authorities, valuers from private sector property valuation companies are engaged as consultants. These valuers must be authorised real property valuers and have sound knowledge of both valuation and the local property market. It is, primarily, in the processes in which the valuers are involved for which the IT system and GIS create the best pre-conditions for facilitating the work and increasing efficiency. A total of approximately 40 valuers were involved in the preparatory work for the most recent simplified assessment of single-family housing units in 2006.

One of the aims of this paper is to describe the processes in the Swedish real property taxation system for single-family housing units in which GIS is used. The focus is on those processes that involve preparatory work. My hope is that examples of applications can stimulate other organisations to use similar applications.

2.1 GIS in preparatory work

The preparatory work in which the authorized valuers are engaged and which precedes the tax assessment can be divided into the following processes:

- Following up and evaluating the previous tax assessment concerning division into value zones.
- Examining and sorting out unwanted materials in the area-related compiled price data.
- Describing standard properties and collecting other relevant information concerning the real property market.
- Carrying out test assessment and formulating recommendations for the division into value zones and standard levels.

Below, a number of examples are given to illustrate how GIS has been used to improve the quality and increase the efficiency of the work processes.

2.2 The examination and sorting out of purchases

An important step in the preparatory work is to ensure that the purchases that are to be used for analyses of the price structure and the final setting of levels for the test assessment were made at current market rates and that the information in the register concerning purchases agrees with the real-life situation. The latter is particularly important concerning factors that influence values.

A purchase cannot be considered to be representative if it is a transaction involving two persons who are related or where there is some other close relationship between buyer and seller. An example of the latter is when the seller is a joint-owner in the company which is buying the property. Investigations of this type require access to national registration and company registers. GIS can be an invaluable tool for checking of some of the information in registers which are linked to the actual real property and for scrutinizing the purchase. In the system that has been developed by Lantmäteriet for examining and sorting out purchases there is currently a direct link to maps. With the help of co-ordinates for the building or the property every purchase can be identified on the digital cadastral index map. If the person who is carrying out the examination is not familiar with the area he/she can easily open a system window and view the cadastral map and locate the unit. This function is especially useful for checking how close a single-family housing unit is to a shoreline, which is an important value factor. It is possible to measure the distance between buildings and a shoreline to determine whether the factor "proximity to shoreline" has been correctly classified for the purchase when the latest assessment was made.

In addition, the check of the value factor, "category of building," (detached, link house, terraced house) is facilitated particularly for purchases of properties that lie in an area with groups of houses. With information about all properties in an area in the GIS it is possible to

quickly compare a purchased property's building category with the classification of adjacent properties that have the same value factor. In this way, possible incorrect classifications of purchases can be corrected. Another important area of use is for determining the number of buildings and their size, which can be done thanks to access to the geometry of the buildings in the map. If the purchase price relative to the current assessed value – the K/T quotient – is abnormally high the reason can be that the assessed value does not correspond to the actual property that has been sold. It may, for example, be found that there is more than one single-family house on the property or that there are valuable complementary houses which were not taken into consideration when the assessed value was set. Living space and supplementary areas, which are the measurements that are used to determine the size of single-family houses, can generally be estimated from the areas of the buildings and then comparing them with the assessment data. It would not have been possible to carry out the checks of the purchases that are mentioned above, quickly and rationally, without GIS. The incorporation of GIS into the process of checking purchases has, above all, resulted in a better check of the value factors "proximity to shoreline", "building category" and, to a certain extent, also the size of single-family houses. A major number of the purchases which previously might have slipped past the checks can now either be corrected or sorted out. Normal procedure is that all of the approximately 250 000 purchases from the selected three-year period are included in the check. After a number of automated removals and the checks mentioned above, about 190 000 representative purchases of single-family houses remain.

2.3 Describing the typical single-family house

As part of the preparatory work, every one of the more than 8 200 value zones must be described regarding both what a standard single-family house looks like and whether there could have been special pre-conditions on which the determination of the value levels was based. The aim is to obtain the basis for the subsequent valuation of the so-called "normative property" for every value zone. The establishment of levels, which will result in correct standard values, is made easier if the valuers have a sound knowledge of the composition of single-family houses in the value zone. An important condition that must be identified is whether there is a large variation between the single-family houses in the value zone or whether the stock is homogenous and comprises houses of the same building category, built during the same period and of similar size and standard.

The basic materials which are available for the valuers comprise a statistical report in which the deviations for the most important value factors are given. These are: the area of the plot, the proximity to a shoreline, water and sewage facilities, the building category, the size of the house, its age and its standard grading. The report is based on statistics for all properties in every value zone. The information has been taken from the latest real property assessment. To ensure that the most typical single-family houses in the value zone have been described, the valuers must have access to a GIS in which every individual property unit's dimensions and classes for the value factors are shown. It is, above all, the value zones which are made up of a heterogeneous stock of single-family houses for which the statistical report does not provide a satisfactory basis for determining the "standard" property. The information has been taken from the latest real property taxation. Average values with large standard errors

for the different value factors' classification data indicate that a deeper analysis needs to be made. With the help of the GIS, the valuer can identify the single-family house which is the most typical by studying its location and by specifying the classification data that is associated with the property. In this way the valuer avoids the risk of defining a property which, in reality, does not exist.

2.4 Overview of the division into value zones

The factor which, without doubt, is most important for the accuracy of the assessment is the correct evaluation of the importance of location. Value zones are used in an assessment to delimit groups of properties that have the same location value. The principles behind the division into value zones can be found in chapter 7, 2 § of the Property Tax Assessment Act and they are followed because, up to now, they have been considered to be the most suitable and, most probably, the most correct way in which to handle the location factor. Every property has its own unique location, which can be defined by x and y co-ordinates and possibly, at a later stage, with a z co-ordinate, but to identify and delimit different locations that have the same influence on the setting of prices cannot be done without sound judgement. This is because location, as a value factor, is qualitative and not quantitative: it is not only the physical locations of the properties that are the reason for possible differences between them regarding location values. In connection with assessment, additional "soft core" factors, which cannot always be measured, are included with location. Examples of such factors include:

- The distance to different facilities and the standard of the infrastructure.
- Environmental factors such as sights, sounds and smells.
- The character of the area as defined by factors related to types of buildings and the development of plots of land.
- Factors linked to occupants, such as the structure of the household, income and wealth.

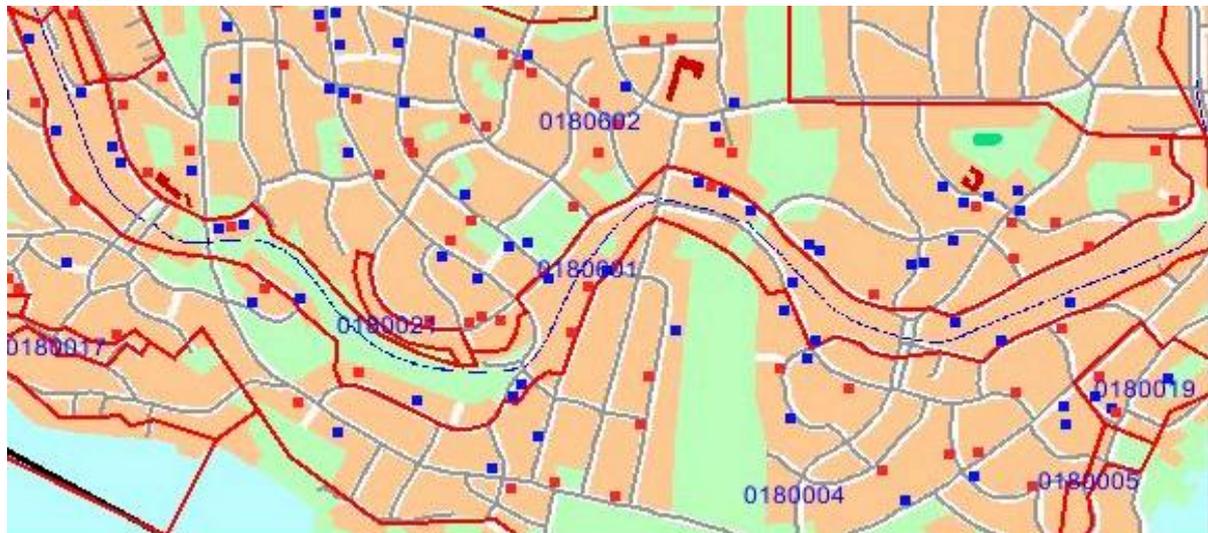
Whilst it is possible to judge whether property A has a better location than property B, it is not, on the other hand, immediately possible to state how much better A is than B without first checking against the purchase. The different values assigned to location can be the basis for grouping properties that have similar location values in value zones.

Prior to the general taxation in 2003, Lantmäteriet developed a special method for investigating whether the existing division into value zones for single-family houses needed to be changed. The method was used by the valuers who were engaged in the preparatory work. In short, GIS is used to display the computed, so-called, standardised residuals for every purchase within a value zone. The standardised residuals have been computed using regression analysis, where the relationship between the value factors for the single-family houses when assessment was done and their sale prices have been evaluated. The standardised residuals are marked in colour in the GIS application. Red dots indicate purchases that were given an estimated price that was lower than the true price in the model equation; and the blue dots indicate that the purchases were given a higher estimated price. Accumulations of red or blue dots can indicate that these groups of houses had location

values that deviated within the value zone. If this pattern is found in a sub-zone containing single-family houses the most likely reason is that the factors that are linked to the location factor in connection with assessment would not have been fully taken into account if the previous division into value zones had continued to be valid.

An example:

In the value zone called Ålsten in the Stockholm municipality the majority of the houses are old and similar in character. A study of purchases of properties that lie close to the tramway (Nockebybanan) that cuts across the area and which have boundaries adjacent to the tramway reserve, shows that the majority of the properties are represented by blue dots. The negative environmental impact of the tramway has most probably affected the value level of these properties. A more detailed analysis of the 26 purchases of properties that lie close to the tramway showed that the affect on values was just over minus (-) 10% or that the assessed value of properties close to the tramway should be decreased by an average of SEK 300 000. This application of the method, in combination with a sound knowledge of the local real property market which valuers must have, meant that adjustments could be made to the division into value zones to make them even better than they were at the time of the last assessment.



The new value zone, 0180601 (Nockebybanan), which emanates from 0180004 (Ålsten), now includes the properties closest to the tramway. With the help of multiple regression analysis and GIS it became clear for the valuers that the division into value zones required modification.

2.5 Test assessment

In the test assessment, the examined and approved purchases, the pre-determined assessment model, the value relationships and functions that have been derived as the result of analyses and the proposed division into value zones are used in the level-setting process to determine the value levels for all value zones. To carry out this important step in the general taxation in 2003 an IT system developed by Lantmäteriet was used. The system comprises a GIS application developed in Esri's ArcView v. 8.1 using Visual Basic for Applications and a

register-based calculation program developed in Oracle Web Forms. In the actual test assessment the area-based price data is used to derive the correct level for the standard values for the "normative property" in every value zone. In this stage the valuers knowledge of local property values for "standard" properties is very important. This is because, in the test assessment system, the valuer must calibrate the market value of the "standard" property by giving commands in the registered-based program. The preliminary assessed value for every available purchase is computed with the help of the tables of value relationships that are loaded into the system. The computed assessed value is then divided by the purchase price which is adjusted using a suitable price trend factor to the price level for the level year. Every purchase is thus given a quotient based on its preliminary assessed value and the adjusted purchase price. If the setting of levels in the specific value zone has been done correctly, the quotient (T/K) should normally, be about 0.75 since the assessed value should be equivalent to 75% of the level of the market value. In the GIS application it is possible to view all purchases in the value zone and colour code them based on the T/K value. In this way the valuer can quickly see whether the majority of purchases fall within an acceptable interval around 0.75. If it turns out that the average T/K for the purchases is not or does not lie close to 0.75, the value level can be changed and updated from the GIS application. An alternative scenario is an average value that is close to 0.75 but that purchases with high or low T/K values are concentrated to different parts of the value zone. In such cases there may be a need to review the division into value zones and break down an existing zone into two new zones so as to create a more correct setting of levels.

In approximately 20% of the value zones there are far too few purchases to be able to set levels. In such situations the valuers must take recourse to simulating the market situation. An important task at this stage is to investigate whether there are other comparable value zones which can temporarily be merged to create so-called test value zones which will, thereby, make it possible to add more purchases as the basis for decisions regarding the value level. A characteristic of test assessment zones is that the involved value zones must have similar price structure and value level. In the GIS application there is a function which the valuers can use to retrieve from the map the value zones which will form unique test assessment zones.

2.6 Checks and quality assurance

During the test assessment, and particularly after it has been completed, it is important to check that no unjustifiable differences in value levels occur between abutting value zones. A thematic layer which shows value levels for the "normative property" in every value zone is an excellent help. If the colour coding is done in a suitable way the valuer can, with the help of the GIS, quickly make a general evaluation of whether there are value zones in which the setting of levels needs to be reviewed. It is not always clear whether the settings are incorrect if the difference in value levels between two adjacent value zones is, for example, 30%. It is particularly important to check on the map whether there are single-family houses that lie very close to each other but on different sides of the boundary of a value zone. In such cases it can be justified to change the value levels. If it turns out that only individual houses are affected then, instead, the correct measure to take is normally to move the boundary of the

value zone so that the nearby properties are included. Relatively large differences in value levels between value zones that abut on each other may be correct since the properties belong to separate sub-markets. This is not particularly unusual and it often occurs in the boundary zone between built-up and rural areas.

2.7 Presentation of the results and decisions for the general public

Since the general taxation of single-family houses was carried out in 2003 there is now a public web service which uses GIS to present the results of the test assessment. On The National Tax Board's website property owners and the general public can, amongst other things, view the division into value zones. By clicking on the map and zooming or entering the name of the local authority and the property designation or entering the value zone's designation it is possible to view the extent of the value zone. In addition, it is also possible to zoom in on the background map to the property level. In addition to the name of the value zone it is also possible to see in which test assessment zone the value zone is included as well as which other value zones are included in the same test assessment zone. The information on standard and value level values which are determined for value zone are listed so that it is possible to see the assessed value that applies for the "normative property." In a special layer there is information concerning purchases that have been made in the value zone and their position is marked on the map. In addition, the computed T/K quotient from the test assessment for every purchase, the sale price and the date of purchase are shown. For The National Tax Board this web service has facilitated communication with property owners during the assessment work. Furthermore, with regard to the transparency of the real property tax assessment process, it has led to an increased understanding by the general public of the value of division into value zones for real property valuation and real property taxation.

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BIOGRAPHICAL NOTES

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