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Land, Kristin; Kristin Karlsson, Former name:

2005

[Link to publication](#)

Citation for published version (APA):

Land, K., & Kristin Karlsson, F. N. (2005). *A Future Legal Coordinated Cadastre for Sweden?*. Paper presented at International Symposium & Exhibition on Geoinformation 2005, Penang, Malaysia.

Total number of authors:

2

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A FUTURE LEGAL COORDINATED CADASTRE FOR SWEDEN?¹

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Abstract

This paper initially presents an introduction to the Swedish land administration system, particularly focusing on the parts of the Real Property Register that compose the cadastre. Here, a brief retrospect of the long tradition of land related registration follows by an account of the current components, functions and parties concerned. The second part of the paper then discusses a vision, expressed by the National Land Survey of Sweden, of implementing a legal coordinated cadastre. In short, that would mean making the boundary point coordinates, mirrored in the digital cadastral map, conclusive evidence of the location of boundaries. The aim of such a cadastre is to make possible more efficient and secure handlings with land within cadastral work, physical planning, infrastructure projects etc. Due to the present hierarchy of evidence, the “monuments before measurements” principle stated in the Land Code, a future reform of that kind would give rise to great challenges in respect of technical, economical and legal aspects. Some of these issues have become subject of a doctoral study at Lund University, Sweden. The aim of the study is to identify and analyse probable consequences of an implementation of a Swedish legal coordinated cadastre. The question of legislation and legal security, both in regard to the public sector and private interests, will be especially emphasised. The last part of this paper briefly presents this ongoing doctoral study.

1 SWEDEN – A BRIEF INTRODUCTION

1.1 General facts about the country

Sweden is a Northern European country somewhat bigger than Malaysia, although housing only nine million inhabitants. The majority of the population lives in the southern part due to the topography, climate and historical reasons. Stretching over 1500 kilometres, the south mainly consists of agricultural land, the middle holds both open landscape and forests, and the north is covered with forests and mountains. Many important industrial cities have been established along the coastline from the Norwegian border in the west to the Finnish border in the east. Major companies are Volvo, Ericsson and IKEA. Steel, paper and pharmaceutical industries are also important trades.

Being a constitutional monarchy, the governing bodies in Sweden are the parliament and the government directed by the prime minister. The royal family has no political power and therefore mainly represents the nation at non-political events.

1.2 The land

Administratively, the country consists of 21 counties divided into 290 municipalities. All land and most of the lakes are divided into real properties; today there are more than 3.2 million unique real property units. There is no perfect and complete definition of the term “real property” in the Swedish

¹ This paper is based on my (unpublished) paper *National Structure of Cadastral Systems and Development Efforts - Sweden* presented at a Ph.D. course at Aalborg University, 1-7 May 2003. Parts of that paper was used in the paper *Use of Digital Historical Maps in the Property Formation of Sweden* published in the proceedings of the International Cartographic Conference, 9-16 July 2005.

legislation, but some characteristics can be listed in order to explain the meaning. The following factors are more or less explicitly stated in the Land Code, the Real Property Formation Act and the Real Property Register Ordinance.

The opening sentences of the Land Code read: “*Real property is land. This is divided into property units.*” All land and almost all water within Swedish territory is divided this way, with one exception. The public waters, consisting of the main parts of the sea and the four biggest lakes, are not included in the official division into property units.

A real property unit physically consists of one or more parcels of land (and water) demarcated by property boundaries, and the buildings, trees and other fixtures in or on the ground. This unit has an administrative identification name and number, based on location and to some extent the time of creation. The unique property unit designation usually comprises municipality, district, block number and unit number (example: Burlöv Åkarp 17:9). In some urban areas the block number is excluded (example: Vänersborg Taggsvampen 1).

Every real property unit is owned with freehold title by either natural or artificial person(s). Two or more persons can own a property together, leading to the co-owners having shares in the same title. It is, on the contrary, not possible to own a specific piece of a property since a title always must respond to a whole unit. Conveyance of land not consisting of a full property must, as mentioned earlier, be followed by property formation in order to keep conformity between property and ownership.

A property may be encumbered with different kinds of rights of user of which some imply vast and long-term rights for the occupants, for example agricultural or site leaseholds. Other rights, such as easements, are more limited in their physical extension and use. All titled owners and many rights of user are listed in the Land Register, which is a part of the Real Property Register.

Besides the ordinary type of property, there is the joint property unit, which is land common to two or more properties. Such commonholds are listed in the property register with administrative identification codes similar to properties, but instead of block number they have an “s” (example: Helsingborg Frillestad s:4). The joint property units often serve space for roads, but other historically co-used land areas such as gravel pits and bogs also exist.

1.3 Cadastral history

In a wide sense, the cadastral system of today has roots as far back as the 16th century, when King Vasa imposed tax on landholders around the country. That early land recording only covered information about possessor and liability to pay tax, and was documented in books by the Crown.

The mission to create nationwide small-scale geometric maps that in 1628 was given to Anders Bure – later considered the father of the National Land Survey – did, in the beginning, merely aim at documenting the range of the kingdom. Not until some fifty years later, when most of the original work was done, did the task of the land surveyors comprise mapping and/or consultation in private land division procedures. At that time the rural villages were spit up into very many small parcels, leading to difficulties in individual farming. When the extensive enclosure movements, i.e. land consolidation and re-allotment projects, spread over the country during the early 19th century, the land surveyors were in great focus. By then the profession had become more or less indispensable for the development of the rural areas, and the surveyors’ powers were reflected in reverence (and possibly fear) showed by the peasantry. When the fragmented villages eventually had been rearranged through the cadastral procedure called *laga skifte*, the structure of the individually owned real property units stayed surprisingly unchanged. Divisions of inheritance and plain subdivisions obviously continued to be executed, but much of the basic parcel structure of that time is still to be found in the countryside today. Many arable and forest boundaries hence date over 150 years back.

The towns and cities, on the other hand, have experienced quite different phases of development. Starting to establish around 1000 A.D, they initially served as craft centres cooperatively run by the inhabitants. The townsmen did not usually own their respective plots until some hundred years ago, when legislation on town planning and urban real property formation was introduced.

Parallel to the land books, which later developed into a register of ownership and other rights to land, two real property registers of rural and urban areas respectively were created in the early 20th century. In 1968, these two registers were put together and integrated with the land register, which was then fairly unique in the European context. The result was a compound Real Property Register, with additional information about e.g. address and tax assessment value. The land register part was already then updated by a Land Registration Authority, while the part representing the cadastre was, and still is, updated by a Cadastral Authority. During almost two decades the register was being computerised, and in 1995 the written part of it was completely digitalised. The cadastral map belonging to the register, which is a mere index map showing a general picture of the location of all parcels and boundaries, is now close to be fully digital.

2 LAND ADMINISTRATION TODAY

2.1 Ministries and executive authorities

The two ministries most directly involved in land-related issues are the Ministry of Justice and the Ministry of Sustainable Development. Another, more indirect or peripheral ministry, is the Ministry of Finance, responsible for different issues of taxation.

The Ministry of Justice is the superior authority of the Land Registration Authorities, which are linked to seven local courts around the country. They mainly register rights to land, including titles and mortgages.

The Ministry of Sustainable Development heads the National Land Survey of Sweden (*Lantmäteriet*), which in turn supervises all cadastral actions, more or less directly. The Cadastral Authorities, conducting cadastral surveys as well as property registration, are either state bodies within *Lantmäteriet* or separate, municipal bodies. There are, hence, no private cadastral surveyors in Sweden. This is a characteristic that has been discussed and sometimes criticised within the country. The State monopoly of cadastral work is, however, prone to survive since the fees are not higher than in many other countries.

2.2 Real property transactions

About 140,000 real properties change owners annually, and unlike many other jurisdictions no notaries are needed. Most property transactions by purchase, exchange or gift only involve the present and new owner, often with assistance of a broker or a banker. (Inheritance does obviously affect ownership as well, but this procedure differs from the mentioned types of transactions.) There are, however, a few strict requirements of form for conveyances. For example, a purchase deed must be a contract in writing, including the property unit designation, the purchase sum, and an explicit note that the vendor transfers the property to the buyer. Both parties must also sign the contract. When such a purchase has been completed, the new owner is due to apply for title within three months. There is no supervision of this compulsory rule, but most transactions are registered (Jensen 1997). Without title it is, for example, not possible to mortgage the property. A Land Registration Authority is therefore, by registering title and distributing a certificate thereof, an administrative part in the property transaction procedure.

If a land transaction only concerns a part of a property, it needs to be followed by property formation in order to be valid (see section *Real property formation* below). If not, the transaction is null and void, according to the Land Code.

2.3 Real property formation

In Sweden, subdivision and other means of changing property units are collectively labelled “real property formation”, or just “property formation”. There are four types of property formation that create or mutate properties (see Figure 1).

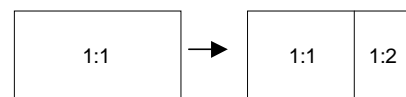
All property formation processes comprises cadastral survey work and subsequent change in or addition to the Real Property Register. Before 1996, these two actions were executed by separate authorities, but today the whole process is handled by one (state or municipal) Cadastral Authority.

The cadastral survey

Cadastral surveys are usually carried out at the request of one or several property owners according to a deed or some other type of agreement. Relatively small-scale projects, such as subdivisions for housing purposes, are the most common actions applied for. Another frequent category is re-allotment (mutation of existing properties) of various range, concerning arable and forest land as well as urban land. Besides such changes in physical structure, properties may be afflicted with rights and obligations concerning private roads, utilities etc through the cadastral survey.

In order to realise infrastructure projects and other exploitations for public needs, the state or municipality may also apply for cadastral surveys. These can be based on agreements as well as being coercive. According the Swedish land legislation, some compulsory purchase can hence be executed through property formation, conducted by a cadastral surveyor. Cadastral procedures are generally considered more efficient than court processes, why exploiters often choose surveyors as their “tools” in order to acquire land by coercive means. From the property owners’ point of view, the cadastral solution is an equally secure way of losing land. And, the sometimes better opportunity to negotiate – and by that influence on the Cadastral Authority’s decision of compensation – is often considered more fair than the decision-making of the court. Both types of decisions can, however, be appealed against as long as the decision in question is not based on an explicit agreement.

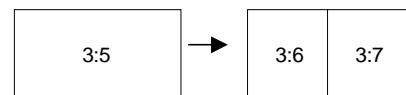
Subdivision creates one new property at some expense of the residual property unit’s acreage.



Re-allotment mutates the original properties, e.g. by land transmissions (figure). One of the properties may also be fully transmitted to the other, resulting in one remaining unit.



Partition splits one co-owned property, resulting in two new properties owned by the respective persons. The original property ceases to exist.



Amalgamation consolidates two or more properties owned by the same person(s), resulting in one new property. The original properties cease to exist.

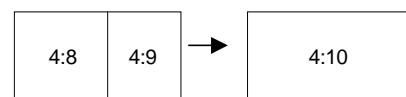


Figure 1: Physical effects of property formation; the situation before and after.
(Designations refer to block number and unit number.)

In the context of changing the properties physically, different kinds of rights to land may also be formed, amended or cancelled. Since property formation by law must be carried out in a way that every property involved becomes “enduringly suited to its purpose”, rights to land are often involved in some way within the cadastral surveys. There are many different types of such rights, where easements and usufructs are the main groups. An easement (servitude), based either on agreement or legal decision, usually benefits a property for all time, i.e. until revoked. Consequently, the servient unit faces a long-term restriction of use. A lease (leasehold), which also can be created either by private or property law, is, on the contrary, in favour of a specific person. Such a right is always temporary, limited by a defined period of time or by natural reason, i.e. until the holder of the right sells his/her property or dies. The purposes of such rights to land can vary almost endlessly, but common kinds are roads, pipes, wells and garages. Besides easements and leases there is a special right named utility easement, which can be created for electricity and telecom lines, water and sewerage mains etc. Transformers, pumping stations and similar devices are included in the utility concept. This kind of right can either benefit the owner of the utility or that person’s property.

The three types of rights to land mentioned above have in common the use of space within someone else’s property, and they are created to serve a single property’s need. There are, however, other rights that enable several properties to share a physical facility of some sort. The need of space is met within the cadastral survey establishing such a joint facility.

The cadastral survey procedure includes administrative as well as technical work. An ordinary case comprises:

- investigation of the current situation (titles, boundaries etc)
- legal examination of the suggested change
- meeting with land owners, exploiters, municipal authorities etc
- field work
- mapping (cadastral survey plan) and production of other documents
- decisions of the change in property structure, compensation etc.

The legal examination of the suggested property formation includes a number of steps stated in the Real Property Formation Act. Some of the most important issues to be tried are the involved property units’ suitability for respective purposes, their accordance with the local plan if any, and their resulting financial status.

The fieldwork comprises measuring and, if needed, the fixing boundary marks (monuments). Normally, new boundaries should be marked on the ground with iron posts or pegs, but in urban areas this is often considered unnecessary and unpractical. Since such boundaries generally are measured with high accuracy, the coordinates that are noted on a cadastral survey plan are often good enough information at later reconstructions of the legal course of the boundary on the ground. Whether new boundaries are physically marked or not should be made clear in the written documents of the survey. This information is potentially important, since disputes or uncertainties occurring at a later stage must be solved with respect to the actions taken in the original survey. Older cadastral surveys often lack coordinate data, so if monuments have disappeared the graphical cadastral survey plans also play an important role as evidence of boundary location.

All documentation of a cadastral survey is compiled in a file kept at the Cadastral Authority office. Such files comprise the application for the cadastral survey, protocols from meetings, legal decisions with motives, and a cadastral survey plan including a list of boundary coordinates (if any). Additionally, there may be copies of deeds or agreements, approvals from holders of rights etc.

If disapproving of the Cadastral Authority’s decisions, the parties involved can appeal to the Land Court, the Court of Appeal and the Supreme Court (in due order). Normally, such appeals must be made within four weeks of the decision. When the cadastral survey has gained legal force, either by being quietly accepted or after being tried in court, this should be noted in the Real Property Register.

Only by the registration is the property formation fully completed and thereby legal towards the third party.

Real property registration

Until a new, e.g. subdivided, lot is registered and given its unique designation, the administrative property unit does not exist. When registered, all properties are listed in the Real Property Register according to their designation. (Contents and characteristics of the register are described below, see section 2.5.)

The registration procedure is since 1996 executed by the same Cadastral Authority that conducts the cadastral survey. In most cases, the cadastral surveyor and registrar is even the same person. This rationalization of the property formation process was initially met with various doubt. Voices were heard asking how the register's quality, and thereby the individuals' legal security, could be maintained by reducing the former double check system into a single person's work. Further training of the cadastral surveyors, and integrated controls in the new computerised handling system, has made the registration procedure run very well. Cadastral Authorities that do not work with this handling system at all or in limited scale due to big and complicated cases still register in a separate procedure.

The registration procedure generates new indirect notes as well as direct changes in the written part of the Real Property Register. Alterations in the digital cadastral map (see Figure 3) should be made at the same time in order to show all current properties and their approximate boundaries.

2.4 Property definition (property determination)

Should boundaries be uncertain or subject to disputes, a so-called property definition (or determination) may be accomplished in order to settle the problem. Property definitions are legally binding procedures carried out as cadastral surveys, either within affected property formation procedures or as separate commissions. It is, hence, the cadastral surveyor – not a judge – who conducts the survey and makes the decision. Besides boundary issues, certain problems of rights to land may also be solved through property definition. Questions to be answered are, for example, to what property a specific piece of land belongs, and the signification or location of a certain easement.

Boundary disputes are the most frequent cause of property definitions. Underlying factors may be vaguely documented boundaries or destroyed monuments, but sometimes the main reason is private quarrels dating generations back. Such procedures tend to be fairly expensive, which may be one reason why the number of cases is very moderate. A thorough cadastral system and a tradition of respect for boundary monuments are probably also aspects of importance. The annual number of boundary disputes per million property units is about ten, a figure slightly higher than in Denmark and somewhat lower than in Finland (Williamson 2000). Although the statistics date some years back, the stability of the cadastral systems in these countries points to only small changes if any. The one Nordic country, Iceland not considered, that presents a different picture is Norway, of which the corresponding number is about 800. Norway's new cadastral system, introducing detailed regulations for both cadastral survey and registration (Enemark 1997), will probably lower that figure gradually.

Despite the fact that a property definition only clarifies and not changes properties, there are specific rules for that cadastral procedure in the Real Property Formation Act. The legislation includes sections concerning the administrative conduction as well as the technical work (measuring and mapping). The material rules determining the legal course of a boundary are listed in the Land Code; the main rules are stated in Chapter 1, Section 3-5. Depending on how, i.e. according to what law and by whom, the property boundary in question once was created, the determining factors are somewhat different. The principle rule is, however, that boundary marks (monuments) fixed in the ground in due

order are the primary evidence of the legal boundary location. A discrepancy between for example a reliable monument and a cadastral survey plan should be solved in favour of the monument. If such marks are lost or moved, the cadastral survey plan and other documents drawn up by a surveyor when the property last was formed or defined are to be interpreted. In this case, possession and other circumstances, such as fences and deeds, shall also be considered when reconstructing the legal boundary location on the ground. If, on the other hand, monuments were originally never established, the cadastral survey plan and written descriptions are to be followed when reconstructing the boundary. The Swedish Land Code thereby states a fairly strict hierarchy of boundary evidence (Figure 2).

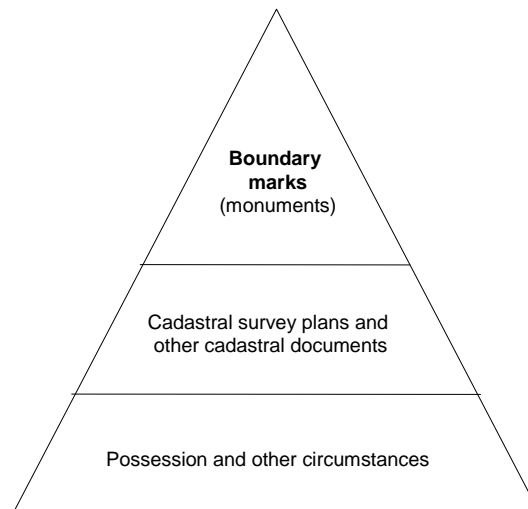


Figure 2: Top to bottom hierarchy of boundary evidence.

It should be emphasized that rules of prescription of any importance do not exist in the Swedish boundary-related legislation. The two remaining rules, which are included in the Promulgation Act to the Land Code, do very seldom have any effect. One rule directs to a section of immemorial prescription in the previous Land Code dating from 1734, the other requires a private agreement of boundary change made before 1972 followed by 20 years of undisputed land use. While immemorial prescription has practically died out, the latter regulation is occasionally claimed in property definition procedures. Very few decisions are, however, based on this type of prescription (adverse possession).

If disapproving of the decision of property definition made by the Cadastral Authority, the parties involved can, just as in the property formation case, appeal to the Land Court, Court of Appeal and Supreme Court in due order.

2.5 The Real Property Register – a joint register

To most users, the Real Property Register seems to be one single collection of data concerning all properties. When looking up a certain property unit, a list of various data is delivered. In the written part one can, for example, see some direct information presenting the current situation. Acreage, legal owner(s) and recorded rights to land are such up-to-date information. Other notes are indirect and, hence, not very informative at first sight. All cadastral procedures the property in question has been involved in are examples of such data. A procedure can be coded “re-allotment”, followed by date of registration and file number. The explicit contents of that re-allotment, e.g. what piece of land was transferred and which other property was involved, is not shown in the actual register. One therefore

has to look into all the listed cadastral survey files (primary source) in order to see the historical development from the creation to the current situation of each property.

Brokers and bankers, planners and exploiters, potential buyers and users of property are some of the customers requiring information from the Real Property Register. The register is public and most of its contents is accessible via the Internet web site of the National Land Survey of Sweden, www.lantmateriet.se. The charge for one property's record via the Internet is at the moment 50 SEK (23 MYR), but frequent users can obtain a licence and thereby get reduced prices. Cadastral Authorities and some other organisations also have direct access to the register through special terminals. If visiting such an office, anybody can get a single record extract of the register free of charge.

Despite the homogenous and concise presentation of the written information, the register is a compound of five parts maintained by some different authorities. Besides the five written register parts, there is also a cadastral map (see example below).

(1) The general part (cadastre) including the cadastral map

In Sweden the term cadastre is seldom used. The so-called "general part" of the Real Property Register however corresponds well to the international meaning of that term. It is, hence, the official register of the country's division into property units, containing information about all properties' designation, acreage, location (by coordinates representing the centre of each parcel), accomplished property formations and definitions (by reference to file numbers) etc. Local plans and other regulations for land use are also referred to. This part of the Real Property Register, which holds information of both existing and former units, is updated by the Cadastral Authorities.

The cadastral map is an index map of all current properties, showing their unique designations and approximate boundaries at an original scale of 1:10,000 or 1:2,000 (rural and urban areas respectively). With the exception of a few cities, the whole map is now converted into digital form (see Figure 3). On top of the basic "property layer" other types of digital information, such as topographic details, rights to land and land use plans, are being linked to the data base and optionally shown in the map. The digital medium hence enables easier and more applicable use of geographical and property related information for different purposes such as planning of new infrastructure. Municipalities, the National Road Administration and the National Rail Administration are, besides the Cadastral Authorities, some major users of the cadastral map today.

One should be aware of the varying accuracy, especially as to property boundaries. While some boundaries respond well to the cadastral survey plans and boundary marks in the field, others only represent a very rough picture. This is due to the fact that much of the boundary data in the digital cadastral map is derived from different kinds of paper maps and small-scale aerial photography. Various adjustments techniques aimed at obtaining geometry without "loose ends" have then been used, reducing the accuracy even more. The accuracy of the digital cadastral map of today hence varies between less than one centimetre (where new surveys have been carried out) and well over 20 metres. A normal discrepancy in the rural areas is that of around 4-5 metres. Consequently, the cadastral map is not a valid evidence of the legal location of boundaries. Further, some old joint property units and thereby their boundaries are not yet recorded. These defects are well known by the Cadastral Authorities, but other users risk to meet with problems if trusting the digital cadastral map too much.

The National Land Survey is responsible for maintaining the cadastral map database, but various information is provided and updated by different parties. Some of the current projects at the National Land Survey are focused on how the wide range of data providers, using different mapping software and reference systems, should be able to communicate with the one common data base. The scheduled completion of all types of data (boundaries, rights to land, local plans and ancient remains) is planned

to 2006. By creating such a multipurpose map, access to property related spatial data is to be facilitated for many users beyond the authorities mentioned above. The demand from the private sector has, for example, increased during the last decade. Along with this development comes an even stronger need to inform the users of the fact that much of the data is not legally binding.

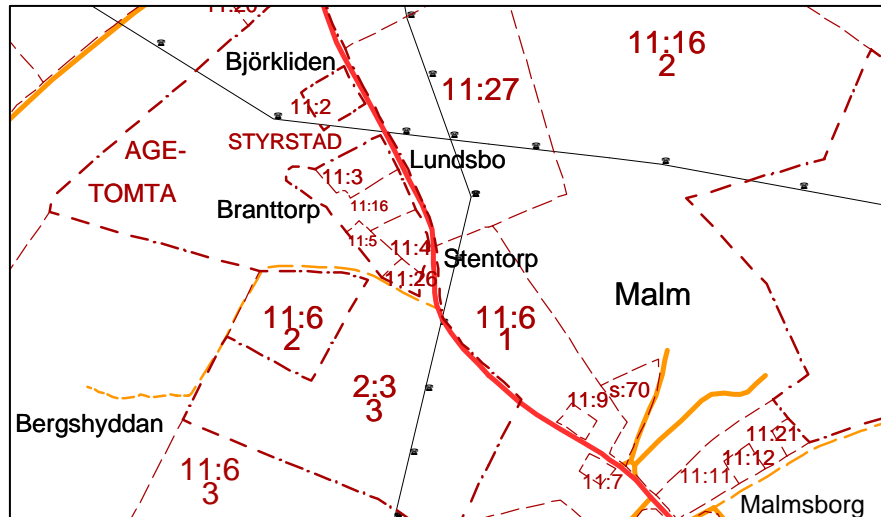


Figure 3: Extract of the digital cadastral map showing property designations and approximate boundaries, roads, power lines and some estate names.

(2) The land register

Land registration is mainly focusing on real property ownership and other kinds of rights created outside cadastral matters, for example leases and mortgages. After property conveyances or other transactions, the titles are registered and thereby secured against the third party. Also, the purchase price is registered. This part of the Real Property Register forms the legal evidence of ownership and other rights and thereby plays an important role in subsequent land transactions and mortgaging matters. The Land Registration Authorities are responsible for the registration and also the updating of the land register.

(3) Site addresses

Most properties are given site addresses, but some rural units still lack this characteristic. (The postal address of the property owner in question might be the same address, but this is not always the case.) Site addresses are updated by municipal bodies.

(4) Buildings

This part contains information about buildings for housing and commercial purposes. Garages and other complementary structures are not included. Every building has a unique identity and can be located geographically through its centre coordinates. Municipal bodies are responsible for keeping this register part up to date.

(5) Taxation Information

Some information kept by the Tax Authorities is included in the Real Property Register. Most properties have one tax assessment value for the land and another for the buildings. Common exceptions are agricultural and forest units carrying no buildings. The tax assessment value(s) and the person(s) liable for property tax are shown in the register. Some properties owned by the State or Municipalities, for example schools, are not rated at all.

3 CHALLENGES OF THE FUTURE

3.1 Rising demand for digital spatial data

Along with an increasing demand – from authorities as well as from the public – for easily accessible digital property information comes higher pressure on accuracy and reliability of the spatial data. The expectations on the quality of the digital cadastral map are, for example, much bigger than on the original analogue map. And while the Real Property Register was earlier accepted as a set of records directly stating titleholders but only *indirectly* giving account for property boundaries and land use regulations (by referring to file numbers), many users of today demand primary information and completeness also in these aspects.

The fact that all archived documents concerning subdivisions and other kinds of property formation are now being scanned into raster data files will, to some extent, facilitate the work at the Cadastral Authorities. With the large-scale plans and descriptions easily accessible in the personal computer, the staff will no longer have to waste time walking to and from the archives often located in the office basement. The aspect of wear and tear is equally important; many of the paper documents date from centuries back and begin to fall to pieces, why the introduction of the digital archive will prevent further deterioration. Since the digital documents contain exactly the same information as the analogue versions, this improvement does however not change the amount of primary data in the Real Property Register. The users will not, in that respect, be provided with any better information.

The information technology that leavens through the processes within land administration has mainly positive effects. Making the current digital cadastral map accessible to more users is, however, not only of good. The problem is that many people trust this map, either fully or at least more than they trusted the former paper version. The fact that the digital cadastral map often only gives a rough picture of how the land is divided into properties – meaning that one still has to look into the cadastral survey plans and trace boundary marks on the ground in order to find the right boundary locations – seems to be less and less known among people in general. This can lead to mistakes when putting up fences, felling trees or undertaking similar tasks normally carried out without assistance from any boundary expertise. Such mistakes may rest unnoticed for some time, but when they finally appear they often create both disagreements among the neighbours and anger towards the National Land Survey as responsible for the maintenance of the map in question. Uncritical trust in the digital cadastral map hence causes many potential problems.

3.2 The vision of a Swedish legal coordinated cadastre

In 2001 the National Land Survey of Sweden expressed a vision to let coordinates, defined in a national geodetic reference system, become best evidence as for property boundaries. The aim is to establish more efficient and user-friendly land administration services based on a *valid* digital cadastral map. On completion of such a legal coordinated cadastre, all boundaries will once and for all be unambiguously determined and recorded as primary data in the cadastre section of the Real Property Register. Should, hence, a boundary dispute rise among neighbours due to discrepancies between various types of evidence, or should an uncertain course of a boundary threaten to hinder or

delay a subdivision procedure or a road construction project, the coordinates in the cadastre would make conclusive evidence.

Consequently, the thorough investigations and decisions of what represents the right course of a property boundary will be a matter of history. The new system would thereby, among other things, make possible considerable timesaving in the day-to-day work of cadastral surveyors, physical planners, parties at the property market etc. Furthermore, with reliable and easily accessible boundary information comes higher legal security for landowners as well as for banks and finance companies. Economical benefits should also reach the public by means of lowered charges related to land transactions and cadastral services.

3.3 A complex task to accomplish

Since property boundaries have been marked on the ground for centuries, and these boundary marks today constitute the primary evidence of boundary location, the proposed reform would require a range of changes in the Land Code and the related legislation. This means a time-consuming process, including writing official reports, lobbying and presenting bills to the parliament. Furthermore, the national geodetic reference system must be improved and technical solutions concerning efficient GPS measuring and digital mapping worked out. The digital cadastral map of today may possibly be used as a basis to some extent, but its considerable variation of accuracy must in that case neither be ignored nor underestimated. Besides these and other issues, the crucial question of data capture has to be solved: *how* to determine unique and sufficiently accurate coordinates of all boundary points of the 3.2 million properties throughout the vast country?

Without anticipating any discussions in the doctoral study, some general thoughts about the question of data capture can be mentioned. If, for example, the legal coordinated cadastre is to be completely based on the valid boundaries of today (i.e. according to the current legislation), the superiority of boundary marks on the ground must be considered all through the work. It would, hence, not be a feasible method to convert the thousands of cadastral survey plans into a digital medium and then calculate boundary point coordinates at the office desk. Cadastral files of old boundaries, dating from the 18th century until early 20th century, do in general include elegant hand-drawn survey plans but they lack (useful) measurements. In order to create coordinates to all such boundary points, the cadastral documentation could, hence, mainly serve as means of assistance in finding and measuring the boundary marks or other signs of possession on the ground. Boundaries of later date, on the other hand, are usually sufficiently well measured but often in relation to local reference systems of various quality. A few of these local coordinates may be transformed into the national system without any perceptible loss of accuracy, others will not. Many modern boundaries consequently need to be re-measured in the field. And even when there are transformable measurements in the cadastral archives, the fact remains that these coordinates are only second best evidence. Should there be a discrepancy between an intact boundary mark and the recorded corresponding coordinates, the former will take precedence of the latter and thereby prove the coordinates wrong. If this risk is to be fully avoided, the coordinates will have to be checked against existing boundary marks. Such a method would uphold the highest level of legal security for the landowners, but would, on the other hand, require substantial work efforts and financial means. Consequently, there are many issues about data capture to be investigated and discussed.

Besides the technical, juridical and financial challenges of a future reform, the question of how the property owners will look upon a legal coordinate cadastre must not be forgotten. Will they see advantages or disadvantages in comparison to the present system? Since the property owners compose a fairly heterogeneous group in regard to age and knowledge about boundary issues, the probable answer is “both”. While the spokespersons point at the likelihood that all mobile phones soon will be equipped with high accuracy positioning device making boundary marks unnecessary, the antagonists emphasise the need for visible evidence on the ground. The way in which a future reform would be

financed – by the State, the users of the information or the property owners themselves – will probably be an equally vital factor concerning the public opinion.

3.4 The doctoral study

Due to the limitations of today's cadastre and the challenging vision of future change, a (part time) doctoral study financed by the National Land Survey was initiated at Lund University a few years ago. The overall aim of the study is to identify and analyse probable consequences of an implementation of a Swedish legal coordinated cadastre. Legal aspects, both in regard to private interests and the State, will be especially emphasised in the discussions about alternative methods of creating and implementing a new system.

In order to be able to start investigating consequences of the suggested cadastral reform, the present system had first to be thoroughly examined and described. The initial half of the doctoral study, completed last year (Karlsson 2004), is therefore concentrated on the current legislation – material as well as procedural rules – concerning property boundaries. Emphasis is put on how boundaries, and especially uncertainties about their location, are regulated by law and handled in cadastral procedures and court cases in Sweden today. Included in this part of the study are also two examples of boundary systems in other jurisdictions: England & Wales and Austria. This international outlook mainly aims at widening the knowledge and understanding of alternative ways of handling boundary issues. While England & Wales represent a traditional general boundary system without any cadastre, the Austrian system, based on the fixed boundary principle and a long cadastral tradition, is gradually implementing a legal coordinated cadastre (*Grenzkataster*). Despite the fairly different views of land administration and handlings of boundary issues within these two jurisdictions, both systems are well-functioning in their own context.

The recently commenced second part of the doctoral study, planned to be finished in the end of 2006, will to a much larger extent concentrate on the idea of a future cadastral reform. Since the vision expressed by the National Land Survey is only vaguely formulated, and many questions about the actual meaning of a legal coordinated cadastre remain unanswered, the initial chapters need however to be focused on mere terminology discussions and some examples of foreign experiences. Already effected legal coordinated cadastres as well as planned reforms and refused ideas are here to be mentioned. Because of the many similarities between the land administration systems in Sweden and Austria, the Austrian way of creating a legal coordinated cadastre will be analysed in depth. Some other countries of interest are Singapore, Malaysia and Canada.

Before working out ideas of how the cadastral reform could possibly be realised and what the consequences would be, some important assumptions also have to be made. One of these assumptions concerns the question if it would be enough to change the hierarchy of boundary evidence giving coordinates the highest status, or if these coordinates should also be guaranteed by the State? And how, in that case, is such a guarantee to be established for example with regard to liability? Nichols (1996) discussed, among other things, the concept of guaranteed boundaries in a report aiming to serve as framework for discussions of cadastral reform among surveyors, lawyers and other professionals in New Brunswick, Canada. Despite the differences between the Canadian and the Swedish cadastral systems, this report emphasises many important issues that will be addressed in the doctoral study in question. Many of the common factors are of technical nature, such as measurement tolerances and necessary adjustments of geodetic network and datum. Some legal and administrative issues mentioned in Nichols' report are also of relevance to the Swedish scene, for example the need of changed legislation. Other Canadian aspects, such as effects of part parcel adverse possession, need however not be considered in Sweden.

Possible methods of data capture will, as mentioned above, be one of the main issues to be discussed in the doctoral study. Here, focus will be on processes rather than on technical device. For example,

do all boundaries have to be re-measured in the field or is it possible to find easier ways to gather boundary coordinates? In Finland, for example, property owners have recently been involved in a project aimed at improving the Finnish digital cadastral map (however not making it conclusive evidence). By signalling strategic boundary points on the ground with big white markers during days of aerial photographing, they provided important information that could be used for adjusting the cadastral map. Another question is if it might be possible to get round the somewhat conservative legislation of today in order to avoid the time-consuming historical investigations. For example, could the landowners, during a transitional stage, be allowed to agree between themselves on the practical (physical) boundaries on the ground – irrespective of old monuments and cadastral survey plans?

The aspect of systematic versus sporadic implementation will also have to be considered. If the new system is to come into force simultaneously for a city, a region or even the whole country, all boundary points within the area in question must first be determined by coordinates. Such a systematic method would require intense efforts, probably financed by the State, if completion is to be enforced. The advantages of getting all properties under the same new system in a limited time might, however, justify these costs. One alternative way of implementation could be inspired by the sporadic and gradual method practiced in Austria. There, all new properties, created through subdivisions or spittings, are registered in the legal coordinated cadastre (*Grenzkataster*) instead of in the traditional cadastre. The same thing applies to existing properties if they have been subject to complete boundary definitions. Such cadastral procedures and the following registration have since long time been paid by the property owners, why the creation of the legal coordinated cadastre does not cause any notable additional costs. The major disadvantage of this implementation method is, however, that the reform pace is very slow. Since the start in 1969, not more than about 12% of the Austrian properties have been geographically defined by coordinates, so without forcing their implementation procedure the *Grenzkataster* will practically never be complete. Consequently, there will be two parallel cadastres and corresponding sets of regulations for unforseeable time, and a digital cadastral map showing a mixture of approximate and valid boundaries. With regard to the Swedish demands of completement and legal security, such a way would, hence, not be an optimum method.

There are obviously many more issues to be considered if the vision of a legal coordinated cadastre should ever be realised. It should again be emphasised that the ongoing doctoral study will not result in any detailed proposals of implementation. Nor is the intension to present a complete feasibility study in which all technical and economical aspects are discussed in depth. The focus is, as mentioned before, on legal issues on a fundamental level. Further considerations and analyses will therefore be needed before any final decisions may be made.

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