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Transforming Society
The Story of the Danish Cadastre from late 1700s

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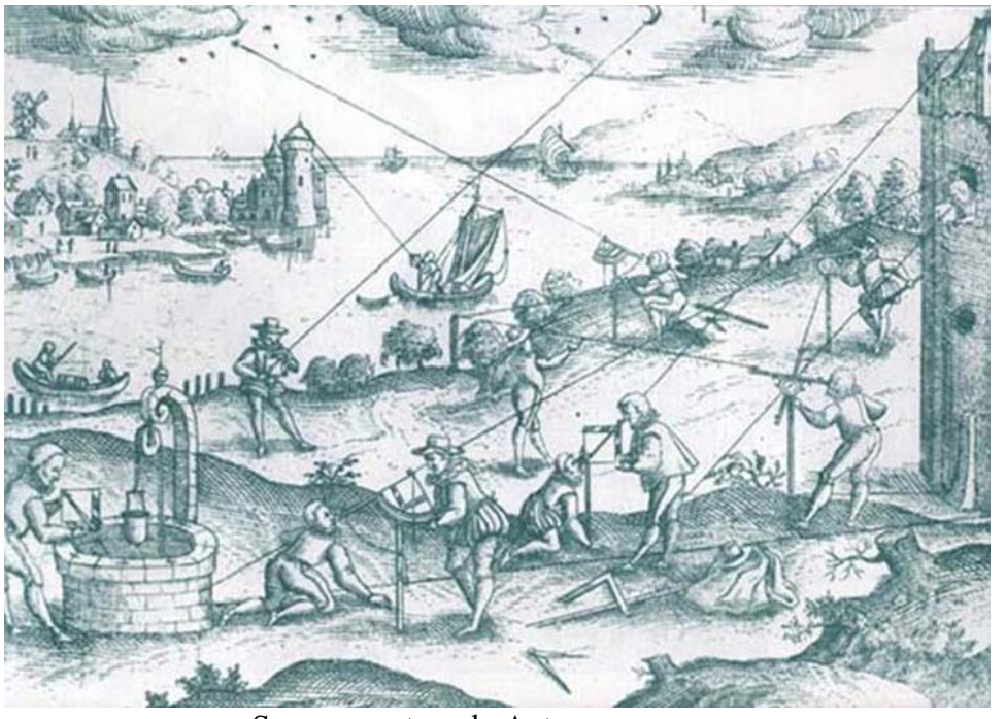
Key words: Cadastre, Historical evolution, Enclosure movement

SUMMARY

This paper provides an understanding of the cadastral evolution in Denmark with a focus on establishing the cadastre as an outcome of the enclosure movement in the late 1700s. The purpose of the cadastre was collection of tax based on the yielding capacity of the soil. The Danish cadastre, this way, was a result of transforming society from a feudal system to a capitalistic and market based economy.

This story is interesting in itself - but it also provides a key to understanding the cadastral system of today. The system has evolved over time and now serves a whole range of functions in society. The paper ends up describing the recent process of developing a fully digitised cadastre serving as basic infrastructure underpinning an efficient land market and effective land-use management.



Surveyors at work. Antwerp museum.

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1. INTRODUCTION

In most countries, the cadastral system is just taken for granted, and the impact of the system in terms of facilitating an efficient land market and supporting effective land-use administration is not fully recognised. The reality is that the impact of a well-functioning cadastral system can hardly be overestimated. A well-tailored cadastral system is in fact acting as a backbone in society.

The famous Peruvian economist Hernando de Soto has put it this way: "Civilized living in market economies is not simply due to greater prosperity but to the order that formalized property rights bring" (De Soto, 1993). The point is that cadastral systems provide security of property rights and thereby pave the way for prosperity as well as enabling control of the use of land and natural resources.

This advanced thinking was of course not predominant in the late 1700s when the present Danish cadastre was established. However, the transformation of society resulting from the enclosure movement at that period also created a need for modernising the system of collection of taxes. The resulting maps from the enclosure movement combined with information on the quality of soil provided an ideal basis for creating a modern cadastre that was put into force 1844 and has been maintained ever since. This paper presents the story and outlines developments towards the digital cadastre of our time.

2. DENMARK IN THE MID 1700s

In the mid-1700s, Denmark was an absolute monarchy and all land in principle belonged to the king who would then dispose of the various manor estates to the members of the aristocracy. These lords would then rent out the minor agricultural farms in the villages to the peasants with an obligation for them to contribute by labour to farming the manor estate. These tenant rights were often passed down from generation to generation and most tenants were not free to depart the manor for other locations or occupations. The manor lord, his officials, and a manorial court administered the estate and exercised jurisdiction over the peasantry.

The peasants also had the duty to pay taxes in the form of natural goods and the manor estate then paid taxes to the king in the form of money. The taxes to be paid to the king were determined by the first cadastre in Denmark initiated 1681 and put into force 1688. It consisted of a simple survey of the length and width of the individual fields and an assessment of the quality of the soil in four – six categories. Tax was then paid according to taxation unit called "hartkorn" equivalent to about 0.55 ha of the best soil. The cadastre did not include any mapping and there were no provisions for maintenance.

The peasants farmed the land in common by dividing the surrounding land of the village into three large fields for different cultivation in a rotation of grass, barley and rye. Each of the large fields were then divided into minor fields of similar soil quality and further into many narrow strips of land cultivated by an individual farm. Even if the land was, in principle, farmed in common the system allowed for each farm to get access to a share of the yield equivalent to size of the farm as stated in the tenancy contract. The farming system is illustrated in figure 1 below showing the village of Aarslev and its surrounding fields. The village includes 14 farms and, in this case, farm no 5 then had 108 strips of land to farm.

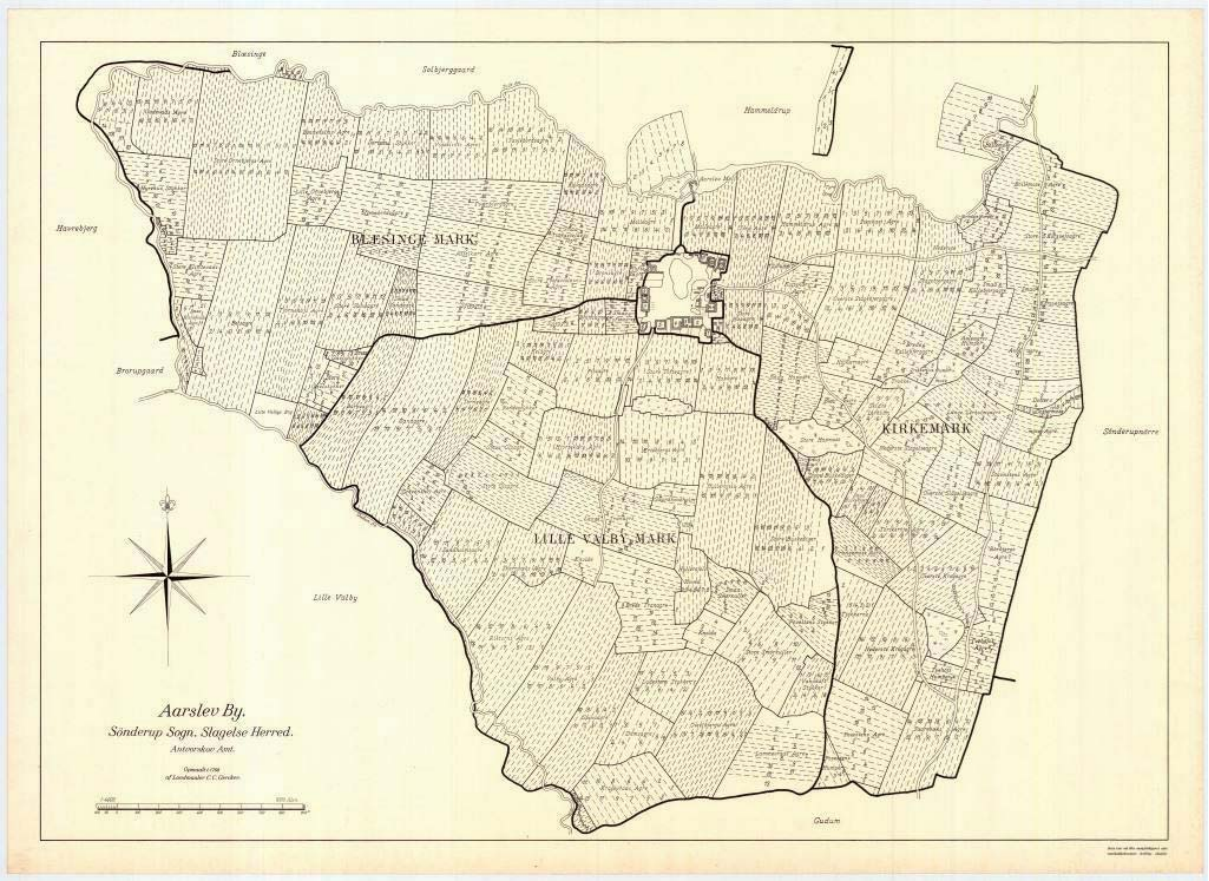

Figure 1. Illustration of the farming system used in the village of Aarslev second half of 1700s. (Courtesy of the Danish Geodata Agency).

3. THE ENCLOSURE MOVEMENT

The feudal system as described above resulted in a rich and powerful aristocracy and a deeply poor population of peasants. However, the aristocracy was challenged by holding the position of converting the in-kind payments from the peasants to monetary tax payment to the state. This position of about 600 aristocratic lords against about 1 million peasants was vulnerably against any changes e.g. in relation to the yielding outcome or monetary rates.

It became clear that reform initiatives were necessary. A few foresighted lords suggested reforms aimed at creating a kind of middleclass of self-owning peasants and thereby consolidating their own position. This resulted in the enclosure movement that eventually converted society into a more capitalistic approach based on a monetary economy.

The enclosure regulations were adopted 1781 and stated that any peasant in the village could require his land consolidated (in no more than three plots) even if the fellow peasants in the village did not approve. Based on just one requirement an enclosure plan for the entire village should be prepared and all members of the village community had to share the expenses. The manor lords could impose these expenses on the tenants and thereby enforce the enclosure work to take off.

The practical regulations included instruction for the mapping of the village areas in the scale of 1:4000 by plane table surveys using dioptre and chain. The outcome was the so-called island maps showing the total village area surrounded by its outer boarders, and without any triangulation or connection to a national grid framework. On this basis a preliminary enclosure plan were developed. Inside the village boundary, the lots of similar soil quality were identified and assessed in relative terms. The final enclosure plan was then developed by ensuring that each farm would have the share of quality soil as previously within the village community. Finally, the new boundaries of the individual farms were set out in field.

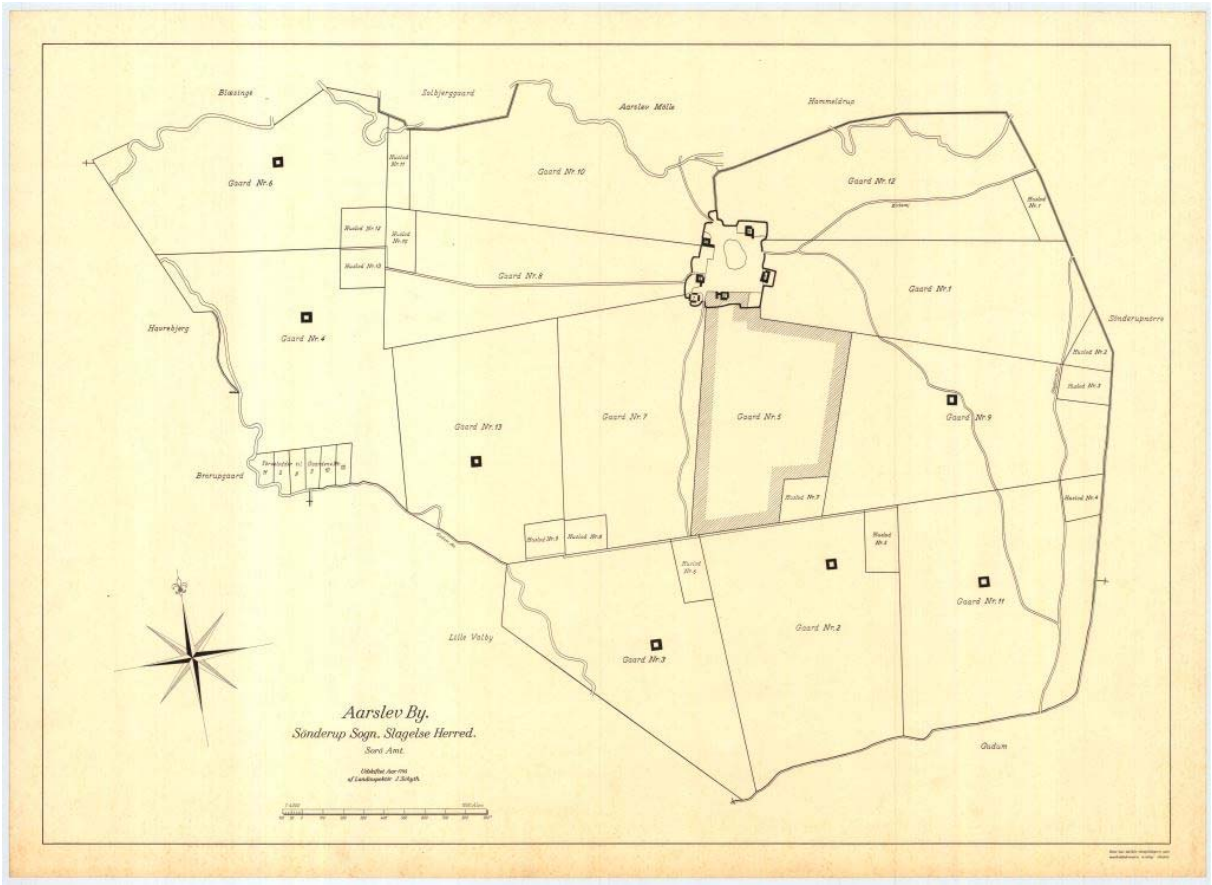

Figure 2. The resulting enclosure plan for the same village area as shown in figure 1. This is a so-called block-enclosure where the land for each farm is located in adequate blocks of land and, where necessary, the buildings were moved to a location serving the farming of the block. Farm no. 5, with formerly 108 strips of land, is now consolidated into one block of land as marked on the map. In order to ensure a fair solution for all farms, some minor plots remained for common use such as extensive grazing, extraction of clay, sand, etc. Also, a few individual small lots where often established for the housing of farm-workers. (Courtesy of the Danish Geodata Agency).

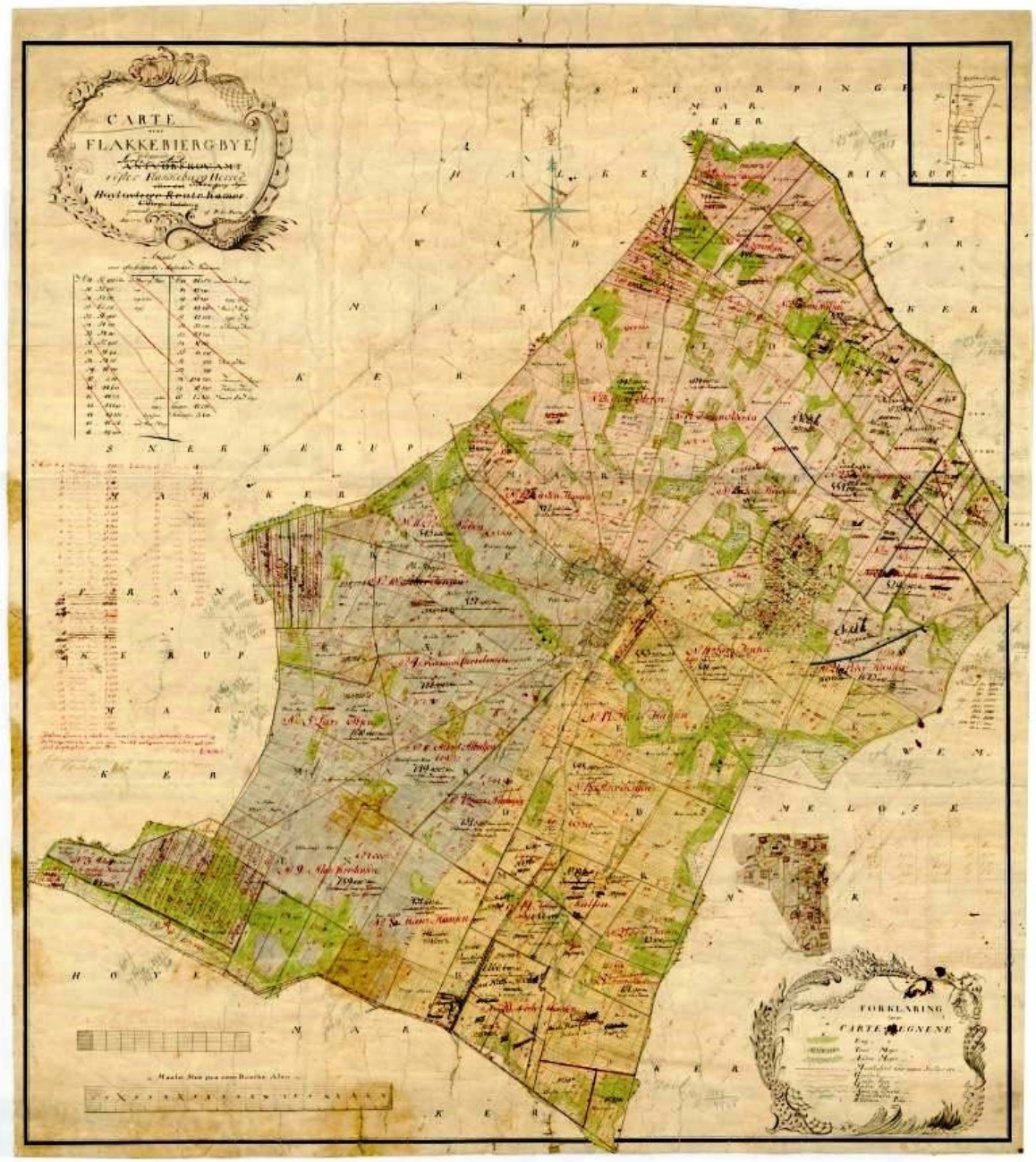

Figure 3. Another enclosure solution is the so-called star-enclosure where the buildings remain in the village and the land is allocated from there in a kind of star formation. This original map shows such an enclose design. (Courtesy of the Danish Geodata Agency).

The surveyors were responsible for implementing the enclosure movement. The first surveyors were officially appointed 1768 – thus celebrating their 250 years anniversary 2018. The work was carried out quite fast. Over just 20 years, by the year 1800, about 60 per cent were completed and, in 1837, less than 1 per cent remained.

The enclosure movement changed the Danish landscape dramatically and most of the boundary features are still present comparing with a satellite image, see figure 4.

Figure 4. A satellite image of the same area as figure 2. The outer boundary of the village area as well as most of the individual property boundary features are still visible today.

4. CREATING THE CADASTRE

The enclosure movement also initiated the creation of a new cadastre for the collection of taxes. The former cadastre from 1688 was no longer adequate and it was decided by resolution of 1806 that new cadastre should be created. The resolution included three steps: mapping, soil assessment, and calculation of taxation.

For the mapping, the enclosure maps were used as the basis and supplemented where needed e.g. by including the village centres etc. Then, the maps were tested by establishing diagonal measurement lines in the field for checking the correct location of the outer boundaries as well as the boundaries between the individual farms. The discrepancies should not exceed ½ per cent or a new map should be created. Also the roads should be included using standard widths ranging from about 19 metres (30 alen) for main transport roads to about 4 metres (6 alen) for private roads (1 alen equals two feet that is 0.628 metres).

The soil assessment was based on a national scale from 1–24 with the character 24 representing an example of the best quality of soil in the country. The quality of the soil was assessed by digging a pattern of holes covering a large field, and thereby dividing the field into minor areas of equal yielding quality. The geometric area of each these minor fields multiplied by that mark (from 1 to 24) and divided by 24 would then represent the relative yielding capacity of the farm to be used as a basis for taxation.

In fact, this calculation of the yielding capacity could be used directly for the taxation. However, there was some scepticism since people were used to old taxation system based on the old yielding valuation unit of “hartkorn” from the cadastre of 1688. So it was decided to

keep the same amount of “hartkorn” as in 1688. By dividing the total area of yielding capacity of the country with the number of “hartkorn” units from the cadastre of 1688, the new unit of “hartkorn” became 72.000 sq. alen or about 2.8 ha of quality soil.

The process of creating the new cadastre was finished by 1837. However, there were still some resistance and objections to be settled before, finally, the cadastre was put inforce 1844. It consisted of two parts: the cadastral register and the cadastral map. The farms within each village area were numbered and recorded in the cadastral register with indication of geometric area and the valuation in terms of “hartkorn” for each property, while the cadastral maps show the location of the cadastral parcels. Simultaneously, in 1845, the land registry system was established for recording of land transfers and mortgages.

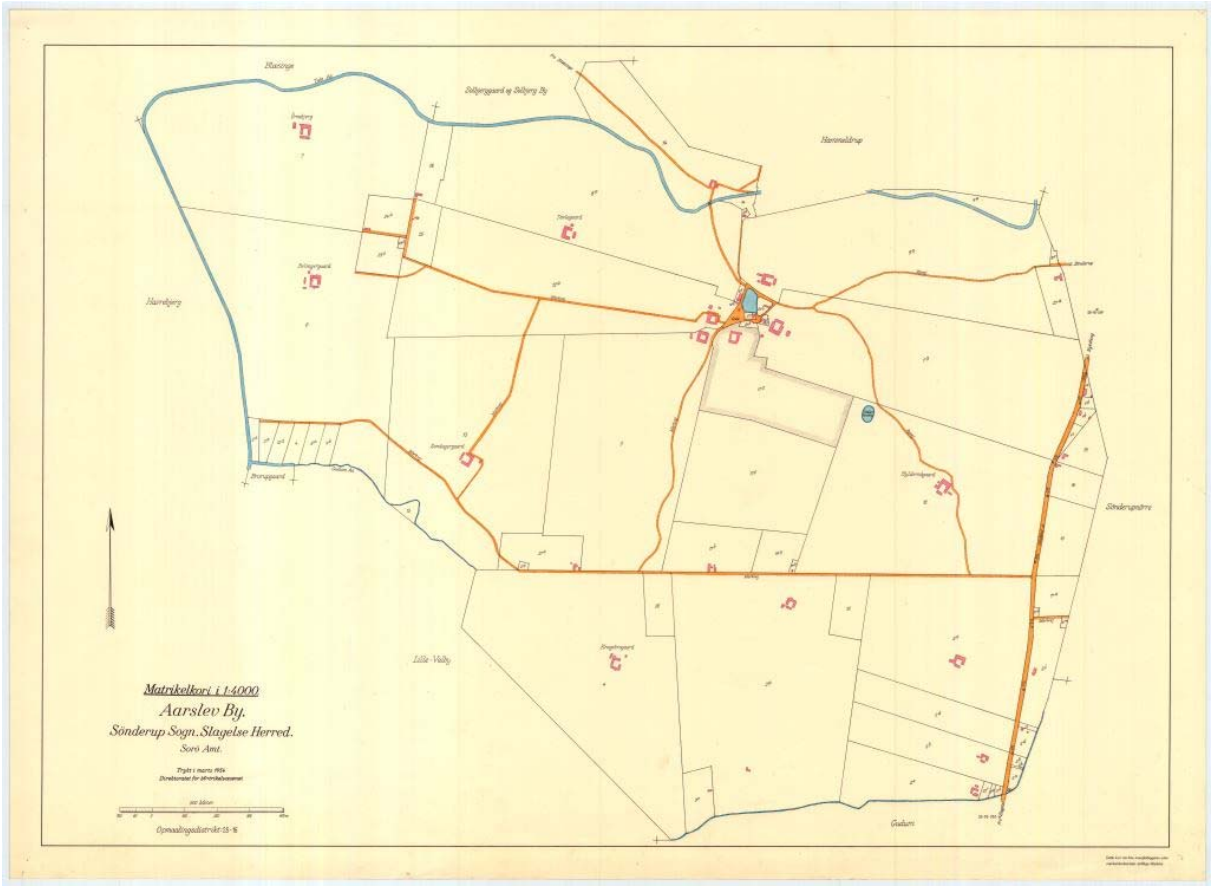

Figure 5. The resulting cadastral map for the same area as shown in figure 2.
(Courtesy of the Danish Geodata Agency).

As mentioned above, the cadastre of 1844 was created for the purpose of taxation based on the yielding capacity of the soil. Therefore, the cadastre included only the rural areas and only areas legible for taxation such as farmland. The provincial towns, by tradition, were excluded for the duty of paying taxes. They were eventually included 1863 by mapping in the scale of 1:800 carried out as traverse surveys and including building etc. All land used for buildings, garden, etc. was assessed by the rate of 24.

5. MAINTAINING THE CADASTRE

The cadastre of 1844 also included provisions for maintenance that became the duty of examined surveyors in private practice. In fact, regulations for such maintenance were provided already around 1800 and a national cadastral office was established 1804 under the Ministry of Finance. Formal education for surveyors was established in 1858 at the Royal Agricultural Academy, Copenhagen, and the national association of surveyors was formed in 1875.

The regulations for maintaining the cadastre have been refined and improved over time following societal, economic and technological development. In the late 1800s the cadastre changed from being a fiscal cadastre primary used as a basis for taxation of agricultural land to becoming a legal cadastre focusing on securing land rights and supporting a growing land market. This evolution was completed in the first years of the 1900s when taxation became based on the market value. In addition, in 1920s, a new land book system was established introducing title registration based on the cadastral identification. A close interaction between the cadastre and the land book was established.

During the first half of the 1900s, land was increasingly seen in Denmark as a commodity, with a focus on agricultural production and the industrial revolution. Land-use regulations based on cadastral information were introduced to simultaneously improve agricultural productivity and sustain the social living conditions in rural areas. In fact, the old yielding valuation unit was used to control development in the rural areas until the late 1960s.

The 1960s introduced a close interaction between the cadastral process (e.g., subdivision) and land-use regulations. Property formation or change of property boundaries required documentation showing the approval of the future land use according to relevant planning regulations and land-use laws. Land was increasingly seen as a scare community resource, and zoning and planning regulations were introduced to control land development. Environmental concerns appeared in the late 1970s and became a major issue in Denmark. Today, comprehensive planning and environmental protection are seen as the main tools to secure sustainable development.

Over the 1980s, the National Survey and Cadastre prepared a legal reform revising and modernising the cadastral legislation in cooperation with all main stakeholders. This included coordination of various sectoral legislation and a whole range of detailed regulations for undertaking cadastral work. The reform was put into force 1991 and has paved the way for a modernised cadastral system serving a wide range of functions in society.

6. MODERNISING THE CADASTRE – THE DIGITAL AGE

The second half of the 1980s also saw the need for a digital reform converting the old analogue island maps into a digital format linked to national grid. The aim was to establish a cadastral information infrastructure accessible for all kind of users, and tailored for efficient interaction with other land data systems. The cadastral register was computerized by1986 and a pilot project for computerizing the cadastral maps was carried through over the years 1985-89, and the full digitization of about 15.000 analogue cadastral maps, comprising about 2.5 million land parcels, was completed by 1997.

In order to decide for the concept of computerization, the existing cadastral information had to be carefully considered. Even if the old cadastral measurements are not well documented, the surveys carried out after 1934 should normally be connected to the national grid network called “System 34”. For that purpose, some 360.000 control points have been established and positioned in the network, especially for cadastral surveys of the public roads.

The process was undertaken in two stages. First, state control points and cadastral surveys connected to the national grid were entered into the map to form a “skeleton” cadastral map. In urban areas, about 40 percent of the boundary points were entered this way and in rural areas about 20 percent. Second, the remaining parcels were inserted by digitizing the analogue map and fitting these into the skeleton map by transformation. Identified elements in the digital topographic map were also used to support the transformation, see figure 6.

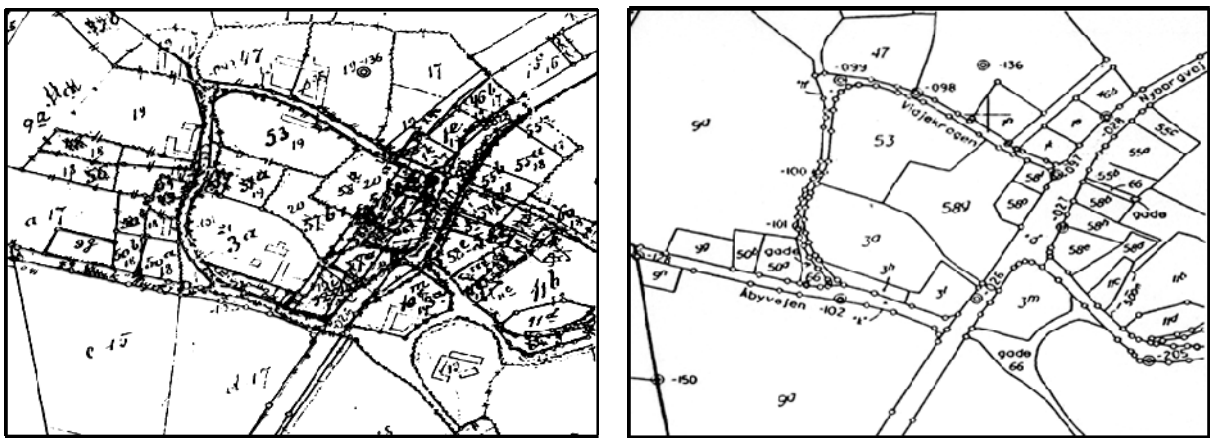

Figure 6. Digitizing the old analogue cadastral maps was difficult for a number of reasons. The old analogue maps are “island maps, they are not linked to national grid, and the display may be difficult to interpret due to maintenance over about 100 years (left). The digital cadastral map from 1993 (right) is linked to the national grid as a “frame map” showing only the current cadastral situation. The boundary points, shown by circles, are established in the map using control points and cadastral measurements.

Using this process, the accuracy of the boundary points in the resulting digital cadastral vary considerably, ranging from a few centimetres in some urban areas to several meters in rural areas. Therefore, the digital cadastral map will not be fully consistent with a digital topographic map. The accuracy of the boundary points relates to the way they are established in the map, and this information is attached to the boundary point in the database. Other metadata includes information about the type of boundary and the file number from the cadastral archive of the Danish Geodata Agency (replacing the National Survey and Cadastre in 2013).

In the analogue cadastral maps, new boundaries were adjusted graphically to the position of existing boundaries. This process is reversed in the digital map, where new cadastral measurements are used for adjusting the position of existing boundaries. This dynamic process will ensure an ongoing improvement of the accuracy of the cadastral map. The accuracy may also be improved by upgrading certain areas — e.g., in relation to major land development projects. This process includes a new transformation of the existing boundary points based on identification and positioning of a range of boundary points within the area.

The digital cadastral map includes a number of problems deriving mainly from the history of creating the old analogue maps and from the process of computerization. Successful use of the digital cadastral map therefore depends on the educated use of the map. However, in summary, establishment of a digital cadastral system has provided the opportunity to combine the cadastral identification with the topographic information and other land related data to support efficient and sustainable management of rights, restrictions and responsibilities in land.

In 2008, the National Survey and Cadastre implemented a new digital system, which combined the cadastral register and the digital cadastral map into a joint cadastral database accessible on the web. The system also introduced digital lodgement from the private surveyors to be used directly for updating the cadastre. Furthermore, the system provides online updating of the Land Book that was ready in a digital format by the end of 2000 and further developed for e-registration in 2009. The linkage between the Land Book and the Cadastre being a unique cadastral unit identifier.

Being the only large-scale mapping framework of the country, the cadastral maps over recent years have been used for identifying a number of land use restrictions such as forest regulations, coastal protection lines, zoning restrictions, etc. The last decade has seen developments towards establishing more integrated land information systems for displaying the various rights, restrictions and responsibilities in land. These systems are based on the cadastral identification of land parcels in combination with the topographic features. An example is the e-planning portal called “Plansystem.dk” that provides public access to all municipal plans and local plans (either adopted or proposed) across Denmark, see figure 7.

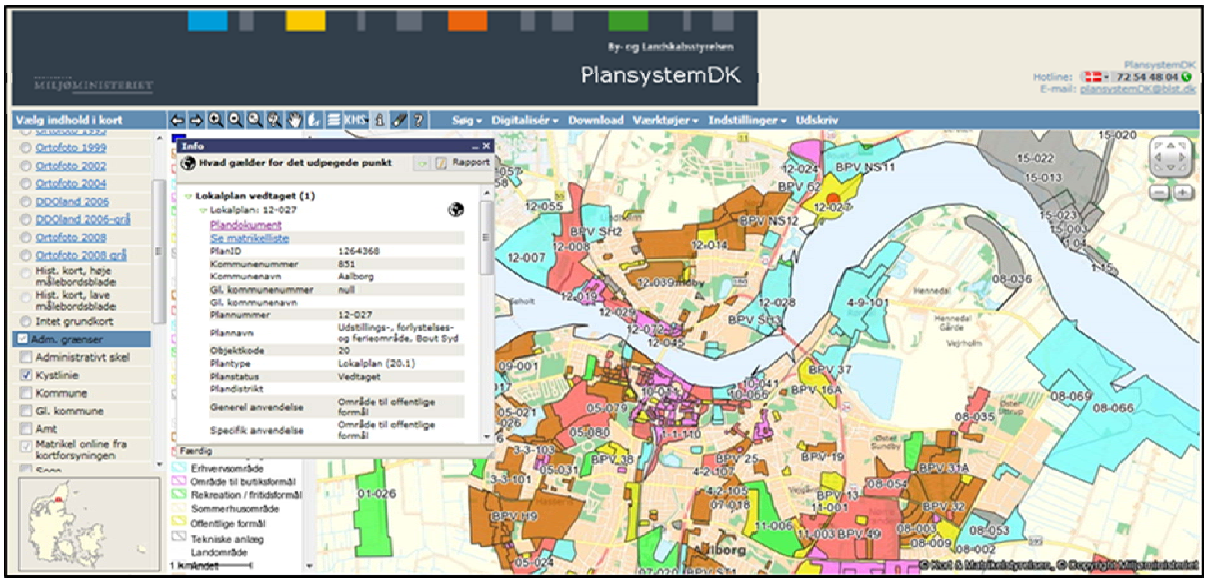

Figure 7. The e-planning portal “Plansystem.dk”. The map-based interface provides a range of navigation tools including street address, cadastral parcel number, municipality, and area polygons. The areas of the development plans can be displayed in combination with cadastral and topographic maps or aerial imagery, as well as other kind of land use restrictions such as conservation areas and coastal protection zones. Once the citizen has identified the development plan of interest, the system provides direct access to an electronic copy and can display and generate a list of all properties (cadastral numbers) affected by the plan. The system also provides the citizens with opportunity to provide direct feedback on proposed development plans during the statutory consultation period.

7. A GLOBAL OUTLOOK

Throughout the world, the cadastral concept has developed significantly over the past few decades. The most recent examples are current world concerns of environmental management, sustainable development and social justice.

The human kind to land relationship is dynamic, and it is changing over time as a response to general trends in societal development. In the same way, the role of the cadastral systems is changing over time, as the systems underpin these societal development trends. In the Western world, this dynamic interaction may be described in four phases as shown in figure 8.

	Feudalism - 1800	Industrial revolution 1800-1950	Post-war reconstruction 1950-1980	Information revolution 1980-
Human kind to land evolution	**Land as wealth**	**Land as a commodity**	**Land as a scarce resource**	**Land as a community scarce resource**
Evolution of cadastral applications	**Fiscal Cadastre** Land valuation and taxation paradigm	**Legal Cadastre** Land market paradigm	**Managerial Cadastre** Land management paradigm	**Multi-purpose Cadastre** Sustainable development paradigm

Figure 8. Evolution of Western Cadastral System (Adapted from Williamson et al., 2010)

Over the last few decades, land is increasingly seen as a community scarce resource. The role of the cadastral systems has then evolved to be serving the need for comprehensive information regarding the combination of land-use and property issues. New information technology provides the basis for this evolution. This forms the new role of the cadastral systems: the multi-purpose cadastre.

The story of the Danish cadastre as presented above fits very well to this evolution.

Plane table. Illustration from *The Compleat Surveyor* by William Leybourn (London, 1653).

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BIOGRAPHICAL NOTES

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