

Cadastral Mapping in Norway in Transition from Municipal Responsibility to Central Cadastre

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Key words: cadastre, cadastral mapping

SUMMARY

Over the last 20 years, Norwegian municipalities and the Norwegian Cadastre and Mapping Authority have cooperated to transfer data on boundaries to a digital cadastral map (DCM) in Norway. This work commenced in the early 1980's, for several reasons. The Norwegian law on the cadastre introduced in 1980 implied that cadastral survey was obligatory in cases of land subdivision, which created a need for an overview of the properties within the municipality for the administration of the law. The 1980's also saw the development of EDB technology enabling digital cadastral mapping. As the digitalisation of boundaries started in the different municipalities and regional offices of the Norwegian Cadastre and Mapping Authority, it became clear that standardization and coordination was needed to handle the digital cadastral map in a future common administration. In 1990, the Norwegian Cadastre and Mapping Authority and The Norwegian Association of Local and Regional Authorities developed a common data model for DCM. This data model has been the foundation for the development of a digital cadastre map until the present day, with hardly any modifications. Substantial investments have been made to establish DCM, and municipalities and the Norwegian Cadastre and Mapping authority have shared the costs. By May 2006, 87 per cent of the properties in Norway are registered in DCM, and approximately 80 per cent are registered with boundaries. However, the quality varies from one municipality to another, as some local authorities have put great resources into DCM with the result that they are close to having a complete cadastral map of high quality for the area, while others have paid little attention to DCM.

DCM has mainly been established through registration of the surveyor's certificates for area measure, and digitalisation of boundaries in economic mapping. Other sources have also been used when establishing the cadastral map, like land consolidation maps and road maps from Public Roads. Some municipalities have also surveyed boundaries in special projects.

17 June 2005, the Norwegian parliament *Stortinget* passed a new law on the cadastre. A main element of the new law will be a new cadastre, integrating the cadastral register (GAB) and DCM into a central database.

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1. CADASTRAL MAPPING IN NORWAY IN A HISTORICAL PERSPECTIVE

Historically, Norway has employed different methods of property registration, surveying and mapping of boundaries in the towns and in the countryside. The towns have used a system of survey of boundaries and exact surveying and mapping through several hundred years, while in the countryside, a system of land taxation without surveying or mapping of boundaries was in use until 1980. However, both systems have their foundation in the need for a basis for taxation.

2. CADASTRAL MAPPING IN NORWEGIAN TOWNS, USING BERGEN AS AN EXAMPLE

In the Middle Ages, Bergen was one of the most important towns in Scandinavia as a trading centre for Norwegian stockfish. As a throbbing mart, the town developed regulations for surveying and mapping of property from early on. The earliest known regulations are from 1687. The background for the increased initiative at this point was the town fire in September 1686. A few weeks before this fire, the King and his men in Copenhagen had discussed the financial problems concerning the town of Bergen. The expenses had been on the rise for decades, and the mayor suggested that the town should be surveyed again to increase the number of dutiable properties. Then the town burned, and this set focus on the need to map properties to be able to reconstruct boundaries efficiently after such a fire. Consequently, the town's need for income and the fire in September 1686 led to the royal decree from February 16 1687, which stated that the town was required to survey all land inside the town borders, and to establish a register of deeds. When the survey of boundaries was finished and handed over to the city council, the rent could be collected.

The royal decree from 1687 also included a paragraph saying that the citizens must report to the authorities when the size of a property was changed, but it was hard to make the citizens follow this regulation. Therefore, in 1700, a new regulation came from Copenhagen saying that no title deeds could be put on record unless it was surveyed, to make the land tax of the town correct. This meant that surveying was obligatory in cases of property transaction in Bergen, and during the 18th century, survey of boundaries was carried out every time a property changed hands. These surveys were carried out by good citizens of Bergen, and after a time they were quite experienced, but the work was always subsidiary to other tasks. In 1830, a city architect post was established. The city architect was for one thing fully responsible for the survey of boundaries.

The surveying was only part of the responsibilities of the city architect. His workload increased heavily in the course of the 19th century and he usually did the surveying on his

own, so the building regulations of 1899 laid down that there would be a city surveyor in Bergen when the city council so decided. The city council then employed the first city surveyor in Bergen in 1899. He also got a staff of one secretary, one assistant, three officers and an office boy. The city surveyor supervised the surveying of boundary marks and was responsible for the cadastral maps.

The building regulations of 1924 were laid down for all the towns in Norway, and could come into force for villages and population concentrations as well, if the authorities so decided. Surveying was obligatory for the areas where the law was in effect, surveyor's certificates for area measure were required before a building could be constructed and the surveying must be done in connection with map coordinates. Surveying was also obligatory when property changed hands. From 1929, the surveyor's certificates for area measure in Bergen were surveyed in the geodetic network of Bergen.

3. CADASTRAL MAPPING IN THE COUNTRYSIDE

In a historical perspective, the mapping of property and property boundaries arose from the need for a basis for taxation. While the towns developed mapping systems early on, the countryside lacked systematic cadastral mapping until the economic mapping started around 1960. A central reason for this is the system of *land tax* which was in operation instead. The land tax regulated the relationship between the land owner, the tenant farmer and the state when it came to rent and taxation. The landscape laws from the 11th and 12th century were the basis of the financial relationship between the land owner and the tenant farmer. The tenant farmer was obliged to pay an annual rent to the land owner, based on the production capacity of the farm. In contracts and deeds, and probably in daily life, the land taxation expressed ownership. Through the land tax, the tenants "owned" a part of the farm and the property. The land tax were registered in the cadastre (the first Norwegian cadastre was established in 1665-1670). The land tax was based on an assessment of the production value of each farm, not on the size and the productivity class. Thus, the system was not dependent on maps. The cadastral system was revised several times during the 19th century, and when economic mapping started in 1807, the aim was to include maps in the revision of the system of land taxation. However, economic mapping was stopped in 1816 because it was too expensive, and partly because farmers saw economic mapping as a threat to their newly acquired ownership rights. The farmers also feared that the mapping would be used to increase taxes. Towards the end of the 19th century, the Norwegian tax system changed from property tax to income tax, and the land tax lost its importance as basis of tax assessment. In spite of this, a law on land taxation came in 1909, and the system of land taxation continued until the implementation of the law on the cadastre in 1980. While other Northern European countries had well-developed systems of surveying and mapping of boundary lines, Norway kept the system of land taxation, although in a developed form. According to regulations from 1764, new boundaries were to be described and marked in the terrain in cases of land subdivision in addition to the land tax being divided. Land subdivision was performed by three laymen appointed by the head of the local police. They were responsible for the land subdivision, the terrain marking and the description of the boundaries. The three men were often respected farmers or artisans with varying degrees of literacy and only random knowledge of the

subject. The land subdivision was registered in the land book, the property was allotted an identification number, and the new property was established. Boundary marking and boundary description were incomplete at best, and the result was often boundary disputes. The practice of land taxation was discontinued when the law on the cadastre replaced the law on land taxation in 1980, and surveying became obligatory for the whole country.

4. ECONOMIC MAPPING

As mentioned above, the first economic mapping started in 1807 and was stopped in 1816. Only in the 1950's was the economic mapping reinitiated in Norway, on the initiative of different local authorities. In 1964, the Norwegian parliament *Stortinget* adopted guidelines for economic mapping (EM). The EM project was to be carried out in 15 years, and cover 135,000 km². The costs were split between the government and local authorities. EM was produced by photogrammetric methods. The land consolidation court was responsible for the photogrammetric registration of boundaries. At first, only easily demonstrable boundaries for properties larger than 5000 m² outside regulated areas were to be registered in EM. Boundaries were marked in economic mapping by means of symbols on the ground in the form of white squares sized 0.6x0.6 meters. The landowners were responsible for the marking, which caused a large number of the boundaries to be left unmapped. Only approximately 50 per cent of the boundaries were mapped, even though it varied according to the local administration. The EM project was finished in most regions during the 1980's, and it is common to consider the economic mapping in Norway complete when the county of Nordland finished in 2002. Approximately 32,000 map sheets had been produced for an area of 185,000 km²; the entire productive area under the timberline. The boundaries in economic mapping became central to the development of a digital cadastral map (DCM). The property boundaries of EM have been transferred to DCM by the regional offices of the Norwegian Cadastre and Mapping Authority, using digitizing tables for the digitalisation process.

5. LAW ON THE CADASTRE OF 1978

With the law on the cadastre of 1978 (implemented January 01, 1980), compulsory survey was introduced when subdividing land. The law had three main elements:

- 1) the system of the old cadastre for property identification in the countryside was introduced also in the towns.
- 2) a new cadastral register (GAB) was introduced replacing the old cadastre. GAB holds information about properties, addresses and buildings. GAB does not include cadastral mapping.
- 3) Compulsory survey when subdividing land

The compulsory survey when selling property that had been in effect in the towns through the building laws no longer applied after the law on the cadastre was introduced. The municipalities were given the responsibility of surveying boundaries, land subdivision and drawing up surveyor's certificates of area measure. A surveyor's certificate of area measure is thus an exact map of the boundaries. In accordance with the law, the local authorities are obliged to survey boundaries and draw up surveyor's certificates of area measure for all new

properties as well as survey existing properties if this is required. Furthermore, the provisions of the law prescribe that the municipalities must register surveyed boundaries, but there are no requirements for anyone to draw up cadastral maps. Thus, after the law of the cadastre, the cadastral maps are the responsibility of the municipalities.

The reason why the law on the cadastre did not include clearer and less ambiguous requirements for cadastral mapping was mainly that the technology and knowledge about the subject was not particularly developed in the late 1970's. The 1980's on the other hand saw a throbbing development in the field of technology. In the early 1980's, the surveying divisions of the municipalities acquired computers with software for land surveying and production of surveyor's certificates of area measure. In the wake of this development, and only a few years after the law of the cadastre was implemented, many municipalities began to establish a digital cadastral map. The county offices of the Norwegian Cadastre and Mapping Authority also started the digitalisation of boundaries and property identifications in the early 1980's. In the late 1980's, it became clear that it would be an advantage to coordinate the efforts of the different administrative levels, and a committee was appointed with representatives both from the Norwegian Cadastre and Mapping Authority and the local authorities. A common data model for digital cadastral mapping was passed in 1990. This model has been the basis of the development in the field both for the local authorities and the Norwegian Cadastre and Mapping Authority until the present day. Mainly the municipalities have registered surveyor's certificates of area measure in DCM, while the county offices of the Norwegian Cadastre and Mapping Authority have digitised the boundaries in economic mapping. This work has resulted in the digital cadastral map – DCM, where 87 per cent of the properties in Norway are now registered.

6. NEW LAW ON THE CADASTRE

17 June 2005, the Norwegian parliament *Stortinget* passed a new law on the cadastre, which replaces the law on the cadastre from 1978. While the purpose of the 1978 law on the cadastre was to make sure that the boundaries were correctly marked, surveyed and mapped, the focus of the new law on the cadastre is more on the quality of the cadastral information.

A main element in the new law is a new cadastre – *matrikkelen*. The new cadastre will replace GAB and DCM in an unambiguous and reliable solution. The new cadastre will be a national register in a central database, under the administration of the Norwegian Cadastre and Mapping Authority. According to the law, the municipalities will be local cadastral authorities. They will be responsible for cadastral registration similarly to how they register cadastral information in DCM and GAB today, but the cadastral map will be administered in a central and governmental register.

Transferring the digital cadastral map to the new cadastre implies that we will get a seamless cadastral map with a homogenous structure and quality norms. However, there will not be any changes concerning quality improvement, and the cadastre will consequently be of high quality for some areas and of lesser quality for other areas. The new cadastre is currently

being developed by the Norwegian Cadastre and Mapping Authority, and implementation of the new system will begin in 2007.

Survey of boundaries according to the new law on the cadastre is defined as a service that any authorized surveying company may provide. However, the Norwegian government which came into force after the adoption in 2005 of the new law on the cadastre, have announced in August 2006 that the existing municipal monopoly on cadastral surveys will be sustained. We assume that this must result in rather comprehensive revision of the new law on the cadastre. However, it should not necessarily affect the implementation of the new cadastre - *matrikkelen*.

7. THE CURRENT DIGITAL CADASTRAL MAP (DCM) DATA MODEL

The principle of DCM is based on the parcel as the main unit. This implies that the entire DCM system is based on areas. The areas are demarcated by boundary lines, and it is possible to enter information on single points in the boundary line.

The parcels are built up by lines and a label point which has certain attributes. Fig. 1 shows that parcel number one is demarcated by line 1 and line 2. Parcel number 2 is demarcated by line 2 and line 3. If the geometry or the properties of the lines change, the parcel references remains.

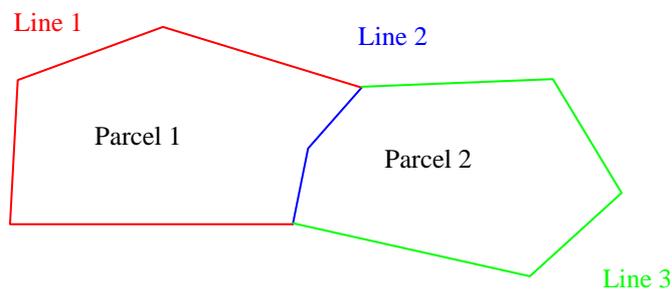
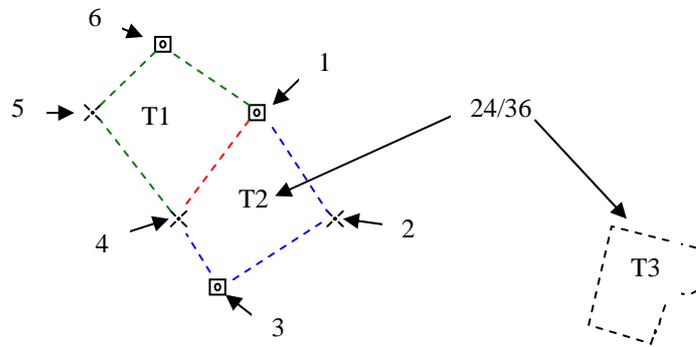


Fig. 1

In DCM, the boundary lines are the smallest units. This implies that no boundary marks can be found in the cadastral map even if boundary marks exist in the terrain. This is solved by adding properties to the lines concerning property boundary marks, accuracy etc. These properties are added to the points of the line. Where two or more lines meet there is a node, and this information may be added. If a node changes, it is crucial that this information also is changed in the other lines holding this node.

Such organization of the data may cause problems concerning updating. Each boundary mark will be stored once for each line it is a part of. Point 1 in the example below (Fig. 2) is stored in line 1, 2 and 3. Consequently, the properties and the geometry must be updated for all three

lines if any changes occur. Such changes may be a new survey. The property 24/36 in the example below consists of the parcels T2 and T3, but no system for assigning numbers to the parcels exists within DCM.



| Line | Point | North | East | Attribute |
|------|-------|-------|------|-----------|
| 1 | 1 | N1 | E1 | Stone |
| | 6 | N6 | E6 | Mark |
| | 5 | N5 | E5 | Stone |
| | 4 | N4 | E4 | Mark |
| 2 | 1 | N1 | E1 | Stone |
| | 4 | N4 | E4 | Mark |
| 3 | 1 | N1 | E1 | Stone |
| | 2 | N2 | E2 | Mark |
| | 3 | N3 | E3 | Stone |
| | 4 | N6 | E6 | Mark |

| Parcel | Line | Cadastral unit |
|--------|------|----------------|
| T1 | 1, 2 | |
| T2 | 2, 3 | 24/36 |
| T3 | | 24/36 |

Fig. 2

The boundary lines in the cadastral map may follow details in the terrain, for instance a river. In the cadastral map there is no information about boundaries in lakes or watercourses unless they are specified in the source material. Accordingly, when a property boundary reaches a watercourse, lake or coast, it stops and the waterline becomes the demarcation. Waterlines from large-scale maps are thus an important source for the cadastral map.

A corridor is established from the centre line of public roads. This corridor is used as a temporary boundary along the network of public roads until boundaries are surveyed. However, if there are surveyed boundaries along public roads, these will always have precedence over the corridor.

The term “fictitious boundaries” is created to be able to establish parcels for properties where we have no information about the boundaries.

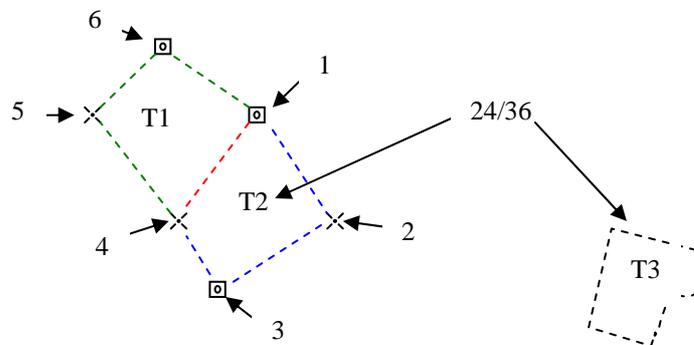
The conclusion is that DCM consists of areas demarcated by lines. The geography (the coordinates) is connected to the lines.

8. THE CADASTRAL MAP IN THE NEW CADASTRE (MATRIKKELEN)

The boundary point will be the smallest unit in the cadastral map in the new cadastre. It will be stored with geographical coordinates in the database. These coordinates can be presented in a number of geodetic systems. Attributes like type of boundary mark, accuracy, may also be added.

The boundary line is described as starting in one boundary point and ending in another. The line does not have any coordinates, but it is connected to the boundary point by pointers. However, boundary lines that do not connect with any boundary points do exist. This phenomenon occurs mainly when the boundary follows terrain details, for instance a river or a coast.

The parcels consist of lines. The parcels do not have any coordinates, but they are connected to the lines by pointers. The cadastral unit which is the property may consist of several parcels, and composite properties may consist of several cadastral units.



| Point | North | East | Attribute |
|-------|-------|------|-----------|
| 1 | N1 | E1 | Stone |
| 2 | N2 | E2 | Mark |
| 3 | N3 | E3 | Stone |
| 4 | N4 | E4 | Mark |
| 5 | N5 | E5 | Stone |
| 6 | N6 | E6 | Mark |

| Line | From | To |
|------|------|----|
| 1 | 4 | 5 |
| 2 | 5 | 6 |
| 3 | 6 | 1 |
| 4 | 1 | 4 |
| 5 | 1 | 2 |
| 6 | 2 | 3 |
| 7 | 3 | 4 |

| Parcel | Line |
|--------|------------|
| T1 | 1, 2, 3, 4 |
| T2 | 5, 6, 7, 1 |

| Cadastral unit | Parcel |
|----------------|--------|
| 24/36 | T2 |
| | T3 |

Fig.3

The cadastral map in the new cadastre is thus built up by boundary points, lines, parcels and the relations between the cadastral units. The geography (coordinates) is embedded in the boundary points.

9. THE LEGAL IMPLICATIONS OF THE CADASTRAL MAP

The cadastral map is a model of the boundaries in the terrain, and the accuracy of the information in the cadastral map varies. In cases where the cadastral map is based on a

surveyor's certificate of area measure, the map will be close to correct and the coordinates and the attributes will have a high degree of accuracy. If the cadastral map is based on economic mapping or other kinds of material the map will be less correct and the map will often not correspond with the terrain.

An important point is the relation between the map and boundaries in the terrain. In the case of a dispute about boundaries where the map and the boundaries in the terrain are inconsistent, the boundaries in the terrain are prevailing according to the legal practice in force in Norway. The principle behind this practice is that the boundaries existed in the terrain before they were surveyed and mapped. However, in accordance with the law on the cadastre, some local authorities have practiced land subdivision by determination of new boundaries on a map, at a meeting in the town hall. This practice may lead to a legal strengthening of the map compared to boundaries in the terrain. However, the legal practice currently in force in Norway states that when there are no boundaries in the terrain, or there is doubt about what is found, both cadastral maps and documents from survey of boundaries, land subdivision and land consolidation may be relevant when the court determines the boundaries.

10. USE OF THE CADASTRAL MAPS

The landowner is mainly interested in marking and documentation of the boundaries through the land surveyor's protocols and surveys. This is important because a survey is obligatory for the property to be registered in the land book, and in the case of later reconstruction of the boundaries. Knowing the size of the land, the use and the productivity class may also be important, especially for farmland and in areas with extensive development.

In *the private sector*, banks and insurance companies benefit from their access to cadastral maps for quick value assessment of the location and size of properties. Land developers and building contractors need cadastral maps to plan and implement their projects.

In *the public sector*, cadastral maps are mainly used by *municipalities*. Reliable information about properties is crucial in the administration of land development, subdivision and construction cases in accordance with the plan and building act. Furthermore, local authorities use cadastral maps for the administration of local tax and local property tax, and assigning addresses. The parts of the public sector responsible for infrastructure, i.e. the Public Roads, electricity board etc. also use cadastral maps regularly. For the *government*, the cadastral maps are important as a foundation for the land registration system, securing a well-functioning property market. The cadastral map has been significant in the production of farm maps. The farm maps are developed by merging soil maps and DCM, thus establishing a digital productivity class register. The farm maps have become the basis of the subsidies to Norwegian farmers, as opposed to earlier, when they were based on information from the farmers.

If a governmental property tax is introduced in Norway, it is probable that the tax will be estimated based on information about the size and location found in the cadastral maps, in

addition to building information. However, the current political environment does not seem to encourage introduction of governmental property tax.

Currently, the cadastral map - DCM - is partly stored with the local authorities and partly stored with the Norwegian Cadastre and Mapping Authority. A number of local authorities have published DCM on the web through different map solutions. The municipality of Bergen and neighbouring municipalities has published DCM on the web in combination with other maps and ortophotos (www.bergensregionkart.no). When DCM has been transferred to the new cadastre – *matrikkelen* - for the whole country, all users should be able access the national cadastral map efficiently in a national system.

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