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Location and Marking of Cadastral Boundaries in the Nordic Countries

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Abstract. *Cadastral boundaries are key components for ordering the ownership of real property by dividing it into territories. This study analyses the similarities and differences in marking cadastral boundaries in Denmark, Finland, Norway, and Sweden. A case study was conducted by examining legislations, ordinances, guidelines, and other instructions. These are issued by both the respective national governments, and associated agencies responsible for real property formation and demarcation of boundaries, such as, the national cadastral authorities. We describe, analyse, and discuss the visual division between properties, boundary marks, natural features used as real property boundaries, the information on boundaries in national registers, prescriptive rights, and the localization of boundaries in each country. The outcome of the study shows that there are many similarities between the four countries, but also differences. As an example, the materials used for demarcation differ between each country. Furthermore, the party performing the cadastral procedures range from governmental officials to licenced private surveyors. Finally, differences were noted in whether a real property boundary following a river or stream when created will change position if the river or stream changes course over time.*

Keywords: *boundary marks, cadastral boundaries, cadastre, Nordic countries, real property formation*

1 Introduction

The ownership of land in most countries worldwide is to a large extent individualised by dividing the land into real property units. The demarcation of land is one of the earliest activities executed by organised human groups, defining property boundaries, parcel shapes and locations (Libecap and Lueck, 2011, p. 427). Registration of ownership and associated rights, restrictions, and responsibilities, RRR, in national registers is a precondition for secure land management and property formation process. The first registration (in modern times) was done in land books and other analogue registers and in recent decades in national digital registers. Boundaries are not only recorded in documents and registers but are often marked with physical man-made objects in the field or follow natural features, such as rivers.

Boundaries and borders are key components for ordering the world by dividing it into territories, ranging from national borders defining the extent of a country to boundaries defining the extent of a real property. See e.g., Popescu (2011) and Szary (2015). Boundaries have been described by the United Nations as *“either the physical objects marking the limits of real property or an imaginary line or surface marking the division between two legal estates. They are also used to describe the division between features with different administrative, legal, land use, topographic, etc. characteristics”* (UNECE, 2004, p. 55). The demarcation of boundaries has a long tradition in the investigated countries and there have during the centuries been changes in how boundaries have been demarcated. The studied countries have been selected based on their cultural similarities. The Nordic countries have had unions and other political constellations throughout history, such as the unions between Denmark and Norway from 1537 to 1814, between Sweden and Finland from the 12th century to 1809, and between Sweden and Norway from 1814 to 1905. These unions have, to lesser or larger degrees, influenced legislation in the countries in question, depending on the legal topic(s).

The aim is to analyse and discuss the current principles for marking real property boundaries in the field in Denmark, Finland, Norway, and Sweden. Our hope is that the results will be an input to national discussions concerning the future development of marking cadastral boundaries and e.g., the role of the national cadastre in a future cadastral system. See e.g., Krigsholm, Riekkinen and Ståhle (2020) for a discussion concerning a socio-technical approach to the future of cadastral systems.

It must be emphasised that this paper is not a historic survey of different types of boundary markings used nationally or regionally in each country during the centuries. Neither does the research concern the registration of real property boundaries in (national) registers and digitalization. The demarcation of rights enjoyed by one (dominant) real property over that of another (servient) property, e.g., an easement giving right of access, as well as rights for e.g., water or electricity installations belonging to others than the property owner, is also outside the scope of this study. Furthermore, this study did not include a quantitative analysis of the

use and distribution of different types of markings (stone, iron pipe, etc.). These topics are subject to future research.

Demarcation of real property boundaries is part of the national real property formation processes and regulated in national legislation, ordinances and other instructions and guidelines. The research presented here is thus based on studies of national legislation and associated instructions, guidelines issued by the cadastral agencies and other instructions for the physical demarcation of real property boundaries, published by the national governments and cadastral agencies and other institutions responsible for real property formation in the investigated countries.

Section 2 presents an introductory theoretical background for the research on real property boundaries. Section 3 contains descriptions and analysis of demarcation of cadastral boundaries in Denmark, Finland, Norway, and Sweden. The findings are discussed and compared in section 4. Conclusions are found in section 5.

2 Background

Ownership of real property is one of the backbones in society giving the owner(s) the right to use and manage the property, including the right to convey it to others (Garner, 2004, p. 933). A real property boundary is created in a legal process by agreement between the interested parties (e.g., an owner/owners of a real property unit and a purchaser of a subdivided part of it) (Grant et al., 2018, p. 32). The authors have not been able to identify a common definition of ownership, even if the concept has been a subject for discussions for centuries, see e.g., Hohfeld (1913 and 1917), concerning the nature and classification of rights, including the right of ownership. Ownership is generally regarded as the strongest right you can execute in an object, see e.g., Wegen et al. (1998, p. 213). The right of ownership is in other words recognised as a fundamental right in society and it can be claimed that ownership is the “*greatest possible interest in a thing, which a mature system of law recognizes*” (Paasch, 2011, pp. 21-33). See Honoré (1987) for an introduction to the principles of ownership. The right of ownership is however not absolute, and a property owner may for example be forced to give up her or his property, or parts of it, for the greater good of society through expropriation of real property or be forced to allow others access to the property in part or in whole, e.g., by tolerating an easement or other use-rights executed by others. Nevertheless, ownership of real property and the registration thereof in registers and marked in the field is important in many societies (UN 2004).

Boundary determination may consist of delineation and demarcation processes. Delineation means the representation of the demarcated boundary through textual or graphical ways, whereas demarcation refers to marking the position of the boundary on the surface of the earth (Al Sayel et al., 2009, p. 1). Textual or graphical methods, such as descriptions in land books, other registers and on maps, can be used to describe demarcated land. The graphical description is provided by cadastral plans showing the property units within a specific area (Navratil, 2011). Demarcation of a boundary can be done in many ways, e.g. by

using man-made objects, such as iron tubes or drilled holes and/or engravings in stones or bedrock, or by using natural objects such as erected stones, or by making the legal boundary follow a geographical feature, such as the highest points of a ridge or the edge of a valley or river, depending on the local topography and other physical conditions. A country may have a mix of boundary marks (stones, iron pipes, wooden pegs, holes drilled into bedrock, etc.), depending on when they were created, and the local topography.

In recent years, there has been research on visualisation of legal boundaries in 3D real properties (Larsson et al., 2020; Seipel et al., 2020), but the authors have only identified limited recent research on how boundaries of traditional, 2D, real property are marked in the field (Andreasson, 2007; Moen, 1983).

3 National descriptions and analysis

The section contains descriptions and analysis of real property boundaries in Denmark, Finland, Norway, and Sweden, focusing on the visual division between properties, boundary marks, natural boundaries used as demarcation, information on boundaries stored in national registers, prescriptive rights, and localisation of boundaries.

3.1 Denmark

3.1.1 Introduction

Denmark is a country with a total area of 42 931 km² (Statistics Denmark 2017, p. 471), excluding the Faroe Islands and Greenland, which are autonomous territories. Denmark is divided into approx. 2,13 million properties excl. condominiums (Geodatastyrelsen, 2022). The practical work with formation and alteration of real property is the privilege of licensed chartered surveyors. The National Geodata Agency is the national cadastral authority.

3.1.2 Visual division between properties

Denmark is an agricultural country with relatively few extensively used areas compared to the other Scandinavian countries. The property boundaries in Denmark are most often visible as divisions of use in the terrain primarily as different types of hedgerows and other fences. Denmark's topography with coastal proximity combined with flat terrain without wind reduction from mountains means that there is a need for creating shelter from the wind through fences around the parcels and fields. Because of this a strong tradition for fencing has developed where fences have become both a matter of privacy and windbreak. Hence according to the Danish Fencing Act, landowners have the right to demand a fence towards the neighbour and to demand the neighbour to contribute with half of the land and costs of the fence (HL, 2019, § 7). For these reasons, there is practically always fencing between residential properties especially in urban areas. Here, hedgerows and timber fences are by far the most dominant, but a few brick walls can also be found especially in the cities. There is a low-cost legal procedure that the landowners can apply for, where disputes on fencing can be resolved.

Further, according to the Danish Act on fields and road peace, landowners have the duty to keep their livestock on their own property (LMV, 2020, § 1).

The farmland is divided by hedgerows or windbreak plants to shelter the crops against the wind, open tree hedges or steel wire to keep livestock on the owner's fields, natural streams, or narrow man-made channels to drain the fields and in fewer cases and of older origin earth or/and stone dikes. Because of the costs of fences, there can be farmland with nothing but a small line of grass to divide parcels. Finally, but less usually, the visual division of use can be invisible due to either the two fields having the same owner (but are registered as two separate properties in the cadastre) or if a field is leased by a neighbour.

3.1.3 Boundary marks

Property boundaries that already existed during the initial cadastral work of the current working cadastre (from 1844) rarely have boundary marks. Since then, later property boundaries have in most cases been marked by licensed surveyors. According to the Danish Real Property Formation Act, cadastral marks are not allowed to be moved, removed, damaged, or destroyed (UL, 2018, § 45). Still, some marks are removed accidentally in connection with construction work or by agricultural machinery when working the field. In very rare cases, presumably marks have been removed purposefully.

Where natural stone was often used for marking in earlier times, then for most years, the marks used have been approved and manmade. The general rule



Figures 1a-b. Danish boundary marks. Photographs by Geodatastyrelsen.
Figure 1a (left). Concrete pillar with white top, royal crown, and the word 'SKEL'.
Figure 1b (right). Iron tube with brass plate, royal crown, and the word 'SKEL'.

is that all new boundaries must be marked by marks officially approved by the cadastral authority. The exception to the rule of marking are water boundaries (shoreline, lakes, streams, and channels) and boundaries sharply defined by cast foundation, masonry etc. (BMA, 2020, § 27). To signify their official status, pre-approved marks have the image of a royal crown and the Danish word ‘skel’ (‘boundary’), on them (KMS 2011). They can be reinforced concrete piles, concrete blocks, or long iron pipes. In dune and bog areas, wooden poles are also allowed, although the material, dimensions, and form of each type of marking is further specified (VMA, 2001, sec.17.2.2). Figures 1a-b show examples of Danish boundary marks.

3.1.4 Natural boundaries

Beside the visual division between properties and the physical boundary marks, nature has created its own boundaries: coastline, lakes, and streams. These boundaries are labile, so when the physical boundary changes (i.e., the stream changes its course), then the property boundary changes.

In Denmark, the sea including its natural resources is assumed to be owned by the State (‘the King’). And hence, the coastal line is also always a property boundary. The definition of the property boundary by the coastal line is defined as the highest daily water level. If the property boundary is following a stream or a river, the boundary between the neighbours on one side of the stream and out into the stream is defined by the principle of proximity. The property boundary towards the properties on the other side of the stream is defined by the place in the stream where the flow of the water goes, visual as ripples on the water. If there is no flow, it is defined as the middle of the stream.

If several parcels exist around a lake, as opposed to a lake fully positioned within one parcel, two scenarios for the position of the property boundary are possible. The normal situation is that the ownership of the lake is divided according to the principle of proximity. The starting point for the division of the lake by proximity is the shoreline of the lake, a labile point that changes over time due to precipitation, wind etc. The second scenario is the exception that exists for specific lakes that according to old documentation is owned by a specific lake-owner, then the property boundary is determined following the same rules as other property boundaries using agreements, cadastral surveys, and prescriptive rights.

3.1.5 Information on boundaries

In Denmark, the property deeds registered in the Land Registry do not include detailed information on the property boundary. The cadastral identifier mentioned in the deed points to the cadastre where the official cadastral surveys are registered. Today, the cadastral archive is nearly fully digitised: All analogue older cadastral maps and protocols (registers) have been scanned and the older cadastral cases with their survey documents have been scanned back to minimum 1906. The licensed surveyors can access the documents online.

When defining the accuracy in property boundary determination, it is the accuracy between neighbouring boundary marks that are considered important,

not the accuracy in relation to the national reference. The latter is only important when discussing the quality of the cadastral plan and hence its use as a tool for administration, planning etc.

In most situations, the property boundary was registered in the cadaster during a cadastral alteration (subdivision etc.) where a survey document was registered along with the cadastral case. In order to determine the property boundary, the surveyor needs to use this survey document. The cadastral map, which nowadays is in digital form, cannot be used. The exception is where the boundary is unaltered since the first version of the cadastral map. The surveys of the first version of the cadastral maps were done by plane table surveying and chains. This means that the geometry of these original maps contains all the information there is left about the survey. For the first cadastral map of farmland, often older maps from the 18th century were reused. The cadastre today further includes the older surveys from the municipality of Copenhagen that started their surveys in 1690.

What has remained constant is that it is professionals that survey the boundaries and uphold whatever accuracy available with the technology at hand at the time. Surveys from 1950 and forward are considered to be of a good accuracy.

3.1.6 *Prescriptive rights*

The Danish legislation on prescriptive rights has in principle been unaltered since 1683. However, court rulings play an important role in defining what qualifies as gaining a prescriptive right. Roughly described, the unlawful use of a part of another person's land through 20 years can give the user ownership to the land until the line of division of use. It can be a hedge, fence etc. that separates the use of two properties at another place than the boundary line registered in the cadastre. In this connection, unlawful means that there is no agreement or lease connected to the adverse possession. If the division of use is not clear and visible, the 20-year period is substituted for a period defined as 'as far back as anyone can remember' (40-50 year). For gaining prescriptive rights, no strong requirement of 'good faith' exists, however, direct deceit and misleading of the other party is not accepted by the court. It is the good faith on time of establishing the adverse possession that is relevant, and new owners' continuation of the adverse possession becomes part of the period of 20 or more years. Yearly, The Danish cadastre registers app. 1,100 cases with changes of property boundaries due to prescriptive rights (Skovsgaard 2014, p. 33). If the position of the new boundary is agreed upon by the involved landowners, a special cadastral case type is used for registration of the prescriptive rights. In most cases where prescriptive rights are registered, it happens with the use of this case type that requires that the respective landowners agree that prescriptive rights have been gained. On average, there are only 63 disputes in Denmark about the property boundary a year (ibid. p.12); nearly all of these disputes concern disagreement connected to prescriptive rights.

3.1.7 *Localization of boundaries*

There are several reasons why the existing property boundary needs to be determined. There can be a wish for replacing lost boundary marks (re-marking).

There can be uncertainty or dispute about the exact location of the property boundary. Furthermore, in the vast majority of cases, it is necessary to establish the position of an existing boundary in order to place a new boundary mark in the correct position when dividing a single boundary line into two lines.

When determining the location of the boundary, the licensed surveyor must start by determining the location of the boundary registered in the cadastre. If it is registered as a labile boundary, the determination on-site follows the current situation on-site as described above. Else the licensed surveyor must use either the survey document - or for boundaries unaltered since the initial cadastral work - the first version of the cadastral plan. In the rare cases where the boundary has never been surveyed, the situation on-site through history must be the starting point using the physical appearance together with orthophoto, historical topographic maps etc.

The licensed surveyor must examine if the cadastral information corresponds with the situation on-site. The situation on-site includes both the physical boundaries for use and the boundary marks. If there is no correspondence, the surveyor must include information from the landowners in order to conclude on the reason for the deviation.

If the boundary marks are placed elsewhere than registered in the cadastre, the reason can be either that there is an error in the survey or that the boundary marks have been moved. The surveyor needs to decide what has happened. If there is an error, the surveyor must correct the error in the cadastre. If the boundary mark has been moved, the surveyor can continue the boundary determination following the registered survey.

If there is a lack of correspondence between the registered boundary and perhaps its corresponding boundary marks on one hand and the boundary of use on the other, the surveyor must use the information from the parties, together with the physical condition on-site and perhaps also orthophoto etc. to investigate the reason for the lack of correspondence. In cases of dispute, the parties are more actively engaged to provide relevant evidence. The surveyor must decide if the lack of correspondence is due to one owner having gained prescriptive rights over the neighbour's land. If the surveyor decides this is not the case, the surveyor can (even if the parties disagree) determine that the original cadastral survey or the boundary mark still are the existing property boundary. If, on the other hand, the surveyor decided that there has been a change of the property boundary due to prescriptive rights, the old boundary cannot be re-marked and at the same time the new boundary can only be marked and registered in the cadastre if either the parties accept the new boundary or if their dispute has been settled legally.

In general, new surveys will have a higher accuracy than older surveys due to modern survey methods. In connection with new surveys, the licensed surveyor also surveys the existing boundary marks nearby, and it will then be the new survey that are used by other surveyors when making a boundary determination. Central is the location of the actual boundary mark, not its coordinates.

3.2 Finland

3.2.1 Introduction

The total area of Finland is 338,472 km² of which 303,948 km² is land and 34,524 km² lakes and rivers. In addition, 52,433 km² of sea areas belong to the territory of Finland. The population of the country is 5.54 million. The cadastral system contains about 2.8 million parcels. From the system and property boundary perspective, it is significant that about 75% of the land area of the country is covered by forests and 7% by agricultural land. The built-up areas make up only 4% (Statistics Finland, 2022). Cadastral activities can only be carried out by civil servants employed by the National Land Survey (NLS), which is the national cadastral authority or the 71 cities updating the Cadastre in their respective city-planned areas. The NLS maintains the national system and updates the information in the rest of the country.

3.2.2 Visual division between properties

The Finnish landscape is relatively flat, especially in the coastal areas in the South and West. Towards the inland in the central parts and in the East and North of the country the landscape is characterised by larger elevation differences. The large number of lakes and the fragmented archipelago skirting the coasts also play a role in how the property boundaries are marked and are visible on the ground. Water both in the lakes and the sea is either part of the coastal properties or common water. Territorial water only exists in the open sea and in some of the largest lakes.

In forested areas, boundary lines shall be opened when demarcated. According to legislation concerning adjoining properties, the landowners have the right to keep such uncontested boundaries open on their own. This is not very strictly implemented, however. In cultivated areas, boundaries are typically visible as ditches or roads between properties. In urban areas, fences and hedges often demonstrate the boundary line around the plots. In lakes and the sea, the boundaries are defined with either marks on land indicating the direction of the boundary, on maps, or with coordinates.

3.2.3 Boundary marks

All property boundaries are marked with boundary marks with only few exceptions. Over the centuries, the regulation on boundary marks has evolved and you can find a variety of different types in the field. Today, most of the new marks are metal poles or bolts, see Figure 2. In the earlier times, the marks were often of stone (one-stone, five-stone), concrete, or a hole or ring and a number chiselled in a boulder or the bedrock. In the peatlands or swamps, wooden poles may be used (five-pole mark) (NLS 2015, 2016, 2022).

3.2.4 Natural boundaries

In addition to boundaries marked physically in the cadastral processes, a boundary can also run along a shoreline, a road, a river, a main ditch, or drain as a curved line. In the case of rivers, property boundaries run along the shore and the



Figure 2. Finnish boundary mark. Photograph by Lempäälä municipality.

boundary between villages in the middle (REFA (1995), NLS (2022), Laki (1902). In minor brooks etc., also the property boundary typically runs in the middle. Particularly in the coastal areas in the West, the land uplift (5–10 mm/year, i.e., 0.5–1 m / 100 years) plays a significant role because the boundary between land and water or the reliction area runs where the shoreline was when the local basic land consolidation was carried out. (NLS, 2022). These land consolidation processes took place mostly in the 1700s and 1800s. A natural boundary is fixed and remains at its original place, even if the location of the physical phenomenon which it has followed changes. A ditch, a brook, or a river can change its course, but the property boundary does not follow. To localise the original place of such a boundary, you must use old maps, aerial imagery, or marks in the field.

3.2.5 Information on boundaries

An entry about a demarcation survey is made in the Cadastre at all concerned property units. The boundary survey map (REFA (1995), REFO (1996)) can show the possible alternative locations of the boundaries in question. Apart from the surveyor's decision and the accepted boundary marks, also the disputed marks and other observations that can have relevance as indication of the position of the boundary are shown on the map. The formal decision must however be explicitly illustrated.

3.2.6 Prescriptive rights

Prescriptive rights do not play a role today. Not even unhindered possession or use of land can make it the user's property or affect where the boundary is. Prescriptive rights in the old legislation from 1734 existed, meaning that if there was no other proof of ownership on a piece of land and if nobody, not even the oldest men in the village, would know anybody else than the current occupant or his/her ancestors

ever having used the land, it could be regarded as the present user's land ('as far back as anybody can remember'). There was no exact time-limit to how far back in history you need to go. In the current law (CRE (1995)) those rights do not exist anymore.

3.2.7 Localisation of boundaries

Through the history of organised cadastral activities, the boundaries have been created, marked, and registered by government or municipal cadastral officials (cadastral surveyors) in a legally defined process. A new boundary line can only be set in a formal cadastral survey process legally, typically in a real estate formation survey like subdivision or division. In the survey, the new boundary points are determined, measured and necessary boundary marks are erected at the new boundary points. If it is not possible to place the mark at the actual corner point or there is a risk that the mark will be destroyed due to e.g., construction work, the mark can be erected at a safe distance from the actual point. (NLS (2011; 2015).

In a boundary survey, an unclarity concerning the location and marking of an existing boundary is solved and determined based on documentation and maps from earlier surveys, boundary monuments and other marks in the field, and other facts. The boundary must be reconstructed to its latest legally defined place (REFA,1995).

The bases for determining the location of an old boundary line include documentation and maps from earlier demarcation surveys, existing boundary marks in the field, use of the area, other legally valid decision or a document, witness's statement, agreement between parties, coordinates or other measurements regarding a missing boundary mark, and other information. There is no set priority in the law between the indices above, but typically what is found in the field indicating the original boundary is regarded as the most important. (NLS, 2022).

Existing factual use of land can be used as an indication on the location of a boundary. It means that it can play a role if there is no other indication on the boundary line, and it is not contradictory to what makes sense. It is also typical that long old boundaries were not necessarily straight even when marked the first time.

An agreement between the landowners on the location of a boundary is possible only if the location cannot be determined reliably with the other above-mentioned means. The agreement must however conform with at least one of the available possible solutions. Clearing of the new boundary line of vegetation is done in the survey process. The surveyor decides on the width of the opening. It is also advised to mark a new line with temporary marks like poles to make its location clear to the parties. It is up to the landowners to keep their boundary lines open after that.

Clearing the boundary line is a way to make the line visible and clear. It was important in the old times when the measurement technology was not as advanced as today, but also today to make it easier to see the boundary without special equipment. An opening in the forest is often visible even after decades as all trees on the line were cut. Generally, new surveys have a higher accuracy than older surveys. This is due to modern survey methods. As part of new surveys, the

surveyor also surveys the existing boundary marks nearby necessary to connect the survey to existing boundaries.

3.3 Norway

3.3.1 Introduction

Norway is a country of just over 320,000 km², excluding Svalbard, but it has just over 5 million inhabitants (SSB, 2021). Only about 1.7% of the total land mass has been developed, most of it for roads. About 3.5% of the land is agricultural land, while the rest consists of outfields, including forests, mountains, lakes, and glaciers. There are more than 2.6 million parcels registered as basic cadastral property units. Freedom of contract applies to property boundaries, so the owners themselves are responsible for the formation, alteration, and registration of boundaries. The cadastral authorities are responsible for the information in the cadastre but can only register boundary information as requested and agreed upon by the parties or as decided by the land consolidation courts.

3.3.2 Visual division between properties

Today, the main man-made visual divisions between agricultural properties are the *boundary fences*. In connection with widespread land consolidation in the 19th century, owners came under a legal obligation to participate in the construction and maintenance of fences on and around agricultural plots. The rules were relaxed a bit in the Boundary Fence Act 1961, which is still in force. According to section 7 of the Act, owners can compel each other to construct and maintain boundary fences when the combined utility is greater than the cost.

Costs are shared in proportion to individual utility, determined by the land consolidation court in case of conflict. Many types of fences can be found, depending on practical requirements, local conditions, and available materials. According to section 4 of the Boundary Fence Act of 1961, each owner must provide up to half a metre of their property for constructing a fence centred on the boundary line. This enables the construction of stone fences. In practice, fences may not always conform to the legal requirements, even if they signify proximity (more or less accurate) to a property boundary.

Hedges, private roads, public road verges, ditches, bushes, large boundary stones and so on might also indicate property boundaries, but not in a systematic manner. For housing plots in densely populated areas, man-made features will provide a rough idea of where the boundary is, but apart from boundary fences, the exact boundary may not be reliably inferred from standardised visual divisions.

3.3.3 Boundary marks

It is normally obligatory to mark the boundary when registering a new property in the cadastre, but exceptions are made in situations when this is impractical, typically in outfields. Increasingly, urban municipalities regard markings as impractical also in area where new development is planned, preferring to rely

only on coordinates and descriptions. The legal basis for this evolving practice is currently in some doubt.

Registering new boundaries for existing and new properties normally requires permission from the municipality pursuant to the Planning and Building Act 2008. A common practice is to mark the boundaries based on maps, descriptions, and coordinates provided in the permission document (Mjøs, 2010). This practice can result in boundary marks located some distance away from the functional boundaries between the properties, for instance in cases of geodetic inaccuracies or adjustments of subsequent building projects to topographic features. This can create problems and may result in property disputes, also suggesting the need for a critical assessment of boundary marks (Mjøs and Leiknes, 2017). Despite being regarded as the most important kind of boundary evidence, they may fail to signify the actual boundary established between the private parties.

For existing properties, a wide variety of boundary marks may be encountered. Following (Moen, 1983), we may divide them into three categories: *natural boundary marks*, *primary boundary marks*, and *secondary boundary marks*. The natural boundary marks exist independently from their use as boundary marks and are not made by humans. Typical examples are prominent trees, particularly large rocks, notable cliffs, distinctive slopes etc. Their use as boundary marks follows from designation in documents pertaining to subdivision and property formation. Rivers, lakes, and the sea can also be used as natural boundary marks. Such designations should not be confused with natural boundaries, discussed below. Agreements that reference natural boundary marks may deviate from natural boundaries.

Like natural boundary marks, secondary boundary marks also arise from designation, but these marks are made by humans, for some other primary purpose. A fence is a practical example, as are roads, footpaths, buildings, cultivated plots (e.g., the potato field), special plants (e.g., the rose bush) and so on. The primary boundary marks only signify a boundary and serve as a reference point for boundary descriptions. Historically, boundary stones, chiselled marks in stone and rock, tree markings, painted or plastered surfaces, and wooden poles were in use (Moen, 1983). Today, metal poles with a cylindrical hat are typically used, see Figure 3a. These are made according to official specifications and come with an inscription when they are used by the government. However, they are also sold to private individuals, without inscription, who can use them to mark their own boundaries.

Historically, different kinds of markings were used depending on who carried out the survey. For instance, the road authorities used a metal pole with a distinctive ‘yellow hat’ during the 1960s and the 1970s, before the surveying system was consolidated in the (now repealed) Property Division Act 1980, see Figure 3b. This reflects that many different actors have traditionally been involved in boundary demarcation in Norway. The significance of the marking when reconstructing the boundary can depend on who made it, as well as when and where it was made. Hence, to understand the significance of different kinds of boundary marks found in Norway often requires detailed historical and local knowledge.



Figures 3a-b. Norwegian boundary marks. Photographs by Leiv Bjarte Mjøs.
Figure 3a. Chiselled cross in rock renewed with standard aluminium boundary mark
was first introduced in 1980.

Figure 3b. Iron pole with plastic hat used by the public roads administration.

In some cases, boundary marks are purposefully placed some distance away from the actual boundary point. This can be due to natural constraints, e.g., for boundaries along lakes and rivers. However, it is also done for procedural reasons, or for practical reasons that may not be obvious from the terrain. Such boundary marks are sometimes referred to as marked ‘for measurement’ (‘på utmål’), typically with the understanding that the boundary line extends in a straight line from the marking to the actual boundary point. This point may not be exactly determined, or it may be demarcated by separate, older or newer, boundary marking. It is necessary to consult the archival evidence, such as the protocol of the marking process, to interpret the meaning of these boundary marks.

Historically, markings ‘for measurement’ could be used when new properties were demarcated, and the owners of neighbouring properties did not attend the survey. In such cases in rural areas, Section 8 in the now repealed Land Subdivision Act of 1909 instructed the laymen not to describe the boundary between the new and the neighbouring property. The new boundaries were still marked, but not in the actual neighbouring boundary line. Instead, the mark could be placed some distance away from the actual boundary, so as not to presume anything as to the correct boundary involving a third party that was not present. This can give rise to island tracts of land where the ownership is unclear. Insufficient knowledge about the history of boundary markings in Norway may easily lead to the wrong conclusions in such situations.

In yet other and more recent cases, we encounter what is sometimes called ‘fictitious’ or ‘assistive’ boundary markings, indicating that the marking records a boundary point that determines boundary lines between two or more neighbouring properties, without necessarily determining all boundaries with common neighbours (who have, in theory, a shared boundary point with the others where all the boundary lines meet). Such markings are still used by the land consolidation courts, who cannot determine joint boundary points with third parties when it hears boundary disputes. In these cases, the cadastral authorities are supposed to

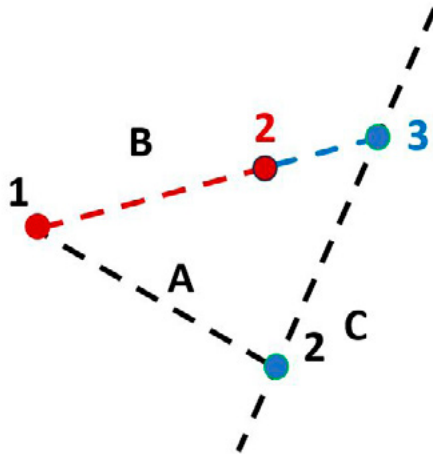


Figure 4. ‘Fictitious’ boundary line in blue on the right with three possible locations for a shared boundary point between A, B and C. Sketch adapted from Bjerva et al. (2016).

record the discrepancies that arise in the cadastre by drawing ‘assistive’ boundary lines between the distinct boundary points that mark a shared point. For an illustration, see Figure 4. The red boundary point 2 and the corresponding red boundary line have been determined by the court as correct for A and B, but the boundary with C is still undetermined, and might be determined by the previously recorded boundary point 2, or continue in a straight line to 3, or it might exit the uncertain points at an angle and meet somewhere else.

A common complaint is that recording such boundaries is complicated and cumbersome, and research indicates that there are serious gaps in the cadastre for cases from the land consolidation courts (Trygstad and Boge, 2021).

3.3.4 Natural boundaries

If a property follows a river, section 2 of the Water Act 1940 makes clear that the boundary follows the deepest segment of it, unless otherwise agreed or determined by law. The water is not subject to private ownership, but ownership of the river includes fishing rights and rights to use the waterpower, e.g., in a hydropower plant. In principle, the property boundary follows the deepest part of the river such as it was when the property was formed. Specifically, Section 6 of the Water Act 1940 states that the property boundary is not changed when the river changes course. Every owner is entitled to re-establish the river if it suddenly changes course, but the right must be exercised within three years.

Lakes are privately owned, but some larger lakes have a common area in the middle, not subject to private property. When a property is demarcated by a lake, the property extends into the water until the deepest point or until the unowned middle is reached. The property extends in perpendicular straight lines outward from every point on the shoreline, such that a point in the lake belongs to the

property that it is closest to. In the sea, there is no special boundary legislation, so the rules follow from case law and customary law. Private property rights normally extend until the water suddenly deepens, or until the water is more than two metres deep during low tide. Boundaries between properties along the shoreline are determined as for lakes.

In the underground and in the air, the natural boundaries follow customary principles and case law. The main principle is that private property extends as far as there is a foreseeable interest in its use. There are ongoing discussions about how to apply this principle, for instance in relation to ground heating pumps that can extend several hundred metres below ground level. Some argue that there is an urgent need for regulation to resolve conflicting spatial claims that can arise from novel uses of the underground.

3.3.5 Information on boundaries

The National Mapping Authority is responsible for the Norwegian cadastre, including the cadastral map that includes boundary information with coordinates. However, the cadastre is updated locally, by the municipalities, who also have a monopoly on property surveying for cadastral purposes. They may hire others to do the work, but updating the cadastre is an administrative decision, subject to procedural law. The information in the Norwegian cadastre is of widely varying quality and there is no presumption of correctness. In rural parts of the country, the information is limited by a historical emphasis on security of title and tax value. Boundary information was not seen as a government responsibility but passed on as local knowledge among active farmers. In case of subdivision, the legal requirement was for local lay people to describe the boundaries and mark them in the terrain, with textual boundary descriptions included in the land registry as a supplement to the deed.

In the cities, there is a longer tradition for detailed public demarcation and mapping of property boundaries, in city-wide common reference systems. Strict rules were put in place in the 19th century or even earlier. A survey requirement was typically imposed, not only in case of subdivision, but also for transactions and in case of new developments. The consequence is that in larger cities, the quality of the cadastral map is significantly better than in the rest of the country. In smaller cities, cadastral surveying was introduced in the decades around 1900. In 1960, a large-scale economic mapping project was initiated that also included property boundaries from rural and newly suburban areas. It is estimated that around 50% of all boundaries were registered in this process. The current cadastre includes this economic mapping data in digital form, but it is quite unreliable. The courts are often hesitant about relying on the information when resolving boundary disputes.

3.3.6 Prescriptive rights

After using a tract of land as one's own for 20 years, one may gain ownership of it by adverse possession, pursuant to section 2 of the Prescriptive Rights Act 1966. The additional requirements, as stipulated in section 4, are that the land was used

in good faith and that due care has been demonstrated in regards the question of ownership. If a tract of land is used for a particular purpose for 20 years, one may gain rights by prescription on the same conditions, pursuant to section 7. However, this only applies if the use is reflected in a permanent construction or pertains to necessary road access or storage space. If not, the time required is 50 years, in accordance with section 8. Unless the parties reach a private agreement, the claimant will have to bring the case before the regular courts, or the land consolidation courts in order to gain the security of title. While adverse possession is uncommon as a stand-alone basis for property claims, it is commonly used as a supporting argument by one or both of the parties in boundary disputes or disputes regarding use rights. Claims of adverse possession or prescriptive rights must be submitted to either the regular courts or the land consolidation courts; such claims cannot be decided by the cadastral authorities.

In addition to the rules set out in the Prescriptive Rights Act 1966, case law also recognises adverse possession through long-term use (in Norwegian: ‘alders tids bruk’), comparable to prescription by use for ‘as far back as anyone can remember’ observed in other jurisdictions. However, since the Prescriptive Rights Act regulates adverse possession after 20 and 50 years of use in good faith, the principle of ‘alders tids bruk’ typically requires a longer time period. Some have argued that 100 years is to be expected in these cases, but no definite time limit has been posited in case law. The importance of the rule is that it might apply even when there is insufficient continuity of use, or questions raised about good faith, that might preclude adverse possession pursuant to the Prescriptive Rights Act.

3.3.7 Localisation of boundaries

Owners are responsible for the localisation of their boundaries. The municipal surveyors have no authority beyond surveying the property as described by the owners. They can act as mediators if the owners disagree, or even act as arbitrators on a voluntary basis, but this is uncommon. They can also help the owners locate boundary markings and recreate existing boundaries. This is a common aspect of surveying in the field, carried out with owners present. Hence, property surveying may serve as a kind of informal mediation, even if it is rarely formalised as such.

The municipality might refuse to update the cadastre (and the surveyor may refuse to complete the survey) if the owners request a *de facto* change of the existing boundary without permission pursuant to the Planning and Building Act 2008. The legal status of the boundary then becomes unclear: the private agreement may be voided, but this is not necessarily the case. Regardless of what is registered in the cadastre, the private law property boundary follows the private agreement.

A boundary dispute is a private law matter that can be resolved either by the regular civil court or the land consolidation court. If the case is heard by the land consolidation court, the court will mark the boundary and the cadastre will be updated with the outcome of the case. This does not happen if the case is heard by a regular civil court. In that case, the owners must request this themselves from the local municipality.

Physical boundary markings and functional boundaries are often the most important forms of evidence, even when they contradict the original boundary descriptions and the boundaries registered in the cadastral map. In difficult cases, the historical record, including information about how the property is and has been used, can become particularly important, partly due to the connection with prescriptive rights and the principles of equity that underpin those rules.

When new surveys are undertaken, it will vary whether the surveyor will survey only new boundary points and keep the coordinates of the existing boundary points unchanged, or whether the surveyor will also survey and update coordinates of all boundary points of the surveyed property. Updating of coordinates are subject to notification of concerned landowners and issuing of a new cadastral certificate if the coordinates are changed more than 10 cm pursuant to the Cadastral Regulations 2009 § 36. The surveyor will normally not resurvey and update coordinates of nearby boundary points, that means boundary points not in the surveyed properties boundary lines, when carrying out a survey.

3.4 Sweden

3.4.1 Introduction

Sweden has a total area of 407,000 km². The area consists of 69% forest and woodland and 8% agricultural land. Other types of open areas are mountains, moors and grasslands which cover 20%. Built up areas count for only 3% of the total area (Statistics Sweden, 2022). The mountainous areas are in the North of the country and the majority of the agricultural land is located in the southern parts of the country. The country is divided into 3.3 million real properties of various sizes depending on their use. The real properties range from hundreds of hectares in agricultural and woodland areas to a few hundred square metres for individual housing in urban highly populated areas in the eastern and southern parts of the country. A real property can consist of one or more individual parcels.

Property formation is the privilege of Lantmäteriet, the Swedish mapping, cadastral and land registration authority, but 40 municipalities have gained permission to conduct real property formation within their domains (SFS, 1995a, 1995b). 40 of Sweden's 290 municipalities are therefore today cadastral authorities within their domain (Lantmäteriet, 2023). It is a rather new arrangement, dating from 1996, and the number of municipalities has increased annually. The majority are larger municipalities with high population density and, hence, real property formation activities within their areas. In total, approx. 35% of cadastral work was done by the municipalities in 2021 (Lantmäteriet, 2022). The municipalities are equal to Lantmäteriet in the way that they are independent authorities conducting cadastral work within their boundaries, but Lantmäteriet has a supervisory role. Lantmäteriet can however not interfere in their work, but cooperation exists. The state/cadastral authorities guarantee the property formation and have the monopoly of managing the property formation and registration processes. There are no formal requirements concerning the education of employees. However, the cadastral surveyors normally have an education in cadastral formation, planning

and land surveying, provided by several Swedish universities and university colleges. Private companies or individuals are not allowed to conduct formation or alteration of real property boundaries.

The concept of real property and its boundary marks has developed through centuries in Sweden, see Karlsson (2004) and Lantmäteriet (1996) for an introduction. There have historically been a number of laws regulating the formation and alteration of real property formation, and alteration of real property, which today mainly is regulated in the Real Property Formation Act, FBL (SFS, 1970a), whereas the Swedish Land Code, JB (SFS, 1970b), specifies the fundamental regulations concerning real property. The Land Code states that *“Real property is land. This is divided into property units. A property unit is delimited either horizontally or both horizontally and vertically”* (SFS 1970b, Ch. 1, Sec. 1). Furthermore, section 3 of the Land Code specifies that *“[a] boundary lawfully determined follows the course marked on the ground in due order. If the marking can no longer be ascertained, the boundary shall follow the course which, in the light of a cadastral plan together with documents, possession and other circumstances, was presumably intended.”* They can only be changed, altered, or removed by the cadastral authority by their own decision or by a court decision. Boundary markings are protected by law, see Julstad (2006, p. 463).

3.4.2 Visual division between properties

Sweden has a variety of nature types, ranging from fertile agricultural and farming land with flat terrain in the southern parts, huge wooden areas in central Sweden to sub-arctic tundra and mountainous terrain north of the Polar Circle. The majority of the population is concentrated in urban areas in the southern and central parts and the coastal areas along the eastern coast by the Baltic Sea. The distribution of the population has influenced the visual division between properties. In the southern parts of the country, boundaries in rural areas are mostly visible through voluntary markings such as hedges, small dikes or changes in vegetation and crops growing on the properties. In contrast to this, boundary lines are mostly not visible in the wooden parts unless an area has been forested, and the boundary is made visible due to the different age of the trees on the adjacent properties. There are no legal requirements for property owners to remove vegetation growing in existing boundary lines.

It is possible to use natural features such as road crossings, coastlines, ditches, etc. as cadastral boundaries if they are clearly defined and judged to be of permanent character (Lantmäteriet, 2021; Lantmäteriverket, 1996, p. 8). The legal boundary is not referred to as a natural boundary; it just may follow some natural features and points on the boundary are given coordinates. The documentation may e.g., consist of a text in the cadastral protocol that *“the boundary follows the centre of the common road as shown on the map”*. These points are regarded as unmarked boundary points and registered on the cadastral plan which is part of the cadastral documents. If a natural feature is surveyed, it is no longer regarded as a natural boundary, since there are (unmarked) boundary points which have been surveyed and registered.

It is not mandatory that e.g., fences follow a boundary exactly, but landowners can agree on e.g., planting a hedge on the boundary line for their own benefit to visualise it. Landowners are not forced to provide areas along boundaries for e.g., construction of a stone wall or fence placed upon the boundary. Such constructions on a boundary are erected through private agreement between the property owners. It is however possible for each owner to plant a hedge or erect a fence on one's own property along the boundary line. Other regulations apply concerning for example the construction or allowed height of a fence.

3.4.3 Boundary mark

No requirement exists in Swedish legislation that boundaries must be marked (UNECE, 2004, p. 29). A boundary resulting from a property formation shall however be set out and marked to the necessary extent (FBL 1970a, Ch. 4, Sec. 27).

Boundaries may extend out into a water body, such as a lake, stream, or river. These boundaries are not marked or surveyed. They can therefore not be reestablished by using the original cadastral dossier or archival documentation. Generally, the water area belongs to the property closest to the shore (SFS, 1970b, Ch.1, §5). The location is determined based on the topographical situation when the property was created. It is therefore of no consequence if the topography has changed, e.g., the location of a stream has moved since the creation of the property. The boundary is thus not moved to follow the new location of water. Several special conditions exist when properties extend out into specified, large water bodies, so-called public water ('allmänt vatten' in Swedish), being defined as the sea and several large lakes. An example of a specific regulation is that boundaries extend 300 metres from the mainland out into the sea, or from the shore of an at least 100 metres long island out into public waters (SFS, 1970b, Ch.1, §2; SFS1950).

Real property boundaries are normally marked with man-made physical objects established in the property formation process. Vegetation such as hedges, or trees planted by the property owner(s) are not regarded as legal demarcation; they are however important for the landowners to see what theirs is and what is not. The boundary marks are normally placed at the ends of the boundary lines or where the boundary changes direction. However, there is no standard for marking boundaries (Julstad, 2006, p. 463), although instructions and guidelines exist (Lantmäteriet, 2019). Today, a normal procedure to mark the boundary points is by hammering galvanised steel tubes into the ground, where possible, see Figure 5b. Modern tubes normally have a red iron ring at the top for making them easier to recognise in the field. They also can have internal steel rods which are hammered into the ground out through the end of the tube, which makes them extremely difficult to move or remove when first in place. Another method of marking is by drilling holes in the bedrock or very large stones, see Figure 5a. Wooden poles are generally avoided and not a common method of marking today but may be used on moors and wetlands. It is possible to leave some boundary points unmarked. This is, however, also generally avoided for not causing confusion among the property owners in the future. If done, they shall be clearly documented in the cadastral



Figures 5a-b. Swedish boundary marks.

Figure 5a (left). An erected natural stone. Photograph by Karolina Larsson.

Figure 5b (right). A modern iron pole with a red top, placed in bedrock.

Photograph by Anna Ø. Forsberg.

dossier. It is also possible to establish eccentric markings, i.e., not placed on the boundary line. These auxiliary markings are intended to be of help in identifying an unmarked boundary point. Boundary markings in woodland areas are placed in a way that property owners easily can remove vegetation obstructing the line of sight between them (Lantmäteriet, 2019).

Cadastral boundaries can be centuries old, but they and their marks still have legal force. Old boundaries may have been created outside the normal cadastral procedures and are therefore not legally defined as such but originate from e.g., private agreements between the property owners. They are marked in different ways by stones, dikes, hedges, etc. They are, however, part of the cadastral boundary system, but do not have the same legal status as the property surveyed and registered mark but may be used as input to identify the legal boundary. These boundaries do not have the same legal force as legally defined boundaries but may be used to determine the location of a boundary. Several special conditions apply concerning how these boundary markings are interpreted in a cadastral process, see Lantmäteriet (2021).

3.4.4 Natural boundaries

Natural features are also used as boundary markers - and have been so for centuries - such as erected standing stones and natural large stones depending on the physical condition(s) of the location. Boundaries may extend out into lakes and rivers. These boundaries are normally not formed today but are remnants from times where it was important to have e.g., fishing rights in lakes and rivers. They are documented in the cadastral dossier and may be marked where the boundary crosses the (historic) shoreline.

A property unit in rural areas which is adjacent to a private water area, such as a lake or another watercourse, often includes the water area outside the shoreline of the property. The water may also belong to another property unit or be jointly owned. The water boundaries are often not defined and are thus without coordinates or other information about the location (Julstad, 1998). Instead, they follow the rules in the Land Code (SFS 1970b, Ch. 1, Sec. 5), where the part of the water area closest to a property unit belongs to that property. Since the shoreline may change due to land uplift etc, the location at the time of the property formation defines the boundary. Thus, the (historic) shoreline is of importance to decide the location of the boundaries in the water. For public water, as mentioned, the main rule regarding the boundary between private and public water is that to the property units belongs the water within 300 metres from the mainland or from an island that is at least 100 metres long.

3.4.5 Information on boundaries

Lantmäteriet and the municipal cadastral agencies are responsible for the registration of cadastral boundaries, which are registered in the national digital real property register, which is operated and managed by Lantmäteriet. Information on the boundaries is found in the cadastral dossier which contains the documentation and, in most cases, an analogue map of the property. It is a general procedure to produce a map showing the new cadastral situation and include it in the dossier, but it is possible to exclude the map if the property can be sufficiently described in writing (Lantmäteriet, 2021, p. 321-322). The map contains detailed measurements of the boundary lines, e.g., the distances between the boundary marks and what they are made of, e.g., abbreviated RB = iron tube in bedrock or RM= iron tube in ground/soil, the X and Y-coordinates for each boundary mark and other details. It must be noted that the national cadastral index map that is part of the Real Property Register is only illustrative and cannot be used as legal documentation in the property formation process or elsewhere. The information contained in the cadastral dossier has the legal force. The cadastral dossier is filed in the archive of the cadastral authority.

3.4.6 Prescriptive right

Prescriptive rights exist in the Swedish real property legislation. There are regulations on prescriptive rights, prescribing that if a boundary is claimed to have another location than it would lawfully have, and if this is based on an agreement made before the introduction of the regulations in the Land Code in 1972, the claimed location is valid. There are no formal requirements for such an agreement to be valid, although it is not sufficient with just a claim (Ekbäck, 2016). There are today few cases of boundary determination due to prescriptive rights per year. No statistics exist, but an estimate by a chartered surveyor at Lantmäteriet is that there are approx. 50 cases per year that concern changing the position of the boundary due to prescriptive rights. If a not lawfully determined boundary has been used in good faith and agreed upon by the respective property owners for a minimum of 20 years before the introduction of the Land Code (SFS 1970b), the position

of the prescriptive boundary is valid (SFS 1970c, sec. 18). The original markings shall apply (SFS 1970b, sec. 4). The process for this is the responsibility of the cadastral authority.

3.4.7 *Localization of boundaries*

When a boundary mark is lost, damaged or cannot be located, for example due to loss through erosion or being (illegally) removed, a new mark can only be re-established by the cadastral authority. The cadastral authority locates, re-establishes, and documents boundary markings documented on the cadastral map and other documents. Physical conditions in the field are of major importance and take precedence over archival information if the boundary marks are judged to be in-situ and not moved since they were created. It is only the real property owner(s) who can apply for the cadastral procedure.

The additional process to demarcate cadastral boundary points is called *särskild gränsutmärkning* [specific boundary demarcation] (FBL 1970, Ch. 1 and Ch. 14, Sec. 15–16). It is a procedure for demarcation of boundary points outside the normal cadastral formation process. If an old boundary has not been legally defined, existing, ancient markings such as old fences, ditches, old hedges, or piles of stone are used to identify the boundary (Lantmäteriet 2021, p. 747).

If there is disagreement about the location of a boundary, it can be decided through property definition. If the boundary is legally defined and created by a decision from the authority, the marking on the land shows the extension, in accordance with the main principle. Complementary rules to this principle (Ekbäck, 2016) provide the guidelines. In case the marking no longer can be determined with certainty, the boundary shall have the intended extension based on the administrative cadastral map, documents, and other circumstances. Furthermore, in case the extension of the boundary has not been marked on the ground in legal order, the extension of the boundary is the extension marked on the map and related documents. However, if these maps and documents are not complete, it is possible to consider other factors, such as prescriptive rights. It might also be the case that the boundary has not been legally determined (such as never having been subject to a cadastral formation process, e.g., old boundaries between villages; boundary between a shire and a hamlet, etc.). In such a case, the marks that have been considered valid by age to mark the boundary apply. These markings may consist of fences, cairns, ditches, hedges, etc. and will have legal force even if they are decades, or even centuries, old. See SFS (1970, Ch. 1.4).

The owners of the property may in the property definition process make an agreement that the boundary should have an extension that deviates from the correct one. However, the deviation may only be minor. The agreement must be in writing and the boundary must have been set out prior to the agreement. In general, recent surveys have higher geometrical accuracy than older surveys due to modern survey methods. Existing boundaries located nearby will also be surveyed in order to connect the new boundary marks to the existing net of boundary marks nearby.

4 Discussion

4.1 Introduction

Finland, Norway, and Sweden have many similarities in size, geography, and land cover. These three countries are large in area, characterised by large forest areas and inland water with a relatively small area of agricultural land and built-up areas. Denmark, on the contrary, is small in area and dominated by fields to a large extent. All four countries have similarities in population, number of properties, and the cadastral system. The Cadastres contain information on about 2 to 3.3 million properties.

How the Cadastral activities are organised differs quite clearly from country to country. In Denmark, formation and alteration of real property is the privilege of licensed chartered surveyors. The Geodata Agency (Geodatastyrelsen) is the national cadastral authority. In Finland and Sweden, the cadastral work is done by civil servants employed by either the governmental authority or municipalities. In Sweden, 40 (of 290) municipalities have this mandate within their whole territory, whereas in Finland the mandate of 71 (of 309) municipalities concerns their city-planned areas only. The governmental authorities, in Finland the National Land Survey (Fin: Maanmittauslaitos, Swe: Lantmäteriverket) and in Sweden Lantmäteriet, handle the rest of the country. In Norway, cadastral work is the responsibility of the 356 municipalities and recorded in the cadastre which is developed and maintained by the Norwegian Mapping Authority. The citizens have the freedom of agreement in boundary matters, but if public law requirements are not met, the boundary might not be registered and in some cases the agreement between the parties can be discontinued and voided.

4.2 Visual division between properties

Regardless of the cadastral system, property boundaries may be clearly visible if local nature types and land uses make the boundary structure visually apparent. For instance, fences, ditches, hedges, or private roads may correspond to boundaries between properties according to recurring patterns of local land use. This phenomenon is observed in all the national systems considered in this article, especially in cultivated areas.

Unsurprisingly, it varies quite a bit what kinds of visual markers one typically encounters. In Denmark, fences are commonly encountered and practically always present around residential properties. There are regulations ensuring the neighbour's right to fence around the property for reasons of privacy and shelter from the wind, and other regulations that obligate owners to fence to keep in the livestock. In Norway, fences are in widespread use, but only in certain situations, e.g., around in-fields in areas of active agriculture with livestock, or around gardens. In some cases, the fences encountered are boundary fences, but this is not necessarily the case. There is no general requirement that fences must be placed only along property boundaries, and some fences are constructed for specific purposes which may also be relevant independently of property boundaries, e.g., to provide shelter for the wind. Even so, boundary fences have

a special legal status in both Norway and Denmark, arising in part from the legal responsibility of the landowner to keep their livestock on their own property. In both jurisdictions, there is special legislation in place to ensure that neighbours can compel each other to participate in the construction of joint boundary fences. Such rules are not found in Finland or Sweden. However, in Finland, a similar kind of rule exists in a different context. Here, the importance of maintaining clear boundaries in forests is reflected in legislation where the landowners have a right to keep the surveyed and uncontested boundaries open on their own. It is advisable to do it in cooperation between the owners, but a landowner does not need the neighbour's consent for doing it alone. The neighbour must be informed in advance, however. In practice, the right may not be actively used. Even so, rules like these illustrate how prevalent patterns of visual boundary demarcation may also be partly anchored in legislation. This is relevant knowledge for local surveyors, especially in the context of recreating boundaries when the official boundary information is missing or contested.

It is important not to confuse visual divisions between properties with official boundary descriptions. Even if the visual division is mandated by law, it is not to be regarded as a boundary marking or used to define a cadastral boundary. In some cases, however, visual divisions may also be used to define cadastral boundaries. In Sweden, the legislation expressly provides for this possibility, but only in case the visual boundary in question is clearly defined and regarded as permanent.

4.3 Boundary marks

Many similarities in how the boundaries are marked exist between the compared countries. Normally, the boundaries must be marked and approved by surveyors and consist of manmade physical objects such as metal poles, bolts, pipes, concrete objects or similar. Sweden has no legal requirement, however, that the boundary must be marked, although marking is standard practice. The boundary must then be clearly documented in the cadastral dossier. Natural boundary marks, such as trees and rocks, are also used in Norway, as well as secondary boundary marks consisting of manmade objects for other purposes such as fences, roads, buildings, and plants. Exceptions are made for e.g., water boundaries or when it is impractical to place a boundary mark. In Norway, boundary marks may be considered impractical also in areas where new development is planned, where coordinates and descriptions are used instead of marks.

Historical marks also still exist. In Denmark, marks for these boundaries rarely exist or consist of natural stone. Finland has used stones or holes for historical boundaries and Norway used stones, painted surfaces, wooden poles, etc. In all investigated countries, historical marks still have legal force and are marked in different ways.

4.4 Natural boundaries

Natural boundaries are physical elements defining delimitation of properties. Most frequent natural boundaries are shorelines of rivers, streams and lakes, ditches, roads, and the coastline. All countries have natural boundaries in addition

to boundaries marked in a cadastral process. There are many similarities and some differences when it comes to how these elements form boundaries. In all countries, it is the common rule that a property unit which is adjacent to a river, stream, or a lake, can include the ground under the water outside the shoreline of the property. The boundary between neighbours on the same side of the watercourse will follow the principle of proximity. The boundary between properties on opposite sides of the river or stream will in Denmark be defined by the place in the stream where the flow of the water goes and if there is no stream, in the middle. In Norway, the boundary in the river or stream will follow the deepest part of it, unless otherwise agreed or determined by law. In Finland and Sweden, boundaries in lakes and watercourses are normally based on decisions in older surveys and documented in the cadastral dossier. In Finland, Norway and Sweden, the boundary will not change if the river or stream changes course. In Denmark, the boundary will follow the new course of the river or stream.

When it comes to the sea, there are greater differences between the countries. In Denmark, the sea and the foreshore are owned by the State, and the private property boundary is defined by the level of the high tide. In Finland and Sweden, private property can extend a rather long distance out in the seabed, 300 metres in Sweden and 500 metres in Finland. The location at the time of the property formation defines the boundary between parcels on dry land and water area, both private and common. In Norway, private property rights normally extend until where the seabed suddenly deepens, or to where the sea is more than two metres deep during low tide. Similarly in Norway, massive natural features like mountains, watersheds and slopes can define boundaries. Mountains and watersheds are often old boundaries between historical communities.

4.5 Information on boundaries

The data on boundaries are similar in the investigated countries. All countries store textual and spatial information in national registers, which can be accessed online by different user groups, such as other governmental agencies, licensed users, and others. The data itself varies slightly. This concerns, for example, what is included in the cadastral documents describing the boundaries, such as how they are marked or if they in some cases can be left unmarked, which is possible in e.g., Sweden. The data also includes older textual descriptions and maps, in some cases dating back more than 300 years. The data varies in detail and geometric quality in all four countries due to being the result of recent or older property formations including surveys and whether they are located within urban and rural areas. In Finland, a boundary survey map shall show the decided location of the object boundaries in an unambiguous way including the existing old and erected new boundary marks. When there are requirements for another solution the claimed marks in the field supporting it can be shown on the map as well.

4.6 Prescriptive rights

In Denmark, Norway, and Sweden, it takes at least 20 years to gain a prescriptive right; however, the rules concerning the 20 years are quite different. In Sweden,

the prescriptive right of 20 years requires an unregistered agreement made in good faith between the parties made at least 20 years before regulations of 1972. Obviously, as time goes by, agreements made in good faith before 1952 become increasingly scarce and hard to prove. In Norway and Denmark, gaining a prescriptive right requires adverse possession in at least 20 years. In Norway, further demand is made on good faith and due care when taken ownership. In Denmark, there is (only) a need for at least some good faith at the point of establishing the situation of adverse possession – especially direct misleading/deceit is not tolerated. The high standard for good faith in Norway results in few cases where prescriptive right is gained, although long-term use in good faith is a common and potentially winning supporting argument in boundary disputes when the boundary is contested or unclear. In Denmark, gaining prescriptive right through adverse passion is common, and a special cadastral case type is used for the registration in the cadastre in the many cases where there is no dispute.

Both Norway and Denmark have other time periods for what is required for gaining prescriptive rights: The 20 years just mentioned, a 50-year requirement in Norway and further in both countries a period determined by case law and described as ‘as far back as anyone can remember’. The period of ‘as far back as anyone can remember’ is the only period ever used in Finland, and that together with the requirement of good faith. The current Finnish legislation does not include these rights anymore. This means that in Finland there are no situations where the registered boundary changes location due to prescriptive rights. In Norway and Sweden there are relatively few changes due to prescriptive rights alone. The opposite is the case in Denmark where there are yearly approx. 1,100 registrations in the Cadastre of changed boundaries due to prescriptive rights – nearly all by agreement between the landowners.

4.7 Localisation of boundaries

In Denmark, Finland and Sweden, boundaries are localised and changed by organised cadastral processes by official or private actors. Denmark has a long tradition with licensed cadastral surveyors, whereas in Finland and Sweden the localisation is handled by governmental organisations and/or municipalities have been given the privilege to do cadastral work. Property owners may assist in locating boundaries and markings, but they have no legal part in the process of defining the boundary. In Norway, the property owners themselves are responsible for the localisation of their boundaries. Cadastral surveyors may act as mediators if the owners disagree and help the owners locate boundary markings and recreate existing boundaries. The cadastral surveyor and the municipality have the right to refuse to survey the boundary and update the cadastre when specific conditions exist. A special condition in Sweden is that the property owners may make an agreement that the boundary should have a minor extension that deviates from the correct one.

5 Conclusion

The aim of this study has been to analyse and compare the demarcation of real property in Denmark, Finland, Norway, and Sweden. The study focused on a limited number of topics, including the visual division between properties, boundary marks, natural features used as real property boundaries, the information on boundaries in national registers, prescriptive rights, and the localization of boundaries in each country. Within these topics, similarities and differences exist between the countries. Similarities include e.g., that all countries use physical objects to mark their boundaries. Examples range from natural standing stones, natural stones with drilled holes or incised marks, concrete monuments and masonry, to massive natural features like mountains, watersheds and slopes which can define real property boundaries. More than one type of demarcation is used within each country, depending on traditions and type of ground, e.g., soil, wetlands, single stones, or rocks. This study also showed that the national processes for creating or changing boundaries are similar. However, the party performing the cadastral procedures differs, ranging from governmental officials to licenced private surveyors to municipal responsibilities. Finally, differences were noted in whether a real property boundary following a river or stream when created will change position if the river or stream changes course over time.

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