

Restoration of Property Boundaries in Sweden's Largest Forest Fire Area

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Key words: property boundaries, restoration, forest fire, risk management, stakeholder communication

SUMMARY

Modern forestry requires accurate and clear property boundaries in order to enable felling all around the year. Between 31 July and 11 August 2014, Sweden experienced the largest forest fire of recent times. Approximately 13,000 hectares of forest land were affected, leaving some 130 property owners with their trees and various facilities in ashes. The forest fire area stretches into four municipalities' administrative districts. For these municipalities, the cadastral services are managed by the State through Lantmäteriet, the Swedish mapping, cadastral and land registration authority. In December 2014, the Swedish Parliament decided to provide SEK 18 million (about USD 2 million) to Lantmäteriet, to subsidise the costs for the property owners concerned who need their boundaries restored on the ground through cadastral procedure. Some land consolidation and handling of joint facility roads will also be required. For Lantmäteriet, carrying out field work in such a severely burned forest area implies new challenges, in particular with regard to risk management and the fact that many boundary indications common for forest areas (e.g. wooden fences and boundary clearings) have been consumed by fire. In addition, almost all of the damaged trees outside the new reserve area have now been felled, which makes it even more difficult to see the previous types of land use (e.g. clumps and different tree types). Hence, the cadastral work needs thorough planning and preparation in order to be handled in a smooth and systematic way. This paper presents the practical considerations, economic aspects, planned actions, and cadastral issues (legal and technical) that Lantmäteriet are facing, both internally and in collaboration with other authorities and stakeholder organisations involved. Ways of preparing the cadastral surveyors for communicating with people in crisis or post-traumatic stress are also touched upon. To give a broader picture of the role of Lantmäteriet, especially concerning collection and dissemination of geodata during and after the fire, the paper also describes actions taken with regard to aerial photography, laser scanning, infrared photography of 'hot spots', and provision of maps for all parties involved.

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FIG Working Week 2016
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1. BACKGROUND

In the summer of 2014, Sweden experienced the largest forest fire of recent times. Approximately 13,000 hectares of forest land in the county of Västmanland were affected, leaving some 130 property owners with their trees and various facilities in ashes. Besides those disastrous consequences, many physical property boundary indicators – old signs of possession as well as modern iron pipes – were gone.

The fire started on 31 July, peaked on 4 August, and was declared under control by the fire brigade management one week later. The work of the final extinction of the fire lasted another month, until 11 September. The County Administrative Board, the regional body representing the State, decided to suspend entry to the whole area for yet another nine months, due to the risk of falling trees and underground embers.

The catastrophe was an unfortunate result of mechanical loosening of topsoil. Being an unusually hot and dry summer, the sparks led to flames, and the subsequent course of events was fast. In addition, the firefighting effort was complicated, due to difficulty of access on the ground and stationary smoke that prevented efficient combat from the air. Besides, as the national rescue services had limited equipment for those flights made by helicopter, assistance from France and Italy was provided during about a week. Using special aeroplanes, the cubic capacity of water from the air was multiplied. The topography of the area was also a contributory factor, as there were no natural firebreaks in the form of rivers, lakes or large agricultural fields. Only some wetlands resisted the flames. (Photo 1)



Photo 1: The remains of burned trees and stumps, and a spot of still green wetland.

There was great damage of many kinds, even casualties; one person died and two were severely injured. Furthermore, about a thousand people and almost twice as many cattle were evacuated. The material damage counted 82 buildings, of which 12 were houses for permanent or recreational use, and 600,000 cubic metres of burned timber. Those couple of million trees, spread over the 13,000 hectares of high-risk woodland, had to be felled and transported out of the area prior to the following summer, in order to prevent infestation by vermin. Logistically, that corresponded to 15,000 timber trailers. That challenge was met relatively smoothly, thanks to good cooperation with the timber buyers and the introduction of one-way traffic on the local roads in order to optimise the transport network. The total cost for the damages was estimated to more than SEK 1,000 million (about USD 115 million).

In addition, seemingly endless kilometres of property boundaries had been damaged in the sense of becoming invisible or at least very vaguely shown on the ground. That was a serious consequence to the landowners, as cultivation and other use of the land need to keep within the own grounds. For example, modern forestry requires clear and accurate property boundaries in order to plant new trees as well as enable felling of full-grown stands in a rational way all around the year. As for the forest fire area, many cadastral records date from the 18th and 19th centuries, implying graphical survey plans and few reliable coordinates or other detailed numerical measurement information. Besides, the current digital cadastral index map, originally based on those paper records, may look good but the view is deceptive. The task to find and reconstruct the correct boundary lines is hence not always straightforward.

2. INITIAL ACTIONS BY THE AUTHORITIES

2.1 Urgent initiatives in autumn/winter 2014

The forest fire area stretches into four municipalities' administrative districts. For these municipalities, the cadastral services are managed by the State through Lantmäteriet, the Swedish mapping, cadastral and land registration authority. The cadastral office in Västerås acted quickly by providing basic digital map data to the rescue services. They then ordered customised maps, printed on demand, during the first days of the fire. The strategy was to make all involved professionals act in accordance with one and the same picture. That proved to be a clever move.

The right-wing Government who ruled Sweden until the election in mid-September 2014 promised Government grants to the people affected by the fire. That undertaking was carried into effect by the left-wing/green coalition who took over the rule a few weeks later. Soon after the change of government, the Department of Rural Affairs within the Ministry of Enterprise and Innovation requested from Lantmäteriet an estimate of the costs to find and, where necessary, restore the property boundaries within the forest fire area. Observations based on experience from previous cadastral work fairly comparable to the current situation, e.g. land consolidation projects in the neighbouring region, were analysed in order to estimate an average restoration cost per meter boundary. Furthermore, a preliminary GIS analysis showed that some 500 kilometres of boundaries were affected by the fire.

In December 2014 the Government decided to earmark SEK 18 million (about USD 2 million) for subsidising necessary boundary restoration and relevant land consolidation. Since then, this huge cadastral project has been extended to include re-formation or formation of joint facility roads in the area. In addition to the cadastral subsidies, there was a grant of maximum SEK 17 million to cover costs for extra road maintenance due to the heavy timber trailers that removed the fire-damaged trees.

2.2 Further recognition in winter/spring 2015

In early February 2015 the Minister of Rural Affairs made a visit to the area. He was accompanied by a municipal commissioner, the County Governor and senior officials from the County Administrative Board. Representatives from the Swedish Transport Administration, the Swedish Forest Agency, the Federation of Swedish Farmers, and Lantmäteriet were also present. All attending organisations were given opportunity to inform the Minister of their experiences of the fire.

The delegation showed great interest in the use of the aerial photographs and laser scanning images provided by Lantmäteriet. By chance, the area had been photographed from the air in June 2014 as part of the authority's scheduled aerial photography activities. These photos hence reveal the condition of the forest prior to the fire. Another two special flying missions have been carried out since then, in September 2014 and June-July 2015, by the division within Lantmäteriet responsible

for capture, dissemination, etc. of geographic information and property information (the Geodata Division). In total, some 300 aerial photographs have been made available for free to all national, regional and local government bodies that are participants of Geodata, a formal cooperation initiative for sharing official data related to land.

In consequence of the fact that the surface layer and the immediate ground bed had dramatically changed, a laser scanning was carried out in May 2015. The main aim was to meet the demand of the County Administrative Board for current laser data to be used for calculating outflow of water from the 13,000 hectares of burned woodland now lacking water-binding vegetation. In some areas, the fire has consumed everything down to the bare rock.

3. THE CADASTRE

3.1 Cadastral organisation and duties

In Sweden, cadastral surveyors can create, mutate, determine or cancel real property or property rights. All such work is an exercise of public authority; no private actors are permitted. The whole procedure of a particular matter is handled by a Cadastral Authority, being either a State body within Lantmäteriet (Cadastral Services Division) or separate municipal bodies. Today, there are about 90 offices in total around the country, holding more than a thousand staff.

Cadastral chores comprise stakeholder consultation, investigation of physical plans and environmental restrictions, cadastral survey work and mapping, legal decisions, and subsequent changes in, or additions to, the Real Property Register including the digital cadastral index map. The services come at a cost (a fee paid by the hour) for the applicant or the parties involved, depending on the matter.

3.2 Cadastral procedure

Cadastral procedures are usually carried out at the request of one or several property owners according to a deed or some other type of agreement. Common matters are *subdivision* for housing purposes or *re-allotment* to mutate existing properties to better fit the land use. Such measures are regularly taken in both urban and rural areas. *Land consolidation* is less common nowadays, but in some parts of the country, particularly the county of Dalarna, there is still a need to create larger and more rational agricultural or forest parcels. By exchanging land between several properties, each property can be transformed from a unit of numerous small land strips to one or a few proper parcels. Land consolidation matters are often major projects, in which hundreds of people may be involved. The legal prerequisites to start such procedures are rather tough, but if they are met all landowners in the area may be forced to participate. (For further reading about land consolidation, see Länsstyrelsen Dalarnas län, 2014.)

Besides such changes in physical structure, properties may be encumbered with rights and obligations concerning private roads, local utilities, etc. *Easements* and *usufructs* fit individual

purposes, while common needs often are met by establishing *joint facilities*. In the latter case, a group of neighbouring property owners build, use and maintain e.g. a road in a cooperative way. If this road serves a purpose of enduring importance also to other properties, they can be forced to join. All properties involved are given participatory shares to be the basis for the distribution of costs for the construction and operation. For the management of such facility, a joint property association is normally formed. This too is a subject of cadastral procedure.

Realisation of large infrastructure projects and other exploitations for public needs can be based on agreements as well as being coercive. In the latter case, there are a few special cadastral laws that substitute the traditional Expropriation Act. The State or a municipality can hence apply for such *compulsory purchase* through cadastral procedure. In some cases even private companies, e.g. electric power producers and telecom providers, have this capacity. Besides executing the legal and technical aspects of the matter, the cadastral surveyor should also decide on economic compensation for the land acquired.

Cadastral procedure is also applied for *property definition* and *special boundary demarcation*, two formal ways of solving boundary issues. The first one determines uncertain and often disputed boundaries. The second one confirms unambiguous boundaries 'just' lacking physical markers. These alternate matters are important as they result in boundaries being marked off on the ground with specific monuments, e.g. erect stones, iron pipes or iron pegs. Such markers are primary evidence of the course of boundary lines, according to the Land Code. If original markers have been lost or damaged, the cadastral plan(s) including coordinates should be used for boundary reconstruction. In the case of property definition, possession and other circumstances, e.g. fences and hedges, shall then also be considered. For special boundary demarcation, on the other hand, only accurate coordinates will do.

Most compulsory purchase and boundary issues cannot be taken to court, unless such cadastral matters are appealed. This makes sense to most parties, as cadastral procedures are generally faster and less expensive than court cases, where solicitors or other legal advisers tend to be required. Cadastral procedures may also be considered fairer to all parties, because of the fact that the cadastral surveyor, contrary to the judge, is obliged to investigate and consider all private and public interests before making his/her decisions.

4. THE PROJECT – BOUNDARIES, LAND EXCHANGES, AND ROADS

4.1 Preparations and project setup

The overall responsibility for the project lies with a senior officer at the Cadastral Services Division at the headquarters of Lantmäteriet. For the operational management of the work, the head of a local cadastral office in the region is appointed Project Manager. Her closest team is composed of three cadastral surveyors. In order to tackle the comprehensive field work, another three staff, all very experienced survey technicians, are seconded from an office in the neighbouring county of Dalarna. Their task is to make an inventory of remaining boundary markers and survey them. At the same

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time, a similar group of professionals work with demarcation and surveying of a new nature reserve, which is handled in a separate process (see section 4.2).

An initial rough estimation by the project management team was that the project would take 3-4 years to carry out, based on the presumptive needs of the property owners. The project has been given priority by the National Production Coordinator at the Cadastral Services Division, and that signal is a prerequisite of successful manning throughout the project. The goal is to complete all cadastral matters by the end of 2017.

Sweden being long blessed from large-scale forest fires and other major natural disasters, our cadastral officers are generally not used to operate in this type of emotionally charged situations. In order to give the staff in question better understanding for the psychological aspects of the fire, and to prepare them for meeting people in various stages of shock or post-traumatic stress, a special course was designed in cooperation with the County Administrative Board and the Swedish Forest Agency. Through that training, everyone got a set of tools to smoothen the interaction with the affected locals.

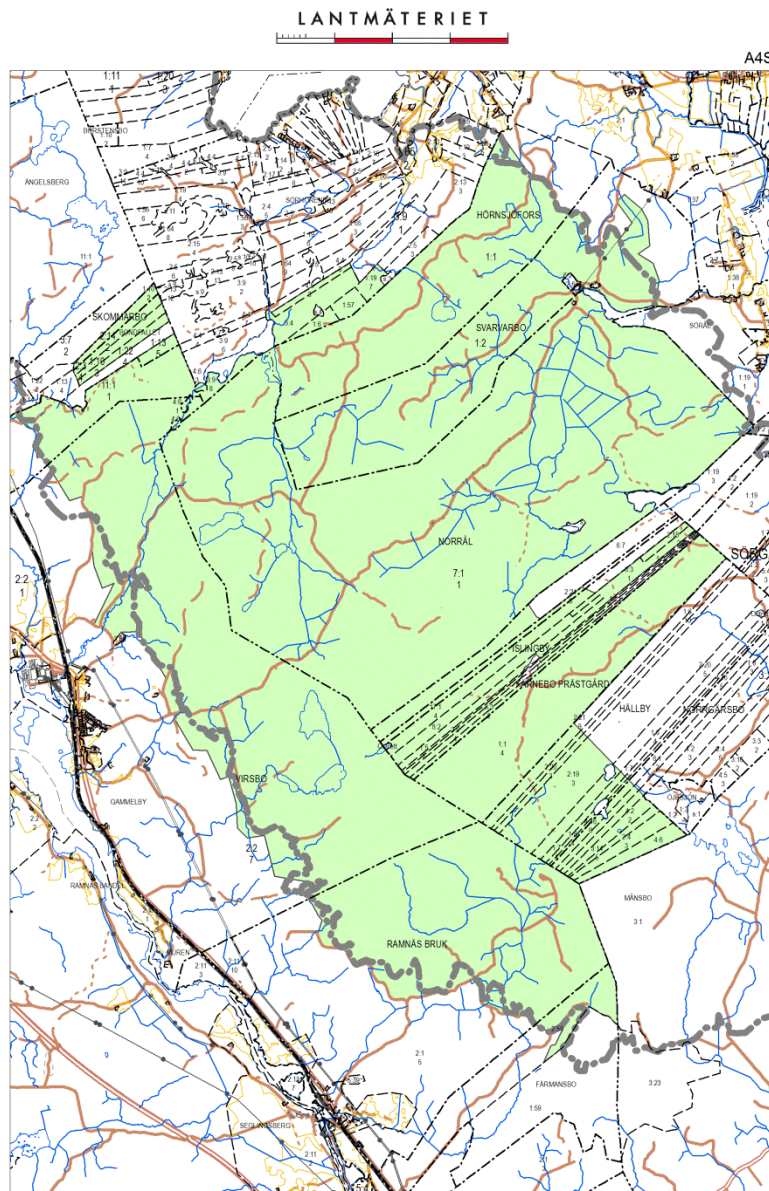
With no actual experience of assessing risks related to personal safety and working environment of forest fire areas, there was need for yet another educational initiative. Together with the national Security Manager at Lantmäteriet, the Project Manager ordered a video course in precautionary measures and safety equipment. The training, which is accessible via the intranet, is compulsory for every cadastral officer who will work in the forest fire area.

During spring 2015, there was a need to investigate the status of the five 'hot spots' (underground embers) that were noticed during late autumn 2014. As that issue was of interest to many parties, a co-financing agreement was made by Lantmäteriet, the County Administrative Board of Västmanland, and the Swedish Forest Agency. The data capture was done from the air, using the Swedish Coast Guard's infrared camera. The flying showed that none of the 'hot spots' had survived the winter, and the area was hence considered a safe working place in that regard.

4.2 Brief on the new nature reserve

As previously mentioned, there are two parallel sets of cadastral activity going on. Before elaborating on the one in focus of this paper, referred to as the 'project', a brief account will be given for the other one: the new nature reserve.

The decision to establish a nature reserve, Hälleskogsbrännan, covering 6,420 hectares was made by the County Administrative Board of Västmanland. The aim is to protect the regrowth of flora and fauna from human influence in a substantial part, close to 50%, of the forest fire area. (Map 1) Minor parts of the reserve will be accessible for visits, but most of it will be left untouched. (For more information, see Länsstyrelsen Västmanlands län, 2016.)



Map 1: The nature reserve Hälleskogsbrännan (in green) as part of the forest fire area (thick grey dotted line).

The creation of a nature reserve is based on a formal procedure conducted by the County Administrative Board. The Swedish Environmental Protection Agency and the municipality are also partly involved. In the forest fire area in question, most of the land needed for the reserve has now been acquired by the State in agreement with the property owners. The remaining plots are still under negotiation; they will change hands either voluntarily in the same way as mentioned or

through compulsory purchase. In order to make the property boundaries of the area match the new ownership structure, the completion of the reserve requires cadastral procedure.

The field work to demarcate and survey the boundary of the reserve is carried out by Lantmäteriet, by order of the County Administrative Board. The markers and coordinates will hence define the reserve area. The field work started in June 2015 and by now one third of the boundary is completed. Within the reserve, no restoration of property boundaries will be needed, as this area will eventually be one single property unit owned by the State. However, some current boundary marks within the reserve to be surveyed in order to secure the intersections of some boundaries that remain outside the reserve.

4.3 Project components and implementation plans

4.3.1 Initial steps and meetings

In order to produce a list of all properties potentially affected by the fire, the cadastral project team (hereafter: the team) based their analysis on an official statement by the County Administrative Board defining the forest fire area. In addition, the team included properties adjacent to that area, as those land parcels may have been affected by various fire-fighting actions, timber transportation, etc.

With that comprehensive list as a starting point, the team invited the property owners to an information meeting in a local sports hall in March 2015. At the meeting, the audience of about 60 people was informed about the Government grants and the options for solving various issues through cadastral procedure. A preliminary time plan for the work was also presented. After that, the Swedish Forest Agency talked about the possibilities to get subsidies for road repairs, and the Federation of Swedish Farmers encouraged their members to accept the offers by the State. Lastly, the attenders were offered to book an individual appointment with a cadastral surveyor, either at the cadastral office or on site, for a free of charge consultation about their particular needs. That offer was also sent by post to all landowners. The aim was for the team to get an idea of the total needs and level of interest among the people affected, as well as to enable the team to estimate the degree of cost coverage Lantmäteriet would offer for the necessary cadastral procedures. Directly after the meeting, the attenders were also given some time for informal talk with the representatives of the three organisations.

The landowners have acted at a quite varied pace for cadastral work to be carried out on their properties. The team has sent reminders twice to the ones who have neither applied nor communicated their decision to refrain from applying for cadastral procedure. By early February 2016, the Cadastral Authority had received applications from 85% of the owners. The team expects most of the remaining parties to contact the cadastral office when the field work starts on the neighbouring lands.

4.3.2 A complex situation at personal level

The landowners' relations to their properties vary a lot among the affected group. Both the kind of connection (e.g. economic or emotional) and the magnitude of it matter for the individual perception. Consequently, the effects of the fire range from moderate material damage to personal crisis.

Some of the large estates were family-run forestry units, developed into solid businesses over the centuries. Other properties were bought more recently, to serve e.g. as capital investment or for hunting and similar recreational purposes. Yet other pieces of land were kept as peaceful havens, secluded in the large forest far from the city life. As for all concerned parties, what they had in spring 2014 is no longer there. The situation is often even tougher for those whose property included a building, e.g. a house, country cottage or barn. What kind of insurance they had may also add to the circumstances.

During conversations with the property owners, the cadastral team has noticed many different stages of mental processing of the fire, even grieving and post-traumatic stress. For every case, the team has to be aware of this complex situation and act accordingly. The tailor-made course mentioned above has been of great help.

4.3.3 Circumstances influencing the project implementation

The initial field work, i.e. the inventory and surveying of boundary markers, commenced in November 2015. The officers find it difficult to move about in the burned terrain, but at least they retrieve the majority of the stone monuments and iron pipes. They are also generally met with a kind reception by the landowners on site.

The result of the inventory so far shows need for extensive cadastral procedures, mainly special boundary demarcation and property definition. The fact that almost all of the damaged trees have now been felled and removed from the area makes it hard to identify the previous types of land use (clumps, boundary clearings, etc.) and hence where many boundaries run. In addition, the structures of ownership and the land's division into properties differ between the four municipalities, implying different conditions for the handling of the cadastral procedures. In some parts of the area, land consolidation on various scales will be required. There will also be need for reviewing old and creating new joint facility roads. Particular conditions and characteristics of each area are presented below.

Fagersta municipality: The main parts of the land in the forest fire area located in Fagersta are owned by either the Church of Sweden or a major private company in the region. Regarding the ground conditions, many of the boundary markers have been retrieved through the inventory work. The team hence assesses the cadastral work to be fairly straight-forward and 'simple', as it is mainly a question of special boundary demarcation where occasional markers are gone.

Sala municipality: In Sala, practically all property owners concerned have come together and submitted a joint application for re-allotment, which in reality may imply a voluntary land consolidation project. The applicants also request cancelling of a number of unused joint property units dating from the great redistribution of land holdings in 1776. In this major cadastral procedure, the biggest challenge will be to run the process without any coercive measures, if possible. The team will probably call in some colleagues with experience from the land consolidation projects in Dalarna, especially when need arises for specialists in optimising parcels, e.g. adapting the parcel shapes to the surrounding natural boundary features (roads, ditches, brooks, etc.).

A first cadastral meeting is to be held in March or April 2016. All property owners concerned will be summoned, including the few who have not signed the application, in order to inform everybody at the same time about the upcoming procedure. The primary ambition of the team is to engage as many people as possible in a common effort to design a suitable property structure proposal. The team will, of course, provide assistance and legal advice in order for them to reach a satisfactory result, and then eventually transform the proposal into a formal cadastral decision.

Norberg municipality: The property owners in Norberg have shown relatively little interest regarding the restoration work. To date, only 60% of the parties concerned have applied for cadastral procedure. That could be explained by the fact that the forest fire area is severely burned in some places.



As both vegetation and soil are destroyed, displaying bare rock, new markers to manifest the property boundaries may seem overrated at this point in time. However, the properties are generally large and the boundaries long, so in a medium-term perspective there will probably be a need for supplementary markers between the old stones to facilitate the maintenance of the boundaries when new trees have started to grow. (Photo 2)

In other words, as there will be little variation of age among these trees, nothing about the vegetation itself will provide enough guidance when trying to follow the boundaries on the ground. In addition, an old nature reserve in the area is totally destroyed. So in order to clarify this particular boundary polygon, a special boundary demarcation effort is needed in any case.

Photo 2: Vast devastation; only a traditional mound of boundary stones remains.

Surahammar municipality: Most of the boundaries within the forest fire area of Surahammar are subjects of the cadastral procedure related to the creation of the new nature reserve. Here, the field work has to some extent become easier thanks to the fire, as boundary markers that were previously overgrown with grass and moss are now visible again. However, there are some problems with discrepancies between old cadastral survey plans, current indications of possession, and the new surveys of remaining boundary markers. At the moment, the team faces a small surplus of land in relation to what is stated in the cadastral records. How these ‘extra’ square metres will be handled depend on if the team discovers errors in previous cadastral procedures. In any case, there is probably guidance to seek in precedents from the Court of Appeal or even the Supreme Court.

Many long and narrow strips of land in the Surahammar area will be cut off by the reserve, making them even harder to use in a rational way. The team plans to draw attention to this situation by addressing all landowners concerned who have not yet applied for cadastral survey. The aim is to provide them with information about the current opportunity to get relevant land exchanges made in connection to the creation of the nature reserve. This way, the costs will be significantly reduced compared to a separate procedure at a later stage.

4.3.4 Economic aspects for the parties involved

Just days ago, the managerial group of the Cadastral Services Division of Lantmäteriet decided to offer full cost recovery to the property owners applying for cadastral procedure related to the forest fire. The calculations made by the project team show that the Government grants will be more than enough for all such matters. Any surplus will be returned to the public treasury.

Not only will the property owners get their procedural costs covered, they are likely to gain other advantages as well. For example, if the voluntary land consolidation in Sala can be carried out as predicted, the total length of the property boundaries in the area will be radically reduced. This should imply that the future costs for maintaining the resulting boundaries would also be reduced, probably to a similar level. Ordinary land consolidation projects indicate that the total boundary length is reduced by about 80% (Länsstyrelsen Dalarnas län, 2014), which may serve as a hint of potential economic saving for the landowners.

In addition, the team strives to use natural/topographical features as boundaries, where suitable. By doing so, existing streams, roads, power lines, etc. make demarcation redundant. This approach saves time and marking materials at the time of the field work, and reduces maintenance costs for the property owners in the long run.

The fact that so many trees are gone has a positive effect on the surveys in the forest fire area; the accuracy easily becomes very high (30 mm). This, in turn, increases the quality of the digital cadastral index map, which should to some extent lower the costs for all kinds of future cadastral work. In addition, many forestry activities such as modern felling will be made much smoother, as the machines navigating by GPS will have access to centimetre level coordinates in great parts of the area.

Lastly, the property owners get new participatory shares in the joint facility roads, without paying for the cadastral procedure.

5. REMAINING CHALLENGES

Although the project planning was thoroughly made and the initial phases have worked well, the team still faces various general challenges:

- Have we managed to reach all people concerned?
- How to secure that we accomplish results corresponding to the property owners' wishes?
- How do we keep a good pace of the process without making the property owners feel stressed and forced to make quick decisions?

Other potential challenges concern the land consolidations, especially regarding the valuation of land. It is also crucial for the success of these matters that the landowners are met with smooth treatment by the team, as some of them might be reluctant to the idea of exchanging pieces of land.

Most cadastral work is likely to be completed by 2017, but there might be additional matters arising along the way. In this case, the whole process may be extended.

6. CONCLUDING REMARKS AND ACKNOWLEDGEMENTS

The huge task to carry out the formal cadastral procedures has just begun, and the success of the implementation is yet to be seen. If the work continues according to plan, an evaluation should be made in early 2018. At this point, we hope to revert with a follow-up paper presenting the outcome of the whole project.

We would like to express our appreciation to Ms. Jeanette Väfors, Project Manager for the cadastral project, for providing statistics, photo No 1 and other information to this paper. Thanks also to Mr. Per-Olov Boström for photo No 2, and to Mr. Jörgen Lindberg for the map extract.

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BIOGRAPHICAL NOTES

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Kristin Land is Coordinator of Research and International Relations related to cadastre at Lantmäteriet, the Swedish mapping, cadastral and land registration authority. She holds a MSc degree in Surveying and a PhD degree in Real Estate Science, both from Lund University. Starting as a local cadastral surveyor in 2000, she moved on to national and international work within the organisation, including development projects abroad. Her specialisation is on legal aspects of cadastre and land administration; the PhD thesis focused on boundary issues. She is a Swedish delegate to FIG Commission 7 and represents Sweden in various international networks.

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