How a Cadaster Might Look Like in Finland in the Year 2035?

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Key words; Cadastre, Coordinates, Digitised Process, Key Registers, Land Register

Summary

The Finnish land administration system is maintained by the National Land Survey (NLS), which is a state authority, and also by 75 towns. The central part of the land administration system is the Land Information System (LIS) which has consisted of the Land Register and the Cadastre since 2010. Both LR and Cadaster belong to the key registers in Finland besides the population information system (PIS).

A totally digitised process has been gradually introduced in cadastre maintenance from 1998 onwards. Electronic archiving has also been launched. Cadastral land surveying work is done in processes. For example, parcellings (subdivisions) are carried out in the basic land survey process and expropriations are carried out in the process of valuations, where values of real estate units have to be estimated and decided. The future three dimensional cadaster is probably maintained also by laser scanning. The border marks and monuments can be replaced with coordinates.

In traditional surveying coordinates are based on a reference system which is realized by fixed benchmarks on the ground. Coordinates of new points are measured relative to the fixed benchmarks, thus giving them automatically in the same coordinate reference system. Typical surveying accuracy with current GNSS is better than 10 cm. New GNSS satellites and signals will allow us to develop novel techniques for precise positioning. Precise positioning without reference stations is one of the emerging techniques which is already available for research but which will be available for production in a few years. This will produce coordinates directly in the reference system of GNSS satellites. This will also raise an issue on the relation between the physical border marker and its coordinate value. Which one will be the entity which actually defines the place of the land area on the earth?

Future directions

The overarching aim is to remove all duplication from Finland's public electronic information resources and to ensure that all new data is entered into one system only. To this end, all duplication

must be eradicated and all databases utilising the key registers must be more closely linked to online interfaces.

Closer cooperation and forward planning are required in the drafting of legislation governing the key registers. Continued efforts are needed to address the issue of interface compatibility but there have also been calls for legislative harmonisation. The aim is to standardise user terms and conditions as well as data access requests and ultimately to develop a ”one-stop-shop” via a functional and technical interface.

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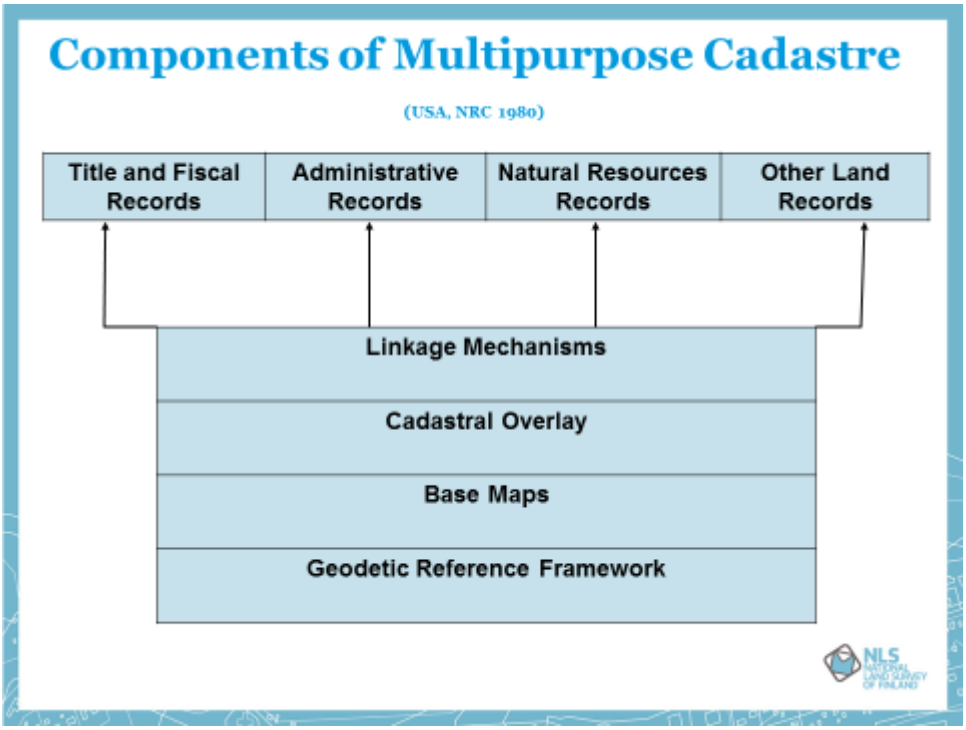
1. KEY REGISTERS IN FINLAND 2016

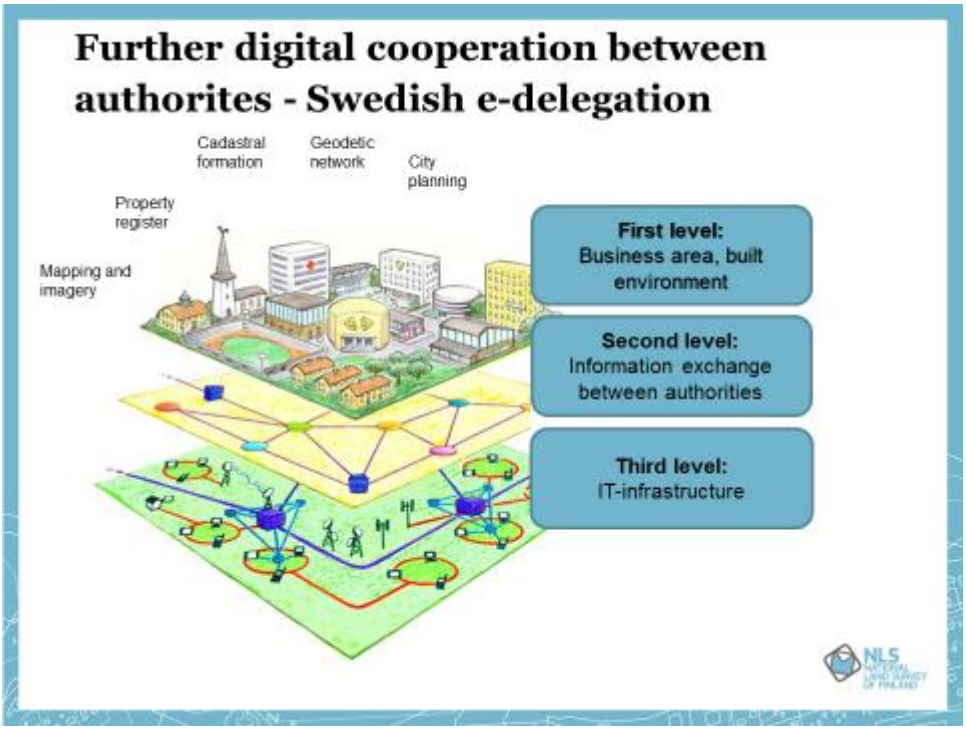
1.1 Background

In the year 1980 National Research Council NRC) in the United States of America published a report *Need for a Multipurpose Cadastre* (NRC 1980). This report became and still was in the year 2007, a guidebook for land parcel data throughout the world. This observation was and still is striking because the 1980 report was written when the big changes in provision of spatial data made possible by geospatial technology and IT were just beginning. In the 1980 report the parcel map was called the cadastral layer. This layer was the primary spatial representation of land. The concept of multipurpose cadaster is depicted here.



Links between parcel boundary maps and the locations of other land features are built on an underlying foundation of geodetic control information. Maps of parcel boundaries and of the location of land interests in parcels, such as easements rely on this geodetic control information. PINs allow for links between parcel maps in analog or digital form to the text of documents that describe the nature of the property rights associated with parcels. These links make possible the combination of records and information about both the nature and extent of land features and interests for the purposes of addressing the full range of land-related problems. (Epstein - Niemann Jr. 2014: Modernizing American Land Records. Order Upon Chaos. Pages 76 - 77)

Another picture which shows and describes the background of already existing totally digital Finnish Key Register system is below.



Finnish Key Register System as it is at the moment is enabled to information exchange between authorities. The third level of IT-infrastructure according to the picture above is possible to clinch in the future. One big advantage in Finland is the digital person register including all the Finnish citizens and most of the residents. This register is based on historical documents collected by church authorities in parishes around the country (parish registers).

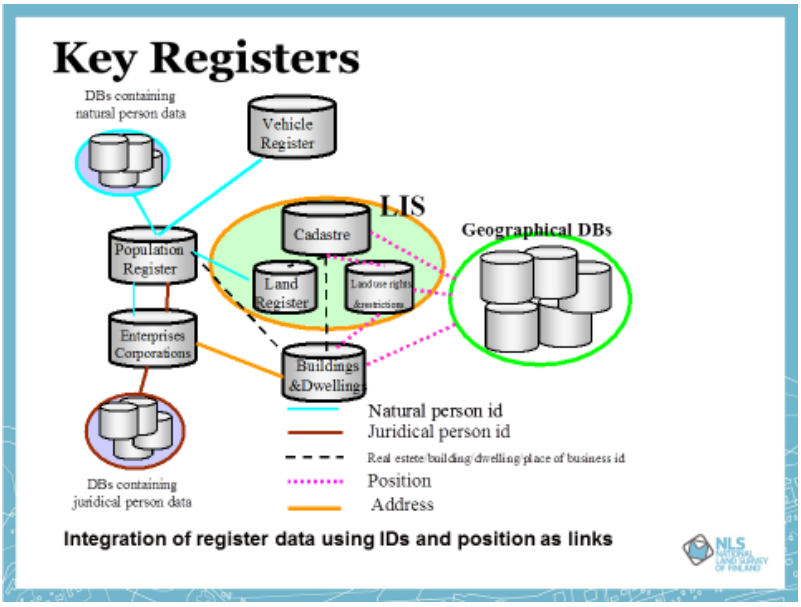
The key principles depicted below regarding spatial, legal and institutional framework belong also to the background of the Finnish Key Register System.

Fit-for-Purpose Land Administration

KEY PRINCIPLES		
Spatial Framework	**Legal Framework**	**Institutional Framework**
• Visible (physical) boundaries rather than fixed boundaries • Aerial / satellite imagery rather than field surveys • Accuracy relates to the purpose rather than technical standards • Demands for updating and opportunities for upgrading and on-going improvement	▪ A flexible framework designed along administrative rather than judicial lines ▪ A continuum of tenure rather than just individual ownership ▪ Flexible recordation rather than only one register ▪ Ensuring gender equity for land and property rights.	▪ Good land governance rather than bureaucratic barriers ▪ Holistic institutional framework rather than sectorial silos ▪ Flexible IT approach rather than high-end technology solutions ▪ Transparent land information with easy and affordable access for all (WB 2016 Wash. D.C.)

1.2 Structure

The Finnish key registers include natural persons, real estates, buildings, enterprises, corporations and foundations. Besides that also topographic database belongs to key registers though no legislation concerning it does not exist. The structure of the key registers in Finland at the moment is shown below.

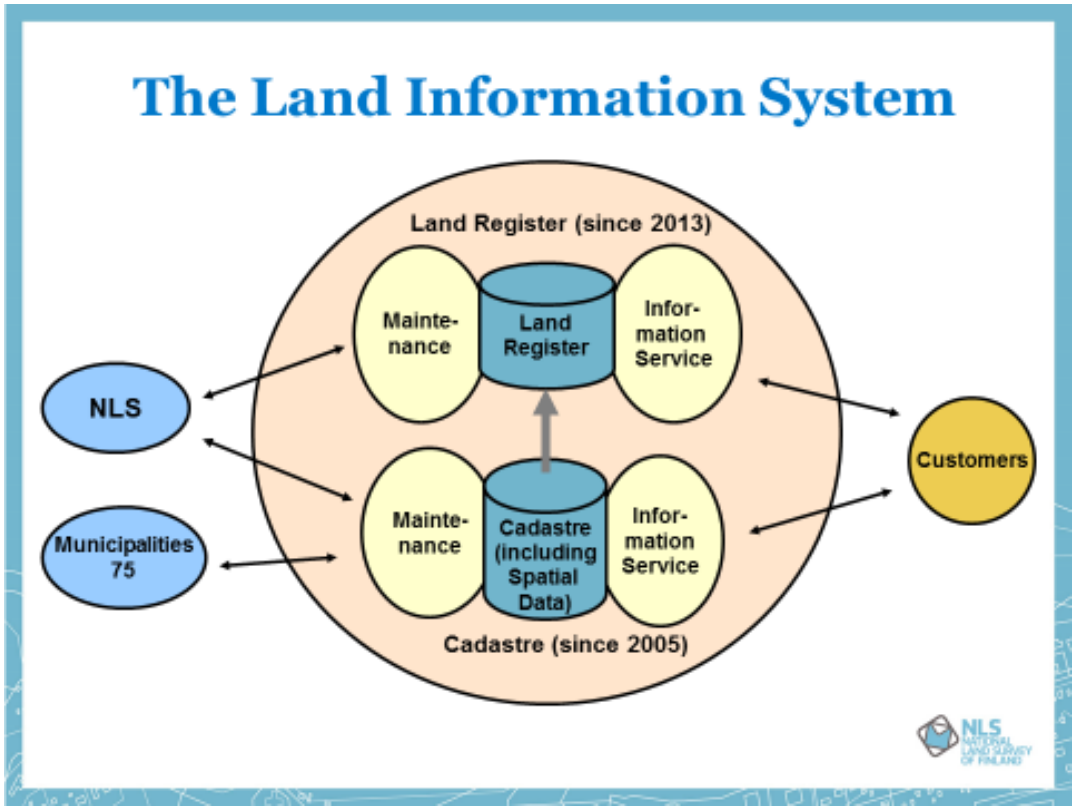


1.2 Land Information System (LIS)

National Land Survey (NLS) and 75 municipalities update the Finnish cadastre. NLS maintains the register. One common register has existed since 2005 which has nationwide coverage. Both land and water areas are recorded. Also water areas can be recorded and identified as real estates and cadaster units. Water areas as well as land areas can be a privately owned and separate cadaster units cadaster number (or identifier). The Finnish Cadastral System is quite similar to the Swedish System.

Land Register maintenance has been a task for Local Courts from historical times in Sweden and in Finland. However, the legislation has changed and NLS has updated and maintained land register in Finland since 2010. LIS should include also other Agencies' data. Land use plans are archived by municipalities. Building restrictions and future areas for detailed planning are unfortunately not completely included to LIS information at the moment.

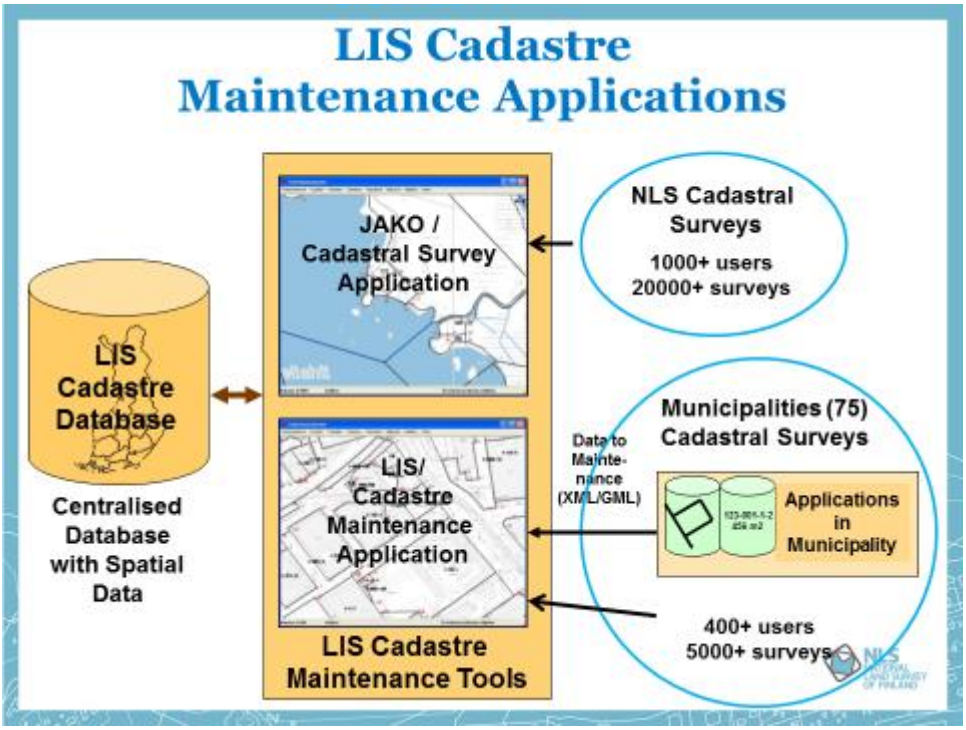
Information regarding buildings and their ownership is maintained by Population Register Centre. NLS has access to this information which is lamentably not complete.



1.3 Cadastre

Cadastre is one part of LIS as mentioned above. Contents of cadastre are based on legislation. Cadastre includes property division with plots and real estate units inclusive shares in common areas Connected rights as easements (servitudes) and usufructs inclusive certain restrictions to property owners rights are all recorded in cadastre. Cadastral index map depicts the property division with easements and certain other rights. Property division consists of register units, their identifiers and boundaries

Part of cadastral data has negative and positive faith and credit. This means for example that State of Finland is obliged to pay compensation for errors in the cadastre that are the consequence of decisions taken in cadastral surveys since 1 of July, 1985.



1.4 Land Register

Land Register has a nationwide coverage. Contents of Land Register include titles and mortgages. All data has negative and positive faith and credit. State of Finland can be obliged to pay compensation for any errors.

1.5 Population information system

Population Register Centre and local register offices update and maintain the population information system. Population information is basic information related to the identification of people (Personal data) and buildings (Building data) That all is recorded in the Population Information System which is is the most frequently used key register in Finland.

Personal data includes person's name and personal identity code (person ID). Besides that address, citizenship, native language (Finnish, Swedish or Sami languages), family relations and date of birth(and death) are recorded.

Population Information System also contains building data. According to law, building code, location, owner's name, area, facilities and network connections are recorded. Concerning buildings are also recorded the intended use of the building and the year of construction.

1.6 Other Parts of System of Key Registers

Key registers in Finland also consist of Trade Register including enterprises, companies and corporations. Apartments and condominiums (housing associations) are not yet separately digitally recorded but a plan of a digital register exists. Companies e.g. actually housing associations which administrate block of flats, semidetached houses and detached houses are registered in Trade Register. The system of housing associations which administrate the block of flats is unique in the world, as far as we know in Finland.

Topographic Database includes geographic information which is a base for all maps of Finland. This Database consists of up-to-date information on terrain and the built-up environment. It also depicts the power lines, water areas, place names, address data, road data, contour, etc.

Purchase Price Register includes information which is received from Public Purchase Witnesses. These authorities witness de facto all real estate conveyances in Finland and they are obliged to report on transactions to NLS and also to municipality. Purchase Price Register is based on this information and the register includes just real estate sales and other transactions which *de facto* have been done. The register includes real property conveyances since the early 1980's and its reliability is high.

2. ELECTRONIC PROPERTY TRANSACTION SYSTEM IN FINLAND

Electronic Property Transaction System is a web-based application which enables electronic transactions related to real estate conveyance. One ICT-service includes both real estate transaction and mortgage management systems. Service was launched in the year 2013. According to the legislation the service is provided by National Land Survey of Finland.

There are certain barriers to implementation. The use of the new digital system is not required in legislation. "Paper process" can still be used as a parallel to digital system. Real estate agents are still required to archive paper forms. Banks have not been able to eliminate their paper processes. Loan related papers are stored in vaults. At the moment there are around 3.5 million paper mortgage deeds.

To enhance the usage of the Transaction System certain legal reforms are required and are under process. Also some information and education is being delivered for real estate agents, municipalities, banks and integrators. The system of Public Purchase Witnesses is under consideration. In Finland no notary system is existing and is not being planned. NLS as a Land Register authority makes

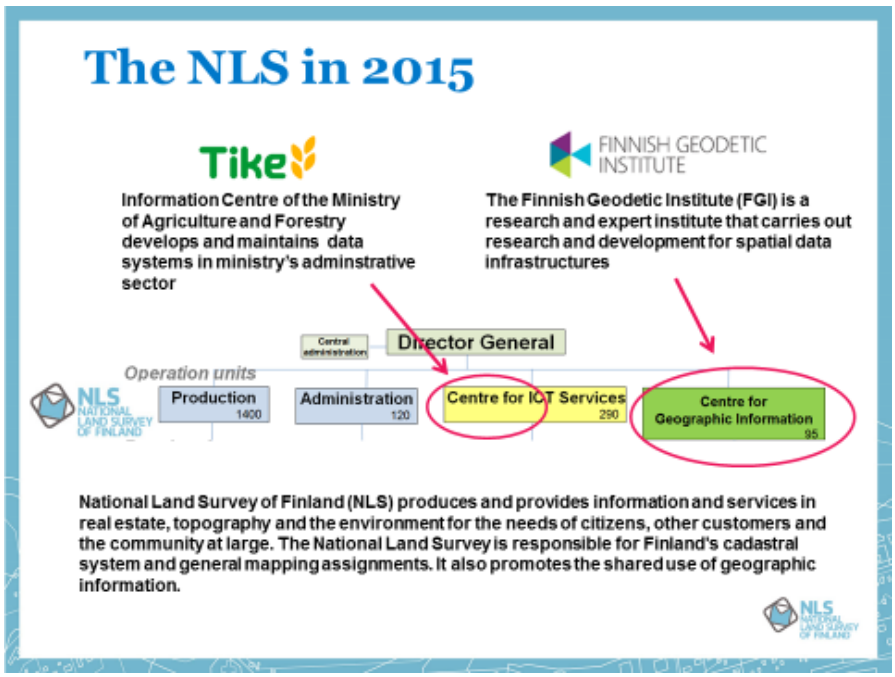
controls if needed prior to giving a title. Also long time leased land areas can be used as a collateral if the contracts have been recorded in the LR and if the leasehold has an identifier.

One aim in Finland is to create a reliable "one-stop-shop" digital land conveyance system from digital sales agreement to land registration and subdivision which enables the usage of the new real estate unit or plot as a collateral. The process will be very quick with interfaces to other authorities registers where information can be obtained and checked immediately under processing.

3. REAL ESTATE BORDERS

When it concerns the future cadastre in Finland one aim here is to launch within approximately in a decade a coordinate-based cadaster. However, some research and development work is yet to be done. Besides that the legislation must probably be reformed.

There has been some organisational reforms concerning National Land Survey in Finland under the last years. This enables NLS to further focus on research which provides opportunities to develop the quality of the cadastre and also the quality of coordinates of the real estate borders. After publication of following picture has FGI been called Finnish Geospatial Research Institute. Center for Geographic Information has not been used at all.



Professor Markku Poutanen from FGI (Finnish Geospatial Research Institute) has made some preliminary studies regarding the background of the coordinate cadaster. I will take some extracts from

his studies here. He delivered a presentation in IPRA CINDER Congress in Dubai 2016 regarding this issue. In his presentation Poutanen discussed the needs and the benefits of technical development in GNSS positioning. With emerging techniques one is faced with the problem of time-dependent coordinates, crustal deformation and coordinate reference system. This will also raise an issue on the relation between the physical border marker and its coordinate value. Which one will be the entity which actually defines the place of the land area on the earth?

"Traditionally all reference frames have been based on solid stable benchmarks on ground. However, situation seems to be changing towards what we call active control networks. It means that basic benchmarks are not anymore on ground but they are GNSS antennas of permanent networks the coordinates of which are controlled continuously."

"We have two possibilities, either their coordinates are used "as is", and we then get a time-dependent coordinate reference system which is in the same system as the GNSS satellites produce their coordinates. Another possibility is to introduce a crustal movement model which "corrects" the movements in time to a fixed epoch of time. This approach leads to a similar result as the traditional fixed benchmark system. Problem is that we do not know all local movements in a sufficient accuracy (e.g. earthquakes)."

"Then there is coming a third technique, called PPP, Precise Point Positioning, with which one can get cm-level coordinates using one GNSS receiver only without any reference stations. Today this is still more on research approach but in a few years it will come for surveying practice. With this you are fully on GNSS satellite system and if needed to get back to a local system, a good crustal deformation model is needed locally."

So Poutanen's opinion is that within a decade or so we are in a situation when such techniques are in every-day use, and we must be prepared also on legal level how to handle the situation. Technically it is possible today, but it is more on mental level and legal issues how to handle coordinates of your land property which are continuously changing. Poutanen has no good answer on this today, but geodetic and surveying community must soon find the procedure how this is handled. Poutanen is chairing the EUREF-commission, so this topic will be discussed also there in near future. EUREF is the expert organisation to handle the reference frames in Europe.

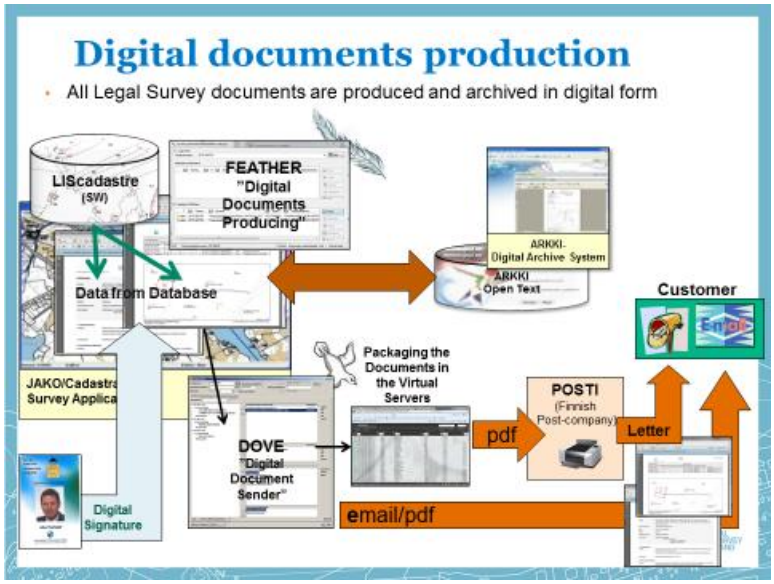
During recent years the Global Navigation Satellite Systems (GNSS) has undergone remarkable changes. Foremost the new satellite systems, European Galileo and Chinese BeiDou have been developed rapidly. Two old systems, GPS and Russian Glonass are fully operational. In addition to the global ones, there are two regional systems under development, Japanese QZSS and Indian IRNSS. Before the end of this decade, the total number of navigation satellites will be more than 100. This means, that at any given time there are tens of navigation satellites visible anywhere in the world, and together with new-generation multi-GNSS receivers this leads to better accuracy and reliability in coordinate determination.

In traditional surveying coordinates are based on a reference system which is realised by fixed benchmarks on the ground. Coordinates of new points are measured relative to the fixed benchmarks, thus giving them automatically in the same coordinate reference system. Typical surveying accuracy with current GNSS is better than 10 cm. New GNSS satellites and signals will allow us to develop novel techniques for precise positioning. Precise positioning without reference stations is one of the emerging techniques which is already available for research but which will be available for production in a few years. This will produce coordinates directly in the reference system of GNSS satellites.

Tradition to mark the land borders by cairns or other permanent markers fits well with the traditional surveying practice. Their position is fixed in the reference system used in the area and their coordinates are not time-dependent. There is no issue whether the land borders are based either on the markers or their fixed coordinates. The situation is changed dramatically if one uses precise positioning without fixed reference benchmarks. Coordinates are time-dependent and in the epoch of the measurement. New measurements at any other time will lead to different coordinates. One has to know the crustal motion (such as the motion of continents or regional tectonic deformation) on submillimetre accuracy to make the transformation from one epoch to another. Additional issue is to get the coordinate reference system to use them together with the existing coordinates of old markers.

4. Future directions

At the moment the cadastral land surveys are carried out with a digitised process which still can be enhanced. The next picture shows the current process. Communicating cadastral land surveys cannot be totally digitised because there is not legislation in Finland that allows informing of legal acts, which cadastral land surveys in Finland can be compared with, by e-mail or by more advanced digital means. Land owners in rural areas and older landowners in towns as well are not equipped with computers and internet. There are also people who always want have their documents and letters on paper. This is why the traditional method of delivering messages and documents to citizens are for the time being inevitable.



The overarching aim is to remove all duplication from Finland's public electronic information resources and to ensure that all new data is entered into one system only. To this end, all duplication must be eradicated and all databases utilising the key registers must be more closely linked to online interfaces.

The Swiss study of 4D-cadastre "Beyond the Limits", Discussion Paper 2014/1, with several authors gives us some hint regarding Cadastre 2035. Property division can be reconstructed not only up-to-date but also regarding a certain given point in time. Legal decisions concerning property borders are at the moment based on old documents produced under different times in cadastral land surveys. The eldest documents in Finland are from 18th century written with pen using old-time Swedish. Cadastral Index Map can be developed and it will be able to reach a quality that enables its usage as a formal map. The accuracy of old maps is not the best possible. Several miles long borders between properties are not documented well in rural areas and particularly in Lapland. All future decisions concerning border disputes can be based on cadastral index map. That is not at the moment possible according to legislation but who knows what kind of cadaster we have in the year 2035.

There has also been discussions regarding so called 5D-cadastre. While maintaining the cadaster with so called "Big Data" which can be obtained for ex. from citizen's mobile phones or car navigation or positioning systems is one option in the future. However, a new application should be developed to enable the usage and analysing of this kind of information. Crowd sourcing is a possible future method of cadastre maintenance.

Closer cooperation and forward planning are required in the drafting of legislation governing the key registers. Continued efforts are needed to address the issue of interface compatibility but there

have also been calls for legislative harmonisation. The aim is to standardise user terms and conditions as well as data access requests and ultimately to develop a ”one-stop-shop” via functional and technical interface. Open access to all possible cadastral data is our aim balanced with individual privacy.

Markku Markkula

Biographical Notes

Markku Markkula is the Deputy General Director of the National Land Survey of Finland (NLS). The NLS is a governmental agency subordinate to the Ministry of Agriculture and Forestry. National Land Survey of Finland (NLS) produces and provides information on and services in real estate, topography and the environment for the needs of citizens, other customers and the community at large. The National Land Survey is responsible for Finland's cadastral system and general mapping assignments. It also promotes the shared use of geographic information. Markku has been working for National Land Survey of Finland since 1978. He started as a Practitioner before taking on the role of Engineer (Land Surveyor). After becoming a jurist he worked as a Judge at Land Court performing multiple judicial tasks for ten years. Since 2008 he has been Deputy Director General for National Land Survey where his main task is preparing legislation. His aim is to politically guide National Land Survey toward resolutions that create sustainable growth for the future. Markku has a Master of Law from Helsinki University and a Master of Science from Aalto University of Technology.

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