

BEYOND LIMITS

Discussion paper 2014/1

GO **4D**DIMENSION CADASTRE
SWITZERLAND - MAY 2014

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Beyond Limits

REFLECTIONS, VISIONS AND EXPECTATION
FOR A DYNAMIC FUTURE CADASTRE

I USED TO HAVE
A POSTAL ADDRESS
AND A POSTMAN...
NOW, I NO LONGER HAVE A POSTMAN,
BUT AN IP ADDRESS INSTEAD!

I REALLY MISS
THE POSTMAN!



Impressum

The report entitled “Dimension cadastre” that was published in December 2011 gave rise to the establishment of the “Dimension Cadastre” think tank. New information and communication technologies, along with economic, financial and political globalisation, the increasing movement of persons and cultural and social change, have resulted in significant differences in the way in which geographic information systems (including cadastres) are perceived. Focusing on six main drivers of change, the 2011 report set out to identify future developments by determining new professions based on future reality while putting forward entirely fresh hypotheses regarding development. It went on to propose a development in four main strategic directions.

@2014 “Dimension Cadastre” workgroup, Federal Directorate of Cadastral Surveying, Conference of Cantonal Cadastral Services (CSCC) and Swiss Engineers and Surveyors (IGS).

This document is available in German, French, Italian and English.

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Publisher: Federal Office of Topography swisstopo
Address for placing orders: Federal Office of Topography swisstopo, Federal Directorate of Cadastral Surveying, Seftigenstrasse 264, 3084 Wabern, www.cadastre.ch.

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Introduction

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Marking territory has always been an essential activity. From the ages of hunting and gathering through to the periods of colonial wars, migration and early human settlement, plotting land has always been a vital factor. And more recently, following the creation of states as we know them today, land surveying has become a crucial factor with respect to property ownership: here, cadastres – which are a kind of “basic map” – play a decisive role, while maps themselves – which depict the beauty of a country – stimulate our imagination.

The 1:100,000 Dufour Map (1) depicting reliefs was followed by the initial series of Michelin maps (2) which were published from 1905 onwards for use by motorists and included keys indicating distances and road gradients, as well as the condition of roadside verges and, at a time when breakdowns were common, the location of repair and filling stations, as well as catering facilities alongside French roads. From that era, what remains is the famous Michelin star and congestion on the motorways. Then not so long ago, Google (3) launched its concept of the “interactive map”: based on images of the real world, this technology made it possible for people to view their property on their computer in “3D” via Google Earth, and to localise restaurants, shopping centres and various other facilities. This new approach to the provision of geographic data was quite unexpected for people who were accustomed to using paper maps such as those produced by Dufour and Michelin. However, with the advent of digital imagery provided by Google Earth and the even more detailed imagery of Google Street View, professional

surveyors, geomaticians, geographers, etc., all began to ask themselves what the future might hold for them: “What remains to be done?” and “Who will be responsible for doing what?”.

It is to this first question that this “discussion paper” is going to try to give a fresh, strong and coherent response. With respect to the second question, which broadly speaking refers to a redistribution of tasks between the private and the public sector and between the various stakeholders at the municipal, cantonal and federal levels, a second “discussion paper” is to be published in the course of 2015. But it is the question of what remains to be done in the wake of Google that is the focus of attention of this document. Our aim is to approach it in a way that is both simple and comprehensible for everyone, while providing additional information in order to explain the technical terms used in the document, as well as including a list of references at the end. The authors of this “discussion paper”, who collaborated within the framework of the “Dimension Cadastre”

think tank for more than a year, chose to open the debate as broadly as possible, including to the general public, so that discussions could extend beyond the specific scope of the initiated.

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The decision to open the debate also took account of the fact that cadastres and maps have always been, and remain, very fashionable and popular representations in each period in which they are published, and it is therefore clearly apparent that the measurement of land serves the purposes of marking the boundaries of property ownership (my land/your land) within the framework of a cadastre, as well as providing landmarks for orientation.

Smart devices to play a central role in cadastral issues

Firstly it should be noted that modern electronic devices such as the smart phone are the centre-piece of this new approach and represent a key instrument of change. Initially, the national maps and cadastre were produced on paper and based on analogue technology, then after the introduction of information technology and the Internet the focus shifted to electronic systems and digital technologies. This development has given rise to the use of mobile devices such as smart phones, laptops and tablets, rather than desktop computers which had been widely used until fairly recently. This transformation is crucial, because in the future it is the land itself which will provide the information. Once

a smart mobile device has fixed on a targeted territory, the algorithms begin their calculation in order to determine a suitable representation by looking for all the relevant data in Cloud databases. Why algorithms instead of basic searches? Because all sorts of calculations, interpretations and new representations are activated together with the searched-for data. In a manner of speaking, the land will “identify” itself (detection via geo-tracking and comparative visual identification), and the desired representation is formed before our eyes – for example, the villa I want to build on a plot of land I intend to buy, or a multi-dimensional representation in real time of a new complex intersection (with several forms of transport: train, tram, motor car, cycle lane, pavements, etc.). This is the technology of the future.

We will therefore have to reorient ourselves on what amounts to a reversal of past practices: we will no longer go to the land with our instruments, measurements, representations or maps. Instead, it is the land that will come to us via electronic and digital technologies through direct positioning and instantaneous calculation of data by predefined algorithms.

We will begin by discussing these new visions, then will go on to link them with present-day reality in order to propose a kind of development comprising several stages (milestones or landmarks) with the aim of drawing up a route, a direction, a plan to follow for the cadastre of the future.

(0) Tithe collection schemes (land taxes) were introduced in the 17th century for fiscal reasons, then the concept of a cadastral survey encompassing all regions of the country came into being at the political level towards 1800 during the era of the short-lived Helvetic Republic. In the course of the first half of the 18th century, manual surveys of plots of land were carried out here and there in accordance with the polygonal method in the signatory cantons of the Concordat of Surveyors of 1868. The introduction of the Civil Code in 1912 resulted in the abandonment of the fiscal cadastre in favour of a legal one (property rights and obligations).

(1) Dufour Map is the name given to a 1:100,000 scale atlas of Switzerland that was based for the first time on precise geometric measurements. The project comprising 25 sheets approximately 70 x 48 cm in size was realised in the period from 1845 to 1864 by Guillaume-Henri Dufour, a Swiss topographer and army officer. The projection method that was used was an equivalent conical projection. The point of origin for height measurements was Pierre du Niton, the altitude of which was at that time estimated at 376.2 metres above sea level. At around the beginning of the 20th century, the first proofs for a new map series of Switzerland were produced. Since the introduction of the federal law in 1935, national maps at all scales comprise the series of official maps of Switzerland still in effect today. They are renowned throughout the world. Today, the series of national maps are available at the following scales: 1:25,000 (247 maps), 1:50,000 (78 maps), 1:100,000 (23 maps), 1:200,000 (4 maps), 1:500,000 (1 map) and 1:1,000,000 (1 map). They are updated every six years.

Plot of land as the nucleus of every real representation

(2) The first Michelin map was only published in 1905 on the occasion of the Gordon Bennett Cup (an aviation trophy). It featured a more rapid method of consultation and folding thanks to its accordion-style design using paper with 2 x 10 folds of 11 x 25 centimetres – a form that has been retained until today. In 1911, Michelin made significant progress when it introduced the indication of mileage figures on its maps, then went on to include filling stations and restaurants.

(3) Google Maps is a free on-line cartographic service. It was created by Google and was launched in 2004 in the USA and Canada, and in 2005 in Europe. It allows users to view maps and to zoom in from large-scale right down to individual streets. Fixed images depicting details of certain streets can also be viewed via a gateway to Google Street View. Three types of views are available in Google Maps, which now covers the entire world: a standard view with names of streets, districts and towns; a satellite image; and oblique aerial views.

WHERE R U?

IN OUR
BED !!



Changing World 09

Examining the evolution of the cadastre and of surveying and its various aspects means above all tracing the development of the methods and technologies from drawing board and pencil to computer, from 2D to 3D, from terrestrial measurement to global navigation satellite system (GNSS) (4), from terrestrial surveying to photogrammetry, from databases to knowledge bases, from analogue to digital technology, etc.

The pace of this evolution accelerated considerably in the past few decades following the combined effects of new Internet applications and the more recent advent of mobile devices, as well as the extraordinary rise of social networks (Facebook has more than a billion members).

The world is certainly evolving. The boundaries between the private and the public sphere are disappearing. Governments have become more vulnerable to external interventions, and are often being pressured by new technological, entrepreneurial and social players. Everything is changing rapidly.

Several aspects of these rapid changes particularly attracted our attention during the various meetings of the “Dimension cadastre” think tank in 2013. Some of the key elements are outlined below:

> *Technology*

The past few years have above all been characterised by the advent of electronic devices such as the smart phone and tablet. We can now carry digital technology in our pockets. It is

mobile and can access data all over the world. When we answer our mobile phone, we no longer say “Hello”, we say “So where are you?”. Whether we are travelling, on our way to work, at home, or even shopping or enjoying leisure-time activities, we are always reachable. Mobility is now the prime driving force behind technological development.

Today’s devices no longer take the form of passive terminals linked to central systems. They are computers in their own right, equipped with an operating system and countless apps that can be downloaded at relatively low cost. Thanks to this innovation we now have “portable intelligence” at our disposal. Therefore, the second key element concerns smart technology (i.e. smart mobile devices).

Furthermore, these devices can find their own way around thanks to global navigation satellite systems (4).

This permits a contextual presence, in situ. Essentially, a global navigation satellite system indicates our location thanks to its integrated

O geo-positioning technology. It is this which tells us where we are. This may seem slightly confusing, since in the past we have always been accustomed to finding our own way. But now, this information is directly provided as soon as we activate the system and indicate our desired destination, i.e. the route we should take is displayed on screen. And even if we deviate from the displayed route, the system automatically recalculates the best one to take. This is really quite revolutionary. We need never lose our way again. From now on, all we have to do is indicate where we want to go, and the system points the way.

With these devices we can also instantly take photos and shoot video footage. This is a far cry from Polaroid technology, since digital images can be modified, transmitted and stored, and remain permanently at our disposal. It is the key factor in the coming decade. More than half the traffic on the Internet will involve video technology. We are moving away from the written word and in the direction of imagery. We are paving the way for a new semantics, a new language and a new framework of understanding.

The pressure of technological development is driving social change

>Data

Other changes are now taking place, for example the use of data mining (5), a new approach to the analysis of, and search for, infor-

mation in large databases. This development has caused a considerable amount of anger and concern throughout the world following the revelations by Edward Snowden (an American IT specialist and former employee of the CIA and National Security Agency [NSA], who disclosed details of a number of large-scale surveillance programmes – cf. Wikipedia), which drew attention to the true power and magnitude of data mining. Today it is possible to configure algorithms that will solely search for the relevant data that are required. Automatic trading on Wall Street had already been exploiting the potential of some of these algorithms, but data mining is revealing an entirely new aspect. In future, we will be able to look beyond statistics in order to evaluate human behaviour. And without a doubt, it will also be possible to utilise these technologies in the area of geo-localisation – this is something we will come back to later.

Also, we should not overlook the issue of open data (6), which is now gaining ground, especially within public administrations, based on the concept of the openness of the Internet and open source software. This is something that will become reality for everyone in the future.

>Social networks

At the social level it is the remarkably rapid rise of social networks which is bringing about what amounts to the biggest change in social behaviour in decades. These networks enable people to “socialise” freely with others at low cost, with varying degrees of commitment and for an indefinite duration in a new kind of “common interest club”. People join Facebook in order to share their life with a small group of “friends”.

They become “linked in” in order to further their career. They “tweet” in order to exchange views on topical matters and keep one another updated. They use apps such as SnapChat in order to send instant messages. They activate “square” in order to search for former friends and acquaintances. They “tube” their personal videos on Youtube, “blog” their ideas and thoughts, post their notices on Pinterest, share their mail on Google+, their space on MySpace, their Powerpoint presentations on SlideShare, their location on Craigslist or, for example, on Rezonance if they live in the region of Geneva. This development represents a complete restructuring of social relationships. It is not driven

by religious movements or cliques, and even less by political circles or unions. Here the decisions are being taken by each individual citizen. This empowerment is the very essence of the ongoing social revolution.

We are merely in the very early stages of a lengthy process of societal reinvention, and it is necessary to look beyond Facebook and co. in order to truly grasp the significance of the ongoing transformation.

We shall be keeping this in mind in our discussion paper.



(4) A global navigation satellite system (GNSS) is a geo-location tool that functions at the global level. The first system – Global Positioning System (GPS) – was introduced by the United States Defense Department. It quickly became apparent that signals transmitted via satellite can be freely received and utilised, and that a receiver is able to detect its location on the surface of the planet with unprecedented accuracy if it is equipped with electronic circuits and the necessary software for processing the incoming data. Thus anyone equipped with a receiver of this sort can use it for navigation purposes. GPS has also enjoyed enormous success in the civilian world and given rise to immense commercial development in a broad variety of sectors, including maritime navigation, road navigation, tracking of heavy goods vehicles, leisure-time activities (e.g. hiking), etc. At the same time, scientific circles quickly developed and utilised the properties of signals transmitted via satellite for a broad variety of applications, including geodesy, the transfer of time between atomic clocks, studies of the atmosphere, etc. The US Global Positioning System was subsequently complemented by a Russian (Glonass), a Chinese (Beidou) and a European (Galileo) system.

Data mining is going to speed up the mass exploitation of “big data”

(5) The purpose of data mining is to obtain knowledge or know-how by analysing large quantities of data using automated or semi-automated methods. Here, the aim is to utilise a set of algorithms from a variety of scientific fields such as statistics, artificial intelligence or information technology in order to construct models based on obtained data, i.e. to identify useful structures or patterns that comply with predefined criteria, and to derive as much useful knowledge from them as possible.

(6) The term “open data” refers to numeric data of public or private origin. The data concerned may be produced by a community or a public service, and their distribution is effected in a structured manner in accordance with a methodology and an open licence that assures free access and utilisation by everyone, without any technical, legal or financial restrictions. “Open data” also simultaneously stands for a movement, a philosophy of free access to data and the practice of publishing freely accessible and utilisable information. It is part of a trend that regards public information to be common property, the dissemination of which is in general and public interest. In some countries, especially in Europe, laws and directives require communities to publish certain data in digital form.

Positioning

Cadastral surveying (7) formed the basis for the development of the cadastre, alongside the land register, as well as cartography. Without surveying, it would not have been possible to calculate the size of plots of land and the value of properties, nor would maps have been able to serve any useful purpose. Above all, it was essential to be able to measure with a high degree of precision, and in view of this the focus was entirely on making accurate calculations.

We are also witnessing the end of surveying in the conventional sense, because positioning will be just as accurate and more or less obtainable in real time. In any case, surveying will use a reference system, that has been entirely virtualised, and an address nomenclature (URI), for example for points of reference or plots of land.

Surveying in the strictest sense will be quickly superseded by other methods such as virtual representation (calculation), with little intervention on the ground. In any case, the contributions from surveyors as we have known it to date will decrease. This will mean the end of the profession of surveyor as we know it today. So what does this mean for their future? In our view they will have a role to play in the transition process, i.e. as professionals in charge of changing and adapting representations of properties, and the management of land and augmented reality. We shall come back to this topic.

Sooner or later it will be necessary to regulate algorithms

It is therefore necessary to have a medium and a long term strategic vision in order to be able to define the adaptation of legislation, the redistribution of tasks and above all the future services to be introduced. One thing that is certain today is the fact that official surveying provides data that are essential for a country's economic development through the guarantee of precision of cadastral measurements, based on the system of property ownership in modern nations. This official guarantee clearly needs to be retained. But it is necessary to know how the complex system will evolve and change with around 7 million objects (plots of land, buildings, etc.), with their metric transformation, their development in 3D or 4D (history), as well as the opening up of data to more people capable of adding relevant information.

But our starting point will be to regard the cadastre as a positioning instrument. What is going to change in the operating method is that positioning will no longer be secured solely by technologies such as global navigation satellite systems, but also through visual recognition. It is by pointing our smart device at a building, a plot of land, a zone or even a landscape that recognition in its entirety will function: the territory will signal our position to us with absolute accuracy. In a manner of speaking, the land will become the map encompassing all maps, including the cadastre, as already demonstrated experimentally by Google Glass. The evolution of positioning methods will have both theoretical and practical repercussions. Let us take a brief look at some of these:

Visual recognition means providing the image with an orientation. We look from a viewpoint with a cardinal direction. This is a new input in territorial data, unlike cadastral representation which to a certain extent was neutral in terms of orientation. It was possible to rotate the “map” in all directions with a pointer indicating, for example, north. Here, the orientation is fixed and depends on a viewpoint. For example, during the modification of a plot of land, we select the object to be modified, view it and are also able

to see the consequences of the changes, for example the encroachment of a new road on a property with trees to be felled. The results are immediately visible in virtual (real) representation on the mobile electronic device (smart phone, tablet, laptop, etc.). The modification is no longer abstract, it is visible. It leads to discussions and negotiations on possible alternatives. We can rotate it through 360 degrees. The representation becomes a kind of stage on which changes can be viewed in real time.

The second theoretical and practical consequence concerns the legal recognition of algorithms. Until now we set out to define databases of objects, cadastral layers, etc. But from now on, in addition to all the existing or future databases we will also be storing and archiving algorithms. These will now require official certification because they will form the basis of the reconstitution of datasets and data. Official objects will be structured on the basis of visual reconnaissance surveys, but they will still need to be legally secured.

The algorithm base has to become legal and needs to be controlled through, for example, measurement.



(7) Cadastral surveying data form the basis of numerous business sectors, as well as use within the administration and in daily life. Real estate ownership, for example, is recorded in the land register on the basis of such data. If an architecture office is planning to construct or manage a building, it needs precise data relating to the boundaries of the property, the location of pipes and channels beneath the ground, and countless other details. Specialists find the necessary details in the land register and in a variety of plans, ranging from the local land-use plan to zoning plans and utility asset maps. All these details are based on cadastral surveying data. With the latest technology, this can be done by measuring the surface accurately and reliably and, for example, determining the boundaries of plots of land, the type of ground cover and the altitude of the site.

Numerous political decisions directly depend on official data

These official data are collected with great care and are constantly updated. In some countries, particularly in Europe, laws and directives require organisations to publish public data in digital form.

The Objects of the Cadastres

4

The cadastral representation of objects provides layered spatial and property or land value based on objects or categories of objects geo-localised information about a classification by type of object.

The representation of objects is produced using data relating to the allocation of the land, to roads and distribution networks, and to individual buildings and structures.

This strict definition is based on the constraint of the legal security of the cadastre, and on its uniqueness, its completeness and its accuracy.

Today, the national cadastre functions in accordance with the principle of subsidiarity and is thus above all the responsibility of the cantons. However, during the past few decades a certain number of new categories have come into being at the federal level, and as a consequence the cantons have had to make adjustments, for example for issues relating to polluted sites, land use or zones exposed to noise (according to the cadastre on public-law restrictions to land ownership).

The legal basis has been an essential factor in the historic development of the existing cadastres to date, based on surveys and entries in the land register. But increasingly, and in the wake of digital technology and the political call for professional land management, new categories have evolved and thus given rise to new

levels of representation.

While technological and political pressures have led to the rapid development of the cadastre in the past two decades, particularly following the advent of the Internet in 1993 (i.e. little more than 20 years ago), we have to anticipate that social changes, in particular the increased involvement of the public (access to open data, apps and open source software), and social networks (e.g. participation in actions and activities such as Wikipedia, eBirds, Youtube), will give rise to a radical new approach, namely a society driven more by a legitimate than a legal impetus.

Explanations:

The legitimate often prevails over the legal

If legal bases were constitutional elements in democracies, especially in the West, the situation is quite different today. In fact it now appears that an action deemed “legitimate” can prevail over a national legal system. Examples of actions by non-governmental organisations such as Green-

peace recently demonstrated this in Russia. And this was also seen to be the case in Switzerland in connection with the blacklist of countries regarded by the OECD as “tax havens”. Although Switzerland’s position was based on sovereign, and thus legal fundamentals, the “legitimate” pressure exerted by some of the major OECD member states sufficed to cause Switzerland to quickly bend one of its most essential principles, namely the rule of law.

This differentiation between a position based on legal fundamentals and one based on “legitimate” actions is a constituting element of societies today, and especially of global governance. As more and more people become involved in social networks, they will continue to exert pressure in this sense, and if we consider the development of public opinion, transparency and the “politically correct” in society in the course of the past few decades, we can no longer have any doubt about this process of societal change.

As a consequence, new objects will appear in the cadastre. These will basically be of the following three types:

Firstly, objects defined on the one hand by the authorities, for example such as the basic accumulation of historical data (e.g. a chronology of the modifications of plots of land), and on the other hand by the public, for example such as data of a general nature which form a kind of

common property in light of what takes place in Wikipedia. We can envisage a representation with added objects, augmented reality, comments and additional histories. A kind of fifth dimension after 3D and 4D. This dimension still largely remains to be created, even if we can perceive its relevance in the outsourcing of data acquisition and the creation of new applications.

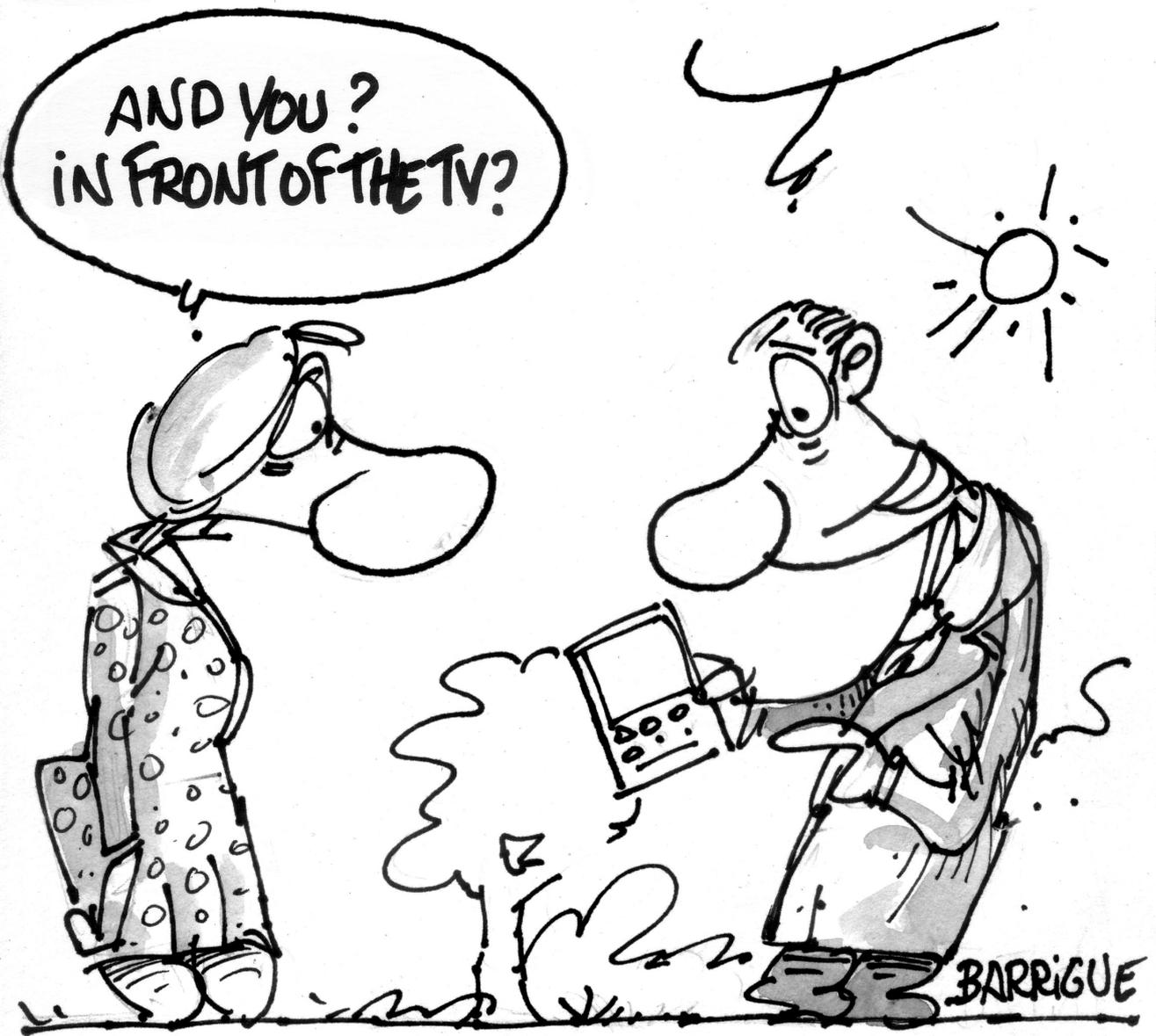
Secondly, we will see the formation of large sets of algorithms which will also have to be officially validated in one way or another. These algorithms will in particular represent the calculation in real time of positioning and measurements. The central authorities will sooner or later have to pay attention to them and regulate them.

And thirdly, virtual objects such as scenes of development in 3D, generated images of the past (historical reconstitution) or fictitious films representing objects on plots of land, or the divisions of the latter into development zones for virtual realities in various areas such as, for example, tourism or land-use planning, will increase in number.

These three paradigm shifts will give rise to changes in legislation, as well as changes in professional practices with new divisions of tasks, both among institutions and between the public and private sectors.

ON MY SMARTPHONE,
I CAN VERY NICELY VISUALIZE
YOUR POSITION IN OUR NEW HOME...
YOU'RE IN FRONT OF THE SINK
DOING DISHES!

AND YOU?
IN FRONT OF THE TV?



Dimensions, Big Data and Data Mining

In order to gain an understanding of the evolution of the cadastre, it is necessary to consider the question of the different dimensions and objects that are involved.

When representation was planar, we were dealing with a world in which objects were described in two dimensions (i.e. in 2D). Maps and plans were sufficient. But for cartographers of the nineteenth century this was no longer adequate, and this is why representation, still in 2D, of contours was invented, which gave the illusion of 3D. The representation of pipes and conduits beneath the ground, and of the height of buildings, slope of roofs, etc., led to the creation of what we now call 3D within geographic information systems. But modifications, and above all their preservation together with their still legible notes on old plans and maps despite the fact that they had been partly erased, gave rise to the illusion of historical development. Today, with the aid of digital storage of data it is – and will remain – easier to obtain a history of modifications of the cadastral system and thus of the recorded objects. In areas such as tourism and land-use planning, as well as regional economic development, there are also calls for data to be attached or linked historically to buildings and land. Temporal (4D) data of this type are not currently regarded as an integral part of the cadastral system, and in the future they should be incorporated, including at the legislative level.

There is one more dimension that also needs to be addressed if we want to take account of the time variable and social networks, namely the “dynamic social dimension” of such a cadastre of the future.

Towards a new dynamic dimension of the cadastre

This concerns the effects arising from a history of modifications (4D) with the open behaviour of the population, companies and public authorities. If we transform an element or an object, this leads to direct or indirect impacts on other elements. For example, those that are affected for reasons of proximity or functionality (e.g. the photovoltaic capacity of the roofs of an entire town or city), but also at the historical level, with administrative or legal procedures relating to modifications of land. This dynamic vision should be introduced, given that today the future of land use is being determined in increasingly complex procedures.

It is clear that, with such a notion of a “dynamic social dimension”, things are going to change. One important aspect of this dynamic side of the

cadastre is the management of what we refer to as “big data”, i.e. very large databases. The huge volumes of data stored at the various levels (i.e. municipal, cantonal, federal and private) in the Swiss cadastre have only fairly recently been linked via the platform of the Internet. It is now possible to use this platform by entering search requests for specific data, with the aid of search engines (which yield a variety of results) or by applying data mining algorithms. The latter form of use of large databases is clearly attractive since the results of this “mining” of data also

yield information relating to tendencies and trends. Data mining anticipates what is happening and developing. We try to anticipate what is going to happen and find out what is going to change. Quite a program! But the evolution is clear. Originally we were able to find a specific item by entering a simple request, then we could obtain a variety of results using a search engine. In the future we will be able to discover the reality of present and future changes thanks to data mining.

Address Component, Algorithms, Cloud and Internet of Things 9

In the vision of dynamic smart interfaces, it is quite simply the real world we are going to utilise. The land will become the map, so to speak – all the maps, including the cadastre.

Smart devices, whether smart phones, tablets, Google Glass devices, video cameras, drones, etc., each act as an intelligent system equipped with geo-localisation, visualisation, simulation and anticipation functions. They will act in the real world with algorithms and huge databases that can be accessed via a kind of Internet Cloud. With them it will be possible to reproduce any representation of reality at any time and anywhere. This means of viewing items is in fact already reality today, if we consider trials with Google Glass or in the field of tourism, for example (8).

What is lacking is an understanding of the implications for the cadastral system. Let us imagine how this system may look like in twenty years from now: we can assume that, in addition to surface, line and point objects, there will also be virtual and algorithmic objects. Together these will form the basis of a new cadastral system. Each of these objects will belong to a new nomenclature recordable in URI format so that it can be directly accessed via the Internet. This will resemble a huge virtual and real library in which each object will have an address in the same way as each book has its own form of identification (ISBN).

Development in the direction of objects that are addressable, intelligent and free of their functional activities

This new aspect of addressing objects is crucial for a better understanding of how the system will evolve, because each object will become completely autonomous in its processing. There will be a clear distinction between open and closed, accessible and private.

In short, objects will have a clearly defined and registered owner or developer in the land register or cadastre, or later in a new system entity that will group the former segments together.

But for now, let us take a look at this system based on two key elements.

On the one hand there is ownership, and on the other there is representation. These are like the two sides of the same coin. Ownership remains individual, while representation moves into common property. As these objects will possibly be able to receive an IP address, they will be addressable anywhere and at any time. They can therefore be manipulated with the aid of algorithms, which themselves form an integral part of the system of available objects. From that point onwards, reality and representation will be separated from their former role. So far, reality was represented on a map, for example, but in the future reality (the land) will offer all possible representations. In a manner of speaking, reality will be represented according to how we look at it.

How will this be possible?

Quite simply, once a smart system has geo-located a real object, it will refer to the algorithms linked to the position, the orientation and the visual aspect, in order to subsequently be able to provide an “augmented” reality of all details, data, levels, virtual models, possible algorithmic interpretations concerning the same chosen location, the current situation or the precise orientation. Thus all data will be available in a contextual manner, including those data that are in social networks or location-based proximity networks such as FourSquare “friends” today. This radical change of perspectives will force us to adapt our point of view and thus our approach to the question of the evolution of the cadastre. Because we are in a real situation, we are navigating in a dynamic environment.

This means that the cadastral system is going to evolve in real time, not as it currently does with several tens of thousands of modifications a year, but rather at the rate of several million modifications a day. Virtual objects providing social/territorial data will evolve at a rapid pace. Representations of land that have for so long been regarded as immutable are going to change enormously and become permanently transformed before our eyes. Under the influence of this new vision, the cadastre itself will also become highly dynamic. This is why the system of addressing cadastral objects is going to shift towards the world of Internet objects where each will have the possibility of having its own IP address and thus an associated electronic chip.

Initially, all cadastral objects will be provided with a uniform resource identifier (URI) so that they can be addressed virtually; later they will be given physical (IP) addresses so that it will be possible to address smart systems associated with the objects themselves.

A dynamic system that projects us into a 4D cadastre

The important thing to remember regarding the future development is that we are moving towards a cadastre of smart, real or virtual objects, of private or common property, within a societal dynamism and with more or less permanent modifications.

Surveyors (in the future acting as brokers of the transition process) will be the architects of this transformation, and will thus have to evolve towards a transformational profession.

As far as the objects forming the present-day cadastre are concerned, it can already be stated that in the future they will mostly be linked with each other via the Internet platform. This is only possible when an infinite number of IP

addresses is available. But the future reality will in fact take the form of a platform where objects will communicate with one another and interact with one another. This will be very useful in the framework of urban development, construction of new roads, etc. It will be possible to provisionally deposit measurement instruments in order to simulate situations such as rainfall, landslides or exposure to sunlight.

(8) Digital technology for leisure-time activities: one example that is causing quite a stir on the web is the use of digital maps of hiking and cycling trails. This is the most successful application of swisstopo, Switzerland's official cartography custodian. Downloading a map for an active hiking weekend in the Alps is the almost essential final activity before leaving work on Friday afternoon.

It should also be noted here that, because of poor coverage of the telephone network in the mountains, it is still necessary to take along paper maps, or at least to have remembered to download the required map (see above). But will there still be a need for the good old map in the future? Well, here it is important to know when the link between real and virtual has become convenient, fast and obligatory. Our world is neither virtual nor real: it is constantly confronted with both at the same time. It is this that demonstrates the power of the Internet: acting in the one means making changes in the other. Google understood this well before the rest of the world.

Towards a Dynamic Model

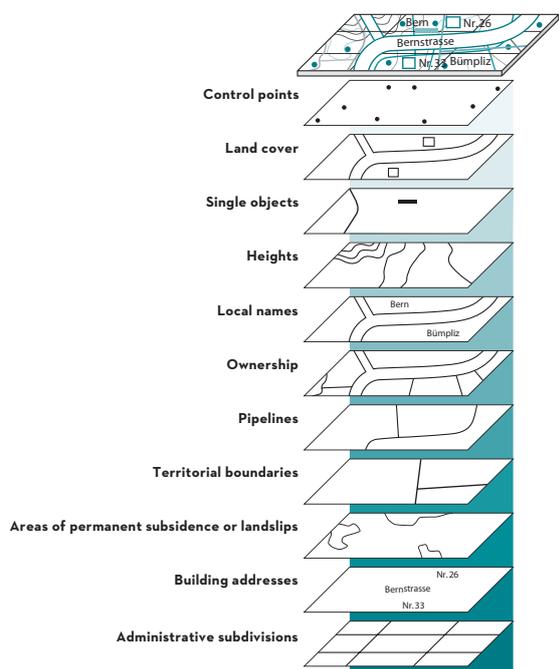
22

Moving towards a dynamic system that continues to provide representations by property ensures that the cadastral system can evolve without losing all the work that has been put into it to date.

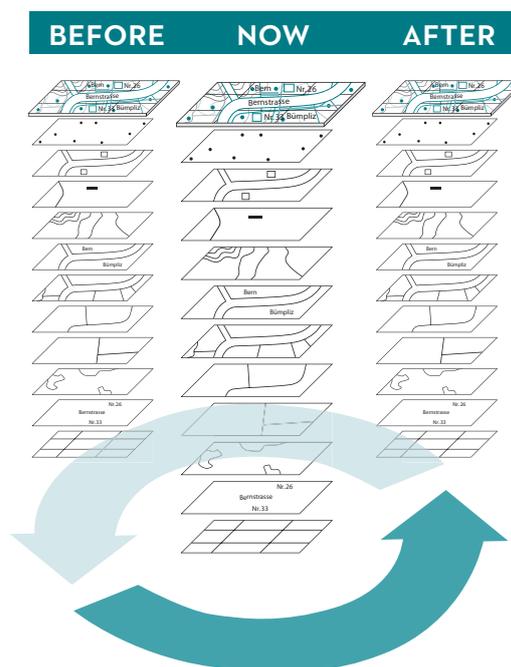
This dynamic system is essentially a series of depictions of the status of the cadastre at different times. In this way, a harmonious development for the future is permitted while the possibility is retained to produce virtual simulations and models.

Given the apparent simplicity of such a move towards a dynamic model, we should not overlook the difficulties associated with the management of distinct temporal statuses, particularly in terms of the volume of data that will rapidly accumulate. The processing of the data for carrying out searches or developing models needs to be done with particular care. We are certainly entering into the age of “very big data”.

STATIC VISION (2D-3D) BY LAYER



DYNAMIC VISION (4D) BY CAROUSEL



WE HAVE TO KEEP UP
WITH THE TIMES ...

I AM ALWAYS
CONNECTED!



24 Augmented Citizen

Citizens are going to participate to an ever increasing extent in the realization of representations in the future. Crowd-sourcing will herald a new era for cadastral professionals: the age of co-creation by the public.

In the previous chapters concerning the major changes taking place today, we have noted that there has been an increase in the role played by citizens (grouped into social networks) in the value-added chain. Thanks primarily to the Internet and so-called smart systems and devices, people now find themselves in a situation in which they can directly intervene in information and production systems. Blogs, feedback, applications like Mash-up, etc., enable them to contribute to databases, including geographic information systems, to such an extent that these have come to rely heavily on their input. Consider, for example, feedback on restaurants, hotels, travel, visits to museums, etc., in the tourism sector, or reviews of music and books, or comments on numerous other products. Everything, or almost everything, can now be reviewed, commented on or ranked by anyone. The information about such items is significantly modified because it has acquired a subjective and more or less emotional dimension. This kind of contribution is unexpected for specialists working with “cold” objects like maps and cadastres! But we should not overlook the fact that maps like Dufour, Michelin or Google already included certain emotional components, for example reliefs (Dufour), stars (Michelin) and mash-ups (Google). The way forward has been

mapped out, and we are moving in the direction of integrated information systems: the objective and the subjective, the legal and legitimate, the real and the virtual. Through this integration we describe the core of our vision for which we have enhanced the dimensions, the objects and the involved players (or stakeholders).

Citizens as the nation's number one geomaticians!

One of the major challenges to be faced in the future concerns the integration of the public as stakeholders in the cadastral system. The solution will neither be obvious, nor easy. Initially the answer will be to prompt people to submit comments regarding, for example, footpaths by asking them to intervene prospectively to report identified dangers and problems and to give warnings so that their contribution can be clearly beneficial to others.

By choosing to submit comments to protect others, people can effectively participate in a positive manner in the progress of dynamic

social information systems in the cadastre. They can always be subsequently asked to report on errors in cadastral surveys before a more active phase of creation of virtual objects is initiated. The path that is taken would have to be both experimental and governed by a legal structure. This combination of experimentation and legal framework should facilitate the acquisition of sufficient know-how to permit progress towards a highly dynamic system.

It will undoubtedly be necessary to create a new advisory service for users at the level of the authorities responsible for the cadastral system in order to support the provision of information by citizens, similar to the Wikipedia model which introduced “recent change patrollers” to verify authenticity and validate the changes, and to identify any deliberate provision of misinformation and similar acts, and thus to assure the receipt of useful input and the efficient management of identified problems.

The new “Common Property” and Stakeholders

26

A new notion is emerging between private and public property, namely one that could be referred to as “common property” or “common asset”, which to a certain extent takes the form of shared knowledge, or public and open know-how.

This concerns neither private nor public property as such, and can be defined as common knowledge arising from the history of plots of land, the current characteristics they represent, or even their potential projection into the future (future of objects in urban planning, land-use management, etc.). For examples of the new notion of common property we can refer to various newspaper articles: Le Temps and NZZ have initiated a form of reporting of information that permits people to describe an iconic aspect of their location in 100 characters (mapyourtown.nzz.ch).

This new present-day reality and its future projection (and even its past) will combine to yield a certain degree of value-added to land.

A new “common asset” between private and public property

This is a common asset. Thanks to their shared history, current relevance and future role, these assets are essentially formed from data and

knowledge, and are going to become the central issue in the area of land surveying. This will involve knowledge relating to footpaths, Google Street View, City Wikis, as well as dedicated web sites such as Craigslist (San Francisco), eBird.org for birds, etc. Virtual visits to tourist destinations, but also knowledge of the past or present development of a particular city, district or street, will also refer to this concept of “common asset”, and will at the same time be tied to surveys of the different levels defined by geomatics, cadastre, geography (economics and sociology), geology (earth sciences), etc.

This information will become a knowledge base that will read, describe and interpret land in a manner that is far removed from the brutal conquests of a not-so-distant era. This could be one of the main focuses of the cadastral system of the future.

For surveying, cadastre and land register professionals, the redefinition of the concept of “common property” as neither private nor public, but somewhere in between, poses the following questions:

- Firstly, who has the right to assess and validate property if it becomes a common asset?
- Secondly, who is going to manage the associated database?
- And thirdly, which appeal bodies will be created?

If, for example, an asset with a historical background is attached to an object in the cadastre, it becomes an integral part of the latter and it will be necessary to be able to validate this move and settle any resulting disputes that may arise. The method adopted by Wikipedia's recent change patrollers represents one potential solution, but there are many others to be considered.

While the various professions have been well defined until now, we have nonetheless become aware that, with the advent of information technology and the Internet, the profession of "geomatician" – a kind of hybrid combining the professions of surveyor and IT specialist with a portion of geographer, who specialises

in the management of geographic information systems – has come into being. But now, the advent of big data, open source software, data mining, cloud, etc., is going to give rise to other new professions. But that is not all: it is becoming increasingly apparent that there is another difficulty that will have to be overcome, namely that of dealing successfully with a broad, or even a very broad vision or approach. We could even speak of a kind of "cadastre@large". This new concept indicates that instead of favouring a functional approach by defining the topics to be processed, we will move in the direction of a vision-at-large on the part of all stakeholders, in other words favouring "multi-stakeholders" rather than global thematisation. This means that the views and actions of stakeholders will be more important than a global solution or the range of specific solutions for specific processes. This is all apparently thanks to the increased involvement of the public in the various processes. We have no choice but to incorporate them, because in a direct democracy we enter into a process of resolution of problems, not a solution entirely imposed by professionals.

I WANNA BE
IN THE MIRROR!

ALREADY
TAKEN !!!



BARRIGUE

Tomorrow's Applications

29

With intelligent devices such as smart phones, tablets, video cameras, drones, etc., we can envisage a broad variety of potential new applications for the cadastre of the future.

Potential applications - a selection :

- “On the spot” visualisation of cadastral objects in superimposed “real” form, such as plots of land, specific zones (land use areas, zones exposed to noise, etc.), underground utilities (pipelines, channels, etc.).
- “On the spot” visualisation of the land register, with names of owners, plots of land, restrictions and other details.
- “On the spot and real time” visualisation of potential modifications, simulation of land changes, templates (elevation of buildings), roads and footpaths, etc.
- “On the spot” visualisation of supplementary data, e.g. historical information, comments and input from the public, as is already the case for footpaths (as noted above).
- “On the spot and real time” visualisation of simulations, e.g. projects for new buildings, with the depiction taking account of necessary modifications at the cadastral level (changes to plots of land, reallocations, implications regarding noise, etc.).
- “On the spot” visualisation of new geo-reconnaissance applications, including recognition of landscapes, names, natural areas (e.g. mountain peaks), historic sites (battle grounds, dwellings, famous figures), recent occurrences (avalanches, accidents, flooding, natural disasters, etc.).
- Possibility to submit - in real-time at a geo-localised and visually accessible place - comments and information, even concerning such matters as changes in Michelin Guide stars or “Likes” on Facebook.
- Possibility to refer to calculation and measurement algorithms on the display for different forms of electronic systems, including personal drones.
- Possibility for citizens themselves to change or develop algorithms to meet new requirements, referring to platforms of algorithms as future creative “robots”.
- Possibility to refer to simulation games on the ground (future role games).

- Activation in real time of cadastral objects provided with intelligence (smart chips) in the world of Internet objects.
- “On the spot and real time” activation of objects connected to the Internet while passing through a smart system, e.g. during a walk along a footpath or during a visit to a tourist destination, in order to carry out exchanges of data or make direct payments.

Apps will be the basis of all land representations, including those in the cadastre

We shall stop our listing of potential new applications there, because the number appears to be infinite. When new products are introduced, especially new technologies, it is only the limits of the collective intelligence that can determine the development potential of new applications. It is clear that placing the datasets of cadastral systems at the disposal of the public (open data) authorises companies to develop various apps that will lead to potential developments described above. It is certainly the private sector which will develop vast numbers of such applications, even if some will originate from the public sector. But it is above all the certification and validation of data and algorithms that will be the principal task of the relevant authorities in the future.

Conclusions and Discussion

The recognition of plots of land has always led to the desire to mark them. Landmarks and fixed points of reference have made it possible to measure them, and it could perhaps be stated that man is constituted of the territory suited to his size.

The United Nations, for example, has carried out cadastral activities. Today, in a kind of metaphorical reversal, it is the land that has taken the upper hand and determines our activities. It is now becoming the map, so to speak. By looking at the landscape with the aid of mobile and intelligent devices such as smart phones, tablets, Google Glass or drones, we are able to obtain images of augmented reality. Think, for example, of the images received in real time by pilots of jet fighters and superimposed on their communication equipment, or the video images they require in order to accomplish their dangerous mission.

This virtuality that was for many years used solely for special effects on the big screen has meanwhile become a reality, and will undoubtedly enjoy increased use in the future, whether for activities via webcams or via applications for smart devices. So how has this technology, which was already in use by armed forces in the 1990s, come so far?

To answer this question we can cite three key elements:

- Firstly, the Internet has provided a common platform and simplified communication between systems that were previously incompatible.
- Secondly, the introduction of geo-localisation via global navigation satellite systems means that any location can be viewed in real time and at any time. The public has been able to use this technology thanks, for example, to the development of navigation systems for use in motor vehicles.
- And thirdly, visual recognition has made possible the remote identification of, for example, the names of mountains, sites and monuments.

The combination of these systems has made it possible to depict more or less complex data-sets and images on screen. Thanks to the utilisation of large-scale databases (or big data), smart devices have developed rapidly, and will continue to do so. The visions outlined in this discussion paper are thus very realistic. So it is not the question of technology that will be the focus of future discussions at the political level, but rather the social choices that will be presented to us.

32 This discussion was mainly initiated around the issues relating to open data and open source software. While we can already feel the good intentions of public administrations and politicians to use the huge databases for the benefit of everyone, the debate has taken a drastic new turn with the capacities of data mining and certain algorithms, and above all the use to which they have been put, in particular in the USA by the National Security Agency to spy on certain people and organisations. The discussion will clearly be clouded by doubts regarding the non-private use of personal data until a technical or legal solution is found for assuring better protection of the private sphere. This is a major challenge, because unless the problem can be satisfactorily resolved, there will always remain a great deal of suspicion regarding the intentions of governments and their leaders.

The other main aspect of the ongoing discussion concerns the question of how to open up “big data” to the public, and not only to companies. The idea based on the model of Wikipedia would be to offer virtual communities (social networks) the possibility of accessing these data without restriction and free of charge.

There – now we’ve said it: free of charge. The introduction of the Internet initiated the concept of access to information without charge, and this led to the often comprehensive modification of business models and activities.

So how can we incorporate the opening up process without harming the private sphere at the same time (a question that is illustrated by the discussion concerning Facebook)? And how can

we retain the concept of access without charge without harming the business sector? These are social issues that the current debate is only now beginning to address.

Land will be entirely and continually “in motion” as a result of informational change

As far as this document regarding the future of the cadastre is concerned, there are several key issues to be discussed:

Firstly, the growing importance of the “legitimate” versus the “legal”. Here we can interpret the phenomenon as a confrontation between a priori and a posteriori legislation. Code versus jurisprudence. To a certain extent it is the shift from a continental (a priori) law towards the Anglo-Saxon (a posteriori) world that we have been witnessing in the last two decades in Switzerland. At present the debate is still very emotional, but it will have to calm down sooner or later.

Secondly, there is the question of the relevance of introducing new objects into cadastral systems. Following the introduction of 3D, we are now witnessing the emergence of 4D with the history of modifications. But until this possibility becomes openly desired, there is no reason to accept objects with more information or detail such as zone management plans because models, estimates, the virtual, etc.,

are bound to follow.

Thirdly there is the question of the public as stakeholder, as consumer/player and co-creator of future information systems. Crowdsourcing appears to be invading the territory of the Internet and it is conceivable that it could affect everything, including matters reserved for public administrations. In Switzerland it is therefore essential to make preparations for this development, even if the debate has barely commenced.

And finally, there is the central question of ownership, the private/public aspect and the new concept of the “common asset”. This is still in its infancy to the extent to which, in our society, it initially concerns the issue of transparency. But if we can see the names of the owners of all plots of land throughout the country on our smart phone, it is difficult to imagine how the question of protection of the private sphere can be addressed. The question of transparency and privacy has not yet been resolved at the social and political levels.

In this discussion paper we have considered some of the issues which will be discussed in the future and will concern society as a whole. But we are well aware that, for the involved professionals, another matter appears to be just as urgent, namely the redistribution of tasks. In other words, who will be responsible for what in the future at the municipal, cantonal and federal levels, in the private and public sectors, and at the professional and private levels. This issue will form the subject matter of a separate discussion paper which we intend to prepare in the course of 2014 and present in 2015.

Our conclusion can perhaps be summed up by reversing Alfred Korzybski’s aphorism “The map is not the territory”:

“The territory is the map”.

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Beyond Limits

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