Cadastral maps as a basis for developing street maps: examples from Australia and Brunei

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Abstract

Cadastral maps can be used as an effective initial set of data for new street maps in particular, and any type of large scale map project in general. This is due to a) a high degree of currency and accuracy of the digital cadastral database (DCDB); b) DCDB's overall high level of reliability in terms of completeness; and c) the availability of DCDB to the public. It is within the context of these three notable features that the Australian and Bruneian experiences with DCDB are examined. The author's invaluable experience with developing street maps in these countries provided sufficient data for the study. It was found that in both countries, DCDB may be used for the development of street maps, but a high degree of caution must be exercised. The identified obstacles are concerned mainly with the spatial accuracy of DCDB, discrepancies between the 'cadastral situation' and the situation on the ground, poor land management practices and others. This contribution provides an ample framework supported by numerous examples to illustrate these problems. It also concludes with remarks regarding some features of DCDB with suggestions for their modification or inclusion into a DCDB.

Introduction

A street directory is a specific type of map, probably the most popular type among map users, especially those living in large cities or small towns frequented by casual visitors or tourists. While all the large cities in the world, with perhaps just a few exceptions, are well mapped and the mapping is kept up to date and accurate, smaller towns do not have such a high level of mapping services available. For whatever reason, it may be necessary to start a street directory project from scratch. Keeping in mind the copyright restrictions attached to existing maps, and taking into account the budget constraints, a map-maker may consider a cadastral map as a basic data source for his or her street directory. This is because a cadastral map has several useful features to suit this purpose. These include the spatial accuracy of a cadastral map, the large scale, the way it incorporates transportation casements (roads, railways, etc.) and the fact that they are in public domain and are kept up to date. However, there are also some problems with cadastral maps which must be mitigated using other available survey or cartographic methods such as a field check. These obstacles are discussed in this paper from the perspective of a mapmaker who, for almost twenty

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years, has been actively involved in the preparation of street directories from scratch, frequently using cadastral maps, in Australia, New Zealand and Brunei Darussalam.

The cartographic context of cadastral maps is discussed along with a few remarks of a more general nature regarding cadastral systems. It is hoped that these remarks will contribute to discussions on the shape of the future use of cadastral mapping over the next 20 years as we work towards Cadastre 2034.

Street Directory Maps

These types of maps are probably the most popular among map users. The recent huge increase in usage of street directory maps (but also smaller scale maps) has mainly been caused by the rapid development and affordable pricing of GPS-equipped mobile phones, personal assistance and car navigation devices. In this context, online services including GoogleEarth®, Google Maps® and Zumi should be mentioned. These devices enable their owners to participate in what one may call the 'spatial economy'. The spatial economy requires that participants are spatially aware in the sense that at any particular moment in time they know *where things are* and *how to reach them* in the shortest time. The things of interest to the participants are of myriad types, including things such as real estate property, cheap factory outlets and a good Thai restaurant. Although many things may be easily reached by online services, the location of the provider remains an important decision making factor. Figure 1 shows an example of an online facility by the Zumi company: http://www.zumi.pl/.

A huge and continuously growing readership of street maps (both analogue and digital) on one hand, and the increasing number of businesses embarking on the spatial economy (by increasing their presence online) is driving the need to update maps regularly to include new points of interest (POI). Additionally, the urban expansion of cities makes it even more necessary to frequently update street maps. Therefore, new editions of street directories in fast growing areas are published annually in many countries around the world.

While location information about POIs is relatively easily accessible through a wide range of business directories, business registration services and from the businesses themselves, data about changes to the spatial arrangement of land, including changes to land use, land cover, land

ownership, land zoning and transportation infrastructure, is not that easily accessible or available. The use of aerial or satellite imagery may be considered to be only a partial solution to the problem of sourcing spatial data, but even then there are some restrictions attached to these sources. An obvious one is that not everything can be seen from up above. This is because of the relatively low temporal resolution of aerial photography (in many countries there are 5 year lapses between subsequent aerial photo acquisitions), the rather high cost of satellite imagery and its limited availability because of persistent cloud cover. Some other limitations include the lack of street names, traffic restrictions, etc.

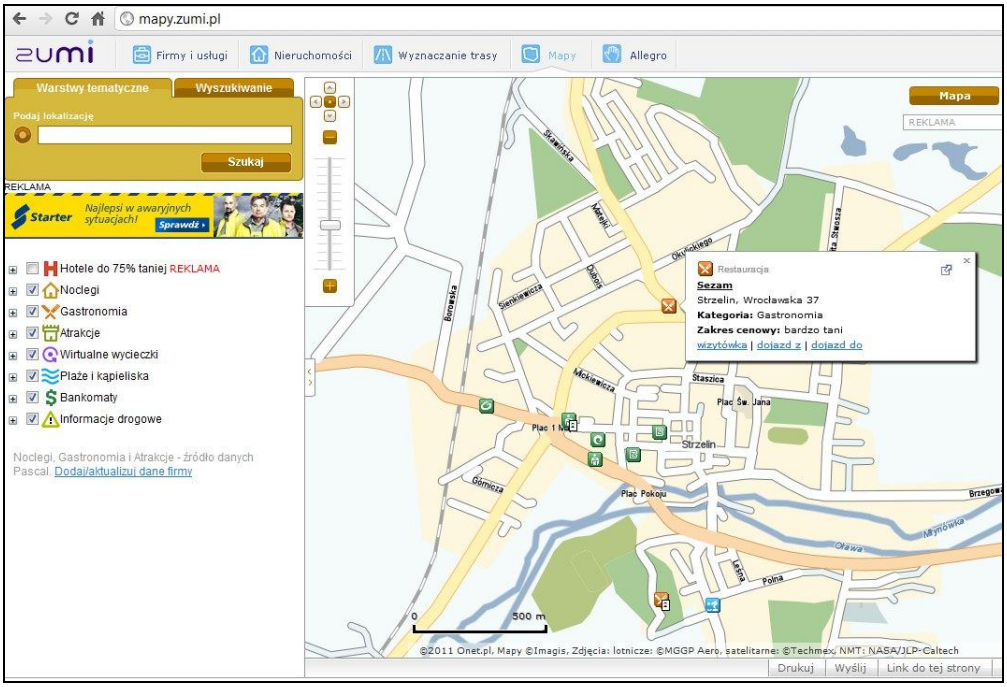

Figure 1. An example of an online service allowing users the access to the spatial component of commercial information.

Bearing in mind these difficulties in keeping street directories current, some time ago a project called OpenStreetMap (http://www.openstreetmap.org/) was initiated. The idea behind this project was to encourage volunteers to supply spatial data in order to develop or maintain a street directory type of map covering the whole globe. This new 'strategy' used to acquire the latest spatial data is known as crowd sourcing or volunteered geographical information (Goodchild 2007, 2008). Some authors even use the neologism 'neogeography' to describe the 'new' cartography which is said to be developing using this illusory and ubiquitous data source.

In the following sections two cadastral systems will be described. The major aim of this presentation is to demonstrate that the cadastral maps produced by a functional cadastral system are a reliable data source for basic spatial data for use in street map development and maintenance.

The Australian Cadastre System

The modern Australian cadastre is typical of most Common Law countries. In fact, the same system applies to all the countries which were in various forms connected (through a colonial or protectorate system) to the British Empire in the past. In the late 1980's and 1990's, all Australian states undertook an ambitious program to convert their cadastral records to digital records. The cadastral paper maps were digitised using the then available equipment and work force, who were not always well trained. These facts, along with the poor quality of the cadastral maps, meant that the resulting digital cadastral maps were of limited accuracy due to the survey instruments and methods used in the nineteenth century and early decades of the twentieth century. Also, in many cases the survey plans or subdivision plans, especially in the outback, were prepared using local reference systems which were usually ill-defined.

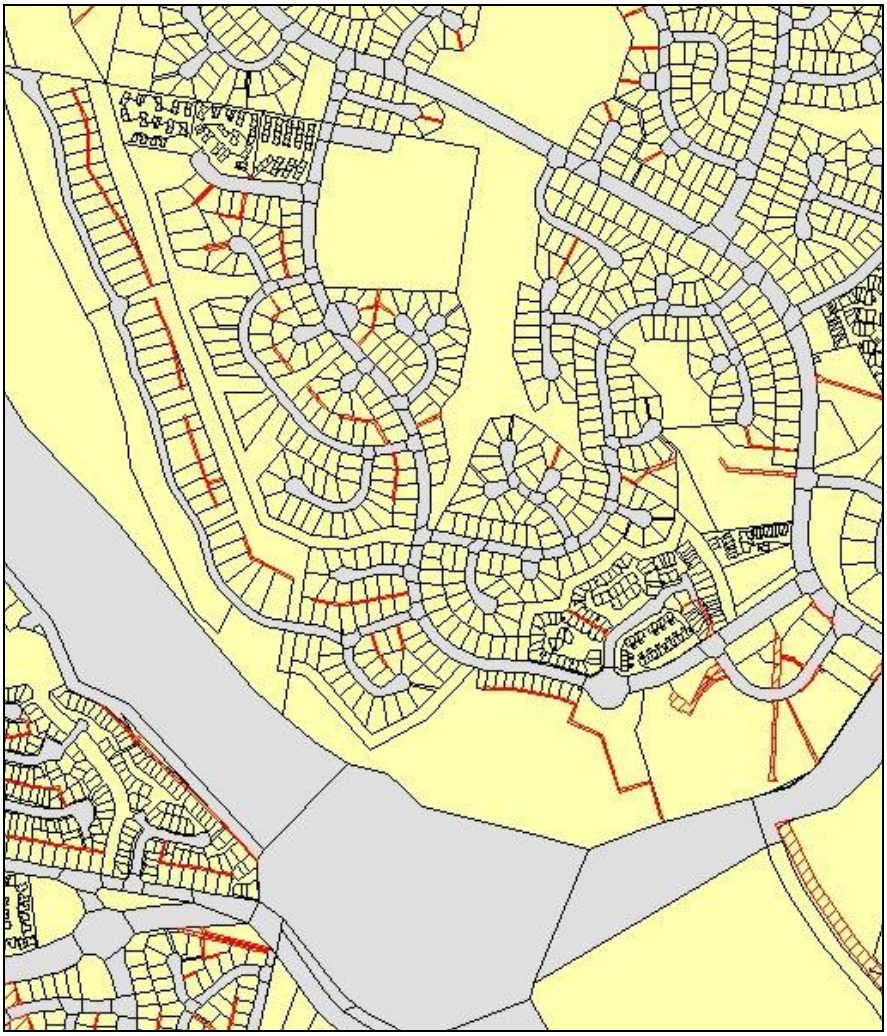

Figure 2. An example of a map generated from the Digital Cadastral Data Base map of Queensland, Australia. Parcel boundaries, transportation casements and easements are shown in this map.

Consequently, the positional accuracy of parcel boundaries for the vast majority of the state of Queensland is about 25-28 m. There are some areas, however, where this accuracy is as low as 200 m. In less than 1% of the state, such as in highly populated costal areas, the cadastre is at the sub-meter accuracy level. Cadastral re-surveying and adjustment programmes are ongoing, with local governments participating in the effort. Despite these shortcomings, the Digital Cadastral Data Base (DCDB) is an important resource for property information in Australia, used daily by both government and private sectors. As Figure 3 shows, there is free of charge online access to the DCDB.

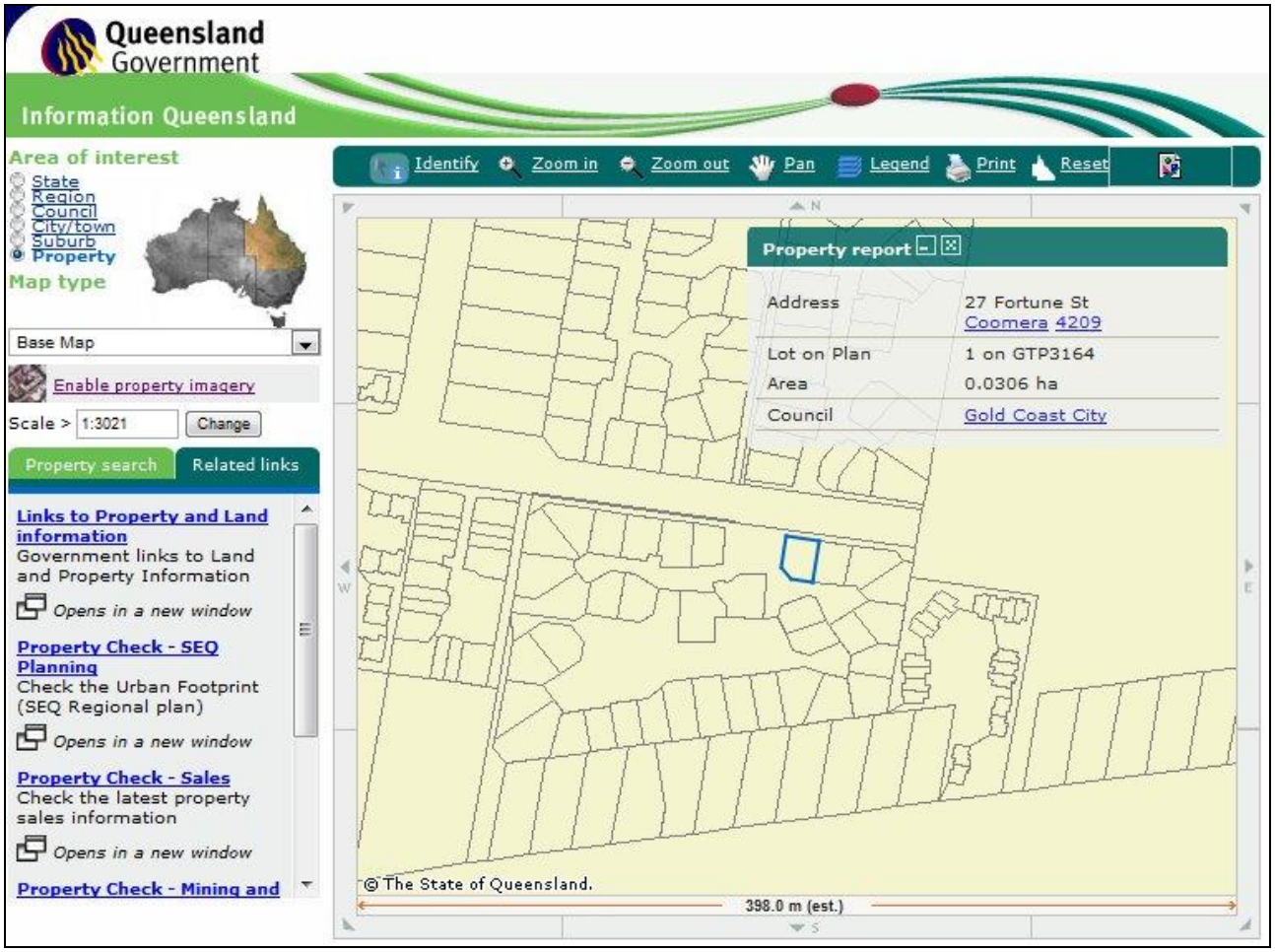

Figure 3. Online access to the Digital Cadastral Data Base of Queensland, Australia. As well as basic data about land parcels, some environmental and marketing data are also available online.

The DCDB can be updated on a fortnightly or monthly basis for a fee of about A$140.00. The DCDB data set comprises about 1.4 million land parcels and water bodies. The basic data provided for a parcel consists of a postal address of the parcel, area, the name of the local council and a unique ID known as the 'lot on plan'. The transportation corridors such as railways, roads etc. form separate parcels and street intersections also form distinct parcels. Using the road parcels, road centrelines can be automatically generated which would be a good starting point for a new street directory project. However, there are some complications to be overcome if one attempts to use the DCDB as the sole source of spatial data for a street directory.

The DCDB represents the legal status of the ground and not its physical status. Furthermore, the DCDB does not contain the 'as constructed' data which means that not every road in DCDB has actually been constructed. It is clear that placing such roads on a street directory would be misleading and must be avoided at all costs. A comprehensive field check of the cadastral roads is the only way to avoid this kind of predicament. Somehow less problematic is the limited spatial

accuracy of DCDB. This is because street directories are commonly prepared in a local coordinate system without reference to the other towns in a region. However, for a 'GPS friendly' street directory or a digital map for a navigation device this may be a problem because the GPS position would not match the correct position in the map. Another obstacle would be the lack of any environmental information about the parcel such as vegetation type, elevation, soil and land use. This extra data on each parcel would definitely help in the preparation not only of a street directory, but also any type of map.

Overall, the Australian DCDB is well suited to be a reliable and accurate enough source of spatial data for production of a street directory. Its value is continuously increasing because of the many programmes to improve the quality of the DCDB that have been put in place. This eventually should lead the DCDB to be an excellent spatial data product for many mapping purposes.

The Bruneian Cadastral System

The Bruneian cadastre is similar to the Australian cadastre in that it is based on Common Law. However there are quite substantial differences between the Bruneian and Australian cadastres. Perhaps the most important factor which has caused quite substantial diversification between the cadastres is the specific land ownership structure. In general, all the land in the country belongs to the government of Brunei. Only about 60,000 land parcels covering about 20% of the total area of the country (5,365 km^2) are temporarily occupied by individuals under the Temporary Occupation Licence (TOL) Scheme. The TOLs are issued for a limited, usually short period of time of around 15 years, for example. There are many restrictions imposed on the recipient of the TOL, including that it cannot be used as collateral against a bank loan and it cannot be subdivided or sold. The remaining 80% of the land in Brunei is not subdivided into any type of land parcels. Roads and any other natural features do not form separate parcels. Figure 4 shows a fragment of the cadastral map of Brunei Darussalam. It also shows the road centrelines which were captured using photointerpretation of aerial photography. Clearly, on many occasions, the road centrelines violate the parcel boundaries. It is suspected that this is due to the lack of coordination between relevant authorities responsible for the maintenance of the cadastral system and the physical assets in the country such as the road infrastructure. Also, there are parcels which appear to be access roads, but they are still part of a property (because roads do not form a parcel; they are white). This indicates that there are problems with the Bruneian cadastre.

Figure 4. A fragment of the cadastral map of Brunei Darussalam. Road centrelines derived from the GPS survey are also shown. In many instances the roads intersect land parcels which indicates lack of coordination between what is on the ground and the legal status of the land.

Naturally, the Survey Department along with the Department of Lands have been trying to resolve this issue, but this is a long-term and difficult process involving not only technical, but also political issues. The cadastral data are not easy obtainable from the custodians and those that are occasionally delivered to customers are stripped of all attributes including the postal addresses of land parcels. This makes it impossible to source the street names for a street directory from the database.

How to Enhance a Cadastre?

In many countries around the world the cadastre is mainly considered as a mechanism to provide the state guaranteed security for land ownership and the data are used to calculate the amount of land tax to impose. However, the reliability of the cadastre system in terms of its currency and completeness can be used as the foundation for storing additional environmental and other types of data attached as attributes to each parcel. The surveyors are often well trained to perform the

acquisition of these extra data for parcels. However, in general, there are no procedures set in place or requirements for them to do so. The surveyors are usually only required to survey boundaries and prepare survey plans and associated documentation (Williamson 1985).

Contemporary developments in cadastral mapping in certain countries tend to achieve the following objectives (Bennett et al. 2010):

- To survey accurate parcel boundary representation
- To increase the number and type of attributes stored against each parcel
- To create a multidimensional cadastre by inclusion of height and time dimensions
- To update and improve access to cadastral information via online or similar facilities
- To integrate the national cadastres at a regional level

Such a comprehensive cadastre would certainly improve the quality and reliability of many spatial services and allow street directories and other navigational devices to be kept up to date more easily.

Conclusions

A street directory is an important type of a map frequently used by many people. Therefore, the author of a street directory should strive to achieve the highest quality and accuracy of the directory. A key element required to achieve the above goal is easy access to a reliable data source. It was demonstrated that a cadastral map of Australia is already proving to be a relatively good source of material for production of a street directory. However, still some elements of the Australian DCDB need to be improved. Unfortunately, in the Brunei case, the cadastral map cannot be used as a reliable source of data at the moment. It is hoped that the relevant authorities in the country improve the existing situation in this area soon.

As a vision for the future one may propose that a street directory for every country of the world will be a customised version of the future Digital Cadastral Data Base.

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