THE APPLICATION OF ARCGIS CADASTRAL FABRIC MODEL FOR CADASTRAL DATABASE MANAGEMENT

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ABSTRACT

Land administration systems are evolving towards an integrated land management paradigm designed to support sustainable development. Land administration generally delivers four functionalities: land mapping, land registration, land valuation and land development, each with specific data elements, with the cadastral data model at the core. Cadastral data modelling potentially plays a key role in both data and business management in modern land administration systems. However, some modifications to existing data models could potentially improve their capacity to deliver sustainability. The ArcGIS cadastral fabric is a dataset created in a geodatabase; it is used for managing cadastral land record information, and is implemented as part of an organization's land information system. This paper describes the data model of the cadastral fabric dataset and introduces the capabilities of ArcGIS cadastral fabric for land parcel management.

1. INTRODUCTION

Properties or parcels are the most basic "business elements" in a County or City. Every day, planners, assessors, public works, fire, police, elections officials, school districts, and many other county/city personnel need access to parcel maps and related information such as addresses, related permits, maps, documents, tax rate areas, voter precincts, relation to flood zones and other natural hazards, etc (Martínez and Ubaque, 2000).

Howerver, most city and county government have created a vast number of diverse geo-datasets, departmental GIS's, and Computer Aided Drafting and Design related maps using a variety of vendor products. Each is in isolation from the others. This made finding and using the correct information difficult and time consuming (Roux, 2004).

A cadastral fabric is a new type of dataset in the geodatabase used to represent and hold data for a continuous surface of connected parcels. The ArcGIS cadastral fabric model helps users manage land parcels using core ArcGIS capabilities. Using an open and flexible object-based data model, the land parcel data model accommodates a wide range of applications and parcel definitions. Thematic layers in the land parcel data model, such as parcel framework, ownership and taxation, and administrative areas, are mapped to the geodatabase structure. Several layers can combine to form a set of feature classes in a feature dataset.

The ArcGIS cadastral fabric model also implements topology as a flexible set of integrity rules that define the behavior of spatially related geographic features and feature classes. Users can model spatial relationships, such as adjacency, and manage the integrity of coincident geometry between feature classes such as coincident parcel boundaries and subdivision boundaries. The paper, therefore discusses the advantage of using cadastral fabric for land parcel management (Ian and Doan, 2009).

2. CADASTRAL DATABASE MANAGEMENT

The definition of a parcel varies according to the jurisdiction. For practical purposes, a parcel is a closed polygon on the surface of the Earth (United Nations 2004). Although the land parcel is identified as the building block of each land administration system, it might have originally been recorded by non-cadastral organisations. So far, cadastral data models relied on land parcels as their foundation. However, land parcels are a fallible organising tool, lacking sufficient flexibility to incorporate the increasing number and diversity of interests in land.

Traditional cadastral models are directed at the management of immovable property for taxation purposes or the transfer of property rights. The cadastral survey, which consists of determining property limits, constitutes the foundation of this cadastral model and is the primary mandate of the Surveying Department. "Cadastral Management" is therefore defined as the fundamental framework that facilitates effective integration of the survey and registry components of the property rights infrastructure (Martínez, *et al*., 2000). Cadastral information must be developed, realized, and maintained. Accurate mapping based on legal descriptions is necessary for cadastres, which detail the ownership information for land parcels or properties. On top of that, governments are pressed to improve information exchange between departments within and between agencies.

Cadastre managers and GIS professionals can use the ArcGIS parcel data model as a starting point for defining parcel information and for planning migration strategies from existing data designs to a geodatabase environment. The data model provides a quicker, less expensive solution to data migrations, the longest and costliest part of a GIS project. Decision makers can apply the model to integrate landownership information with other data. Land and GIS professionals can apply the definitions and structure of the model to establish consistent and representative parcel information for data distribution. The purpose of the ArcGIS parcel model is to describe parcel information to support local government and private sector decision making (Ian, 2010).

3. ARCGIS CADASTRAL FABRIC MODEL FOR CADASTRAL DATABASE MANAGEMENT

A cadastral fabric is a continuous surface of connected parcels. Parcel polygons are defined by a series of boundary lines that store recorded dimensions as attributes in the lines table. Parcel polygons are also linked to each other by connection lines, for example, connection lines across roads. Because each and every parcel is either linked or connected, a seamless network of connected parcel boundaries, or cadastral fabric, is formed. Parcel lines have endpoints, which are the parcel corners. Parcel corner points are common between adjacent parcel boundaries, establishing connectivity and maintaining topological integrity in the network. In the geodatabase, topology is the arrangement that defines how point, line, and polygon features share coincident geometry (Ian and Doan, 2009).

Spatial accuracy in the cadastral fabric is improved and maintained through adjustment by least squares. Control points are processed together with recorded dimensions to derive new, more accurate coordinates for parcel corners. Parcel corners locate parcels on the surface of the earth, resulting in an accurate coordinate-based cadastral system (Figure 1).

The cadastral fabric acts as a basemap for overlying feature classes. Feature classes such as building polygons and utility lines are constructed in relation to parcel boundaries. Standard feature classes using parcel boundaries as a basemap will fall out of alignment with an adjusting cadastral fabric. To bring standard features back into alignment with the cadastral fabric, Cadastral Editor captures coordinate shifts resulting from the least-squares adjustment and stores them as displacement vectors in the geodatabase. Displacement vectors are then applied to overlying features in a rubber sheeting process to bring them into alignment with the cadastral fabric. The result is GIS features that are aligned with an accurately coordinated cadastral fabric (ESRI Europe, 2005).

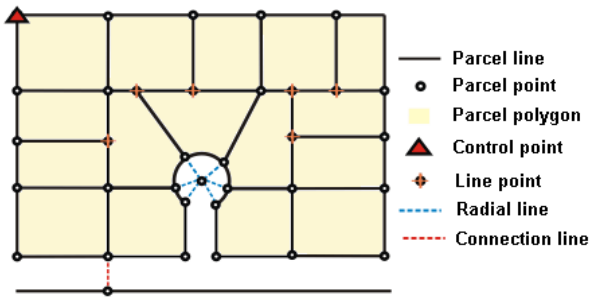

Figure 1. Cadastral fabric data model *(Source ESRI.com)*

A parcel in the cadastral fabric is composed of a series of individual lines that close to form a polygon (Figure 2). Each line has a from and a to point that are also the parcel corner points. Parcel points can have up to one line point and one control point. A parcel is always associated with one plan (record of survey).

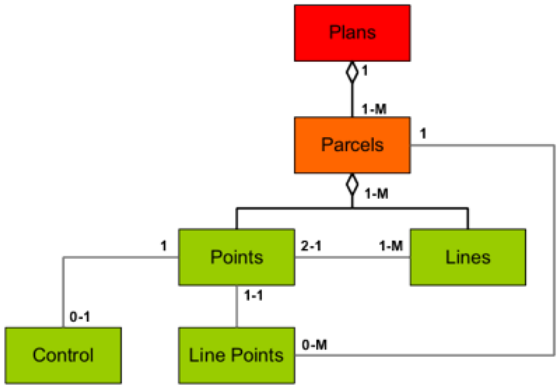

Figure 2. Cadastral fabric parcel data model *(Source ESRI.com)*

The workflows to build a cadastral database may consider a variety of data sources and also a variety of software options to generate the cadastral fabric in the geodatabase. Once that data and its cadastral intelligence is prepared, it is stored in the Geodatabase (Figure 3).

4. CASE STUDY

A cadastral database in Ward 1, Ho Chi Minh city, Vietnam was used as a case study. The purpose of the study was to create and manage a cadastral fabric in the geodatabase with the following steps:

- Creating a cadastral fabric from a cadastral data
- Adding surveyed points to improve cadastral fabric accuracy
- Using parcel construction tools in Cadastral Editor to update surveying data to Geodatabase
- Updating large surveying data to Geodatabase

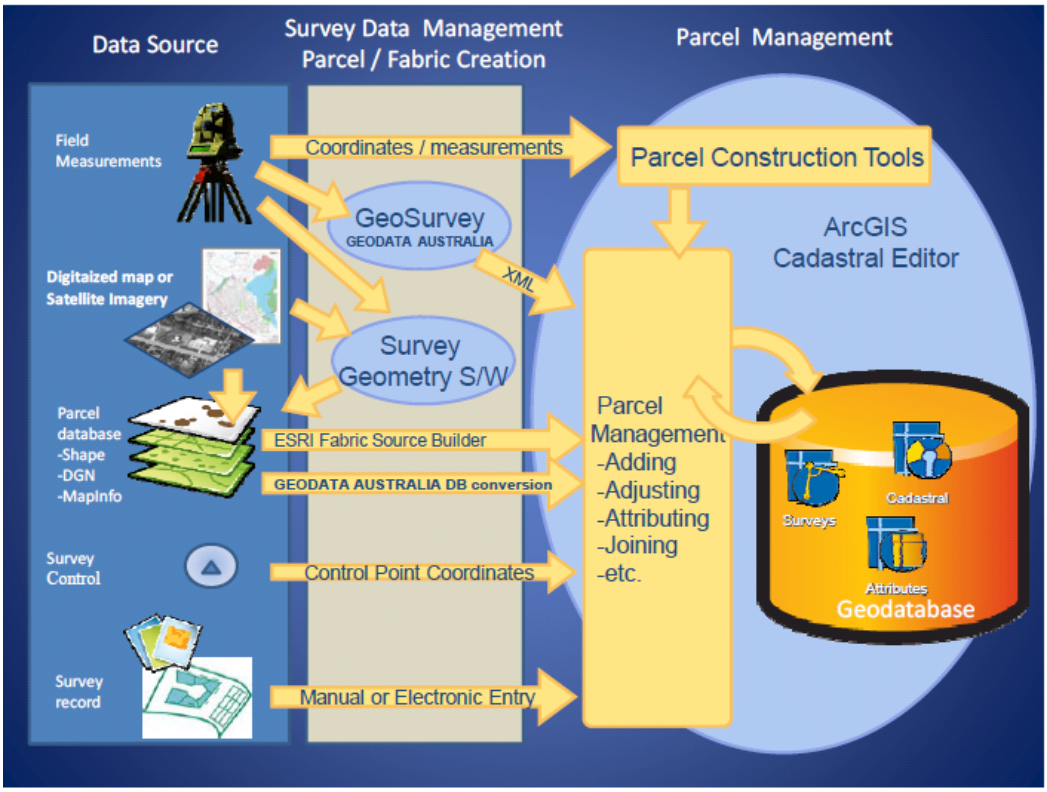

Figure 3. The Cadastral database workflows

Cadastral databases are created from various data sources. Figure 4 shows an existing cadastral database.

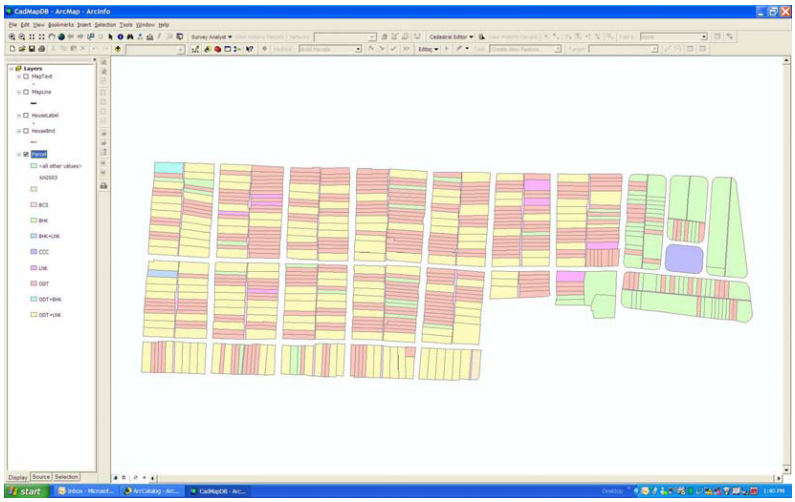

Figure 4. An existing parcel data in a file geodatabase

In Figure 5 the existing cadastral database has been converted to a fabric by loading the original parcel coordinates to provide measurements to define the parcels. Connections across roads have also been created to provide connections across the model for the adjustment to be proceed. Survey control points are needed for the adjustment so some of the parcel corners have been assigned as control points (Figure 7). The coordinates for those control points may be from the original coordinates of those parcel corners. This means that the new fabric would have the same spatial position as the original database. GPS coordinates may be used for those corners or any others in the model. By obtaining the acurate coordinates of those control points and running an adjustment on the model, the spatial position of the complete model will be very close to its actual position.

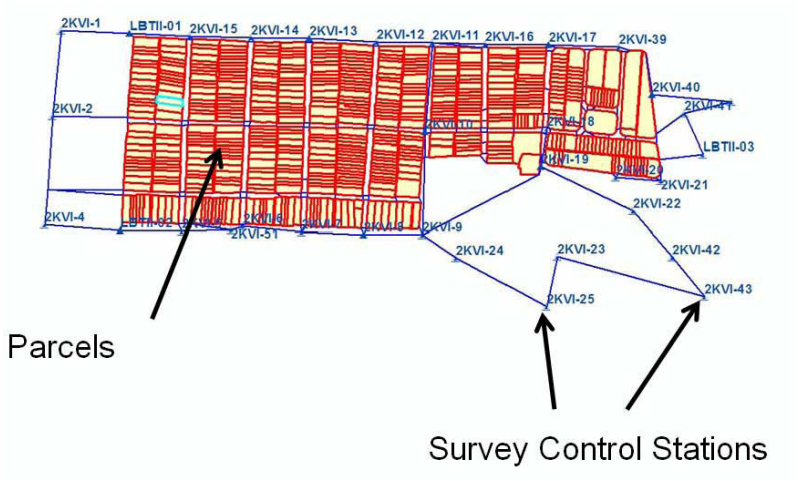

Figure 5. Cadastral fabric created from an existing database and control points.

It was approved that the original cadastral database had been created by survey data measured by a total station. Both the original database and the survey control points were then imported into the cadastral fabric. This allowed the survey control stations coordinates to be used as control points in the adjustment. Again for connectivity, survey connections were required to join those control points to the cadastral model. The benefit of having good connectivity within a model is that less survey control is required to get greater accuracy because the adjustment is using existing survey measurements. After this database is adjusted and added to the parent fabric (figure 5), updating database such as adding a new parcel, subdividing an existing parcel or combining parcels are done very efficiently (Figure 6).

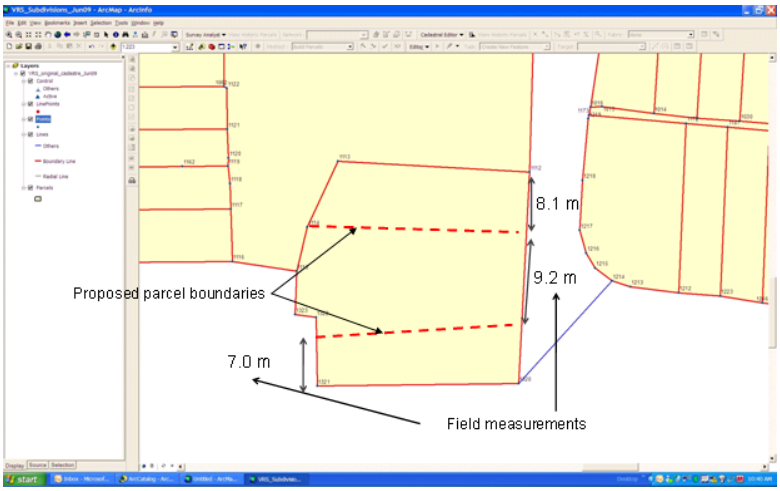

Figure 6. Subdividing an existing parcel from field tape measurements

(a) (b)

Figure7. Parcel adjustment in cadastral fabric: (a)before and (b) after adjustment

5. CONCLUSION

This paper describes cadastral database management modelling based on the ArcGIS cadastral data model. Cadastral databases are traditionally built from all the original measurement data, technology exists are able to create a cadastral fabric database by migrating cadastres from existing databases. This not only maintains the existing level of spatial quality but also provides a high level of efficiency to work with increasing cadastral accuracy. The cadastral databases, therefore, are able to benefit from a "survey accurate" cadastre, rather than working towards one and benefiting in the future. The more accurate a cadastral model is, the more effective it becomes, eventually providing accurate information for Land Administration System. Thus, a complete and accurate cadastre based on survey records should be the desired output for all jurisdictions. It should be maintained by the cadastral office and be a reliable foundation for all aspects of governance in a Land Administration System.

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