Creating a Survey Data Model and Cadastral Fabric for a future Land Administration System for Vietnam.

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Key words: cadastral modelling, survey data model, Vietnam

SUMMARY

As the Vietnam government looks to manage its economic and social future, land administration systems must incorporate its unique social doctrines which vary from many other countries that have historically followed a capitalistic doctrine that was built on a foundation of land ownership being defined, whether it was for state or private entities. The implementation of a strong, efficient spatial cadastral definition and management process is critical.

Vietnam requires consideration of a variety of existing spatial land representation of urban and rural land usage or tenure rights, ranging from hand drawn hard copy area maps through to accurately measured electronic property survey data models.

This paper outlines how the new and unique cadastral survey technology utilised by the ESRI Survey Analyst - Cadastral Editor process builds a 'cadastral fabric' model of survey and all other spatial data to represent the cadastre at a level of precision related directly to the source data.

Once the Cadastral Fabric is built, changes are efficiently made to the model and if more accurate field survey data is utilised in the upgrade, the spatial accuracy of the database is increased. It includes issues of data flexibility, accuracy and storing historical data.

The process manages the transition from historical measurement based title systems created for the measurement technologies of the past to a position based title system to deliver the efficiencies provided by GPS and other technologies through to the coordinated cadastres of the future.

The technical outcomes of the process also deliver the remarkable vision that was outlined many years ago within the FIG CADASTRE 2014 Document and the Cadastral Fabric database provides a working spatial foundation to supply all the intelligent data components for a future ISO Standard for the Vietnam government land administration.

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CONTENTS

1. THE NEW TECHNOLOGY COMPONENTS

1.1 The Survey Data Model

A model of survey and other measurement data adjusted to fit a geodetic reference system to build a spatially accurate 'cadastral fabric' database as the foundation for property title and asset administration.

1.2 The Cadastral Fabric

A continuous model of land objects (parcels) that provides the most accurate electronic representation of the legal cadastre as found on the ground using existing survey records and current field measurements.

The Survey Data Model and the adjustment process utilises recognised survey boundary definition rules to build the model and generate the cadastral database.

2. THE CADASTRAL SURVEY DATA FABRIC MODEL

2.1 Features

2.1.1 The process is able to import and utilise all types of measurement data:
- Accurate field survey data
- Other survey data – tape measurements etc
- GPS
- Geodetic survey control coordinates
- Electronic survey co-ordinate geometry data
- Existing cadastral GIS databases
- Historical village or regional hard copy cadastral area maps
- Existing survey/title records

2.1.2 The accuracy of the model is dependent on the spatial quality of data imported
- The fabric accuracy is directly related to the precision of the survey data entered
- If modern survey data is entered, checked and managed in a rigorous process, the expected accuracy urban areas would be 20mm

2.1.3 The database retains original survey or title document records and details of historical parcels:
- Stored in the Geodatabase
- Important for legal background

2.1.4 The cadastral attributes can be identified and added at data entry stage or imported via 'intelligent' XML cadastral modelling data structure to be available for metadata or linked to Land Administration Models. This would include but not limited to:
- Unique parcel/plan identifiers
- Date of survey
- Surveyor's name
- Jurisdictional identifiers

2.1.5 The Cadastral Editor process is a rigorous process with various levels of data checking.

2.1.6 If an existing accurate fabric model is available, the precision of the geometry of a new survey can be verified in the 'Parcel Joining' process.

2.1.7 The Least Squares Adjustment (LSA) process:

- benefits from as much survey measurement data as possible. This provides redundancies which increases the level of rigour in the outcome.
- is an iterative process
- will report on the increment of the adjustment
- will identify problems in existing survey information – i.e. Drafting errors, data entry errors.
- allows control points to be not held fixed, which allows the model to generate new coordinates to check against the true coordinates. This provides validity of the spatial precision of the survey geometry model.

2.1.8 The adjustment is optimal for less than 5000 parcels:

- The adjustment is managed 'in-house'.
- The boundary of a 'packet' of parcels is held fixed, the packet extracted, new data joined, the packet adjusted and returned to the fabric in the geodatabase.
- The affect on the database of a cadastral survey is usually localised, thus it is beneficial that the adjustment is able to manage that localised area easily.
- This allows the opportunity for provincial agencies to manage the cadastral fabric locally and provide a clean, accurate database back to regional or national agencies.

2.2 Outcomes

- Efficiency in cadastral database management.
- Once the cadastral fabric is created, the database is easily updated and spatially improved.
- The survey rigour in the process provides the highest level of accuracy from the survey data available with many checks to validate the data.
- In Australia, the NSW Land and Property Management Authority is increasing efficiency through the survey data model process with automated spatial checking of survey title plans as part of a proposed electronic lodgement process.

3. FIG Cadastre 2014 Data Model Vision

The **'ArcGIS Cadastre 2014 Data Model Vision' (Kaufmann)** document was released in 2004 and comments on the major components of the Cadastre 2014 document and the outcomes expected.

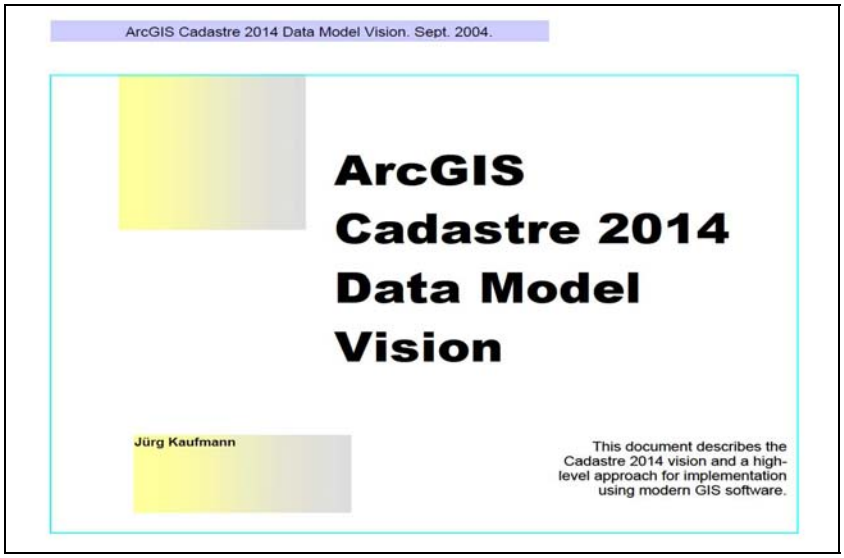

Diagram 1 – A report on the vision of Cadastre 2014 from 2004

Remarkably, the vision that was identified is now close to reality.

Technology has produced the tools that deliver the technical outcomes identified in the vision. The underlying component is accurate and efficient definition of objects to represent all the spatial components of a Land Administration System with an asset management system an integral part. This basic spatial component applies, irrespective of existing or current political, social or religious edicts.

Those technical outcomes are also facilitate the future governance issues also identified in the vision.

CADASTRE 2014 is a standard that is built on spatially defining real world property objects and then defining the many types of relationships between those objects and people.

THE 6 STATEMENTS OF CADASTRE 2014

3.1 Statement 1 – "Cadastre 2014 will show the complete legal situation of land."

- All public and private rights must be defined to avoid conflict – accuracy in the model is beneficial

"Consequences – A new thematic model is necessary. Surveyors must take into consideration public law."

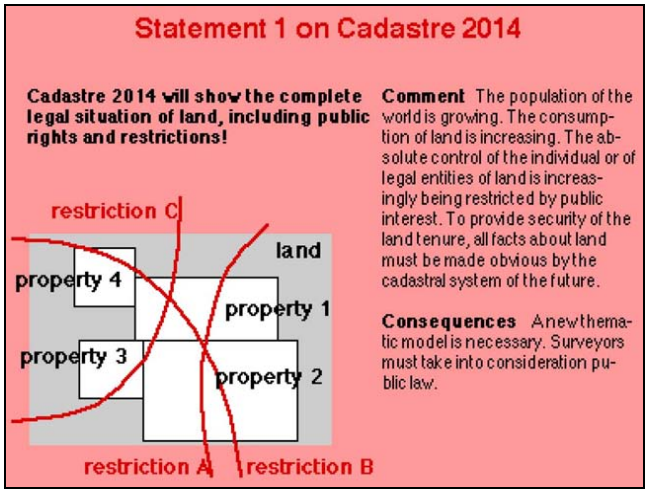

Diagram 2 – Documentation of the legal situation of land

3.2 Statement 2 – "The separation between 'maps' and 'registers' will be abolished."

- Electronic technology will change existing workflows between spatial representations and registers of interests."

"Consequences - The division of responsibilities between surveyor and solicitor in the domain of cadastre will be seriously changed."

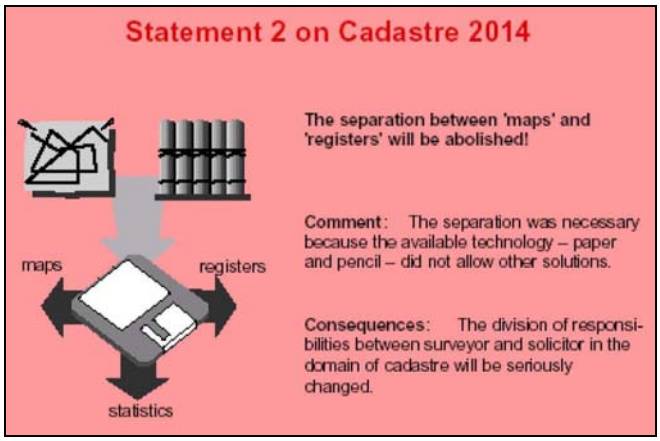

Diagram 3 – Cadastral maps and registers not separated

3.3 Statement 3 – The Cadastral mapping will be dead! Long live modelling

- In CADASTRE 2014 Cadastral Modelling will be the basic tool defining spatial objects.

"Consequences – In 2014 there will be no draftsman and cartographers in the domain of cadastre."

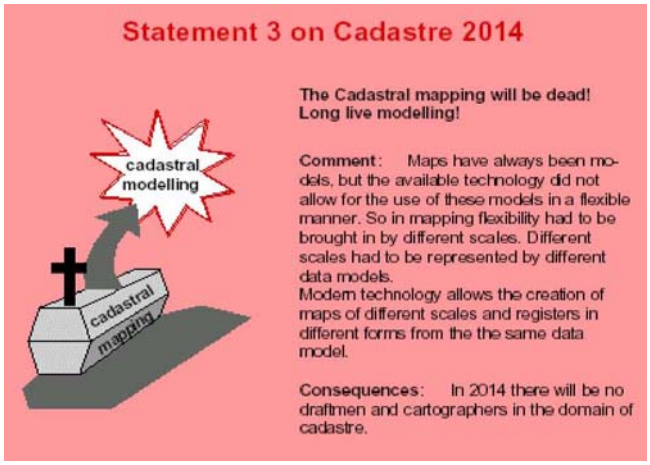

Diagram 4 – Cadastral modelling is most important

3.4 Statement 4 – 'Paper and pencil' – cadastre will have gone

- In CADASTRE 2014 all object and subject data will be stored electronically.

"**Consequences – The modern cadastre has to provide the basic data model. Surveyors all over the world must be able to think in models and to apply modern technology to handle such models.**"

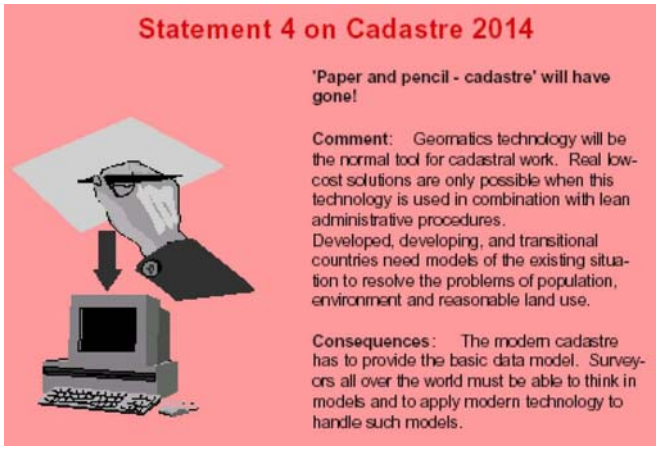

Diagram 5 – "Paper and Pencil" cadastre will have gone

3.5 Statement 5 – "Cadastre 2014 will be highly privatised! Public and private sector are working closely together!"

"Consequences – The private sector will gain in importance. The public sector will concentrate on supervision and control."

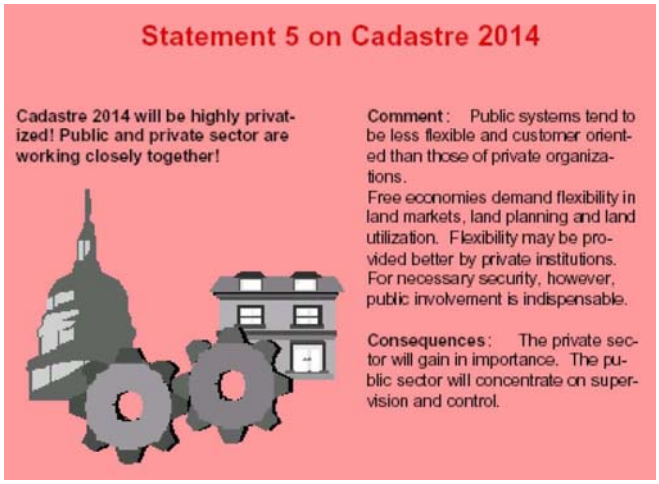

Diagram 6 – Public and private sector working closely together

3.6 Statement 6 – "Cadastre 2014 will be cost recovering!"

-The CADASTRE 2014 model must be economically sustainable.

"Consequences – Cost benefit analysis will be a very important aspect of cadastre reform and implementation. Surveyors will have to deal more with economic questions in future."

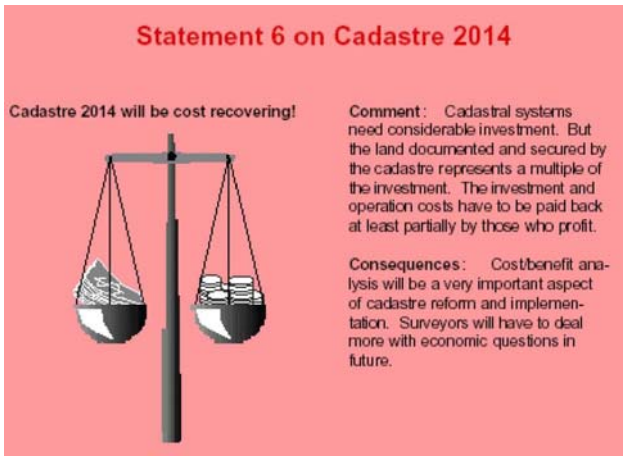

Diagram 7 – Cadastre 2014 will be cost recovering

The conclusion of the vision document notes that “The important work in CADASTRE 2014 is to identify legal land objects”.

The CADASTRE 2014 Land Administration Model provides a universal framework applicable to any jurisdiction, but just as important to the model is the supporting infrastructure.

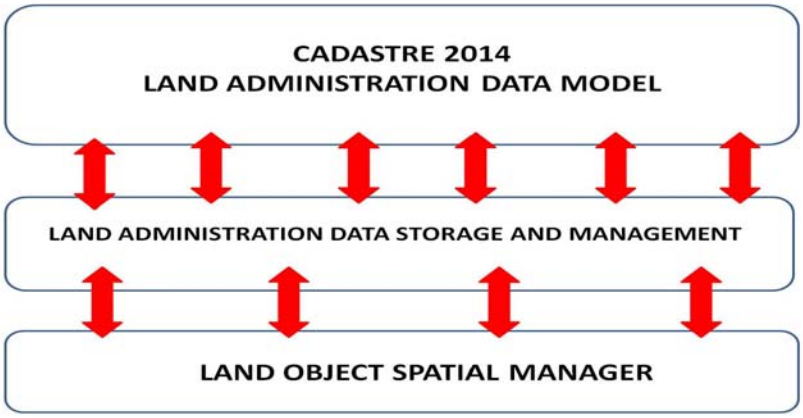

Diagram 8 – The supporting structure for Cadastre 2014

For the greatest efficiencies the database structure must incorporate a Land Object Spatial Manager that provides the highest precision for administration and operational purposes.

4. VIETNAM – CADASTRE 2014 Land Administration Data Model

4.1 Existing land administration issues

There are many levels of governance and other issues to consider in the creation of the Land Administration Model for Vietnam. They include but are not limited to:

- General Department for Land Administration
- Ministry of Construction
- State-owned land
- State-owned enterprise
- -1998 Land Law
- People Committees
- Land transfers
- -State land management
- Un-allotted State land,
- Socialist Economic Theory
- Land Brokers
- Urban & Rural land valuation
- Land Title Certification
- Foreign ownership rights
- Occupancy rights
- Usage rights
- commercial leases
- Tenure period

Most importantly, the spatial component of those issues must be defined as effectively as possible.

4.2 Spatial Land Administration Data Model Workflow.

The workflow Stages of spatial and cadastral data include:

4.2.1 Data Collection

- Digitised area maps
  Whilst these area maps may be spatially poor, the cadastral relationships are recognizable by all parties. Even an illiterate land user would recognise their parcel shape by the relationship to adjoining owners or physical features. These maps would contain the required cadastral intelligence and would be valuable to allow a functioning Land Administration System to operate immediately.
- Field survey data
  -Tape measurements
  -Total Station
  -GPS

4.2.2 Survey data interpretation, computations, parcel creation and fabric creation.

Survey data can be collected in various forms, however it must be presented in a database format, so that the spatial component, which is the focus of the surveyor can be combined with the cadastral intelligence required for a Land Administration System.

However cadastral data is represented, the essential elements are some form of spatial definition of a parcel shape (coordinates or measurements) and a unique parcel identifier. Those essential elements combined with a date or knowledge of the data accuracy is all that is required to begin working in a cadastral fabric environment in the geodatabase. Whatever other cadastral intelligence is available - plan number, areas, State, location, surveyor's name, date of survey etc, etc, can also be added for a more powerful database.

Some survey coordinate geometry software is capable of producing these intelligent database outcomes, otherwise the connection of spatial data and cadastral intelligence must be done through several software processes, which affects productivity.

4.2.3 Data Management and Storage

The Cadastral Editor process simplifies the electronic updating of large cadastral databases. It would be possible that a database for a locality or region can be updated and adjusted by the local operators. This has some advantage of allowing the people who collect and know the data to have input into the adjustment process to more easily recognise and overcome problems with the data. Once a section of the database is updated it can be forwarded as 'clean' data to the regional or national database register for efficient implementation.

The Geodatabase is the main storage component of the system. The benefits of Cadastral Editor operating inside the GEODATABASE include:

1. It holds the complete cadastral fabric database ranging from a small project to a State or Federal government database.
2. Allows only specified users access to amend the cadastral fabric.
3. Allows one person at a time to amend a specific 'packet' of cadastral data

4.2.4 Data usage in Land Administration Model

The effectiveness of the Land Administration Data Model relies on its ability to access and utilise the stored data and the linkages between that data.

The Vietnam Cadastral Database Spatial Workflow diagram.

The workflows must 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. (See Diagram 9)

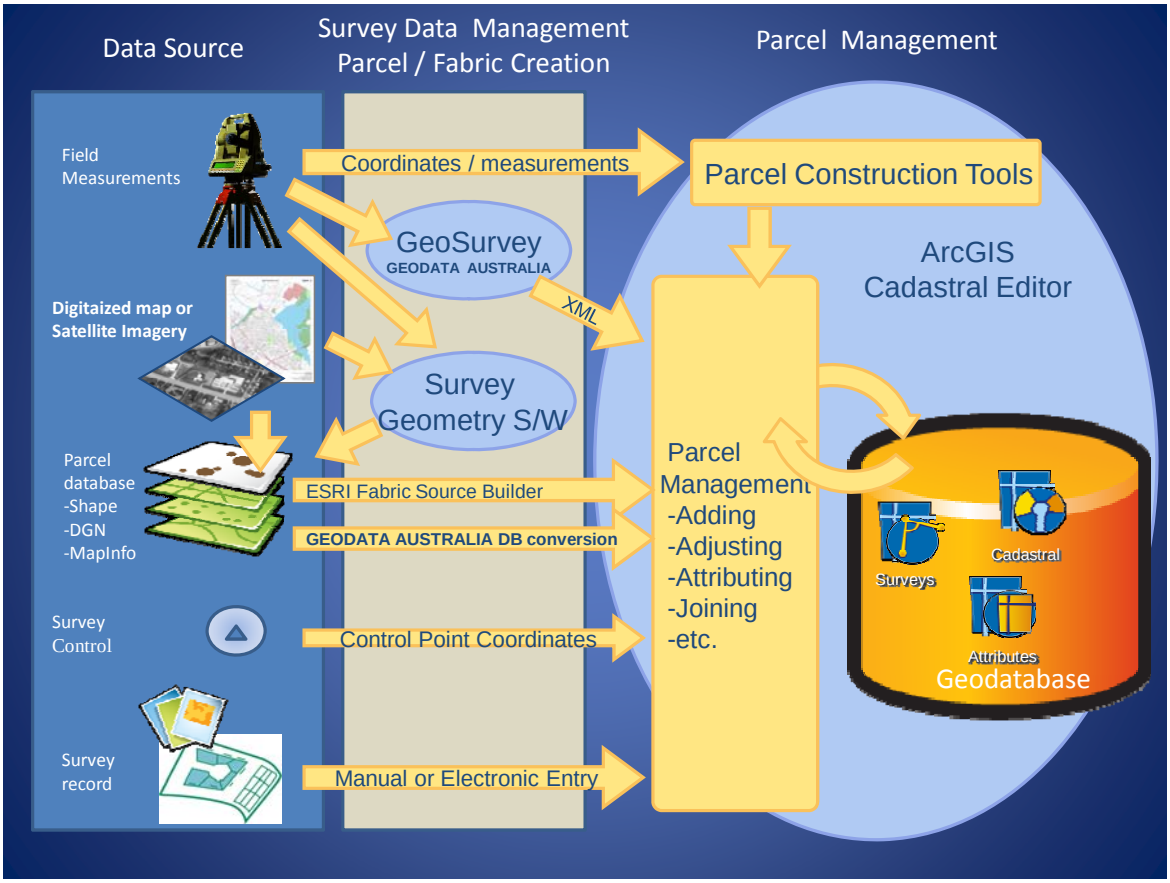

Diagram 9 – The Cadastral database workflows

The Geodatabase then becomes the working data silo for the Land Administration System

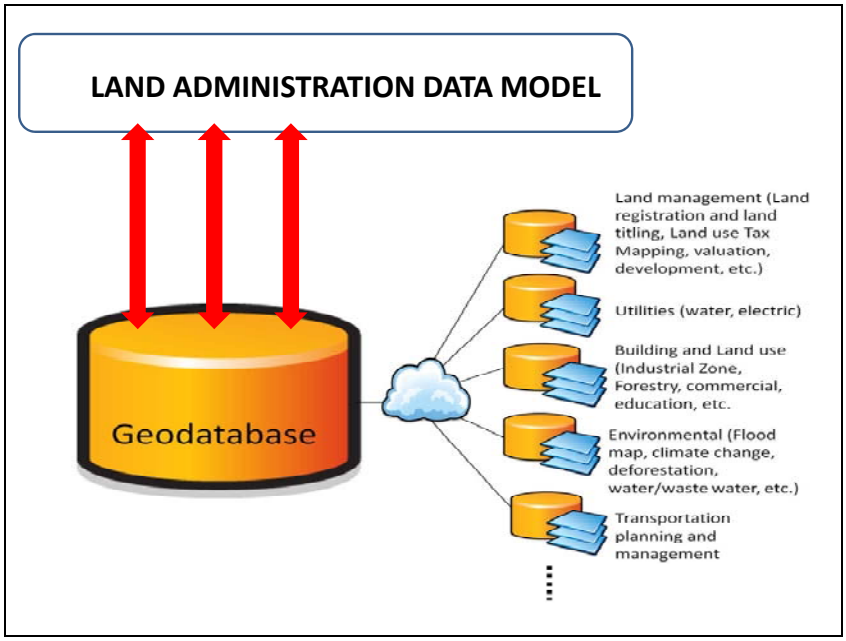

Diagram 10 – The Geodatabase supporting The Land Administration Model

Cadastral Editor and the Geodatabase complete the most effective foundation structure for CADASTRE 2014.

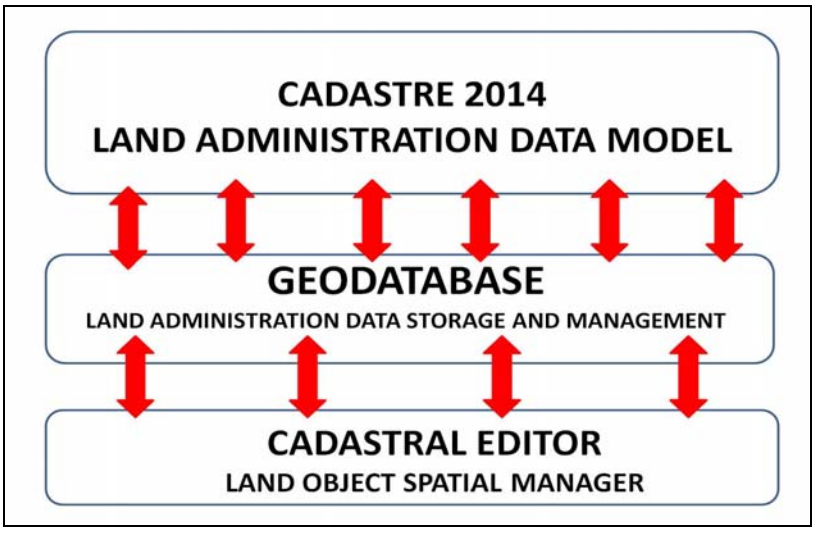

Diagram 11 – Cadastral Editor and the Geodatabase supporting The Land Administration Model

4.3 Survey and Cadastral data examples - VIETNAM

Cadastral databases are created from various data sources. Diagram 13 shows an existing cadastral database

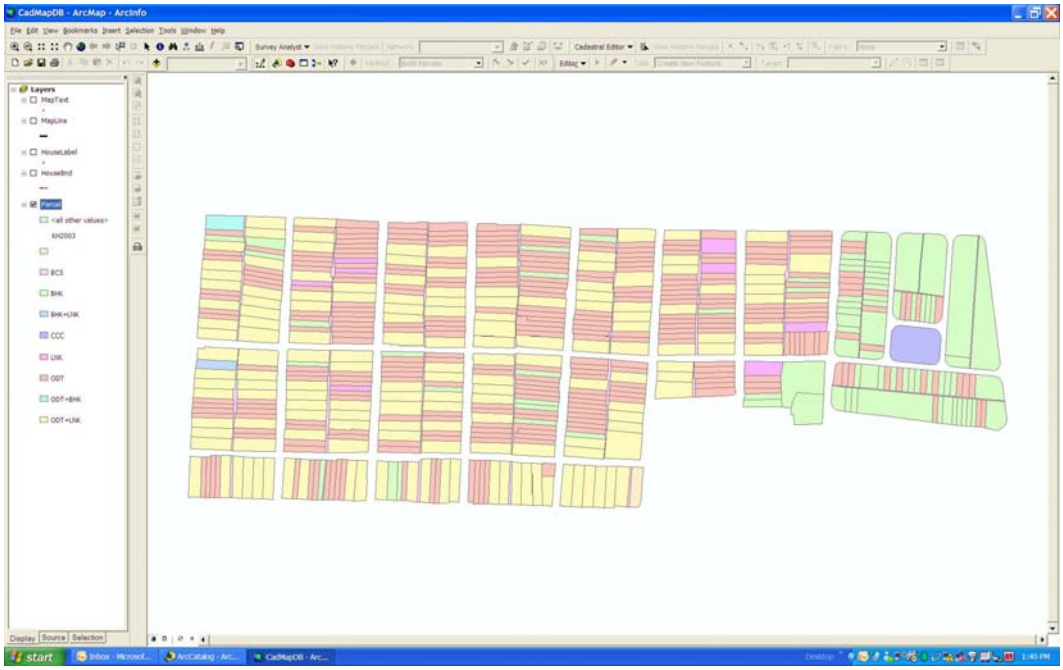

Diagram 13 – An existing cadastral database.

In Diagram 14 the existing cadastral database has been converted to a fabric by inversing the original parcel coordinates to provide measurements to define the parcels. Connections across roads have also been generated to provide connectivity across the model for the adjustment to proceed.

Survey control points are required for the adjustment so some of the Cadastral corners have been adopted as control. The coordinates for those control points may be from the original coordinates of those cadastral corners which would mean the new fabric would have the same spatial position as the original database.

An option is to get new GPS coordinates for those corners or any others in the model. By adopting the true 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 true position.

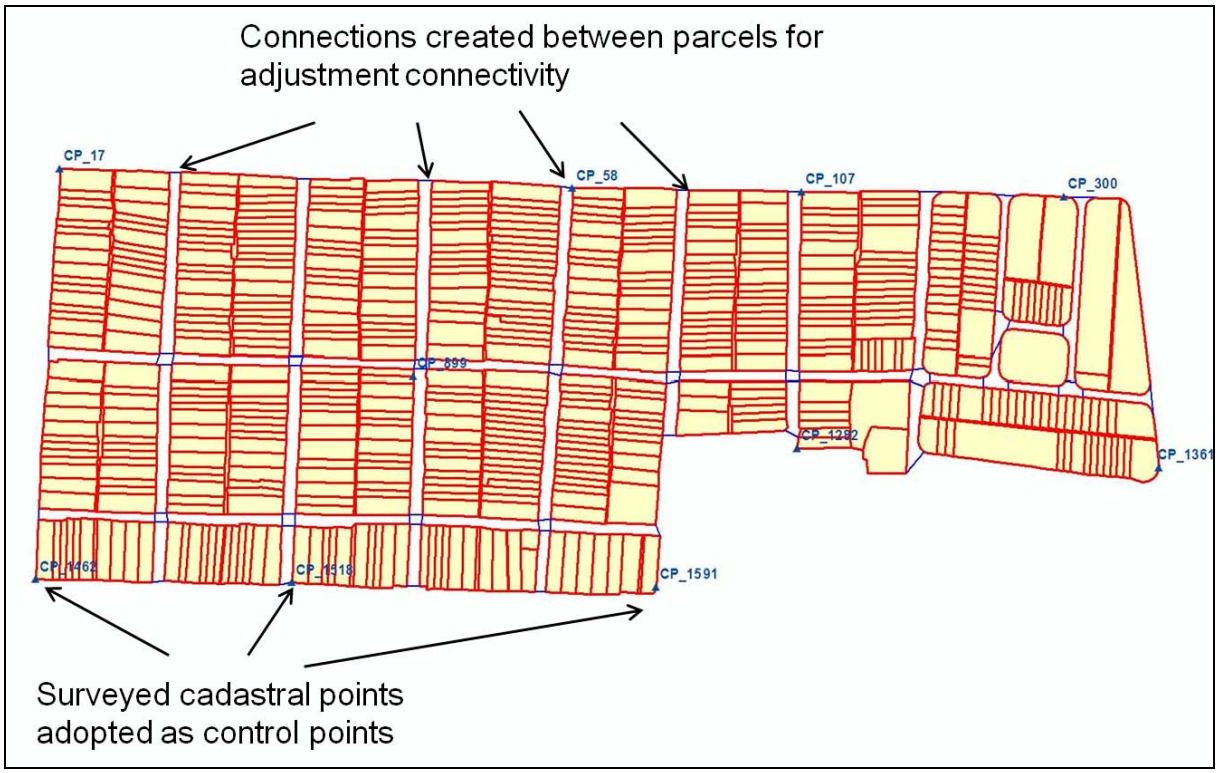

Diagram 14 – Cadastral fabric created from an existing database with some cadastral corners adopted as control

It was later found that the cadastral database had been created by survey using a total station. Both the original database and the survey control traverse was then imported into the cadastral fabric. (See Diagram 15) This allowed the coordinates of the true survey control stations to be used as control in the adjustment.

Again for connectivity, survey connections were required to join those control points to the cadastral model. (See Diagram 16)

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.

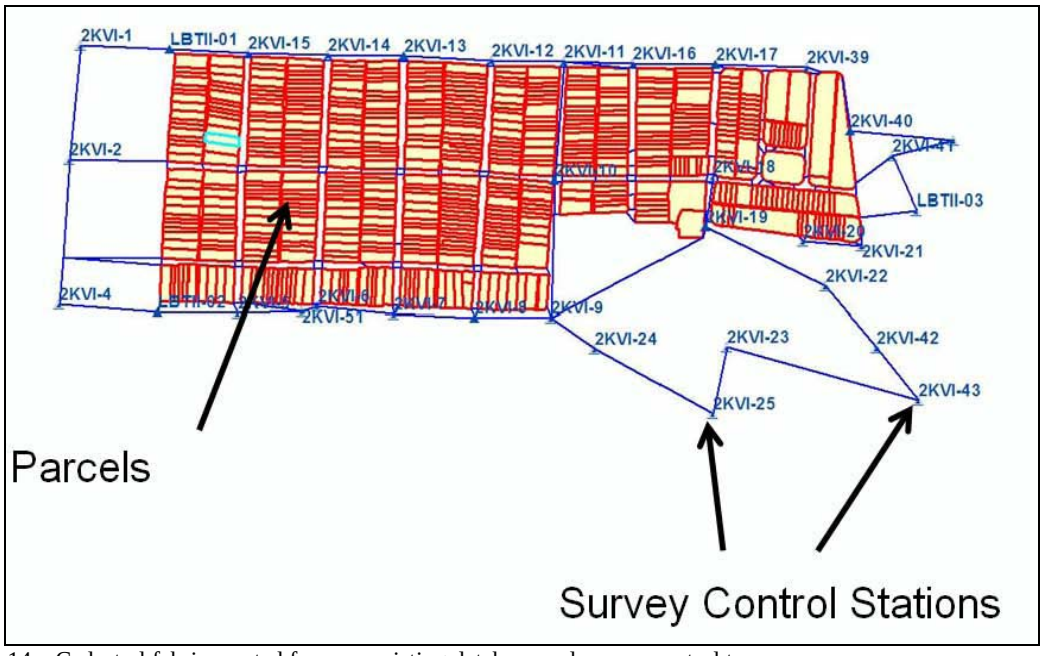

Diagram 14 – Cadastral fabric created from an existing database and survey control traverse.

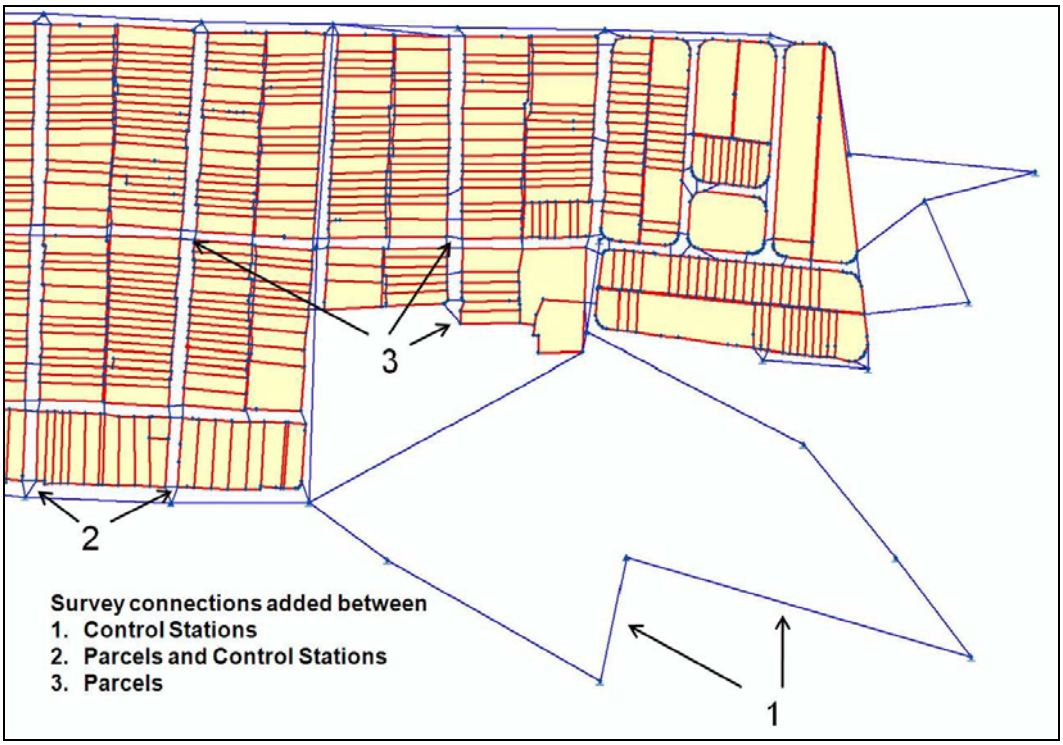

Diagram 15 – Cadastral fabric created from an existing database with survey control traverse and added connectivity.

Once this database is adjusted and added to the regional or national fabric, upgrading with a new parcel subdivision or extra survey control is done very efficiently.

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BIOGRAPHICAL NOTES

Ian HARPER – Bachelor of Surveying UNSW (1977)

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- 4 years consulting in survey and cadastral database management

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