Unit 164 - Land Information Systems and Cadastral Applications

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Advanced Organizer

Topics covered in this unit

This unit describes the origin, components, functioning, and uses of land information systems, with particular emphasis on systems for maintaining cadastral (land ownership) data.

Intended learning outcomes

After reading this unit, you should be able to:

- discuss several purposes for land records and cadastral data
- define a land information system (as used to manage land ownership data)
- describe the way land ownership is conveyed and recorded (in the United States)
- list components of a land information system based on modern spatial information technologies
- identify some of the challenges in automating and managing cadastral data in a geographic information system

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Instructors' Notes

Metadata and Revision History

Unit 164 - Land Information Systems and Cadastral Applications

1. Introduction

1.1 Importance of cadastral records and land information systems

- access to and use of land are fundamental to life as we know it... food, fiber, habitation, recreation, and so forth
- land parcel is the basic unit for access and control of land, land use decisions
- current, reliable land information necessary for many public programs, for example:
    - land planning
    - infrastructure development and maintenance,
    - environmental protection and resource management
    - emergency services
    - social service programs
    - and so forth
- basis for land markets, development, and other economic activity

1.2 GIS issues in land records

- relating "legal" description of property to coordinate-based systems
- ambiguous or overlapping boundaries
- complex attribute relations
- public access

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2. Definitions

2.1 Cadastre

- broad context -- description of legal and fiscal interests in land
- typical context -- land ownership records
- *a joke -- combination of a cadaver and a disaster*

- *Legal cadastre* - parcel-based description of interests or rights in real property; typically supported by titles or deeds, and registry.

  Functions of a legal cadastre:
    - define property rights (often in conjunction with formal and case law)

    - describe the extent (spatial, sometimes temporal) of property rights
    - support land transfer
    - provide evidence of ownership (e.g., using land as collateral)
    - program administration (e.g., enforcement of laws, targeting of incentives)
    - public land management
- *Fiscal cadastre* - property valuation and land taxation.

  Functions of fiscal cadastre (from Dale and McLaughlin, 1988):
    - information base for property taxation
    - distribution of funds from public programs
    - monitoring and supporting land markets
    - information for growth management and land use planning

2.2 Land information system (LIS)

- Means to acquire, manage, retrieve, analyse, display land records.

- LIS as component of GIS or vice-versa... a long-standing debate, mostly a matter of semantics and disciplinary orientation.
- Typical LIS:
    - cadastre as a primary component
    - maintained by unit of government responsible for tracking land ownership, control; typically county government in US
    - parcel-oriented
    - hard copy maps and/or CAD or GIS software for spatial representations
    - relatively large (cartographic) scale (e.g., 1:4800 in rural areas, 1:1200 in developed areas)
    - bridge between legal (e.g., deeds) and technical (e.g., maps, GIS coordinates) land descriptions
    - may incorporate other technologies
        - parcel indexing systems (relational data base management systems)
        - fiche and document imaging systems
        - surveying
- multipurpose cadastre (figure 1)
    - National Research Council effort of early 1980s
    - recognized limitations in manual systems
    - proposed automated methods for managing land records, linking to other spatial data
    - parcel as primary organizing principle
- multipurpose land information system (figure 2)
    - alternative to multipurpose cadastre
    - parcels as one component of layer-based system
    - oriented to integration and analysis of data
    - geodetic reference framework as organizing principle

2.3 Land Tenure

Rights and obligations in land, along with system for defining and governing.

Difficult to capture all tenure rights in a land information system -- multiple dimensions.

- definition of rights
  - "bundle of sticks" -- all the possible ways of using land, allocated between individuals (and organizations) and the state (or other form of society)
  - rules and procedures defining who possesses which sticks -- can be MORE EXPLICIT and MORE COMPLETE with automated land information system
  - responsibilities -- obligations of tenure possessor, e.g., land taxation, environmental protection
- dimensions of rights (table 1)

2.4 Land records

Components of legal and fiscal cadastre maintained by local governments (typically counties)

Many components amenable to automation; appropriate data models still evolving

- titles -- a description of a land parcel, potentially including:
  - description of location or boundary (e.g., bearings and distances survey description, metes and bounds description, public land survey system reference, lot number in platted subdivision, etc.)
  - method of conveyance (e.g., warranty deed, quit claim, etc.)
  - "Torrens" system, found in some British commonwealth nations, government backs claim to land title
- deeds -- registration of land transaction with public authority (Register of Deeds)
  - land transaction are between individuals (no government guarantee)
  - only required government record is real estate transfer tax notice
  - registration is essentially voluntary, though typically done to support claim to land
  - grantor and grantee (conveyed from, to) used to organize records (manual system --> "book, volume, page" is reference)
- chains of title -- a fully supported land claim must be traced back to original conveyance from government or crown, evidence tracing through all transactions to present is chain of title; *abstract* is summarization of chain of title
- indexes -- to make chains of title easier to research, Register of Deeds may create *grantor/grantee* index, or *parcel* index. If all parcels are uniquely identified and linked to GIS representation, can search spatially into parcel index
- tax roles, tax maps -- other than Registry (which is maintained as public service) the main interest of local government in land ownership information is tax assessment. Tax roles and associated tax maps:
  - account for all lands, their value and their owner.
  - may or may not be directly linked to Registry
  - may or may not be derived from deed/title descriptions
  - often used as source of data for GIS (Registry typically not involved in mapping)
  - often not maintained at accuracy needed to convey land, only to assess and collect taxes
- related "layers" -- assessment, zoning, permits, etc.

- private records
    - title insurance - private backing of title validity
    - title abstracts - summarization of evidence about ownership
    - plat maps -- approximations of land ownership parcels, derived from a variety of public and private data sources

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3. History

3.1 Old stuff

- Magna charta & English common law, definitions of property rights
- Northwest Ordinance and related documents - basis for US property registry system
- early land offices, deeds registries and property conveyance
- land grants, Homestead Act of 1862

3.2 Evolving land rights and definitions

- the "bundle of sticks" - evolving rights, and hence evolution of what government records
- ad valorem taxation - need to account for land ownership

3.3 Beginnings of automation

- 70s - recognition of problems, the "Larsen report"
- early 80's - NRC reports
- initial experiments - North Carolina state supported program, Dane County Land Records Project, others

3.4 Maturing systems

- IMAGIS (Indianapolis Mapping and Geographical Infrastructure System) multi-organizational land records system
- Wisconsin Land Records Program - state support for local land records modernization
- POLARIS -- Toronto's "privatized" land records systems
- etc.

3.5 One concept for a modern system:

- document imaging system -- deeds and other documents imaged transactionally (as registered), "dumb image" retrievable by remote terminal
- digital parcel map
    - unique parcel identification number for every parcel
    - created from deed description -- direct tie to legal evidence
    - updated by transactional trigger from Registry
    - problems with land records resolved, e.g., redundancy, discrepancy

    - problems with land ownership adjudicated, e.g., gaps and overlaps
- on-line parcel index and grantor/grantee index
- access to all pertinent records for other government functions
- public access interface for routine record retrieval by companies and citizens, with appropriate privacy restrictions/protections

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4. LIS Players

4.1 Local government

Some with explicit mandates for maintaining land records - e.g., Deeds Registry
Others use local land information (whether in the form of automated records or paper maps, indexes, deeds, etc.)

- tax assessor / real property listor
- zoning administrator
- and every other agency that needs to know who owns/uses the land, for example:
    - plat review
    - building inspection
    - land use planning
    - transportation planning and management
    - emergency response
    - waste management and disposal
    - protected area designation, monitoring
    - parks and open space
    - infrastructure management
    - public utilities
    - etc.

4.2 Public

Public interacts with local land information system primarily in land conveyances and land tax assessment; may also have some involvement in particular applications.

4.3 Land-related business and NGOs

- development / real estate
- banking
- title abstracting and insurance
- conservation & environmental protection
- community, land use, economic development
- etc.

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5. Land records data (in GIS context)

The challenge -- using modern spatial information technologies to prop up a land records system developed 200 years ago for an agrarian society

5.1 Geodetic / geographic control frameworks

Land information system starts with spatial reference framework

- local technical choices -- datum, coordinate system, linkage to national spatial reference system, other
- linkage between coordinate system and legal system (deed description such as land description such as Public Land Survey System aliquot, metes and bounds, bearings and distances)
- may involve recovering, remonumenting, measuring (GPSing) reference points used in property description

5.2 Conversion -- legal description to mathematical coordinates

- digitizing existing maps (e.g., tax parcel maps)
- new coverages - coordinate geometry from deed descriptions
- orthophotos or ground surveys - interpretation of occupation boundaries
- URISA/IAAO procedures for automation of parcel data (GIS Guidelines for Assessors)

5.3 Data quality

- commensurate with source material, typically new compilation e.g., deed/COGO >> than existing cartographic products
- occupation boundaries may be different than deed boundaries... which to portray??
- accuracy should be commensurate with requirements of application
    - coordinates are generally not legal means to transfer property
    - other applications, e.g., planning, infrastructure management, etc. may not require conveyance-level accuracy
    - may start with existing lower quality records that supports some applications and build more accurate records overtime

5.4 Maintenance of dynamic layer

- transactional updates - system design needs to accommodate constant changes AND maintain historical records
- "ripples' through the organization - overall system needs to move changes in data from entry point (e.g., Register's office) to all others using land records

5.5 Access and use

- "corporate data" data base design is common approach to allow access throughout organization;

- information products - many different needs must be accommodated
- public access - public access terminals, read-only access to data bases, standard and custom information products
- costs and benefits
    - efficiency -- less costly retrieval & duplication of routine or required records
    - effectiveness -- better information for administration and management of government programs and activities
    - equity -- outcomes of decision-making

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6. Land Information and cadastral system examples

- Dane County, Wisconsin "citizen access" terminal to provide parcel-based information; a set of mapping tools will be added to provide support for creating simple parcel maps in 1998.
- New York state Office of Real Property Services, using GIS in a variety of tax assessment and real property listing applications.
- A commercial service (Direct Line Software) for searching deeds, titles, and so forth, along with a variety of related activities, facts, etc.

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7. Summary

This unit describes the origin, components, functioning, and uses of land information systems, with particular emphasis on systems for maintaining cadastral (land ownership) data.

In the United States, the land records system evolved from English common law. Following the American Revolution, several Acts established a rudimentary deeds systems and various systems for granting state lands to citizens. The implication for GIS is that we are now using modern information technologies to support a system designed for a simple agrarian society. The system was not designed to provide proof of land ownership, nor was it designed to handle complicated land arrangements such as de-bundling the "bundle of sticks"... individual property rights.

The main component of a local land information system is the land ownership parcel. It may be described in many ways -- as a record on a deed, a description on a tax assessment record, surveying records, etc. The reconciliation of records in various forms will continue to challenge us as we attempt to automate these records.

One vision for a fully automated system would include more than just a GIS -- other computer-based components such as document management system, database management system, and resolution of organizational and legal problems. Such a system would support not only mandated land records management responsibilities of local jurisdictions, but would also serve the needs of a broad range of actors using land information for a wide variety of programs and functions.

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8. Review and study questions

9. References

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Citation

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Unit 164 - Land Information Systems and Cadastral Applications

Instructors' Notes

Many students or their parents will have had personal experience with their local land information system, through property conveyance, re-financing, tax assessment appeals, building inspections, re-zoning and variance applications, and so forth. This can become the basis for discussion and projects.

Discussion

Particularly if this lesson comes after they have a solid grounding in GIS, students can talk about their perceptions of the local system -- what components have been automated and how, what procedures may be amenable to automation, what kind of technical problems were or will be encountered, and so forth.

The material on the evolution of the American land records system is only a bare outline. It could certainly be expanded to an entire lecture or more, particularly in conjunction with a colleague with expertise in American history. Many students will find it interesting to learn how social, economic and political forces influence the technical choices that underlay our land information systems. Similarly, people with expertise in land tenure, particularly in developing nations, will be able to expand on the role of land information, land titling, registries, land valuation, and so forth on land reform, development, access to capital, etc.

Projects

- Acquire copies of land records pertinent to your dwelling -- deed, zoning, assessment, etc.
- Write a brief report on the status of automation of the land information system of your local jurisdiction, including areas where GIS is or may be useful.
- Many examples of how cadastral data are used in applications can be found on the Web. Have students find examples from your local area with a search that uses key words such as [*local jurisdiction*], [land information or land records], and [*application area* such as:
    - zoning administration
    - conservation
    - utility maintenance
    - emergency services
    - others ??

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Land Information Systems and Cadastral Applications

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Unit 164 - Land Information Systems and Cadastral Applications

Metadata and Revision History

1. About the main contributors

- Stephen J. Ventura, Institute for Environmental Studies and Department of Soil Science, University of Wisconsin-Madison

2. Details about the file

- current URL of file
  - http://www.ncgia.ucsb.edu/giscc/units/u164/
- unit title
  - Land Information Systems and Cadastral Applications
- unit key number
  - 164

3. Key words

4. Index words

5. Prerequisite units

6. Subsequent units

7. Other contributors to this unit

8. Revision history

- First posted October 16, 1997
- Formatting revised and posted to GISCC October 23, 1998

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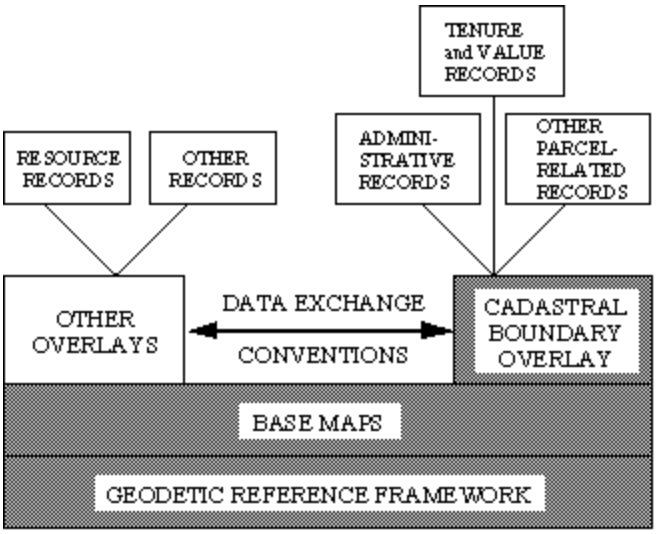
Concept for a Multipurpose Cadastre



adapted from:

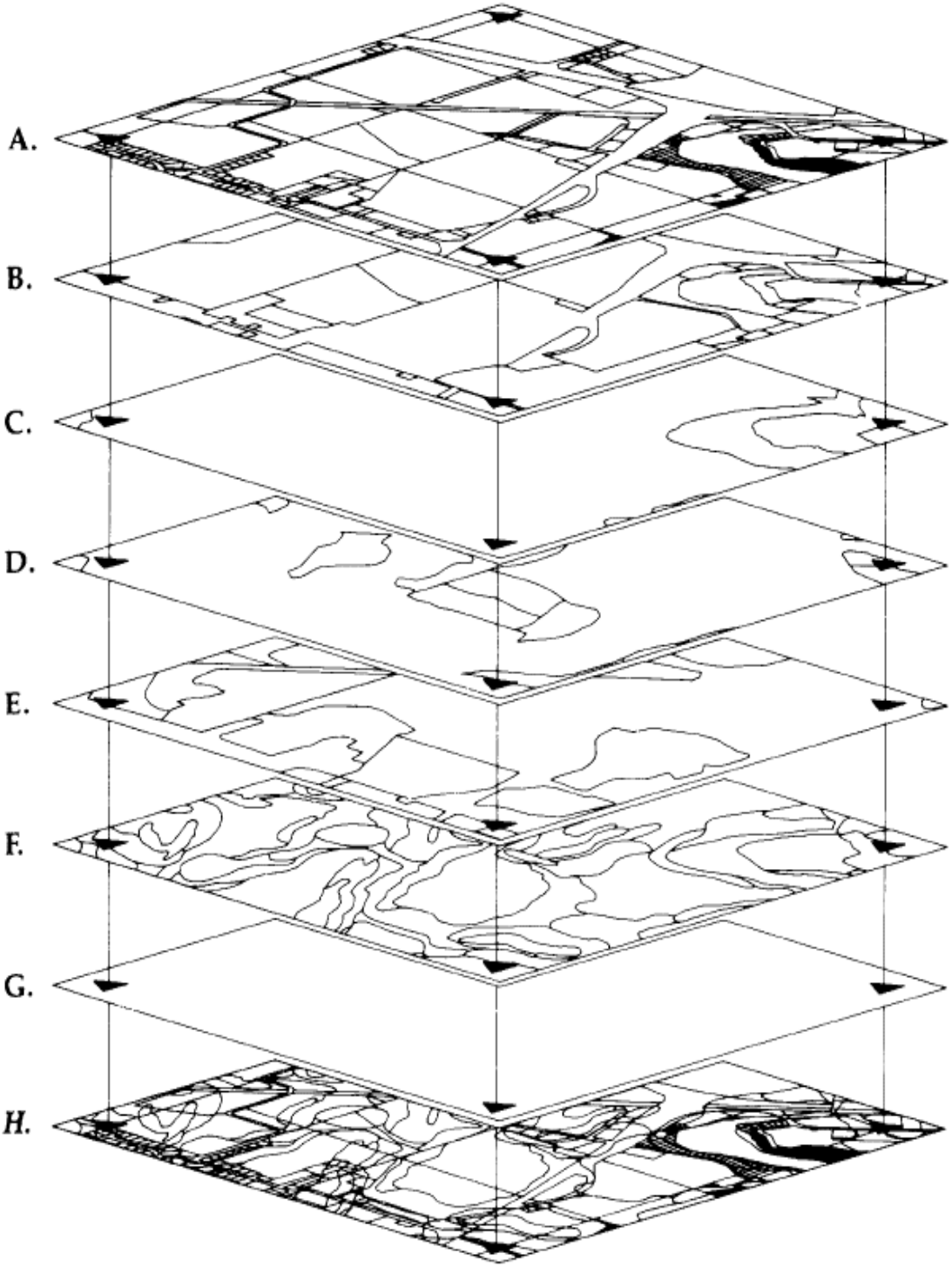
National Research Council (1980). *Need for a Multi-purpose Cadastre.* National Academy Press, Washington DC

National Research Council (1983).*Procedures and Standards for a Multipurpose Cadastre.* National Academy Press, Washington DC

Figure 1. Multipurpose cadastre.

Concept for a

Multipurpose Land Information System



Concept for a

Multipurpose Land Information System

Section 22, T8N, R9E, Town of Westport, Dane County, Wisconsin

Data Layers:	**Responsible Agency:**
A. Parcels	Surveyor, Dane County Land Regulation and Records Department
B. Zoning	Zoning Administrator, Dane County Land Regulation and Records Department
C. Floodplains	Zoning Administrator, Dane County Land Regulation and Records Department
D. Wetlands	Wisconsin Department of Natural Resources
E. Land Cover	Dane County Land Conservation Department
F. Soils	United States Department of Agriculture, Soil Conservation Service
G. Reference Framework	Public Land Survey System corners with geodetic coordinates
H. *Composite Overlay*	*Layers Integrated as needed, example shows parcels, soils, and reference framework*

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Figure 2. Multipurpose land information system

TENUROIDS

Toward definition of multi-dimensional tenure objects for identifying and recording land and natural resource tenure rights and obligations

(Steve Ventura, 11/27/95)

Many kinds of tenure exists in multiple dimensions, creating challenges in defining (identifying and describing), observing (delineating and recording) and managing transactions (creating, modifying or destroying records) tenure in computer-based data base management systems. To create a general information model of tenure, the dimensions of tenure must be distinguished and explicitly accommodated in a data structure. The following represents first thoughts on the dimensions and types of tenure, and some possible values of tenure objects.

Dimension: SPACE

- precise, defined location
  - pointer to GIS boundary record
- imprecise, defined location
  - pointer to GIS boundary record
  - estimate of record precision (observation system accuracy)
  - boundary fuzziness (lexical imprecision)
- referenced/relative location
  - pointer to other GIS-based object
  - pointer to other tenure object
- other
  - description

Dimension: TIME

- perennial
  - pointer to initial authority
- lifetime
  - pointer to (possessor)
- seasonal
  - season(s)
- fixed duration
  - time period
- cyclical
  - definition of cycle
- other
  - description

Dimension: POSSESSOR

- individual
  - name
- family
  - name
  - head/decision-maker
- household:
  - name
  - head/decision-maker
- jurisdiction/community
  - name
  - spokesperson
  - decision-making structure

Dimension: GRANTOR

- legally defined
  - jurisdiction
- community defined
  - community
- individual
  - name (primary right-holder)

Dimension: RIGHTS

- unrestricted
- unspecified
- enumerated
  - activities allowed
- restricted
  - activities prohibited
- obligations
  - requirements
  - consequences of failure to meet requirements

Dimension: EVIDENCE

- registered
- titled
- community enforced
- self-declared

These concepts have been extended by Mohamed Mohamed, including some testing with

field data and the development of an Arc/Info data model:
Mohamed, M.A. (1997) *Use of Spatial Information Technologies to Delineate and Model Indigenous Tenure Concepts.* Ph.D. disseration, University of Wisconsin-Madison.

Table 1. Dimensions of rights.