UNIT 54 - CADAstral RECORDS AND LIS

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Compiled with assistance from Frank Gossette, California State University, Long Beach

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Since subdivision and other parcel maps are often hand drafted they do not reproduce well.
Try to get an example from your local land record office to show in class, replacing the overhead provided here.

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A. LAND SURVEYS AND LAND RECORDS

Public need for accurate land information

- governments, land developers, and property owners need and use land information daily

- land information is the basis of property rights in most countries
  - land information must be used to resolve disputes
  - must be accessed when property changes hands

- most of the information that a municipal government stores is tied to specific geographic locations within its jurisdiction: property lines, easements, utility and sewer lines, and many categories of spatial data

- the ability to store, retrieve, analyze, report and display this public land information efficiently and accurately is of great importance
  - requests for information from a land information database can number thousands per day

- land information is of variable quality
  - the legal description of land properties relies on accurate survey measurements, monuments with accurately known location, but also problematic descriptions such as "middle of river" (river may change course), marks on trees (tree may have died) etc.
  - in resolving disputes, the source of land information and its accuracy may be as important as the information itself
    - a land information database may need to include more than just coordinates

  - in the UK:
    - base mapping at 1:1,250 scale exists for all urban and many rural areas
    - over 250,000 sheets
    - regular program of maintenance and update
    - currently being converted to digital form

  - in the US:
    - largest scale base mapping is 1:24,000 or 1:50,000, too small for property boundaries
    - approximately 108 million parcels of taxable real property
    - records on these are maintained by 83,216 state and local government agencies
    - in local governments, 75% of daily transactions involve land information
      - e.g. address verification, parcel identification, ownership, budget
summaries, delivery of services
- records are held in unrelated formats
  - e.g. property record books, paper files, microfiche, maps, charts, computer databases
- methods of information management are often as old as the system of land rights itself - which dates to before the Constitution
- land data held by one agency are frequently unavailable to another - not because of jurisdiction, but because of the method of record keeping
  - leads to unnecessary confusion, cost and duplication

The cadaster

- the cadaster is an official register of the ownership, extent and assessed value of land for a given area
  - cadastral refers to the map or survey showing administrative boundaries and property lines
- cadastral information is usually the largest-scale (most detailed) land information available for an area
- as such, cadastral information can provide a large-scale base to which other layers of data can be added for specific purposes
  - this is the concept of the multipurpose cadaster or MPC
  - the ideas of integration of spatial data inherent in the MPC are found in many other areas of GIS application
  - the MPC is an ideal - the actual state of cadastral information varies widely within the US and from country to country, despite wide acceptance that the arguments for MPC are very persuasive

- LIS is a generic term for information systems that deal with land records

B. GEOMETRY OF CADAstral MAPS

Plane surveys and geodetic control

- most cadasters are based on plane surveys
  - surveyors have measured the boundaries and property lines as planar distances from known locations or benchmarks or monuments
  - many, but not all, benchmarks are tied to actual geodetic control points (longitude/latitude or State Plane Coordinates)

- conflicts occur when boundaries plotted from survey data overlap or fail to meet

Absolute versus relative accuracy

- absolute accuracy refers to the relationship of a point on the map to its actual location on the globe
relative accuracy refers to the relationship of one point on the map to another point on the same map

e.g. a property line may be 400 feet from a USGS marker which has been globally positioned to be at 112 degrees West Longitude and 34 degrees North Latitude
- either or both of these measurements could be inaccurate
- the property line might only be 398 feet away and the benchmark might be shown to be several hundred feet off, when measured by GPS or adjusted to the new North American datum

Coordinate geometry (COGO)

overhead - Portion of a parcel map

- land surveyors record subdivisions in terms of geometric distances and angles from control points (benchmarks)
  - legal descriptions are made up of distances and bearings that trace the boundaries of the land unit
- special computer programs have been devised which accept this coordinate geometry (COGO) and translate the instructions into X-Y coordinates on the plane
- this gives the maps created by this process better "relative accuracy," in most cases, than maps created by digitizing the boundaries from existing basemaps

 Coordinate geometry vs digitizing

C. THE TAX ASSESSOR AND CADAstral SURVEYS

- originally, cadastral maps and surveys were used exclusively to develop parcel maps for taxation purposes
  - based on the Original Surveys of the land area (county, city, sub-division, etc.)
  - however, these maps are not necessarily the legal authority for taxation or ownership
    - the actual surveyor's notes and legal description provide this authority

Assessor's parcel maps

- basic unit of land is the parcel
  - parcels are usually contiguous and are owned by a single entity (family, individual, corporation, etc.)

- Tax Assessor (usually a county official in the US) assigns a number (identifier) to each parcel on the map

Parcel numbers and Tax Roll

- working from the Parcel Maps, the Tax Assessor makes a list of parcels and their
taxable value
  - the value of land depends on many things, including the size of the property (area) and the actual or permitted uses (agriculture, industry, residential, etc.) of the land

- tax rolls may also include the legal ownership, the size of the parcel and the improvements made to the property

- important to note that tax rolls and parcel maps contain significant amounts of data that can be used for many purposes beyond tax assessment
  - however, many problems arise when they are used for other purposes since they were compiled at an accuracy and detail that is required for tax only
  - e.g. boundaries shown may not be accurate enough for city planning purposes

D. EXAMPLES OF THE NEED FOR MPC/LIS

- the following examples illustrate the need for geographic information systems to handle this type of information
  - (this section quotes from and relies heavily on materials prepared for the US Department of the Interior, Bureau of Land Management's Study of Land Information, mandated under Public Law 100-409, 1989)

Prince William County, Virginia

- a mid-size Virginia county

- land deeds are filed with the Clerk of the Court office, and microfilmed

- a copy of the microfilm is given to the Real Estate Assessment Office
  - certain information is abstracted from the deed and becomes an assessment record on the county's mainframe computer, accessible to all departments

- a copy of the deed is used to update a parcel database
  - new parcels and subdivisions are entered into an automated mapping system using COGO
  - digital and mylar maps are updated weekly

- since the Assessment Office defines parcels in its own way for tax purposes there is not a one-to-one correspondence between the parcel database and the assessment records
  - the geographic data in the parcel database cannot be linked effectively with the non-geographic assessment records
  - the county is developing a LIS which will implement a single database with no duplication of data elements

Louisville/Jefferson County, Kentucky

- 26 governmental units and local utilities produce or modify 111 sets of maps at annual costs of $3.2 million
  - of the 111 sets, 59 are used by more than one organizational unit and 20 by more
than five

- parcels and subdivisions are routinely mapped at least six times by government and utilities, often at different scales and levels of accuracy
- area agencies maintain some 95 automated geographic databases and 110 manual databases
  - wide divergence in types and capabilities of computers
  - communication of data is complicated
- replacing current practices with an automated system will save as much as $5.7 million over a 10 year period
  - conservative estimates are that staff efficiency will increase by at least a third
  - plan will include users and data collectors: Metropolitan Sewer District, local government agencies, utilities

Los Angeles County, CA

- government consists of over 40 departments, plus committees, commissions and special districts
- 4084 sq mi area
- approximately 50% of all information is geographically related
- 7 problems common to all departments:
  - lack of structured communication regarding sources, availability of georeferenced information
  - lack of timely and convenient access
  - information is not always current or accurate
  - information is duplicated, independently maintained
  - existing system is time consuming, difficult, labor intensive
  - limited ability to relate geographic and non-geographic records
  - difficulties of different scales, standards, accuracy, coordinate systems etc.

- LA county presents enormous problems, not only related to size
  - complexity of jurisdiction - many of the incorporated cities within the county provide their own services, county government services the residual area
  - management of elections is a major potential application of LIS - there is one election on average every 2 days in LA county - each election has its own set of districts with complex definitions
- a CAD parcel database alone is estimated at 300 Gbytes
- plan to achieve a county-wide LIS by target date of 1997

E. ADDING MULTIPURPOSE LAND INFORMATION LAYERS

- a Land Information System can be seen to be the result of adding more "layers" of
information (geographic features) and including more attribute data to the cadastral map
  o the base map or cadaster now becomes an MPC (or LIS)

  these data are useful for other, related functions of land management, planning and administration

**Geographic layers**

overheads - City map overlays (9 pages)

  ● additional geographic features can be registered to the parcel basemap
    o e.g. street centerlines, public rights-of-way, "footprints" of public buildings, and other information for which the graphic representation is useful by itself

  ● other examples include:

    ● Infrastructure and Public Facilities
      o infrastructure may include water lines, sewer lines, fire hydrants, power poles or other "utilities"-type information

    ● Hydrography and Topography
      o streams, ponds, underground aquifers, and the 50 year floodplain are all geographic features which could be useful adjuncts to basic land information

**Role of CAD systems in early LIS development**

  ● early LIS development stressed the cadastral map as the main system product
    o ability to add layers of graphic information to the base map was a major incentive

  ● because of the availability of Computer-Aided Design and Drafting (CAD) tools, early automation of land information was often done on such systems
    o since basic parcel boundaries, street information and some infrastructure information is immediately useable in graphic form, CAD systems provided LIS basemaps which could be easily updated and quickly produced
    o the capabilities of these systems do not generally extend beyond simple production of maps - do not support sophisticated queries or analysis

**Non-geographic land attributes**

  ● geographic features may be associated with an infinite number of characteristics
    o parcel not only has ownership, area, and value, but can be distinguished on the basic of the allowable uses to which it can be put, the school district to which it belongs, or the age of the head-of-household

  ● typical LIS attribute data include:
    o Land Use and Land Cover
    o Zoning and Administration
    o Demographics
• as the attribute or tabular data become an increasingly important component of the system, the ability of simple, "flat-file" databases which are a part of CAD systems represent a serious impediment to system growth
  o more powerful data managers and GIS software may be needed

F. GIS AND THE MULTIPURPOSE CADASTER

• many early LIS were created using CAD systems and relatively simplistic data managers
  o as the volume of information increases and more sophisticated applications are attempted, the functionality of full-featured Geographic Information Systems may be required
  o powerful, relational DBMS and topologically-structured, vector GIS software can handle the types of land-information management tasks which are typical of contemporary LIS

• example areas in which GIS capabilities are essential:

Integration of graphic and non-graphic information

• general queries
  o retrieval of administrative records using geographical keys (pointing at map, using topological relations such as adjacency, outlining query polygon etc.)

• Urban and Regional Planning: thematic mapping
  o ability to merge geographic boundaries with statistical information - rapid creation of thematic maps in support of planning activities

• Community Development: zoning changes
  o rapid update of zoning records, rapid display in map form using parcel boundaries

Spatial operations for LIS applications

• Urban and Regional Planning: notifications
  o use of buffering operation to identify property owners within fixed distance of proposed project

• Planning: feasibility studies
  o use of overlay, modeling to support spatial search for feasible areas meeting requirements for project

• Public Works: roadwork surface modeling
  o use of 3D capabilities to make engineering calculations

• Utilities: hydrologic modeling
  o use of network modeling capabilities to predict urban runoff, effects of changes in storm water system

• Schools: population models and districting
- forecasting school populations by small areas based on demographic, migration, housing development models
- redistricting to achieve balanced school populations

- Fire: optimal routing
  - use of network models for routing emergency vehicles, site selection for stations

REFERENCES


Reports on the Need for Multi-purpose Cadaster


EXAM AND DISCUSSION QUESTIONS

1. Determine the status of LIS development in your own county/municipality. Is there an LIS, or are there plans to automate the land records system?

2. The 1980 NRC report cited above recommended, amongst other things, that "Federal legislation should be proposed to authorize and fund a program to support the development of a multipurpose cadaster in all parts of the Nation". What factors might account for the fact
that this recommendation has not yet been implemented?

3. Discuss the significance of scale in a multipurpose cadaster. What is the minimum scale required to carry out each of the applications of an MPC described in this unit? What scale would you recommend for a cadastral base for your community?

4. How do the contents of an LIS database differ from those of a) a CAD and b) a GIS database? What additional information must be stored if the LIS database is to function effectively?

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