RECONSTRUCTING CADASTRAL HISTORY FOR DECADAL-SCALE INVESTIGATION OF LAND OWNERSHIP, LULCC AND CARBON DYNAMICS IN NORTHERN FLORIDA

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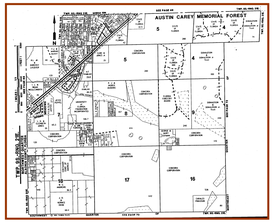
OBJECTIVE

- Document changes in land ownership/land tenure patterns over the past 25 years
- Analyze how the changes impact LULC and carbon dynamics in the region

THE PROBLEM

In rural Florida ownership parcels are generally described by means of a "legal description" which is typically a textual "metes and bounds" list of the boundary components (dimensions, corner monuments and adjacent property owners). While these legal records do contain the full history of ownership, extracting such a history on a parcel-by-parcel basis would be extremely time consuming. Furthermore, obtaining historical graphic data on parcels would entail painstaking interpretation of the long wordy legal descriptions. Fortunately, there are other sources of cadastral data.

The County Appraisers' offices in Florida (and elsewhere in the US) maintain sufficient cadastral information to enable them to fulfill their property assessment and taxation functions. For a variety of reasons, including their ability to generate funds, these systems have modernized much faster than county deeds records systems. Because they are focused on individual property parcels, they maintain a current graphic depiction – tax map – of all parcels within the county.

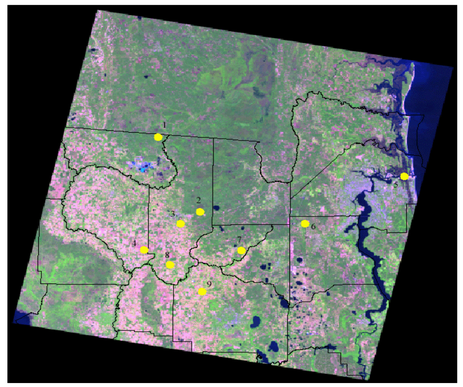


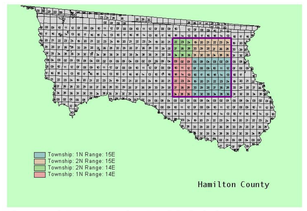
Typical Appraiser's Tax Map

While these are not the "legal" depiction of the properties, the accuracy was deemed to be adequate for the objectives of this project. This source of graphic parcel data meant we did not have to resort to the written legal descriptions contained in individual deeds. However, appraisers are most concerned about keeping their records up-to-date and have little use for historical data. This meant we could easily obtain a map of the parcels for the current year (2000), but working back in time would not be that simple.

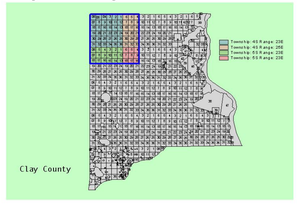
Extracting Cadastral Data from the Alachua County Appraiser's Office

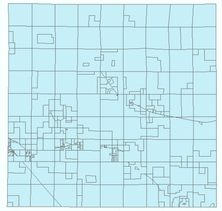
The County Appraiser's office does, however, keep annual records of their tax rolls. These are lists of parcel-based appraisal data including the ***parcel number (PIN), area, owner's name,*** and detailed data used to assess the appraised value of the property. We concluded that the most effective strategy would be to extract key data elements from the tax rolls for the years in which we were interested and then by organizing this in a spatio-temporal database we could work back through 25 years of cadastral history. We were able to obtain 1990-2000 tax roll data in a digital format for some of the counties, but beyond that we were forced to sift through either manual records or microfiche copies of the tax rolls.



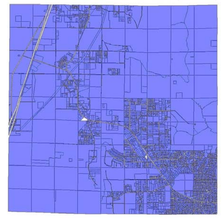


Original Rectangular PLSS Subdivisions





Current Cadastral Parcels (2000)



DEVELOPING SPATIO-TEMPORAL CADASTRAL DATABASE

There has been some effort to develop a temporal component for cadastral databases, but this has typically been aimed at capturing future transactions (e.g. Hunter and Williamson 1990) as opposed to focusing on the historical aspects. The challenge of developing a spatio-temporal cadastral database lies in linking three fundamental characteristics of an object, namely *location*, *time* and object *description* (Peuquet 1994).

The location data is typically provided through a digital cadastral map, but we also included Public Land Survey System (PLSS) location data – section, township and range – since the landscape is uniformly subdivided into these units (allowing us to later to use this as our unit of analysis if necessary). Time in most GIS' is simply dealt with as an attribute. In our case we link to it through a History table and also incorporate it as part of a unique parcel numbering system. But to do all of this we would first have to define our primary object – the ownership parcel – for the 25 year study period. Given the breadth of our research questions, and the delayed impact of ownership change on land use/land cover, we concluded that a temporal resolution of 5 years would be sufficient for our purposes. Working from GIS coverages, or paper tax maps (which we manually digitized) in some counties, we were able to develop a graphic record of cadastral parcels for the current year (2000). Drawing on the family tree analogy, this record gave us the children from the current generation but what we lacked was the spatial definition of the parents and grandparents as well as the relationship between parents and children.

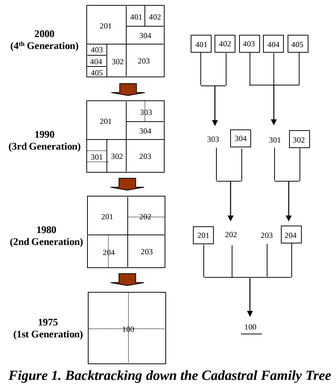


Figure 1. Backtracking down the Cadastral Family Tree

Figure 1 illustrates how parent parcels are subdivided through time to produce the current generation of parcels. This strategy relies on two major assumptions: (a) parcels are uniquely numbered, (b) no consolidation (merging of parcels) has taken place.

Unique parcel identification: While parcels are given a distinct parcel number (PIN) in the county appraisal system, this is often not unique through time. For example, when a parent parcel is subdivided into two pieces, the appraiser's office often retains the PIN from the parent for one of the subdivided pieces. We also encountered situations where distinct, non-adjacent parcels were given the same PIN because they had the same owner. This meant that we had to develop an alternative parcel identification system that would be unique for each parcel. Since we needed to maintain a link to the appraiser's PIN system, we used this as a basis for a unique parcel identifier (UPI) and simply appended a 4 digit temporal suffix to the PIN. The suffix was composed of the birth date and end date of the parcel (e.g. 1367-000-7595). Through adding this temporal information we were not only able to make the UPI unique, but also make the temporal component more evident.

Parcel Consolidation: The second assumption relating to consolidations proved to be reliable for Hamilton and Alachua Counties, but in Clay County we encountered a number of these cases. Tracking back through time from year 2000 would not allow us to define the boundaries of parcels which were subdivided and then consolidated sometime between 1975 and 2000. In Clay County we overcame this problem by first identifying parcels that were common to both 1975 and 2000, and then working in two directions - back wards from 2000 as well as forwards from 1975.

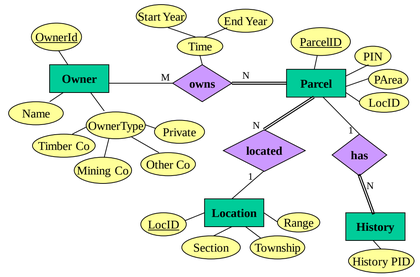


Figure 2. The Entity-Relationship Diagram for the Spatio-temporal Cadastral Database

In order to design a spatio-temporal database we first pursued a design that was based on a relational structure, but which treated the ownership unit as an object (Leslie 2001). This approach focused on attributes changes to the object, but it did not adequately deal with the spatial changes in cadastral parcels. We then pursued a design which focused on the key entities – owners, parcels, location and history – of the cadastral object as shown in the Entity-Relationship Diagram in Figure 2 (Agrawal 2002). This approach allows us to capture the location, time (history) and attributes (ownership) of cadastral parcels or objects. The graphic component of the database was developed in ArcGIS, while ACCESS was used to develop the tabular database.

RESULTS

We have implemented and tested the spatio-temporal cadastral database in both Hamilton and Clay County and anticipate completing Alachua County by the end of 2002. In each case we have developed complete cadastral parcel maps ands related attribute and history data for the years 1975, 1980, 1985, 1990, 1995 and 2000. Some of these are shown in Figure 3 below. Owners were divided into specific categories – timber companies, mining companies, private owners, government ownership, and other (usually other kinds of companies). We have focused specifically on rural areas and have excluded all parcels of less than 5 acres from the Hamilton County study and all parcels less than 10 acres for Clay County. This was justified on the basis that these areas contribute very little to ownership questions relating to LULCC and carbon dynamics, but contribute the majority of the property transactions (contributing significantly to data collection times).

In Hamilton County most of the property transactions have occurred between timber companies and mining companies, with timber companies shifting from owning 43% of the study area in 1975 to 18% in 2000. During the same time mining companies expanding their holdings (in terms of area) by 23%. Private holdings have increased slightly over the 25 year period, but these changes have largely been as a result of the actions of a single private land owner who owned more than one third of the total area in 1975.

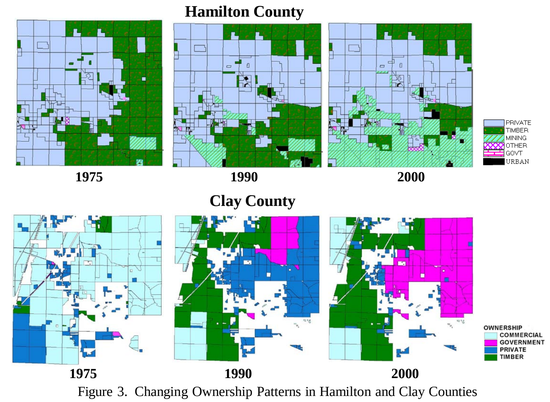


Figure 3. Changing Ownership Patterns in Hamilton and Clay Counties

Clay County is characterized by an increasing presence of timber companies, receding commercial ownership and significant urbanization as Jacksonville has expanded south and west. Our analysis and data collection have been complicated by the number of parcel consolidations and an increasing number of small urban parcels (excluded from our analysis and shown as blank in the above cadastral maps).

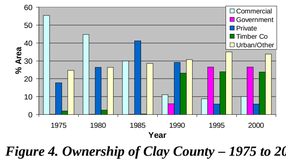


Figure 4. Ownership of Clay County – 1975 to 2000

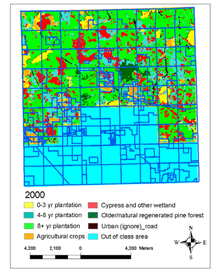


Figure 5. Integration of Ownership and Land Use Data – Hamilton County

NEXT STEPS:

Mining the data out of the public appraisal records has been a significant challenge in itself. However, we are now at the point where we can start analyzing ownership and particularly whether different ownership types affect overall carbon dynamics in the region. This will involve integrating ownership data with LULC data (*see Figure 5 to the left*).

A significant missing part in this research is land management. We were forced to withdraw this from our original proposal, but it will constitute an important part of the next phase of this work. Ownership does not, for example, explain situations where private or commercial land is leased to timber companies who effectively manage it like the rest of their land.