Title: Monitoring Land Use Change Using Time Series of Parcels Themes Paper 268

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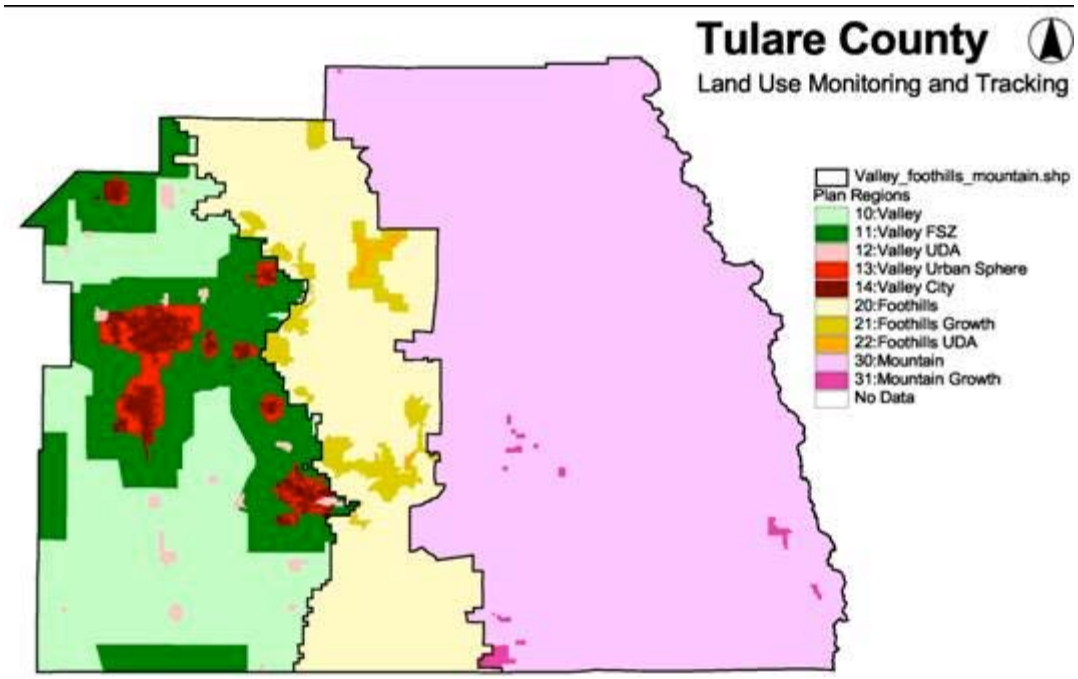
ABSTRACT
Tulare County's program of monitoring land use changes consists of three parts. First, on a quarterly basis the county's current parcel theme is compared with the earlier parcel theme to identify land use changes. Second, the county has created a "resistance to development" model which predicts the susceptibility of each parcel to become urbanized. On a quarterly basis this model is refreshed to reflect the impacts of recent development. Third, the actual land use changes are compared to predictions and the resistance to development model is improved over time.

BODY

Background: Tulare County is located in California's San Joaquin Valley, approximately half way between Sacramento and Los Angles. Tulare County is 4840 sq.mi. in size, just a little bit smaller than the State of Connecticut (which is 5200 sq.mi.). Tulare County is the second-leading producer of agricultural commodities in the United States (and number one dairy county in the world

The county can be divided into three broad regions: the Valley, the Foothills, and the Mountains. County planners have divided each of these regions into a number of sub-regions.



Since the mid-1970's, the County has been concerned about the possible loss of its agricultural base if cities were allowed to sprawl as they have in Southern California. In the 1970s two innovative programs were implemented in Tulare County:

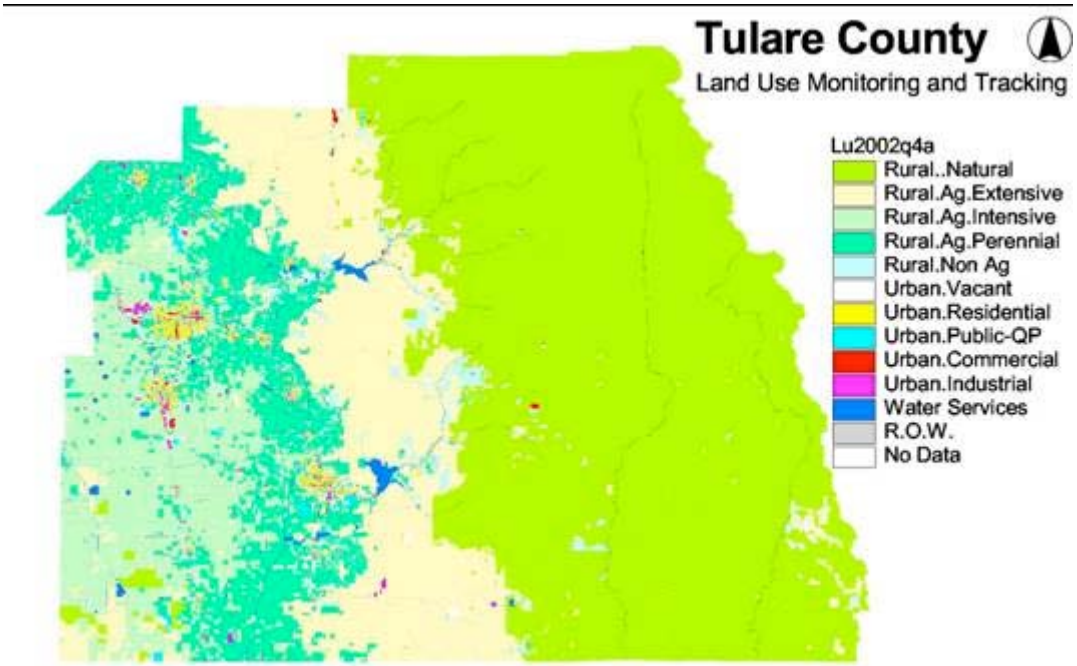
Urban Growth Boundaries – to restrict urbanization to areas close to existing settlements ("Urban Spheres" for incorporated cities; UDAs (Urban Development Areas) for non-incorporated settlements).

The Rural Valley Lands Plan (RVLP) – to control the conversion of agriculturally zoned lands to non-ag uses.

In 2001 the county initiated its "AgTrack Project" to use GIS to monitor land use change county-wide in order to calculate rates of change and determine the effectiveness of current policies.

Part One: Monitoring Land Use

Tulare County GIS generates a PARCELS theme each week, from data tables and parcel maps generated by the County Assessor. On a quarterly basis the county's current parcel theme is added to the AgTrack archives and a generalized land use map is generated, based on the Assessor's 'use code'.



LAND USE CLASSIFICATION: The AgTrack project uses the following land use classification scheme:

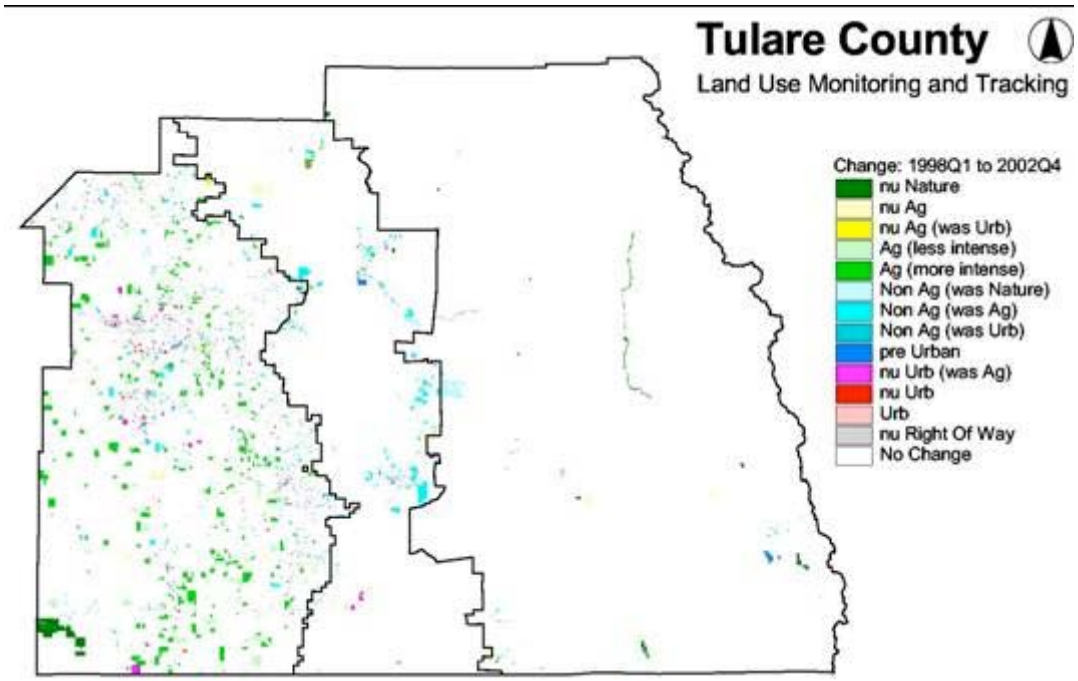
Agricultural		
	Ag.Extensive	grazing lands (primarily the foothills)
	Ag.Intensive	irrigated croplands and animal operations
	Ag.Perennial	orchards and vineyards
Urban		
	Urb.Residential	
	Urb.Commercial	
	Urb.Industrial	
Other		
	Natural	forests, wildlife preserves, etc.
	Rural.Non-Ag	
	Urban.Vacant	
	Urban.Public-QP	schools, churches, hospitals, etc.
	WaterServices	lakes, rivers, canals, sinking basins, etc.
	RightsOfWay	roads, railroads

LAND USE CHANGE: By comparing land use maps of two time periods, the result is a 12 by 12 matrix of all possible changes.

	01.	02.	03.	04.	05.	06.	07.	08.	09.	10.	11.
	Rural	Rural	Rural	Rural	Rural	Urban	Urban	Urban	Urban	Urban	Nature Reviews
	Unchanged	Ag.Extensive	Ag.Intensive	Ag.Perennial	Non Ag	Vacant	Residential	Public-QP	Commercial	Industrial	
Rural	1,562,028.42	62.97	0.00	0.00	2,915.49	0.67	0.00	62.94	0.00	0.00	0.00
Ag.Extensive	1,734.21	577,614.78	2,112.77	1,018.06	6,417.05	1,239.21	45.32	305.32	26.25	226.42	0.45
Ag.Intensive	3,469.23	1,001.19	329,592.84	28,568.15	2,711.97	400.03	120.77	727.09	78.54	301.16	25.14
Ag.Perennial	0.00	732.43	8,016.39	304,304.25	2,623.23	652.38	230.21	135.50	18.46	134.12	40.04
Non Ag	206.62	4,025.64	2,542.49	1,757.79	49,201.18	1,013.44	352.98	142.46	204.25	196.18	26.97
Vacant	0.00	142.79	100.10	31.21	1,214.08	15,362.14	1,052.16	67.39	122.11	103.05	20.91
Residential	2.00	0.39	9.56	11.79	163.03	171.49	24,102.26	16.82	44.40	4.23	1.56
Public-QP	0.00	11.12	22.91	16.60	107.09	35.59	45.00	12,042.63	22.02	2.22	0.23
Commercial	0.00	24.29	0.67	17.35	141.29	205.07	29.00	35.14	4,675.95	31.38	0.00
Industrial	0.00	0.00	383.44	0.12	55.61	26.52	1.11	3.34	120.11	5,287.16	0.00
Reviews	0.00	14.68	1.34	53.23	57.16	0.00	0.45	0.00	0.22	0.45	22,511.84
ROWay	591.55	131.67	355.07	102.39	340.08	100.32	23.41	56.50	16.46	0.45	26.14
2002Q4	1,574,652.15	584,052.03	335,422.37	334,052.35	66,086.87	20,722.25	26,032.53	14,152.33	5,329.42	6,374.79	22,757.87

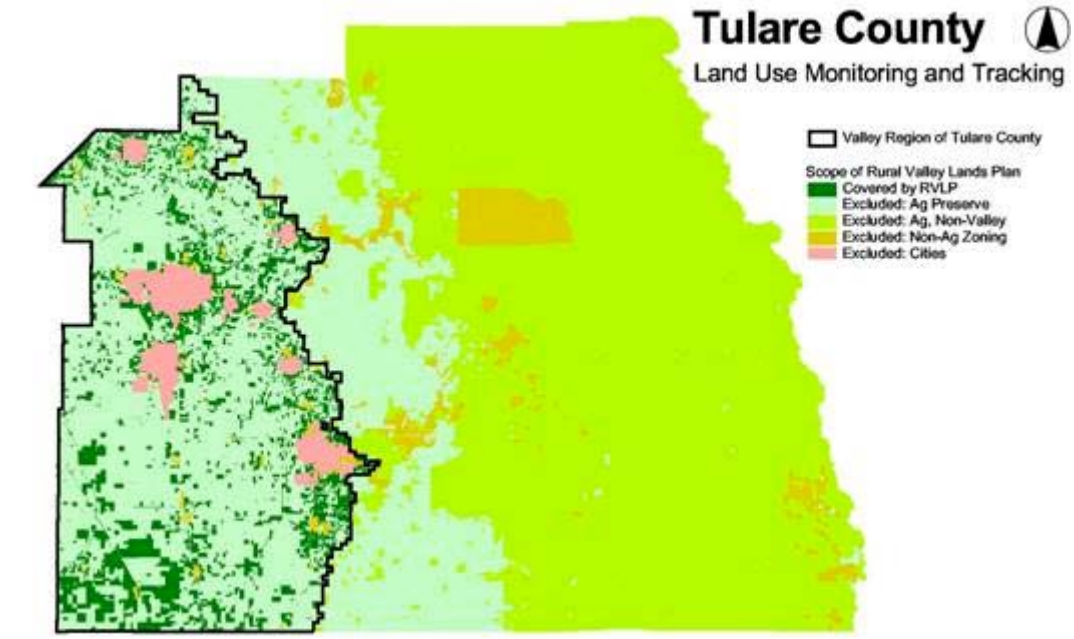
This data was simplified by grouping the changes into 10 categories. The table below summarizes all land use changes in the county from 1998q1 through 2002q4:

Area	Name	Notes
20.3 sq.mi.	Misc	“Other to Other” and “Urban to Urban”
14.8 sq.mi.	Ag.Gain	from “Other” to “Ag”
22.5 sq.mi.	Ag.Loss	from “Ag” to “Other”
46.5 sq.mi.	Ag.MoreIntense	from “Ag.Extensive” to “Ag.Intensive”, etc.
18.3 sq.mi.	Ag.LessIntense	from “Ag.Perennial” to “Ag.Intensive”, etc.
0.9 sq.mi.	UrbToAg	from “Urban” to “Agricultural
4.5 sq.mi	AgToUrb	from “Agricultural” to “Urban”
3.4 sq.mi.	UrbLoss	from “Urban” to “Other”

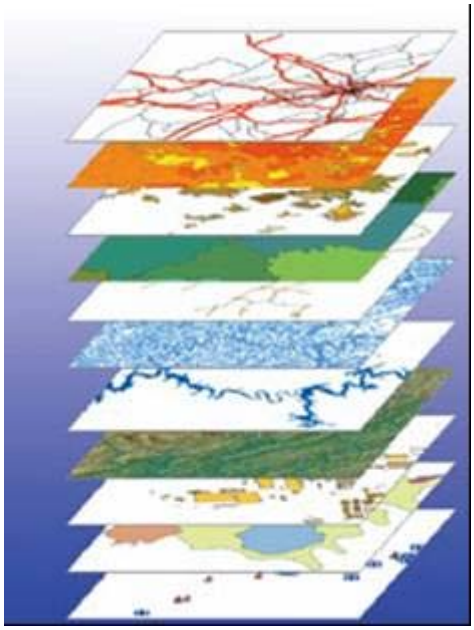


Part Two: Calculating Land Use Change

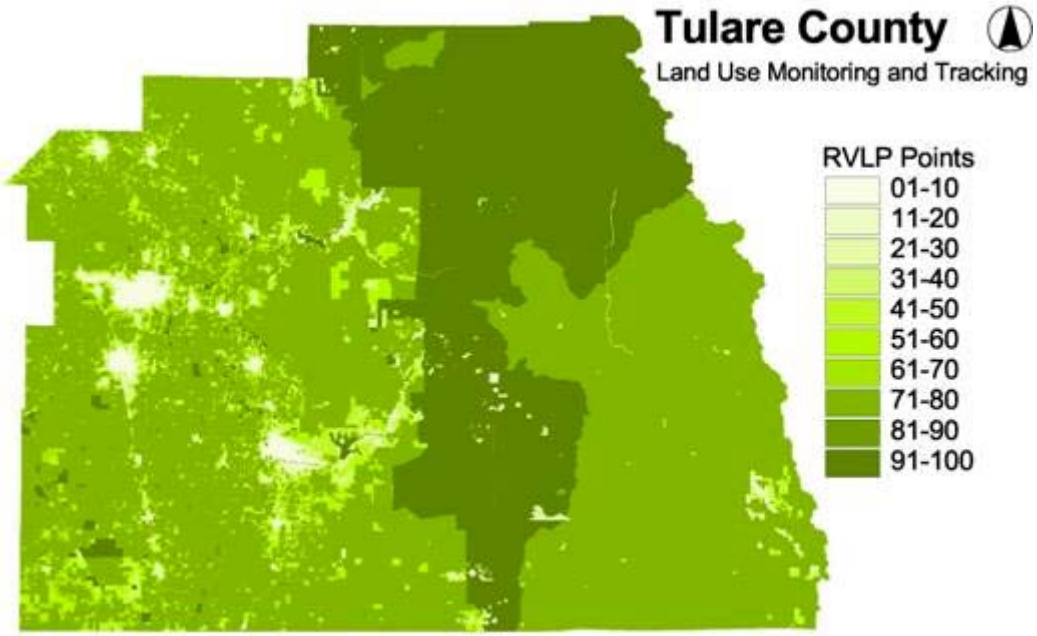
The county has created a "resistance to development" model which predicts the susceptibility of each parcel to become urbanized. The starting point of this model was to map the various factors that were used by the RVLP to score rezoning proposals. The original RVLP point system was restricted to agriculturally zoned lands in the Valley that are not in an 'Ag Preserve'.



The RVLP point system consists of fifteen variables (such as land use, lot size, access to water, etc.) These variables have been retained but the scoring system has been modified such that the score would apply to all parcels in the county.

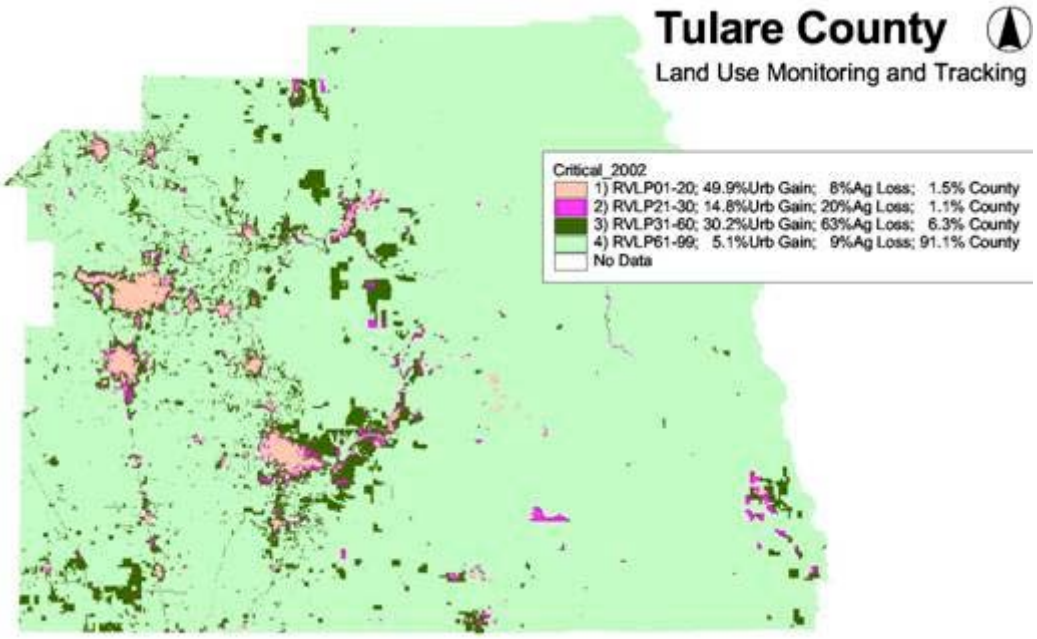


This model is slowly evolving as GIS staff imagines ways that the model can be changed in order to become a better predictor of where development will occure (and were agricultural lands will be lost).



Part Three: Evaluating Results

Actual land use changes are compared to predictions and the resistance to development model is improved over time. The "resistance to development" model seems to be a good predictor of where urbanization will occure and where agricultural lands will be lost. However, the observed changes are more complex than were anticipated.



For example, the initial assumption was than urbanization would be the driving force in the loss of agricultural lands. However, for the time period surveyed (March 1998 through Dec 2002) this does not seem to be the case. Countywide, urban lands increased by 3.87 sq.mi. and agricultural lands decreased by 11.31 sq.mi. This finding was unexpected, and could be explained by some error in classifying the data… or other, unanticipated forces could be at work…

Future Evolution:
At least three modifications must be made to the AgTrack Project to improve its predictive capability; one change is technical, two changes are conceptual.

CHANGE ONE: Adopt New Technology.
Currently the AgTrack Project uses ArcView v3.2 and Spatial Analysis v2.0. Avenue code was written to generate generalized land use maps from assessor's data (using 'use code', ownership info, and value of improvements); this works fine. These vector-based maps are converted to GRID in order to tack advantage of 'spatial analyst' (and to avoid the sliver-hell that is the inevitable result of comparing lots of vector themes).

It was hoped that the Model Builder would be a powerful tool for setting up such analysis, but that was not the case. Our options were 1) do the analysis manually, take good notes, and wait for better tools -or- 2) write a whole lot of Avenue code. We chose to wait; it looks like ArcGIS/Spatial Analysis v9.x will have the tools that we need to more thoroughly automate our analysis.

CHANGE TWO: Adopt a Standard Land Cover Classification System
The conceptual conversion from "Land Use' to 'Land Cover' will resolve a number of ambiguities (and eliminate 'changes' that are triggered by change in ownership rather than changes to the land itself.

Land uses in the 'agricultural' and 'urban' categories are taxable – the assessor's codes for such parcels are generally reliable. "Other lands" tend to be either tax-exempt or lands in transition from one use to another - the assessor's codes for such parcels are less trustworthy. (The assessor has no incentive to record details about tax-exempt lands, since the assessor's responsibility is to collect property tax, not document land use throughout the county.) So the "Other" land use category is most prone to classification error. GIS is contemplating ways to improve the classification of the "other" uses, but not decision has been made. The current 'best contender" is to blend data based on the assessor's use code with data from the 1992 NLCD (National Land Cover Data), which was obtained from analysis of satellite imagry on a 30 meter grid. (30 meters is approximately 100 feet.)

The classification system used by the 1992 NLCD will be adopted and a 'Level III' classification schema will be developed to provide for data at the desired level of detail. Ambiguities in "Other" category will be clarified by comparing such lands with other data sources.

CHANGE THREE: Searching for a Statistical Tool
A number of improvements are envisioned for the 'Development Resistance Model'. Before any such changes are implemented, a way of measuring the quality of the model must be found, in order to know if changes to the model actually are improvements…. Still looking….