Influence of Category Aggregation on Land-Use/Cover Change Signals

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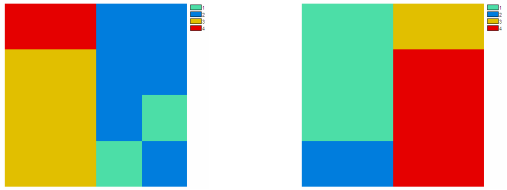
Abstract

Aggregation of land-use/cover categories is a common practice in the analysis of land-use/cover change; however, a naïve approach to this practice can significantly alter the amount of change exhibited by the maps. Thus, in order to accurately report change signals, the effect of aggregation must be considered. This research uses the cross-tabulation matrix to show that naïve category aggregation can significantly reduce the amount of net change while increasing total quantity change and swap (change associated with a loss of a category in one location accompanied by a gain of that same category at some other location. The maximum amount of change is maintained by combining categories that exhibit a net gain with other categories exhibiting a net gain and categories exhibiting a net loss with other categories exhibiting a net loss. Aggregating categories with dissimilar net change can yield a deceptively small change signal. Such practice could have far reaching effects, especially in the form of misleading land-use/cover change models and ineffective policy. The concepts presented in this poster are demonstrated using illustrative examples and empirical data acquired through the collaboration of NSF-funded Human-Environment Regional Observatory sites across the United States.

Unaggregated Landscape

Time 1 Time 2



An illustrative map that exhibits the transition from Time 1 to Time 2. Two categories experienced gain, while the other two categories lost.

		Time 2 1	Time 2 2	Time 2 3	Time 2 4	Time 2 Total	Loss
Time 1	1	0	0	0	2	2	2
Time 1	2	0	0	2	4	6	6
Time 1	3	4	2	0	0	6	6
Time 1	4	2	0	0	0	2	2
Time 1	Total	6	2	2	6	16	16
	Gain	6	2	2	6	16	

This traditional cross tabulation matrix is used to analyze the maps and the transition from Time 1 to Time 2.

		Time 2 1	Time 2 2	Time 2 3	Time 2 4	Time 2 Total	Loss
Time 1	1	0	0	0	13	13	13
Time 1	2	0	0	13	25	38	38
Time 1	3	25	13	0	0	38	38
Time 1	4	13	0	0	0	13	13
Time 1	Total	38	13	13	38	100	100
	Gain	38	13	13	38	100	

Manipulation of the cross tabulation matrix yields a percent matrix.

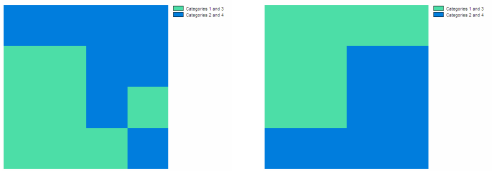
	Gain	Loss	Total Change	Swap	Absolute Value of Net Change
1	38%	13%	50%	25%	25%
2	13%	38%	50%	25%	25%
3	13%	38%	50%	25%	25%
4	38%	13%	50%	25%	25%
Total	100%	100%	100%	50%	50%

Further analysis of the cross tabulation matrix and the percent matrix yields summary statistics for the change over time. The analysis shows that categories 2 and 3 lose over time while categories 1 and 4 gain.

Aggregations

Gain-Loss Aggregations

Time 1 Time 2

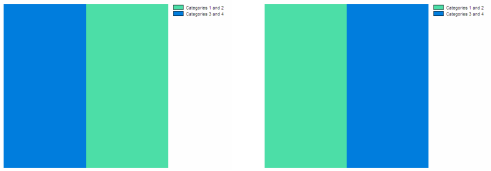


This aggregation combines categories with dissimilar net changes in the original unaggregated landscape. Categories 1 (a gainer) and 3 (a loser) are aggregated and categories 2 (a loser) and 4 (a gainer) are also aggregated.

	Gain	Loss	Total Change	Swap	Absolute Value of Net Change
1 and 3	25%	25%	50%	50%	0%
2 and 4	25%	25%	50%	50%	0%
Total	50%	50%	50%	50%	0%

Analysis of this aggregation shows that the entire net change signal of the original image is lost, while the amount of swap is maintained and the total change is reduced.

Time 1 Time 2



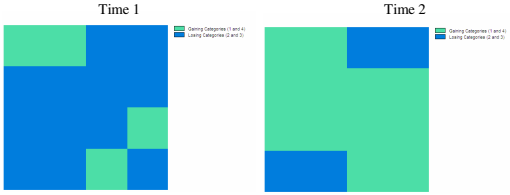
This aggregation combines categories with dissimilar net changes in the original unaggregated landscape. Categories 1 (a gainer) and 2 (a loser) are aggregated and categories 3 (a loser) and 4 (a gainer) are also aggregated.

	Gain	Loss	Total Change	Swap	Absolute Value of Net Change
1 and 2	50%	50%	100%	100%	0%
3 and 4	50%	50%	100%	100%	0%
Total	100%	100%	100%	100%	0%

Analysis of this aggregation shows that the entire net change signal of the original image is lost, the amount of swap is increased and but the total change is maintained.

Gain-Gain Aggregation

Time 1 Time 2



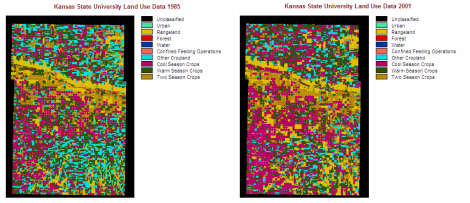
This aggregation combines categories with like net changes in the original unaggregated landscape. The gaining categories (1 and 4) are combined and the losing categories (2 and 3) are also combined.

	Gain	Loss	Total Change	Swap	Absolute Value of Net Change
1 and 4	50%	0%	50%	0%	50%
2 and 3	0%	50%	50%	0%	50%
Total	50%	50%	50%	0%	50%

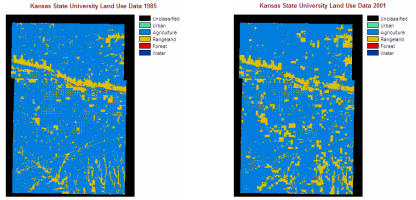
Analysis of this aggregation shows that it retains the net change signal while decreasing the swap to its minimum and reducing the total change.

Empirical Data

Empirical data gathered by HERO sites across the country was used to in our investigation. Data from the Kansas State University site exhibited how the signal change could be drastically reduced. Here, Anderson Level II categories were aggregated to Anderson Level I. The effect on the signal is seen in the summary statistics below. Note how the net change signal (yellow cell) was drastically reduced after aggregation. Similar dramatic effects are seen in the total change (green cell) and the swap (red cell). This was due to naïve aggregation of dissimilar categories

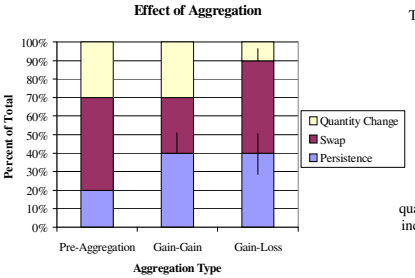


	Gain	Loss	Total Change	Swap	Net
Urban	0.11	0.00	0.11	0.00	0.10
Agriculture	0.00	0.00	0.00	0.00	0.00
Rangeland	8.45	4.77	13.22	9.54	3.68
Forest	0.13	0.14	0.26	0.25	0.01
Water	0.08	0.00	0.08	0.00	0.08
Wetland	0.00	0.00	0.00	0.00	0.00
Barren	0.00	0.00	0.00	0.00	0.00
Confined Feeding Operations	0.19	0.09	0.28	0.19	0.09
Other Cropland	7.61	15.39	23.00	15.22	7.78
Cool Season Crops	19.84	10.89	30.73	21.78	8.95
Warm Season Crops	16.93	21.73	38.66	33.85	4.81
Two Season Crops	7.66	7.96	15.62	15.31	0.31
Total	60.98	60.98	60.98	25.06	12.90



	Gain	Loss	Total Change	Swap	Net
Urban	0.11	0.00	0.11	0.00	0.10
Agriculture	4.65	8.50	13.15	9.30	3.85
Rangeland	8.45	4.77	13.22	9.54	3.68
Forest	0.13	0.14	0.26	0.25	0.01
Water	0.08	0.00	0.08	0.00	0.08
Total	13.41	13.41	13.41	9.55	3.86

Possible Effects of Aggregation



The graph to the left shows the behavior of the total change (the sum of swap and quantity change), persistence, swap, and quantity change based on various aggregations

Gain-Gain Aggregation

Quantity change is maintained while swap can be decreased and persistence increased.

Gain-Loss Aggregation

This aggregation is more complicated, but the quantity change will be decreased. The swap can either increase or decrease and the same goes for the amount of persistence.

Next Steps

Work on this project will continue through the summer and over through the fall semester. When finished, the effect of the different category aggregations on the total change, swap, and net change will be definitively determined. Also, the effect of a variable resolution will be determined.

Acknowledgements

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