Assessment of the Land Classification System Used for Property Valuation in Clarion County

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Abstract

Land classification is directly linked with property valuation. In Clarion County, the currently used land classification is outdated, not only in terms of age (1958) but also in terms of processing and integration within the valuation procedures. This project will evaluate the current state of data as well as processes for land valuation in Clarion County, and, using remotely sensed data and GIS techniques, new estimates for land classification will be produced and tested. The produced system will be also compared with the current one. Change estimates will be produced in order to evaluate the transformation in the quality of land during the past 50 years.

Keywords: Land Classification, Property Valuation, Change, Assessment, GIS, LiDAR

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Introduction

Clarion County is one of western Pennsylvania's rural counties that rely on property valuation as a major source of income. The currently adopted valuation system relies on a Land Classification based on 1968 data (aerial photographs (1968) as well as soil classification system from the Natural Resources Conservation Service (NRCS) (1958), formerly known as the U.S. Soil Conservation Service). This system still uses a manual method of extracting each property's land cover composition and calculating its value through the identification of the percent cover types.

More recently, the GIS and Mapping Department at Clarion County has scanned, georeferenced and digitized all land classification polygons from the 1968 aerial photographs (Figure 1). This was carried out in an attempt to automate the property valuation process and to help in the estimation of the percent cover of each land class for each property.

Figure 1. Clarion County's digitized land class polygons. The basemap is a georeferenced 1968 aerial photograph.

Nevertheless, the process of property valuation remains the same. The digitized land classification polygons are still used in a manual manner and the whole process is not radically improved. This project aims at the production of a most recent land classification system based on the most current soil data

(2015) as well as land cover classes (forest coverage) derived from 2004 LiDAR LAS files. The presence of a systematic method of extracting land classes using updated data would help in future processes. A comparison of the resulting land classification and the 1968 maps is planned for a pilot area in order to estimate the change in land values.

Data

The data used in this project are summarized in (*Table 1*).

Table 1. Collected datasets for the current project

Dataset	Source	Notes
Land Classification for Clarion County	Clarion County (based on 1968 aerials)	PDF document of different land classes and valuation based on improvement percentages
Land Class Polygons	Clarion County (based on 1968 aerials)	Sample Feature class of Ashland Township that includes attributes for the 1968 land classification
Parcels	Clarion County	Sample parcels for Ashland Township
Soils Data	US Dept. of Agr. (1958) NRCS (2015)	Soil Survey, Clarion County (USDA, 1955) Microsoft Access database of different soil information and the corresponding spatial data associated with it.
LiDAR data	PAMAP (2004)	LiDAR point cloud data stored as LAS files
DEM	PAMAP (2004)	Tiles PAMAP Digital Elevation Models generated from LiDAR data.

It was unclear how the currently used land classification system was created. Investigating the source of the classification schema lead to no information. Nevertheless, from the available sheets (see Appendix) used as a main reference, most of the classes referred to soil qualities and attributes. This lead to the exploration of soils classification systems.

Soils data was obtained for 1958. The digital soil survey report (USDA, 1955) did not include any maps, rather it included a detailed description of the similar 8 classes that the County uses. Additionally, a printed copy of the report was obtained from the Clarion County Conservation District office. The printed report included aerial photographs as well as the soil polygons. Those aerial photographs were scanned and georeferenced in order to compare them to the existing land class polygons (Figure 2). In most cases, those polygons were matching, which gave an appropriate justification to proceed with the soil maps of 2015 as the basis for the estimation of the updated land classes.

Figure 2. The scanned and georeferenced aerial photographs from the USDA report

The soils data acquired from the NRCS included several data in tabular form, the table "*Comp.txt*" was the one that contained the different soil classifications. Two fields contained this information for each soil polygon: *NIRRCAPCL* (Non-Irrigation Capability Class) and *NIRRCAPSCL* (Non-Irrigation Capability Sub-Class). Those two fields worked as the foundation for the polygon classification in this study.

Furthermore, the LiDAR point cloud data was used to extract the forested areas based on percent tree coverage calculations (tree density) created in a previous study (Ayad, 2015). While the Digital Elevation

Model tiles (DEMs) were used to generate the slopes which were later used to identify different slope ranges for each land class.

Methods

The attributes of both the Clarion County land classes as well as the soil polygons acquired from the NRCS were compared side by side. *Table 2* summarizes the matching of the different land classes between the 1968 Clarion County and the NRCS soil polygons. Some compromise was done due to the inconsistencies between the two datasets. For example, in the data provided by Clarion County, the improved properties were described as any property with a structure added to it, the percent improvement was taken in the land valuation system (see Appendix). In this study there were no specific differentiation between the improved and the non-improved properties. In future work, improved properties could be identified using building footprint feature class when available. Also, in Clarion County's data, the main class could be assigned a negative value, which indicates a lower grade of the same class, this system was not present in the NRCS soil classification, instead, each soil class could be assigned a letter describing its limitation and risk of erosion (e), presence of water interfering with plant growth (w) or its shallowness, prone to drought or stony soil (s). Any of those letters were assumed to be a lower level of the same class and therefore was assigned a negative value instead (*Table 2*).

Table 2. Land Classification comparison between the 1968 Clarion County data and the NRCS soil classes

CLASS	Clarion	Value ($)	NRCS	Notes
CLASS I	1	450	1	
	1P	450	1	Improved
	-1	400	1e or 1w	
CLASS II	2	350	2	
	2P	350	2	Improved
	-2	300	2e or 2w	
CLASS III	3	250	3	
	3P	250	3	Improved
	-3	200	3e, 3s or 3w	
CLASS IV	4	150	4	
	4P		4	Improved
	-4		4e or 4w	
CLASS V	5	100	5	
	5P		5	Improved
	-5		5e or 5w	
CLASS VI	6	80	6	
	6P		6	Improved
	-6		6e or 6w	
CLASS VII	7	60	7	
	7P	60	7	Improved
	-7	40	7e or 7w	
CLASS VIII	8	25	8	
	-8		8s	

The new unified classification was then applied on the Clarion County's sample Land Class polygons' attribute table (1968) as well as the Soils polygons from the NRCS (2015).

The land classification system relies on those soil class codes as well as two more variables; Forest cover and Slopes. Figure 3 shows the process of extracting the different land classes from the most recent datasets, refining them using calculated slopes and forest covered areas, then comparing them with the 1968 existing land classes. In the following sections, the extraction and the integration of both the forested areas as well as the slopes is discussed.

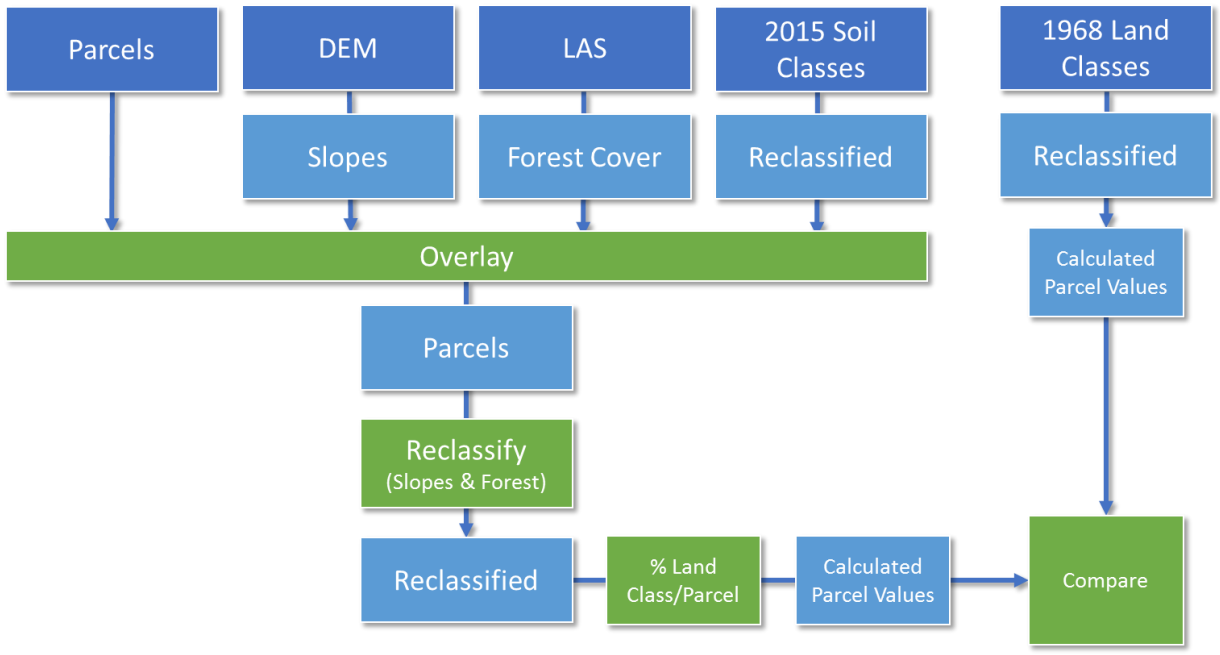


Figure 3. The process of extracting the most up-to-date land classes from existing soil classes, slopes, and forest cover.

Forested Areas Identification

The extraction of the forested areas was based on the LiDAR point cloud data (LAS). The LAS dataset was filtered for both tree coverage as well as ground returns, the percent tree cover was calculated, reclassified and smoothed to represent the forested areas (Figure 4). All of those areas were categorized as class number 7 (CLASS VII), or mainly "woodland".

Slope Calculations

The slope percent was calculated using a DEM mosaic dataset. It was then reclassified to three classes: level/gentle, moderate, and steep slopes. Figure 5 shows the extracted three slope classes. Depending on the definition of each class from the Clarion County's document (see Appendix), each of the 2015 soil polygons were reclassified according to its slope.

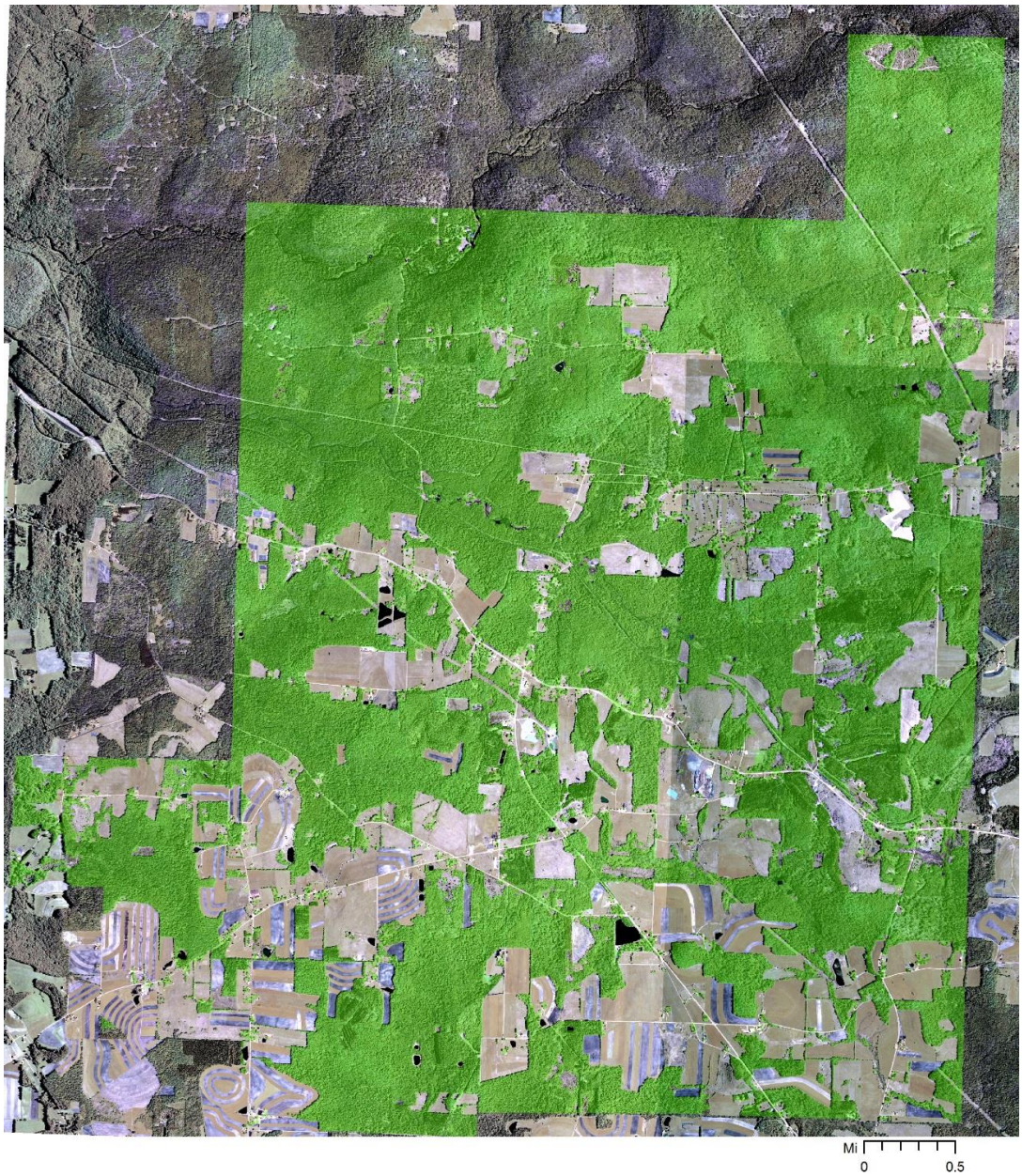


Figure 4. Extracted forested areas from LiDAR point cloud data.

Results and Discussion

Updated Land Classification

The slopes, forest cover and soil polygons were all overlaid with the Ashland Township parcels. The soil classes were updated according to the slope and forest cover attributes. For example, any polygon that was classified as forest and assigned a different class code other than 7 was reassigned to class 7, also, the slopes were taken into consideration when refining each soil class. The newly updated land classification codes were stored. The percentage of each class code within each parcel was also calculated for 1968 as well as 2015 (Figure 6 and Figure 7). Each of those was multiplied by its corresponding value (see *Table 2*).

Figure 8 and Figure 9 show the final results for each parcel in Ashland township. Also, the difference between the 1968 and the 2015 values was calculated and presented in Figure 10.

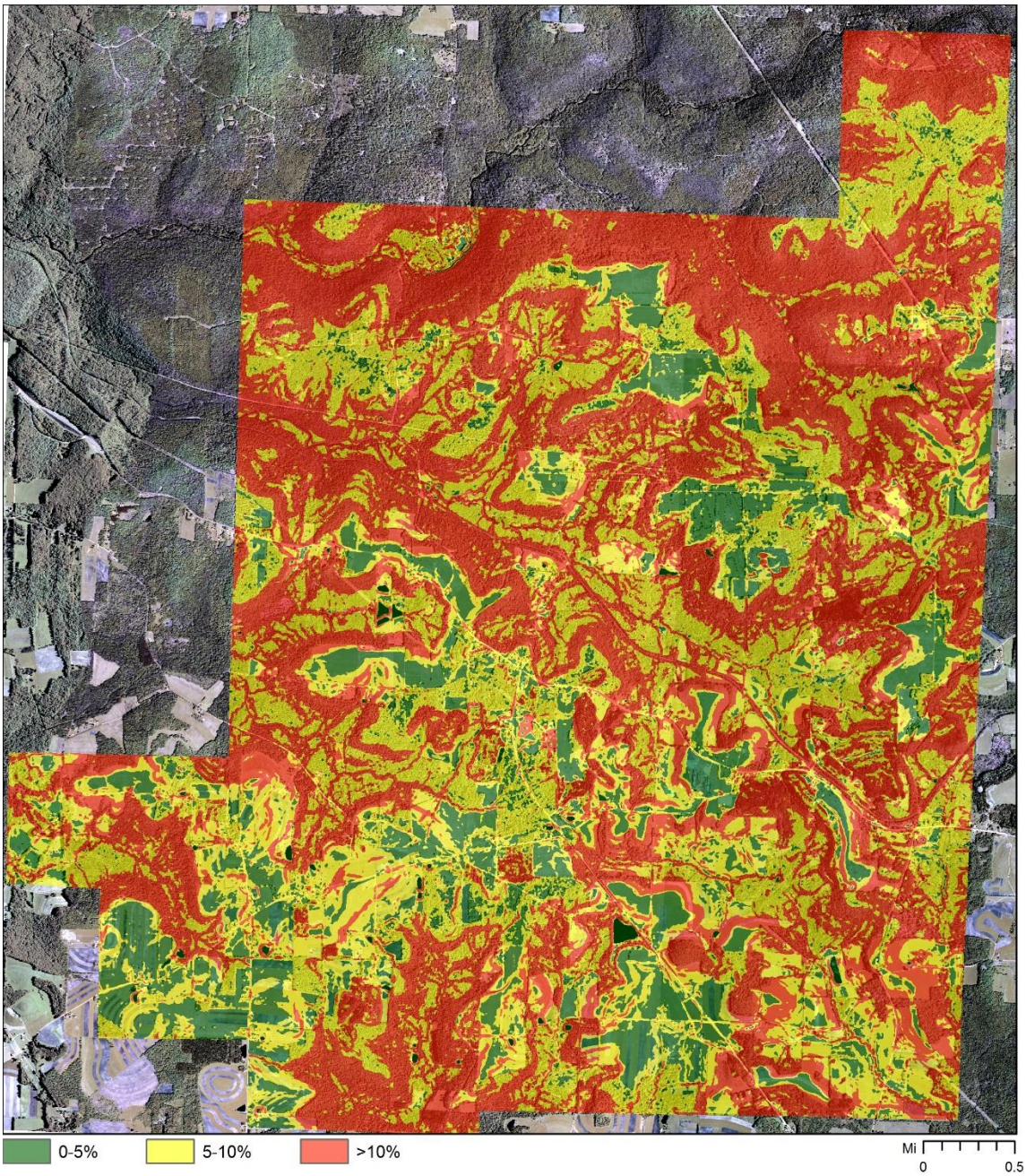


Figure 5. Reclassified slope degrees; green is level/gentle, yellow are moderate, and red are steep slopes.

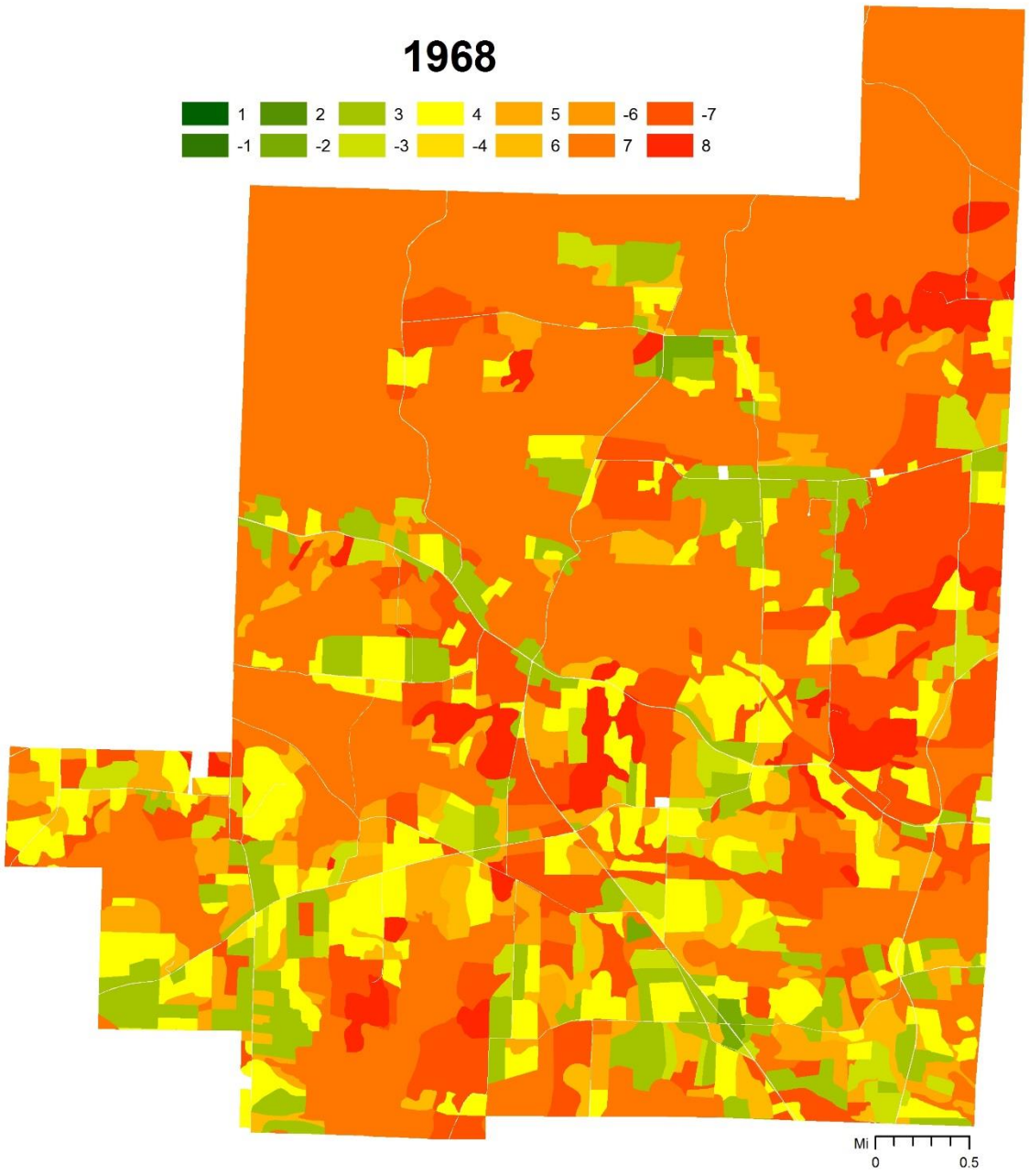


Figure 6. Land Classification Polygons of 1968

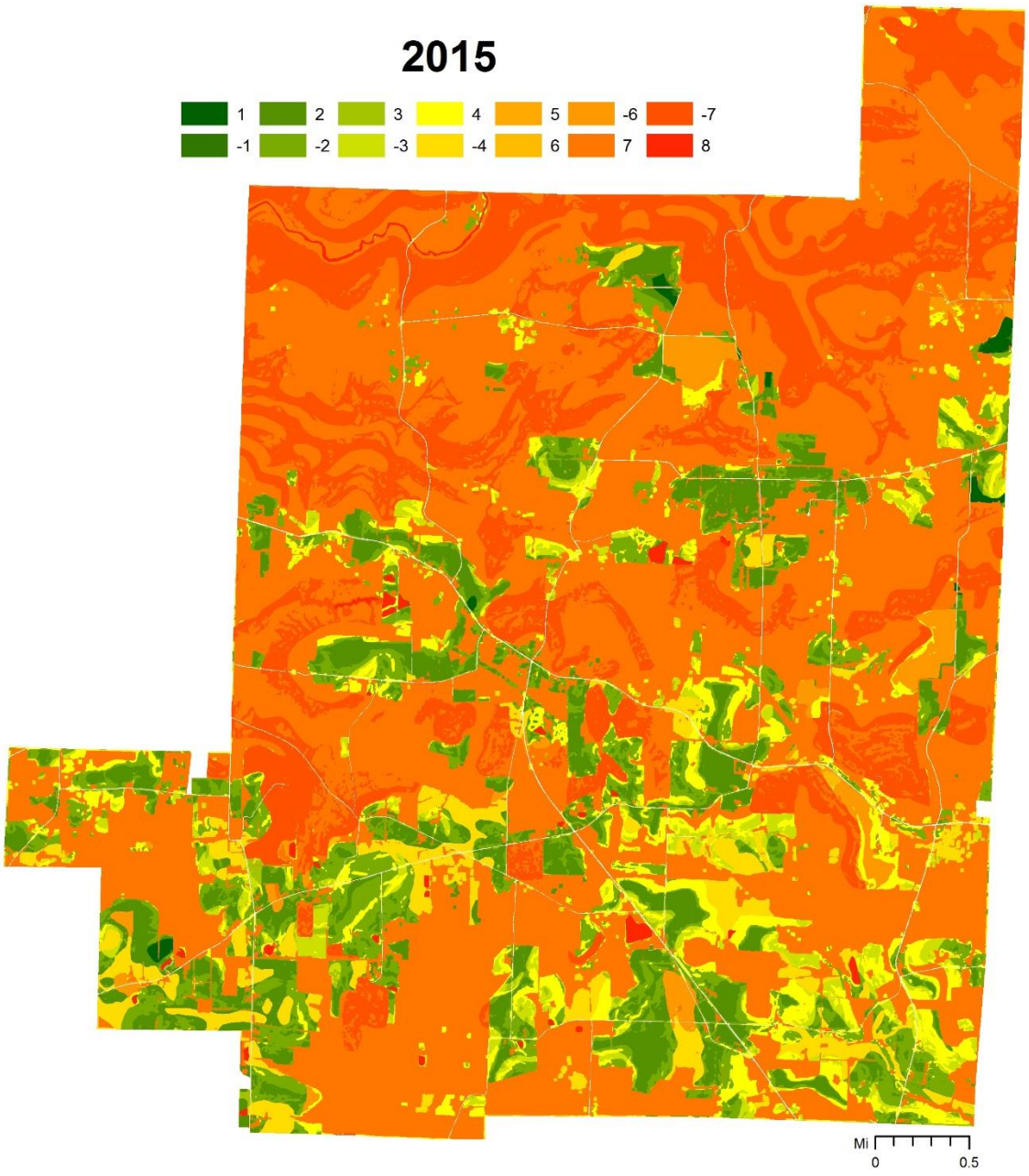


Figure 7. Calculated Land Classification Polygons of 2015

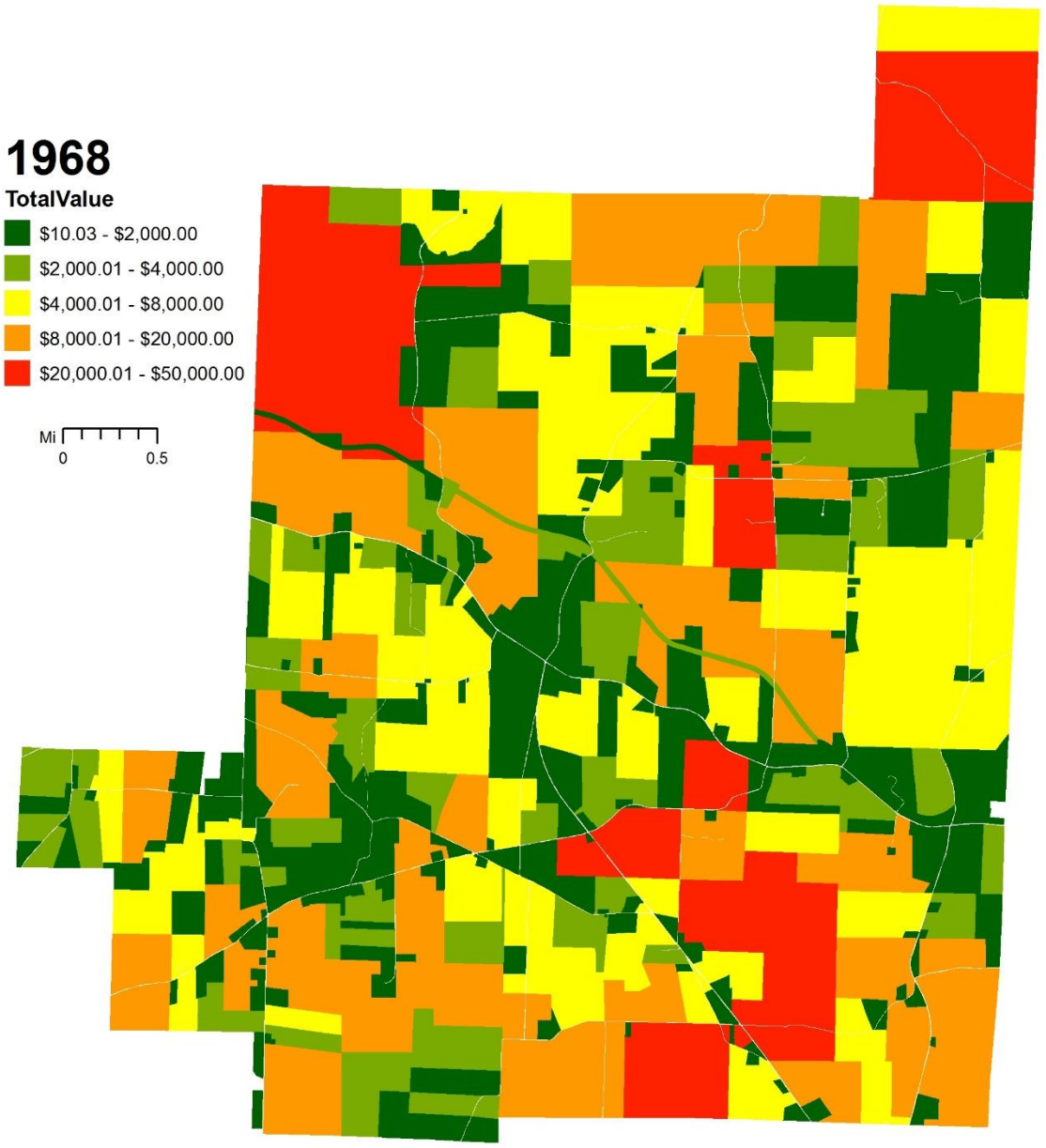


Figure 8. The calculated 1968 parcel values

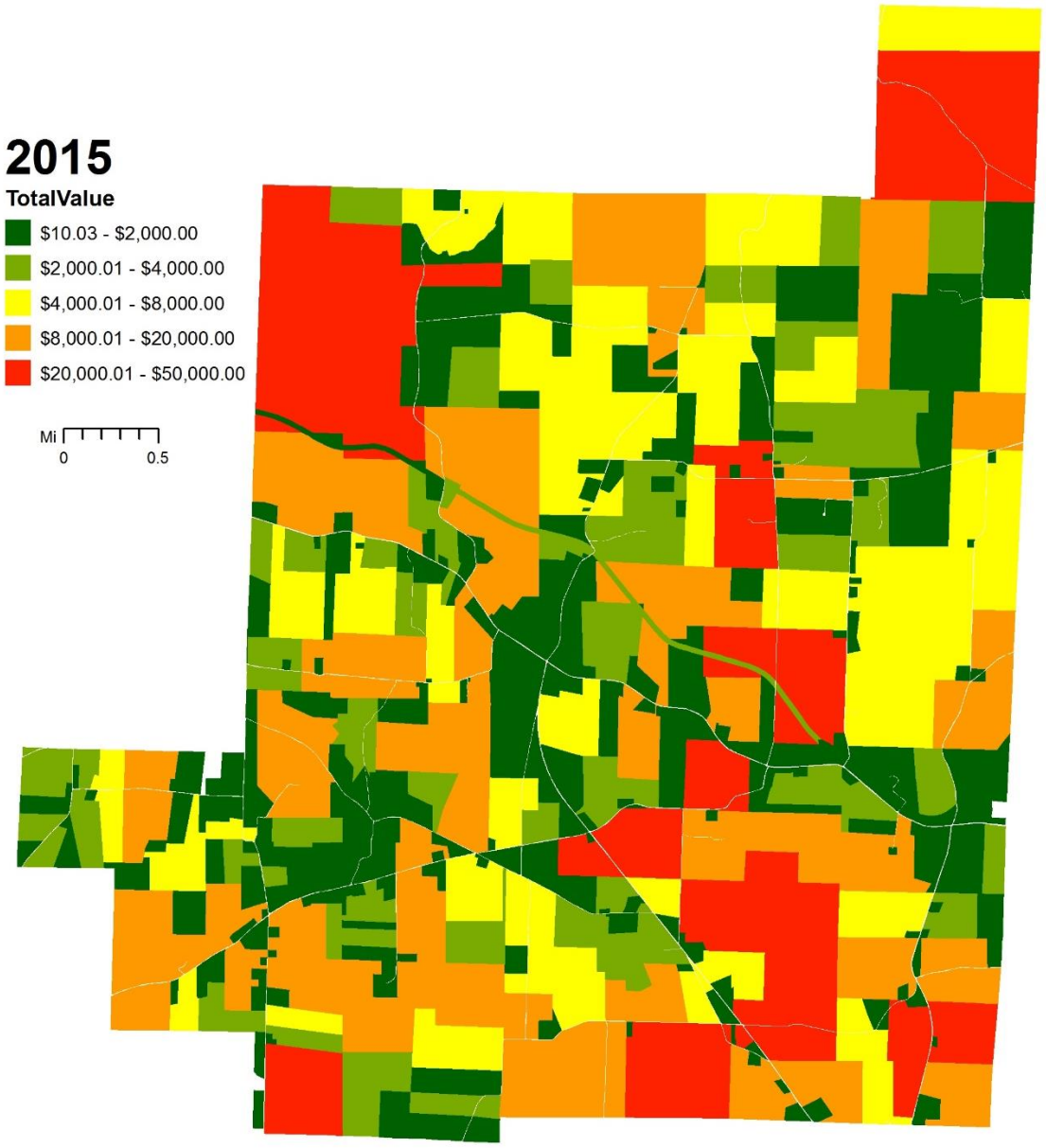


Figure 9. The calculated 2015 parcel values

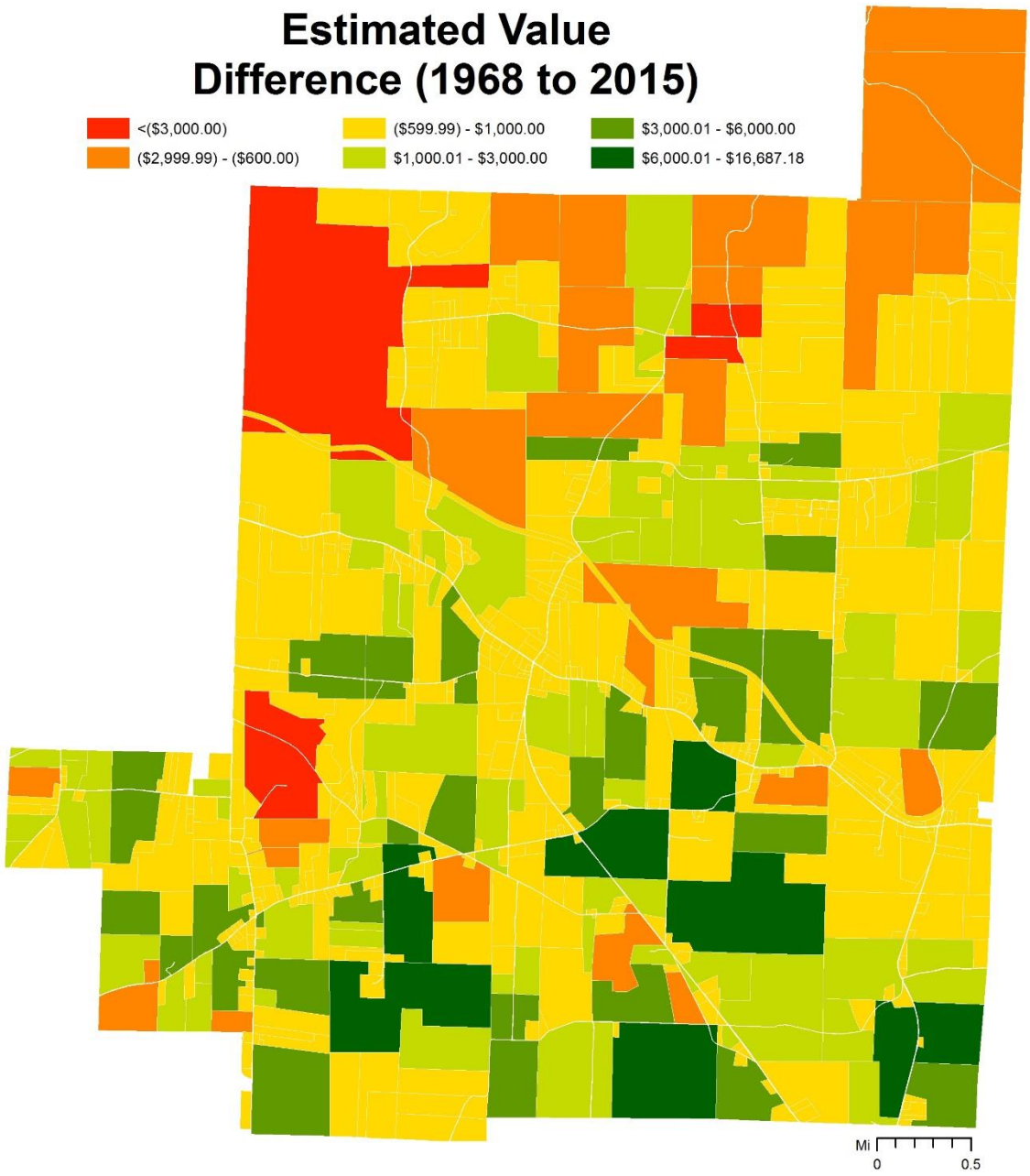


Figure 10. Estimated value difference between 1968 and 2015. Yellow polygons are those with no to little change.

Overall, there is a general area decrease in class 3, -3, 4, 5, 6, and 8, and an area increase of classes 2, -2, -4, -6, 7 and -7 (Figure 11). This is translated in a total property value increase of $263,297.94 in Ashland township. It is important to note that the dollar values were calculated with no consideration to the percentage of improved land within a parcel for either 1968 or 2015.

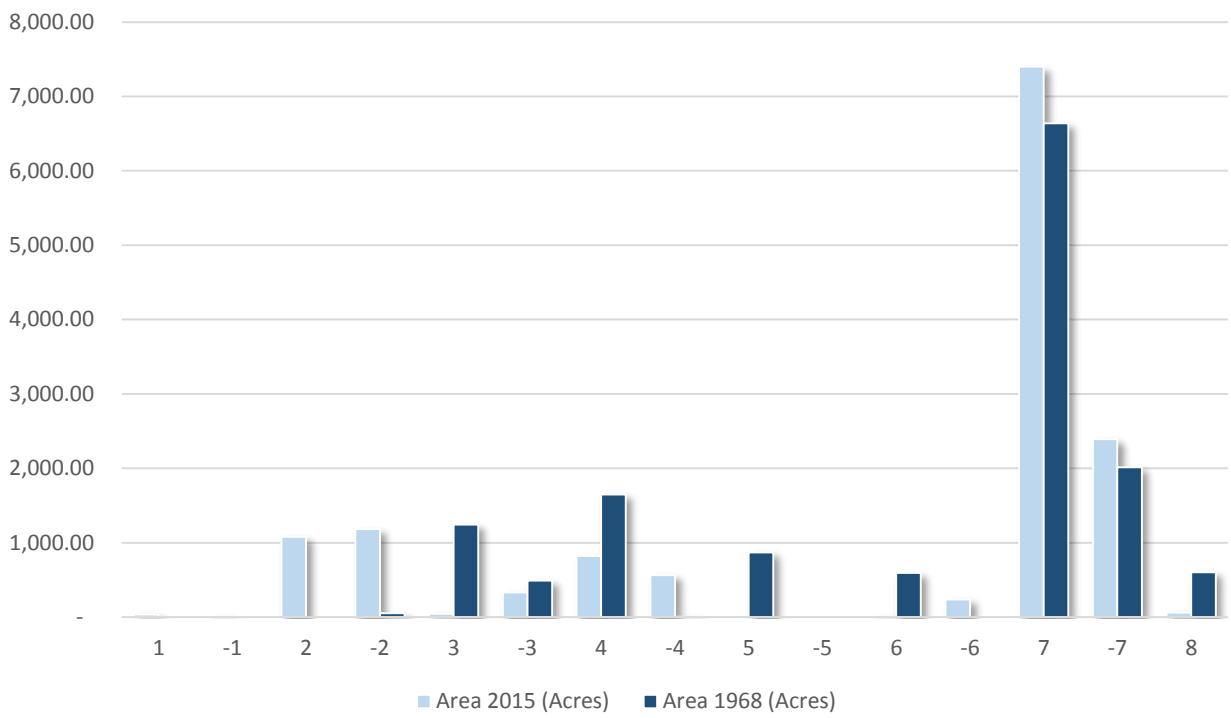


Figure 11. Total acreage difference between 1968 and 2015 in Ashland Township

Furthermore, the estimated difference in parcel value was also calculated for the parcels of 100 Acres or more. 29 parcels with the largest being at 681.12 Ac and the smallest at 103.11Ac, 10 of those had decreased in value from 1968 to 2015, while the remaining 19 parcels increased. Overall, there were a $54,424.12 net increase in value of all parcels. The change in value for those parcels are presented in Figure 12.

On the other hand, the parcels with areas between 50 and 100 acres (57) had an overall net increase of $88,432.53 from 1968 to 2015. The largest parcel was 95.59 Ac while the smallest was 50.02 Ac. The largest decrease in value was $5,525.42, while the largest increase was at $6,270.71 (Figure 13).

Conclusions

It is expected that the land value of most of Clarion County municipalities would follow the same overall trend since land during 1968 was heavily mined, and, from since, many remediation practices took place. Land has been reclaimed and many farmers have adopted higher standards for agricultural practices. This resulted in the increase in forested areas as well as an overall increase in the quality of the agricultural land.

The methods presented in this study could be applied on all municipalities in the county, new estimated values could be calculated, and the results could be compared in order to trace a more solid recommendation for reevaluation of the land classification system that is currently being used for property valuation in the Clarion County Assessment office. The inclusion of any percentages of improvement in the property value calculation is possible, in this case, the building footprints would be an

integral part in the process. It is also recommended that this method is applied to a variety of townships and evaluated in order to have a more robust confirmation of the applied techniques as well as the results.

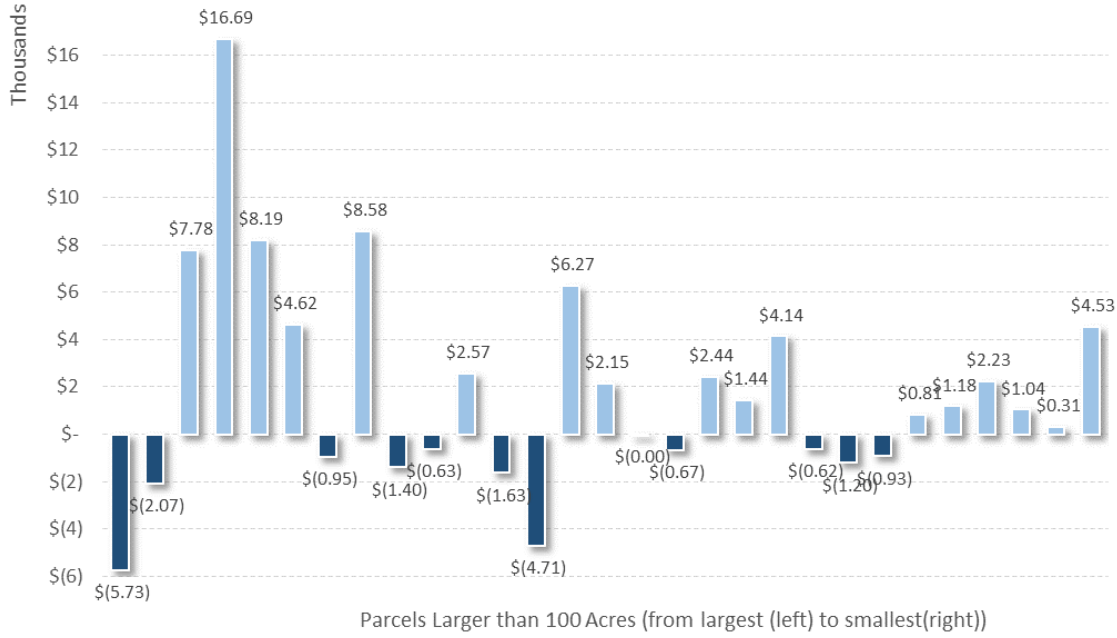


Figure 12. Estimated value change between 1968 and 2015 in parcels of 100 Acres or more (Ashland Township)

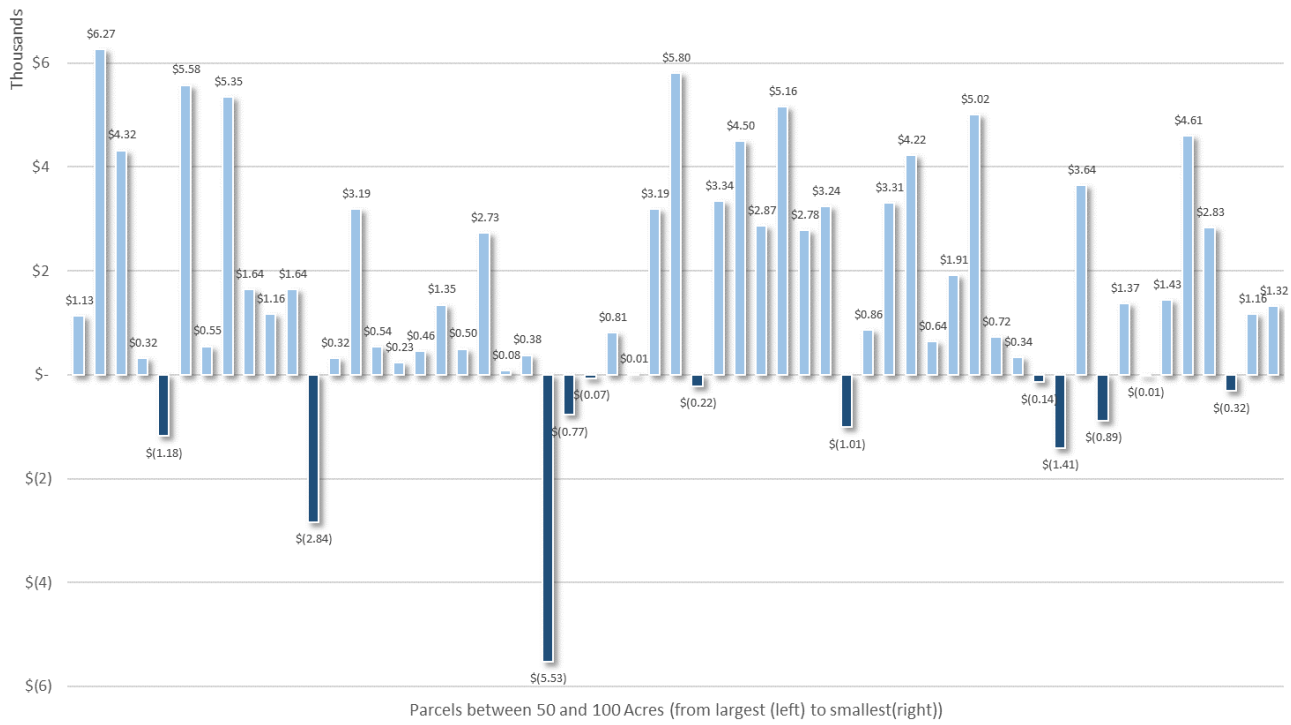
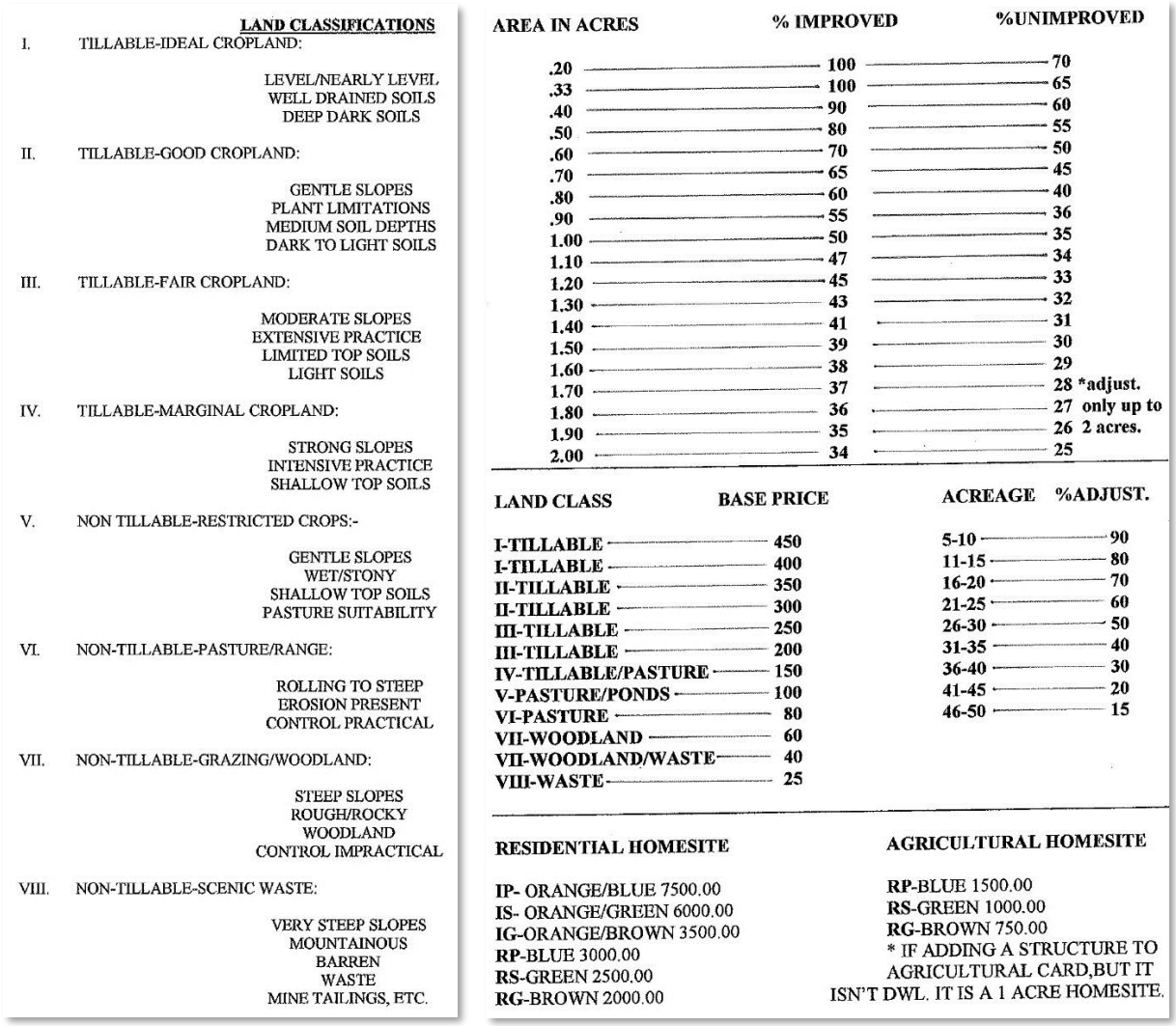


Figure 13. Estimated value change between 1968 and 2015 in parcels of area between 50 and 100 Acres (Ashland Township)

Appendix

Land Classification adopted by Clarion County for property valuation



LAND CLASSIFICATIONS

I. TILLABLE-IDEAL CROPLAND:
LEVEL/NEARLY LEVEL
WELL DRAINED SOILS
DEEP DARK SOILS

II. TILLABLE-GOOD CROPLAND:
GENTLE SLOPES
PLANT LIMITATIONS
MEDIUM SOIL DEPTHS
DARK TO LIGHT SOILS

III. TILLABLE-FAIR CROPLAND:
MODERATE SLOPES
EXTENSIVE PRACTICE
LIMITED TOP SOILS
LIGHT SOILS

IV. TILLABLE-MARGINAL CROPLAND:
STRONG SLOPES
INTENSIVE PRACTICE
SHALLOW TOP SOILS

V. NON TILLABLE-RESTRICTED CROPS:-
GENTLE SLOPES
WET/STONY
SHALLOW TOP SOILS
PASTURE SUITABILITY

VI. NON-TILLABLE-PASTURE/RANGE:
ROLLING TO STEEP
EROSION PRESENT
CONTROL PRACTICAL

VII. NON-TILLABLE-GRAZING/WOODLAND:
STEEP SLOPES
ROUGH/ROCKY
WOODLAND
CONTROL IMPRACTICAL

VIII. NON-TILLABLE-SCENIC WASTE:
VERY STEEP SLOPES
MOUNTAINOUS
BARREN
WASTE
MINE TAILINGS, ETC.

AREA IN ACRES	% IMPROVED	%UNIMPROVED
.20	100	70
.33	100	65
.40	90	60
.50	80	55
.60	70	50
.70	65	45
.80	60	40
.90	55	36
1.00	50	35
1.10	47	34
1.20	45	33
1.30	43	32
1.40	41	31
1.50	39	30
1.60	38	29
1.70	37	28 *adjust.
1.80	36	27 only up to
1.90	35	26 2 acres.
2.00	34	25

LAND CLASS	BASE PRICE
I-TILLABLE	450
I-TILLABLE	400
II-TILLABLE	350
II-TILLABLE	300
III-TILLABLE	250
III-TILLABLE	200
IV-TILLABLE/PASTURE	150
V-PASTURE/PONDS	100
VI-PASTURE	80
VII-WOODLAND	60
VII-WOODLAND/WASTE	40
VIII-WASTE	25

ACREAGE	%ADJUST.
5-10	90
11-15	80
16-20	70
21-25	60
26-30	50
31-35	40
36-40	30
41-45	20
46-50	15

RESIDENTIAL HOMESITE

IP- ORANGE/BLUE 7500.00
IS- ORANGE/GREEN 6000.00
IG-ORANGE/BROWN 3500.00
RP-BLUE 3000.00
RS-GREEN 2500.00
RG-BROWN 2000.00

AGRICULTURAL HOMESITE

RP-BLUE 1500.00
RS-GREEN 1000.00
RG-BROWN 750.00
* IF ADDING A STRUCTURE TO AGRICULTURAL CARD,BUT IT ISN'T DWL. IT IS A 1 ACRE HOMESITE.

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