

Exploring the ecological legacy of redlining maps used by the Home Owner's Loan Corporation in Indianapolis: 80 years later

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Abstract

Redline mapping, as practiced by the Home Owner's Loan Corporation (HOLC) in the 1930s, has been criticized for evident racial discrimination in addition to financial risk assessment. Modern urban tree canopy cover has been demonstrably lower in historically redlined zones of four US cities already. This project is focused on Indianapolis, IN, where a HOLC map was developed in 1937. Analysis using a geographic information system (GIS) was conducted in order to detect evidence of an ecological legacy of redlining. Using this method, evidence of relatively high-intensity development, low greenspace and forest cover, and disproportionately high incidences of brownfield, Superfund sites, industrial waste sites, and interstate highways were detected in historically redlined zones in Indianapolis. While opportunities for further and more detailed research are considered, the method employed here should be replicable for other cities with redlining histories in Indiana and other states with comparable spatial datasets.

Introduction

The Home Owner's Loan Corporation (HOLC) utilized maps which classified risk of loan defaults in cities across the United States in the 1930s. The maps accounted for, among other socioeconomic factors, the ethnic and racial profiles of each mapped zone (Figure 3). Zones of the lowest grade were shaded red, considered "hazardous" financial risks and residents routinely were denied loans. Modern canopy cover has been analyzed in four US cities – Durham, NC, Fresno, CA, Pittsburgh, PA, and Portland, OR – and evidence of an ecological legacy of redlining has emerged. Specifically, canopy cover steadily decreased moving from Grade A through Grade D zones (Cooper, Liberti, and Asch).

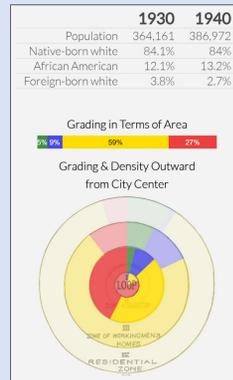


Figure 1. Historical demographic and HOLC grading overview for Indianapolis. Source: University of Richmond.

Indianapolis, Indiana's redline map dates to 1937 (Figures 2 and 3), during a decade of growth for the city. Both the overall population and proportion of African Americans grew in the 1930s, and each of these measures has more than doubled over the course of the seven decades to follow (US Census Bureau).

This project was undertaken in an attempt to:

- Detect evidence of any ecological legacy which correlates to Indianapolis' redlining history
- Develop techniques and presentation of results which will be replicable for other cities

Methods

A digital copy of the HOLC map for Indianapolis (Figure 2) was captured from the University of Richmond's web project, *Mapping Inequality: Redlining in New Deal America*. Upon uploading the map into ArcMap 10.4, the HOLC scan was georeferenced using six control points along the edges and interior of the map. Then, the editor toolbar was used to trace polygons (Figure 4) over each of the 71 zones which appeared in the map. This new digital map layer (Figure 5) was saved as a shapefile and regarded as the official area of interest, so all subsequent map layers were trimmed to the areas contained within these boundaries.

Additional map layers from the Indiana Geographic Information Council's *IndianaMAP* resources were considered for their relevance to human health or habitat disruption. Five were imported to ArcMap and analyzed over the area for which they intersected HOLC zones:

- Land Cover
- Brownfields
- Superfund Sites
- Industrial Sites
- Interstate Highway Mile Markers

The land cover was a raster layer (.tif file), so it was converted to polygons in ArcMap before it could be overlaid with the HOLC zone polygons. Maps were exported to display each of these intersections (Figures 6 and 7). The Calculate Geometry feature was used to determine the area of each polygon in square meters. The attributes from each layer which intersected with the HOLC polygons were exported as tables into Microsoft Excel (.xlsx) files for data analysis. All other calculations, including unit conversions and summing of land areas, were completed in Excel. Tabular summaries (Tables 1-3) were constructed and formatted in Excel.

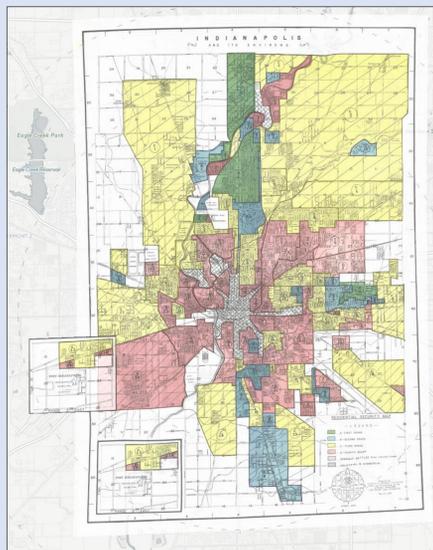


Figure 2. Digital scan of the 1937 HOLC redlining map for Indianapolis, Indiana. Source: University of Richmond.

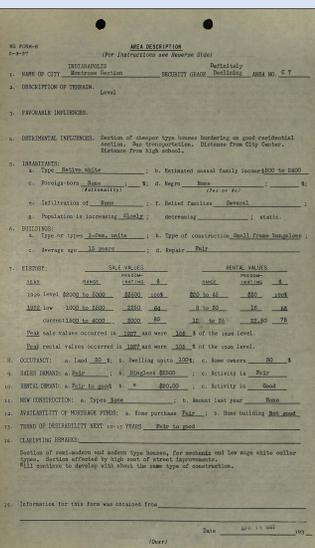


Figure 3. Digital scan of the Area Description report for Zone C7, dated 11 April 1937. Reports of this type remain viewable for most HOLC zones in the city. Source: University of Richmond.

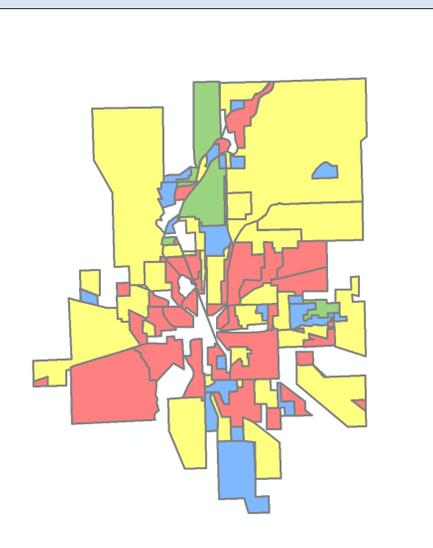


Figure 4. Polygons traced over the 1937 HOLC redlining map after georeferencing in ArcMap 10.4. All other map layers were overlaid with this one, with all summary data reflecting those attributes which intersected with the polygons in this shapefile.

Results

A majority of the land area assigned in 1937 was designated Grade C, though more zones were assigned to Grade D (i.e. "redlined") than any other (Table 1). Most of the Grade A land area was found in the north part of the city, near the Meridian Hills neighborhood. Neighborhoods gaining Grade B designation were scattered throughout the city, while Grade C designations were common on the outer edges of the HOLC map. The redlined zones were especially common in the central core of the city and nearby to the south. While most HOLC zones were less than 2 square miles, the largest (Zone C5) was greater than 25 square miles (Figure 5).

Table 1. Summary of 1937 HOLC zones in Indianapolis, based on geometry calculations of vectors drawn in ArcMap 10.4 and summarized in Microsoft Excel.

Grade	A	B	C	D	TOTAL
Zone Count	5	17	23	26	71
Area, sq. mi.	7.5	12.2	81.8	37.4	138.9

Land was predominantly developed throughout the HOLC zones according to 2011 imagery, collected 74 years after the redlining map was generated. With each grade successively higher than the redlined Grade D, the proportion of developed land cover decreased while the proportion of greenspace increased. There was greater than a five-fold difference between greenspace coverage in Grade A versus Grade D zones, while forest cover per area was more than seven times greater in Grade A versus Grade D zones (Table 6). The disparities appear less dramatic when the redlined zones are compared to all non-redlined zones together (i.e. Grades A, B, and C), but the redlined citizens still enjoy less than half the greenspace and forest cover per area (Table 3).

The legacy of redlining also appears to correlate to other environmental factors. Nearly 60% of modern brownfields in the study area of Indianapolis were found in zones which were redlined in 1937 (Figure 7a). Of the four Superfund sites registered to the study area, all four were in redlined areas (Figure 7b). Industrial sites were located all over the city, but 49.1% of them were found in redlined zones (Figure 7c). Two stretches of interstate highway to cut across the city: I-65 and I-70. Of the mile markers found within the study area, most (69.2%) were found to be situated in the historically redlined zones (Figure 7d). Considering that the redlined zones made up only 27% of the historical HOLC map (Figure 1, Table 1), all of these environmental burdens appear to have been disproportionately placed upon these citizens in the intervening decades.

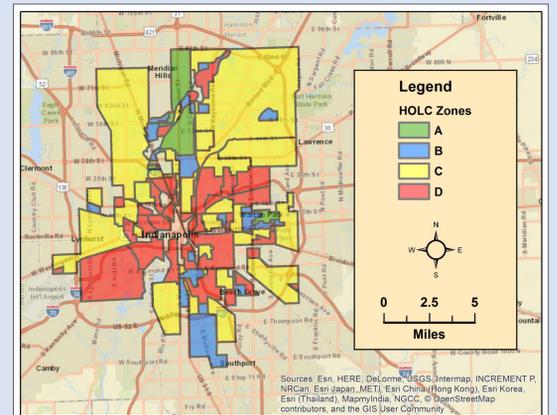


Figure 5. Lending security zones of the Home Owner's Loan Corporation (HOLC), dating to 1937, laid over a modern-day street map of Indianapolis, Indiana.

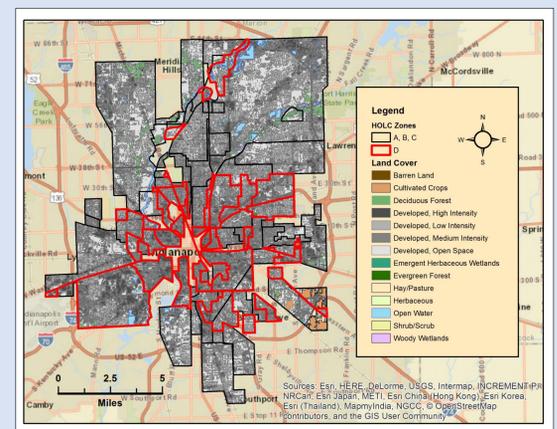


Figure 6. Land cover, dated 2011, as it was distributed throughout the lending security zones of the Home Owner's Loan Corporation (HOLC), dating to 1937. Zones which were "redlined", where residents were least likely to be accepted for loans in the 1930s, are highlighted.

Table 2. Land cover, dated 2011, in Indianapolis zones designated in the Home Owner's Loan Corporation (HOLC) lending security map, dating to 1937.

Land Cover	Percentage by HOLC Zone				All HOLC (9364 Acres)
	A (418 Acres)	B (753 Acres)	C (5175 Acres)	D (3018 Acres)	
Open Water	1.2	0.6	0.6	0.8	0.7
Developed - Open	28.0	20.9	22.0	19.0	21.2
Developed - Low Intensity	28.6	32.9	32.2	29.2	31.1
Developed - Medium Intensity	28.9	29.7	32.5	36.0	33.2
Developed - High Intensity	4.3	10.7	9.6	13.3	10.7
Barren	0.0	0.0	0.0	0.0	0.0
Forest - Deciduous	7.0	3.8	1.9	1.0	2.0
Forest - Evergreen	0.4	0.2	0.1	0.0	0.1
Shrub	0.4	0.1	0.2	0.0	0.1
Herbaceous	0.1	0.2	0.0	0.0	0.0
Hay/Pasture	0.0	0.0	0.1	0.0	0.0
Cultivated Crops	0.0	0.0	0.1	0.0	0.1
Wetlands - Woody	0.0	0.0	0.1	0.1	0.1
Wetlands - Herbaceous	1.2	1.0	0.6	0.6	0.7
Percent Developed	89.7	94.1	96.3	97.5	96.2
Percent Agricultural	0.0	0.0	0.2	0.1	0.1
Percent Green Space	9.1	5.3	2.9	1.7	3.0
Percent Forest	7.4	4.0	2.0	1.0	2.1

Table 3. Land cover, dated 2011, in non-redlined (Grades A-C) versus redlined (Grade D) zones designated in the Home Owner's Loan Corporation (HOLC) lending security map, dating to 1937.

Land Cover	Percentage by HOLC Zone		All HOLC (9364 Acres)
	A B C (6347 Acres)	D (3018 Acres)	
Open Water	0.6	0.8	0.7
Developed - Open	22.2	19.0	21.2
Developed - Low Intensity	32.0	29.2	31.1
Developed - Medium Intensity	31.9	36.0	33.2
Developed - High Intensity	9.4	13.3	10.7
Barren	0.0	0.0	0.0
Forest - Deciduous	2.5	1.0	2.0
Forest - Evergreen	0.1	0.0	0.1
Shrub	0.2	0.0	0.1
Herbaceous	0.0	0.0	0.0
Hay/Pasture	0.0	0.0	0.0
Cultivated Crops	0.1	0.0	0.1
Wetlands - Woody	0.1	0.1	0.1
Wetlands - Herbaceous	0.7	0.6	0.7
Percent Developed	95.6	97.5	96.2
Percent Agricultural	0.1	0.1	0.1
Percent Green Space	3.6	1.7	3.0
Percent Forest	2.6	1.0	2.1

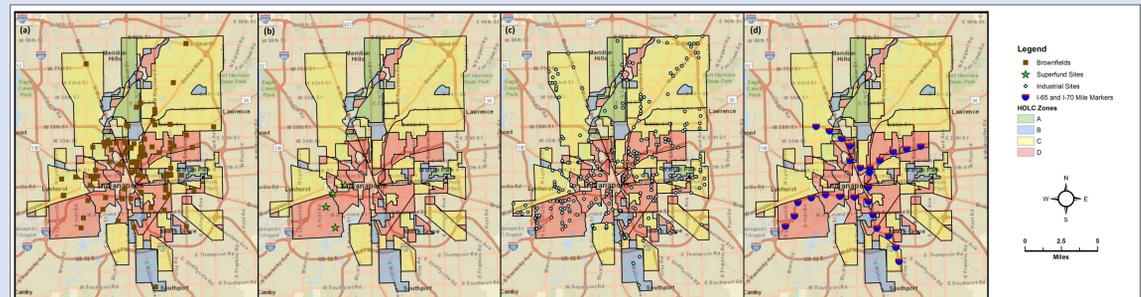


Figure 7. Distribution of modern attributes throughout the zones designated in the Home Owner's Loan Corporation lending security map, dating to 1937. Mapped are (a) brownfields, (b) Superfund sites, (c) industrial sites, and (d) interstate highway (I-65 and I-70) mile markers.

Discussion and Conclusion

Land cover analysis revealed that historically redlined zones have experienced more intense development than other parts of the city. Unless some of the redlined development has or is reversed, there was such a high rate of developed lands in Grade D zones that achieving forest coverage comparable to the Grade A or B zones will be virtually impossible. Use of higher-resolution imagery, such as the 1-m raster produced by the National Agricultural Imagery Program (NAIP), could make estimations and recommendations more precise.

The remaining variables demonstrated a disproportionate high-frequency of environmental burdens in the redlined zones in Indianapolis. All of these other variables were point vector layers (Figure 7), making the analytical steps virtually identical for each so far. More complex analysis will be possible if other attributes – especially those which more adequately capture the true "footprint" of each point – can be added to the datasets and subsequently mapped. Threats to human health or habitat can be inferred by the existing data, but much remains to be explored in finer detail.

Overall, the strengths of this method are in its relative simplicity and convenience. Relatively few spatial analysis steps were required to take the analysis to its present state, and all data were freely available within the state of Indiana. The method will be improved by as more varied and/or detailed datasets can be incorporated, both of social and ecological natures.

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