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How Much Heirs' Property Is There? Using LightBox Data to Estimate Heirs' Property Extent in the United States

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Abstract

The ramifications of a tenancy in common or heirs' property ownership are extensive. This kind of tenuous ownership affects not only individual families but also the economic health of the typically minority and lower-wealth communities where these properties tend to cluster. Very little research has identified heirs' property extent at a broad scale, however. We present results of our approach to identifying heirs' parcels for every county and census tract in the United States, using geospatial methodologies and aggregated parcel records acquired from LightBox. The method estimated 444,172 heirs' parcels for the U.S., not including territories. The combined acreage is 9,247,452 worth $41,324,318 billion. We discuss shortcomings of secondary parcel data and the problems this presents for accurately assessing heirs' property extent, while the spatial location aspect allows us to analyze for spatial patterns such as clustering, which supports new analyses of issues associated with heirs' property.

KEYWORDS: geographic information systems, heirs' property, spatial analysis, tenancy in common

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Introduction

Wealth disparities between African Americans and Whites were more pronounced in 2020 than at the turn of the twentieth century (McIntosh et al. 2020; Traub et al. 2015). This is due in large part to differences in assets held by the two groups, especially for those at the lower end of the socioeconomic ladder (Oliver and Shapiro 2005; Thompson and Suarez 2015; Traub et al. 2015). Those in the top 10 percent of the U.S. income distribution are twice as likely as those in the bottom 50 percent to receive an inheritance (Feiveson and Sabelhaus 2018). Also, White families are two times as likely as African Americans to receive intergenerational wealth transfers, which add a median $104,000 for a typical White family, compared to $4,000 for the typical African American family (Batchelder 2020).

Home ownership represents a larger share of African American (relative to Whites) assets and thus intergenerational wealth transfers (Aliprantis and Carroll 2019; Oliver and Shapiro 2005; Shapiro, Meschede, and Osoro 2013). Yet, there are dramatic differences in homeownership rates between African Americans and Whites, a large part of which can be attributed to both historical and contemporary racial discrimination (Rothwell and Perry 2022). In the past, this presented as federally mandated redlining in the public sector and exclusion of Blacks from federal lending programs, and more recently as institutionalized banking practices where subprime mortgages were more likely to be offered to African American and Hispanic or LatinX borrowers (Rothstein 2017; Traub et al. 2015). Crucially, when African Americans do own homes and other real property, it is more likely to be held in an informal manner, as a tenancy in common, that is, as "heirs' property." This means the property is owned by multiple family members whose names do not appear on the property deed or title, but rather the names of deceased family members who died without a will (that is, intestate) transferring their ownership interests to specific family members. Because of uncertainties about who the co-heirs are or how many exist, heirs' property ownership amounts to undocumented possession, which severely curtails co-owners' ability to operate more fully in formal credit markets, other factors equal (Deaton 2005; Heller 1998).

Challenges associated with heirs' property ownership have become a focal point of national-, state-, and local-level policy, owing to the array of problems this form of real property ownership presents to owners. To address these issues comprehensively, it is necessary first to understand the scope or magnitude of heirs' property extent. Certainly, one of the first questions typically posed about heirs' property is "How much exists in my [fill in city, state, or neighborhood]?" Recent popular press articles (*ProPublica, New Yorker, The Nation*) report that more than one-third of all Black-owned land in the South is heirs' property, summing to 3.5 million acres worth approximately $28 billion (Chen 2019; Presser 2019). However, these estimates were misconstrued. The $28 billion price tag reported by Presser (2019) is a preliminary, unpublished estimate of heirs' property extent calculated by the second author and applies to heirs' properties broadly in the U.S. South, not just to African American–owned land. The reporters may have also linked this estimate to C. Scott Graber's late 1970s calculations which estimated that roughly one-third of all Black-owned land in the South was heirs' property at that time (Graber 1978). Of course, the more recent dollar value is not related to the prior tabulations of heirs' property acreage. This is just one instance illustrating how information about heirs' property ownership and extent has been difficult to calculate and even more challenging to verify.

We present a methodology that automates the process of identifying heirs' property parcels and related values at both the county and U.S. Census Bureau census tract scale for all 50 U.S. states and the District of Columbia. This is an important undertaking from a policy perspective because it helps delineate where

this kind of ownership clusters. This demarcation, in turn, aids efforts to pinpoint place-based, legislative responses to communities contending with an array of social challenges, in addition to heirs' property ownership (Mitchell 2005). Recognizing that social vulnerabilities bunch and are thus compounded, identifying heirs' property concentrations can also help determine whether and to what extent these parcels co-locate with other social vulnerability metrics and indices (e.g., SoVI, SVI) (ATSDR 2022; Rufat et al. 2019). However, our primary goal in this paper is to estimate the number of heirs' property parcels in the U.S. and to map their extent across the country.

Literature Review

Since the late 1970s, various efforts to document heirs' property ownership at varying scales have been undertaken. We review several of the most-cited efforts historically, along with several recent attempts. Our review is not exhaustive. For instance, we do not include estimates for some smaller locales and any examining Native American allotments, which are effectively heirs' properties if they remain in federal trust (Johnson Gaither 2016; Kunesh 2019; Shoemaker 2003).

Early efforts involved manual reviews of tax and court records and surveys. Graber (1978) assessed heirs' property extent in 10 Alabama, Georgia, Mississippi, North Carolina, and South Carolina counties. Local tax officials identified African American landowners listed on county tax rolls, and then local tax auditors named heirs' properties. Graber (1978) extrapolated these findings to the larger five-state region, estimating that roughly one-third of all rural Black-owned land was heirs' property at that time. Two years later, the Emergency Land Fund (1980) used a household survey and extensive ground-truthing (collaborating with local tax and court officials) to verify African American–owned land, again in the same five states. That analysis uncovered roughly 9 million acres of land in these states associated with Black landowners. Of these, about 3.8 million acres were classified as heirs' property based on respondents' replies on queries specific to heirs' property.

Deaton's (2005) study of Letcher County, Kentucky, was the first to document heirs' property outside of the Deep South, using data from the county's taxing authority. A randomly distributed survey was sent to nonindustrial family landowners asking how they held land, that is, as fee simple (allodial holding), partial interest (tenancy in common), life estate, or another arrangement. Roughly 24 percent indicated they owned a tenancy in common or heirs' property. A few years later, Dyer et al. (2009) examined tax records in Macon County, Alabama, to identify specific terms used to denote heirs' parcels. Notation such as "heirs of" or "both dec'd" (deceased) next to the owner's name provided evidence of tenancy in common status. Estimates were verified by staff at the taxing office who were familiar with the property-owning public. The method yielded 1,516 parcels, covering 15,937 acres (4.1 percent of county land area), with a value of more than $25 million.

Building on Dyer et al. (2009), Georgia Appleseed (2013) used a two-stage process to identify heirs' parcels in Georgia. They first examined online tax parcel cards for properties in selected Georgia counties. These data were used to build an index of probable heirs' parcels based on property characteristics indicating whether the owner's mailing address was different from the property address; low land value; lack of recent sale or conveyance information; and lack of or dated improvement information. Seasoned real estate attorneys then narrowed these selections to derive final estimates. For Chatham, Chattooga, Dougherty, Evans, and MacIntosh counties, 1,620 parcels were found across 5,215 acres, valued at $58,649,195.

Advances in data digitization and aggregation have resulted in the proliferation of "big data"—that is, exponential increases in the volume, production, and variety of data that allow analysts to mine and manipulate huge quantities of data relatively in short timeframes (King 2011). Pippin et al. (2017) accessed one such data source, computer assisted mass appraisal (CAMA) files from the University of Georgia, Anderson County, South Carolina, and Cameron County, Texas. The researchers used a geographic information sciences (GIS) format to automate the methodologies described by Georgia Appleseed (2013) and to a lesser extent Dyer et al. (2009), resulting in the first documented effort to spatially locate heirs' properties across a broad geographic range.

The methodology scrubbed parcels associated with businesses, educational institutions, religious organizations, or governments, leaving only "natural people" (Pippin et al. 2017:26). Also excluded were parcels with preferential tax status, as heirs' property owners are less likely to have this advantage; and parcels that had a sale date within the past thirty years were removed because parcels with more recent sale dates are less likely to have deceased owners. The resulting dataset was described as "potential heirs' properties" because indirect indicators were used to pull the records. Estimates for ten Georgia counties ranged from 11 to 25 percent of all county parcels. The total appraised value was $2.1 billion. Percent of heirs' property for Anderson County, South Carolina, was 9 percent, with a value of $821 million, and 25 percent for Cameron County, Texas, total value of $2.5 billion.

A recent analysis of heirs' property in an urban context was published by The Pew Charitable Trust for Philadelphia in 2021 (Pew Charitable Trust 2021). Called "tangled titles" in Philadelphia, heirs' parcels were identified by matching names and addresses of residential property owners as of 2016 with the Social Security Administration's Death Master File to determine whether the recorded property owner was still living. Properties with owners who had been dead for more than two years were flagged as heirs' parcels. A total of 10,407 properties were identified which accounted for 2 percent of all residential properties, with a value exceeding $1.1 billion. The study found similarities in terms of co-location of heirs' property with other vulnerability markers such as low income, higher poverty rates, and percent African American. An earlier analysis was also conducted in Philadelphia in 2007 by the University of Pennsylvania's Cartographic Modeling Lab for the nonprofit group VIP, also comparing the same database of death records with owners listed on the deed—14,001 parcels were classed as tangled.

Finally, Thomson, Bailey, and Gunnoe's (forthcoming) analysis built on both Dyer et al. (2009) and Pippin et al. (2017) to automate heirs' property identification for the thirteen states comprising the USDA Forest Service's Southern Region (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia), plus West Virginia. Like others, they restricted their search to residential properties owned by natural or noncorporate individuals. Their approach employed a weighting scheme where properties with more explicit indications of heirs' status, such as "estate of," "heirs of," "et al.," were assigned a value of two. Parcels with the notation "care of," those that had not been repaired in the past 29 years, nor sold in the past 29 years were assigned a score of one. A parcel could obtain a maximum score of five. Parcels with a score of three or more were categorized as heirs' property.

Methodology

To build an automated process and complete estimates of heirs' property quantities across the U.S., we required three inputs: parcel data, knowledge of terms and phrases associated with heirs' property designations, and applicable computing technology. For input data we used a commercial parcel dataset

product from LightBox (formerly Digital Map Products, Inc.) (LightBox Holdings, L.P., 2022), acquired through a contract that the Forest Inventory and Analysis (FIA) Branch of the USDA Forest Service has with the company. The dataset provides spatial location and an array of attribute fields, most importantly including owner, area, and value information, for each parcel. Proprietary datasets such as this are usually built by performing mass imports of county parcel data; however, neither the original county data nor the mass imports are without error.

Consequently, some fields, such as market and assessed property values and acreage varied by state, with respect to being completely populated. Thus, we advise caution in interpreting parcel value results. The LightBox datasets we used were transferred to FIA on November 23, 2021, and stored by FIA in geodatabases, one per state. Each state geodatabase contained a polygon feature class and a point feature class. In many cases the former was missing the parcels of one or more counties, so we used the points feature class throughout.

We estimated heirs' parcels for each county and census tract in the U.S., including the District of Columbia. Our approach to identifying heirs' properties relies on computer evaluation of terms and phrases in the parcel data to identify those that indicate a parcel has not been probated and ownership not formally transferred. Following Pippin et al. (2017) and others, we also concentrated on parcels owned by actual people, removing from the data parcels described as businesses, various forms of trusts, religious organizations, and publicly owned properties. We also build significantly on Dyer et al. (2009) in terms of identifying phrases indicating heirs' parcel status. The method thus returns what we consider to be actual counts of heirs' property rather than potential heirs' property or a weighted likelihood of heirs' status. We nevertheless consider our results to be estimates due to possibilities of error in the input datasets and in our choice of terms. See table 1 for a list of inclusion and exclusion terms used to select heirs' parcels. The inclusion terms were found as notations in the owner name column, next to the owner name. The exclusion terms were identified by the owner name.

Table 1: Inclusion and Exclusion Terms Used in Research Process

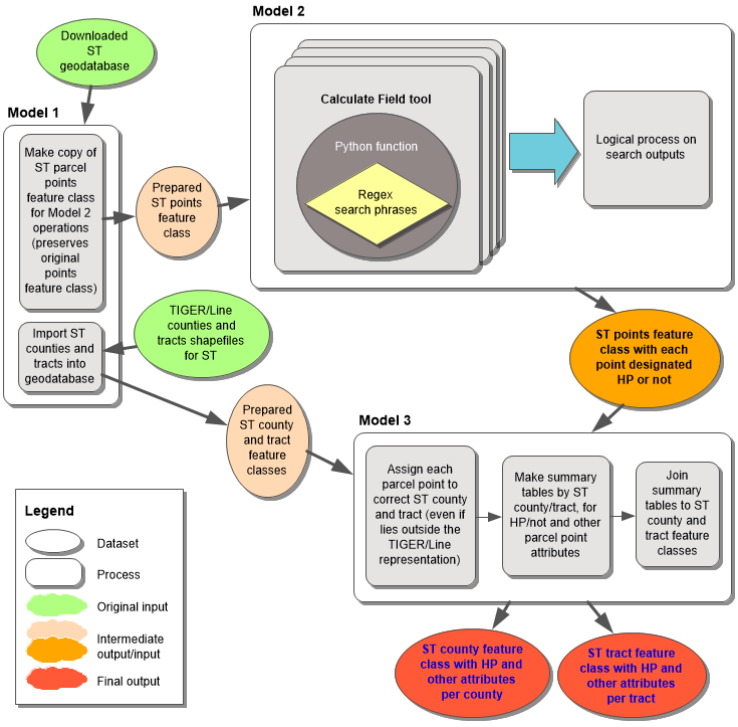
Term or category	Include or exclude	Comments
Business indicators	Exclude	LLC, Inc, etc.
Care of	Include	Recognizes an heir who acts for the whole group, or a caretaker of the property
Conservator*	Include	A court-appointed manager of the property
Deceased	Include	
Digit as first character of owner name	Exclude	Is likely to represent a business
Estate	Include	Include where refers to legal status
Estate	Exclude	Exclude where refers to real estate businesses, subdivisions, etc.
Et al.	Include	Sometimes used with names or one or a few heirs, to represent the rest
Executor or executrix*	Include	
Family of*	Include	Survivors of the deceased owner
Financial institutions	Exclude	As owners or co-owners of parcels
Heirs	Include	
Interest; a fraction; undivided; each	Include	Refers to heirs having ownership of a fractional or undivided interest in the parcel
Public entities	Exclude	Counties, towns, states, etc.
Religious entities	Exclude	Churches, temples, etc.

*Subsequent conversations with a real property attorney and review of our data suggested that these identifiers are less useful. Parcels with this notation are included in our estimates but represent less than 1 percent of the estimates.

The appropriateness of heirs' proxy indicators was triangulated via interviews with personnel at fifteen Property Valuation Administrator's (PVA) or tax assessor county offices in Kentucky. Commonly used terms in these counties were "heirs/heirs of," "estate," "et al.," an indicator of fractional interest such as 1/6, and "care of." We also observed that the data contained many variations on each term (e.g., "heirs," "heirs of," "HRS," "et al.," "etal") due to lack of conventions among counties or even between clerks or the same clerk on different days, regarding abbreviations, punctuation, spaces, and ways of denoting ownership. This suggested that the search mechanism needed to encompass the potential permutations of the search terms. We therefore used "regular expression" (regex), a powerful pattern-matching language that can be used inside code written in other languages. We embedded our regex search parameters within Python functions, which were in turn embedded in ArcGIS (ESRI 2019) Modelbuilder models that could be run with ease by both members of the research team. The Modelbuilder subprogram allows the user to build, store, edit, and run complex sequences of geospatial processes by adding and connecting input datasets, tools and parameters, and output datasets diagrammatically in a model window. The term "model" in this context thus refers to a model window containing one or more such stored sequences.

The basic shape of our automated process is illustrated in figure 1. Model 1 prepares a state's parcel point feature class and TIGER/Line (U.S. Census Bureau 2021) census tract and county feature classes for the subsequent operations. Model 2 runs the Python functions containing the regex expressions and adds attribute table fields whose values reflect the presence or absence of inclusion terms and exclusion terms, respectively. A logic process on those values creates a single final value for each parcel indicating whether or not it meets our criteria for heirs' property. Model 3 then associates each parcel with its correct county and tract and creates summary outputs which are then joined to the county and tract feature classes. After all three models have been run, the user is able to visualize heirs' properties individually as parcel points carrying the heirs' property designation, and collectively as quantities or percentages of such parcels per tract and per county. Assessed or market values and acreages, where included in the acquired parcel datasets, are likewise summarized and can be visualized.

Figure 1



Results

Table 2 contains the total estimated heirs' parcels by state and the District of Columbia, along with associated acreage, and land values for all parcels. The methodology estimated 444,172 heirs' parcels for the entire country.

Table 2: State Heirs' Parcels and All Parcels Totals (dollar figures as of November 2021)

State	Heirs parcels	Heirs acres	Total parcels	Total acres	Perc. heirs	Land market value (x $1,000)	Market value (x $1,000)	Heirs land market value (x $1,000)	Heirs market value (x $1,000)	Assessed value (non-heirs) (x $1,000)	Assessed value (heirs) (x $1,000)
Alabama	18,132	334,265	3,074,053	33,906,354	0.59	146,492,522	468,326,922	727,694	1,296,743	71,102,034	189,106
Alaska	3,593	8,594	792,034	14,977,778	0.45	41,105,031	112,283,557	41,454	87,420	112,113,697	87,728
Arizona	1,970	8,949	3,372,997	31,317,740	0.06	225,566,441	1,107,169,900	47,155	160,970	106,456,341	19,199
Arkansas	7,496	183,002	2,303,114	34,004,454	0.33	50,112,127	207,783,697	113,402	238,881	41,508,955	47,776
California	15,513	141,784	13,034,235	103,382,702	0.12	0	0	0	0	7,319,506,391	3,207,561
Colorado	2,877	143,605	2,756,634	61,374,344	0.1	337,521,079	1,266,817,380	173,269	475,312	146,316,422	59,958
Connecticut	365	1,351	1,339,557	3,924,145	0.03	0	0	0	0	407,665,283	91,265
Washington, DC	67	54	215,689	37,575	0.03	159,675,813	34,655,5390	180,044	300,665	346,254,725	300,665
Delaware	791	3,347	485,199	1,810,671	0.16	1,425,340	8,277,442	2,398	9,014	32,836,367	6,641
Florida	27,743	128,849	10,486,369	41,033,928	0.26	1,008,009,754	3,341,933,347	1,257,759	3649,651	2,968,748,405	3,252,769
Georgia	22,779	371,318	4,754,048	35,904,901	0.48	365,311,729	1,188,355,678	1,072,153	1,914,117	475,704,926	766,485
Hawaii	1,388	55,639	585,470	4,826,985	0.24	646,125,283	1,190,579,577	364,559	539,569	1,177,225,434	381,261
Idaho	996	26,022	1,076,201	29,560,244	0.09	82,497,841	263,714,051	64,669	140,533	261,347,869	140,167
Illinois	6,322	233,400	5,888,607	132,504,817	0.11	226,779,528	1,190,825,225	210,283	667364	293,846,998	213,262
Indiana	5,535	164,358	3,509,984	21,623,117	0.16	117,842,201	510,624,496	230,737	415,883	339,680,960	415,883
Iowa	6,975	205,310	2,660,512	36,889,007	0.26	92,689,460	346,776,101	301,737	406,127	510,208,613	403,379
Kansas	2,279	160,331	1,679,141	53,794,988	0.14	54,502,330	269,792,535	44,010	113,959	33,554,766	19,806
Kentucky	21,129	582,477	2,389,567	26,754,884	0.88	63,135,357	360,734,063	214,964	844,070	353,382,495	746,178
Louisiana	23,185	284,784	2,717,995	28,347,963	0.85	84,889,069	400,683,915	465,856	1,586,967	49,870,623	150,717
Maine	251	30,765	890,182	26,997,184	0.03	0	0	0	0	193,694,167	41,147
Maryland	7,436	29,274	2,381,409	6,757,045	0.31	354,162,220	950,245,777	764,956	2,136,720	923,997,951	2,075,585
Massachusetts	2,293	11,455	2,518,126	7,303,758	0.09	0	0	0	0	1,523,357,192	906,736
Michigan	3,008	35,261	5,213,426	42,853,443	0.09	72,591,642	966,765,482	52,669	331,382	485,053,612	165,770
Minnesota	1,239	26,545	3,215,925	56,827,965	0.06	348,594,973	888,594,502	149,538	267,345	888,035,242	266,706
Mississippi	30,811	468,447	1,885,157	27,858,931	0.04	36,451,764	147,893,185	320,358	906,385	18,141,659	165,770
Missouri	2,364	70,263	3,320,484	42,648,871	1.63	87,873,438	540,874,815	42,524	184,170	121,677,789	37,672
Montana	1,666	218,185	938,255	91,285,642	0.07	67,965,232	190,907,237	74,362	138,280	185,312,784	135,725
Nebraska	1,100	135,270	1,170,317	49,397,760	0.18	145,424,700	276,831,966	343,806	395,678	251,380,370	324,850
Nevada	342	3,568	1,255,845	45,348,721	0.09	166,256,124	43,431,7351	16,475	42,634	153,613,911	14,951
New Hampshire	518	7,871	696,619	5,475,772	0.03	0	0	0	0	214,656,734	105,994
New Jersey	5,254	9,370	3,172,633	5,110,218	0.07	551,790,760	1,303,798,089	780,624	1,640,316	1,301,184,774	1,642,825
New Mexico	3,445	94,343	1,648,375	46,655,134	0.17	51,422,442	193,546,945	37,484	86,752	65,173,413	30,656
New York	12,338	183,372	6,385,853	34,973,465	0.21	1,907,249,194	4,797,468,314	1,681,300	3,425,506	1,269,306,674	1,371,485
North Carolina	39,162	301,997	5,599,920	27,961,731	0.19	386,788,427	1,239,805,529	1,370,100	2,332,102	1,259,711,734	2,313,678
North Dakota	1,836	182,205	739,678	42,815,470	0.7	40,139,521	107,000,417	138,667	149,997	53,455,868	74,705
Ohio	5,088	68,364	6,246,221	26,140,063	0.25	292,920,790	1,055,741,230	351,552	574,211	365,061,780	179,719
Oklahoma	6,072	303,592	2,367,084	49,747,766	0.08	55,740,719	266,293,961	57,771	133,249	28,117,190	14,924
Oregon	1,564	37,467	1,963,680	60,368,758	0.26	343,697,349	864,181,647	18,0260	1,497,225	449,591,971	321,593
Pennsylvania	4,801	106,506	6,003,325	30,986,689	0.08	216,151,913	959,674,465	144,824	639,208	685,977,543	325,726
Rhode Island	108	193	418,628	964,839	0.08	0	0	0	0	160,341,162	34,696
South Carolina	16,779	162,803	3,060,041	18,523,812	0.03	180,306,763	552,895,683	529,203	930,169	31,601,815	34,599
South Dakota	1,878	162,418	717,392	45,024,816	0.55	0	0	0	0	119,677,658	302,909

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State	Heirs parcels	Heirs acres	Total parcels	Total acres	Perc. heirs	Land market value (x $1,000)	Market value (x $1,000)	Heirs land market value (x $1,000)	Heirs market value (x $1,000)	Assessed value (non-heirs) (x $1,000)	Assessed value (heirs) (x $1,000)
Tennessee	5,607	163,091	3,451,380	27,843,061	0.26	199,554,291	706,510,418	266,987	501,650	188,890,235	138,651
Texas	77,462	2,677,481	13,426,841	197,916,219	0.58	1,192,999,772	3,616,012,433	5,202,517	8,472,347	3,369,969,063	5,877,114
Utah	409	12,059	1,386,084	16,837,120	0.03	185,763,584	546,567,879	38,727	78,868	533,536,957	73,212
Vermont	1,599	40,975	337,938	5,960,848	0.47	0	0	0	0	92,024,181	252,549
Virginia	14,333	202,015	3,934,881	23,718,994	0.36	495,815,716	1,447,717,410	858,586	1,392,619	1,444,610,772	1,389,352
Washington	1,968	53,442	3,345,947	37,768,608	0.06	613,082,058	1,527,972,147	311,162	690,522	77,582,497	655,999
West Virginia	17,880	341,587	1,489,839	17,061,120	1.20	37,989,163	130,219,944	312,751	623,843	483,403,658	344,909
Wisconsin	5,427	48,991	3,104,606	32,034,962	0.17	27,359,711	433,679,781	43,105	663,358	483,403,658	636,798
Wyoming	999	20,838	344,814	28,575,593	0.29	27,853,698	92,021,897	86,498	242,537	8,782,830	23,016
Total	**444,172**	**9,247,452**	**155,752,311**	**1,875,720,975**		**11,789,626,872**	**36,818,771,780**	**19,668,949**	**41,324,318**	**32,477,658,148**	**30,779,827**

These contain 9,247,452 acres with a land market value[1] of $19,668,949 billion and total market value of $41,324,318 billion.[2] The average land market value per acre for all heirs' parcels is $2,179, which compares to an average land market value per acre for all parcels of $7,032; the average total market value per acre for heirs' parcels is $4,669, and $21,959 for all parcels. The assessed value includes values for both land and improvements before any tax exemptions are applied. This is the value on which property taxes are based. As such, it is a useful indicator for calculating potential tax revenues associated with heirs' parcels. Heirs' property parcels identified by our methodology have an assessed value of $30.7 billion compared to roughly $32.5 trillion for all non-heirs' parcels in the country.

Table 3 displays mean values for heirs' parcels summed at the state (and District of Columbia) level. The mean number of heirs' parcels for all states and the District is 8,709. The mean number of heirs' parcels acres in each state is roughly 181,000. The average land market value for the state/district distribution is approximately $458 million, $961 million for the market, and $618 million for assessed value.

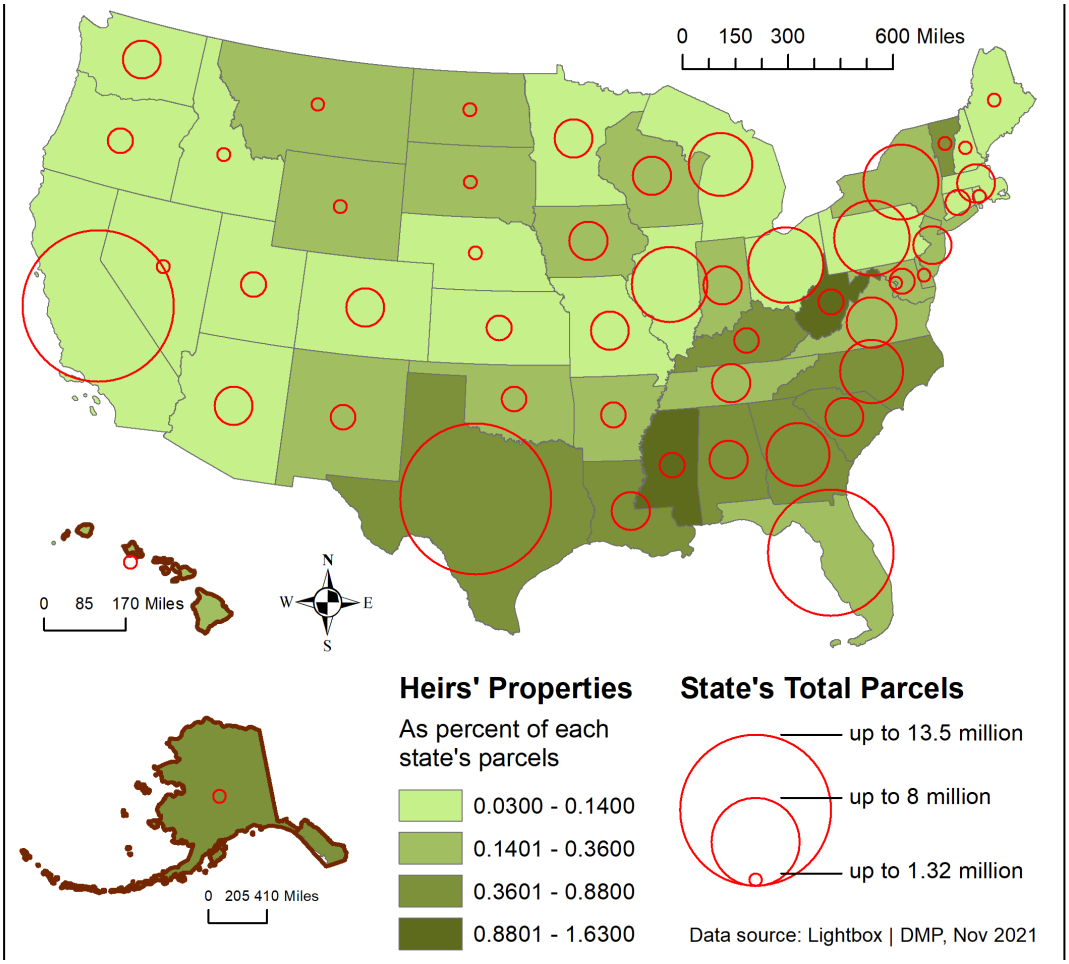
Table 3: Heirs' Parcels Descriptive Statistics for 50 States and District of Columbia Totals (N=51) (dollar figures as of November 2021)

	Parcels	Acres	Land Market Value	Market Value	Assessed Value
Mean	8,709	181,322	$457,417,458	$961,030,588	$617,856,978
Std. deviation	13,349	380,041	$840,171,961	$1,452,219,230	$1,084,608,852
Median	3,445	106,506	$210,280,000	$501,650,000	$179,270,000
Minimum	67	54	$2,398,400	$9,013,600	$34,695,725
Maximum	77,462	2,677,481	$5,202,516,922	$8,472,347,435	$3,207,560,812

The very large standard deviations indicate the wide range of totals for the states/district. As well, both the heirs' land market and total market value distributions are positively skewed with Texas as an outlier ($5.2 billion). For total market value, the states with the five highest totals are Texas ($8.47 billion), Florida ($3.6 billion), New York ($3.42 billion), North Carolina ($2.33 billion), and Maryland ($2.14 billion). States with the lowest total market value are Delaware ($9 million), Nevada ($42.6 million), Utah ($78.9 million), New Mexico ($87.8 million), and Alaska ($87.4 million). Median values for all values are well below the mean, which again indicates the positive skew.

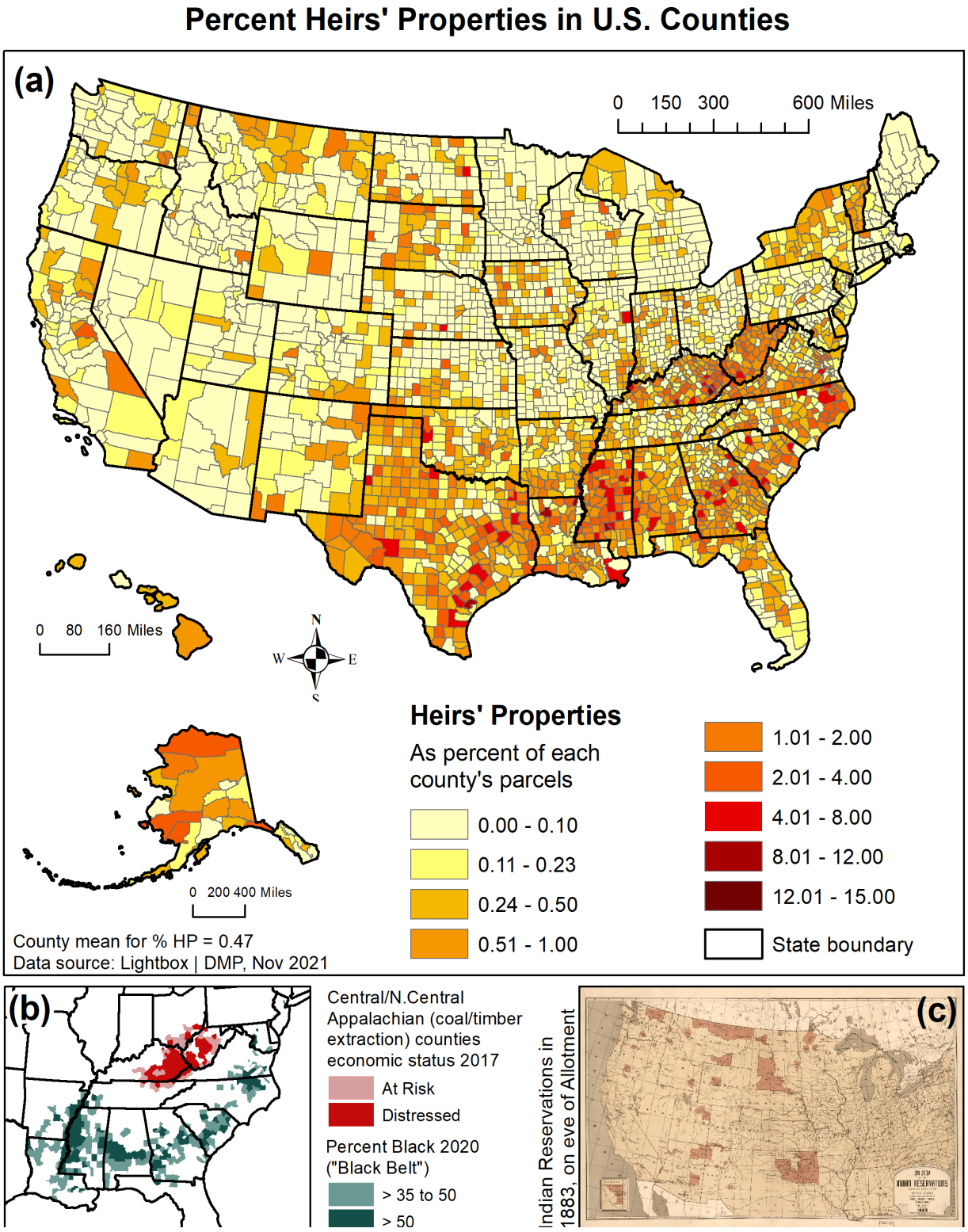
Using the geospatial outputs of the automated process for the fifty states and District of Columbia, it is possible to visualize our results in a number of ways that help us understand nationwide patterns of heirs' property occurrence. In Figure 2, states are shaded to represent heirs' property extent as percent of all parcels in the state. Because the total number of parcels varies widely from state to state, changing the absolute meaning of a given percentage, we have included, for reference, a circle at each state, associated with the size of the state's parcel total. As expected, visualization of the data at this scale shows broad regional patterns, most notably that the South (Virginia to Oklahoma and Texas) contains more of the country's heirs' properties than any other region. Figure 3(a), while covering the same geographic area, visualizes percentage of heirs' property per county instead of per state and demonstrates both the same broad regional patterns and the presence of variation within states, including individual counties with percentages much higher than any at state level. County-level patterns and visual comparison to figures 3(b)-3(c) suggest potential correlations for investigation, between current heirs' property and historical plantation agriculture in the Black Belt South; historical and modern fossil fuel and timber extraction in Central/North Central Appalachia; and historical allotment of Indian reservations (even though we did not include allotment-specific terms in our process) spotted throughout the Great Plains and West. We find it no coincidence that the spatial distribution of heirs' property parcels is co-located with such places of long-standing poverty and other inequities.

Figure 2: Output of Automated Process by State



State shading represents heirs' properties as a percent of all parcels in the state. Red circles for each state indicate total number of parcels in the state.

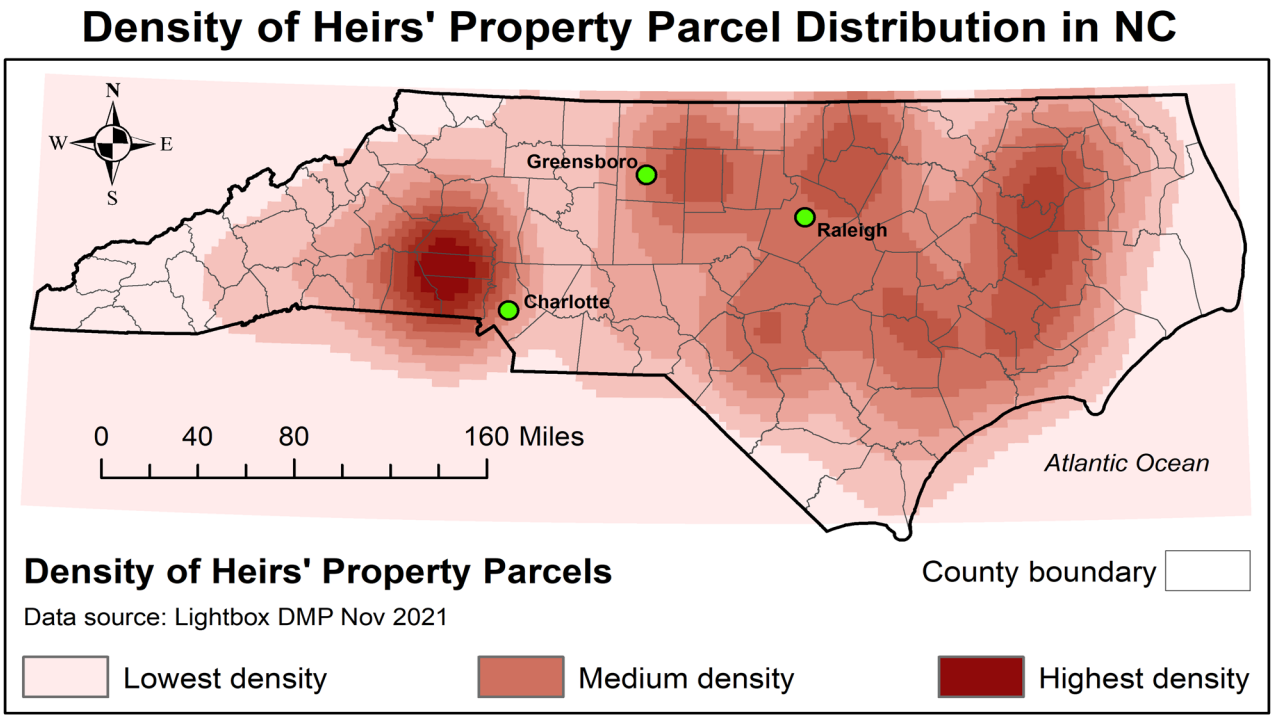
Figures 3(a)-(c): Output of Automated Process by County



Output of automated process by county is shown in figure 3(a). Shading represents heirs' properties as a percent of total parcels in the county. Figure 3(b) displays "Black Belt" and "Coal Country" areas for visual comparison. (Data sources: US Census Bureau, 2020 Decennial Census; Appalachian Regional Commission.) Figure 3(c) illustrates (again for visual comparison) Indian Reservations in 1883, not long before the federal government cut them up into individually held allotments. (Image source: Library of Congress, Geography and Maps Division.)

The data outputs can be visualized at additional scales. In figures 4 and 5, we employ two different means of identifying spatial clusters of heirs' property within an individual state. The first (figure 4) utilizes kernel density to visualize patterns within those parcel points identified as heirs' property for North Carolina, thereby illustrating both distribution and density of heirs' properties. We used a cell size of 0.05 degrees and a search radius of 0.7 degrees, with the weight field set as the HP indicator resulting from our Model 2. We speculate that the highest density area, west of Charlotte, results from the dissolution of former mill villages, as this part of the state was home to an intense concentration of textile mills. The other dense areas are agricultural regions, where legacies of enslavement probably contributed to formation of heirs' properties. For instance, concentrations are evident in the northeastern part of the state near Warren and Bertie Counties, where percent of the population that is African American exceeds 50 percent.

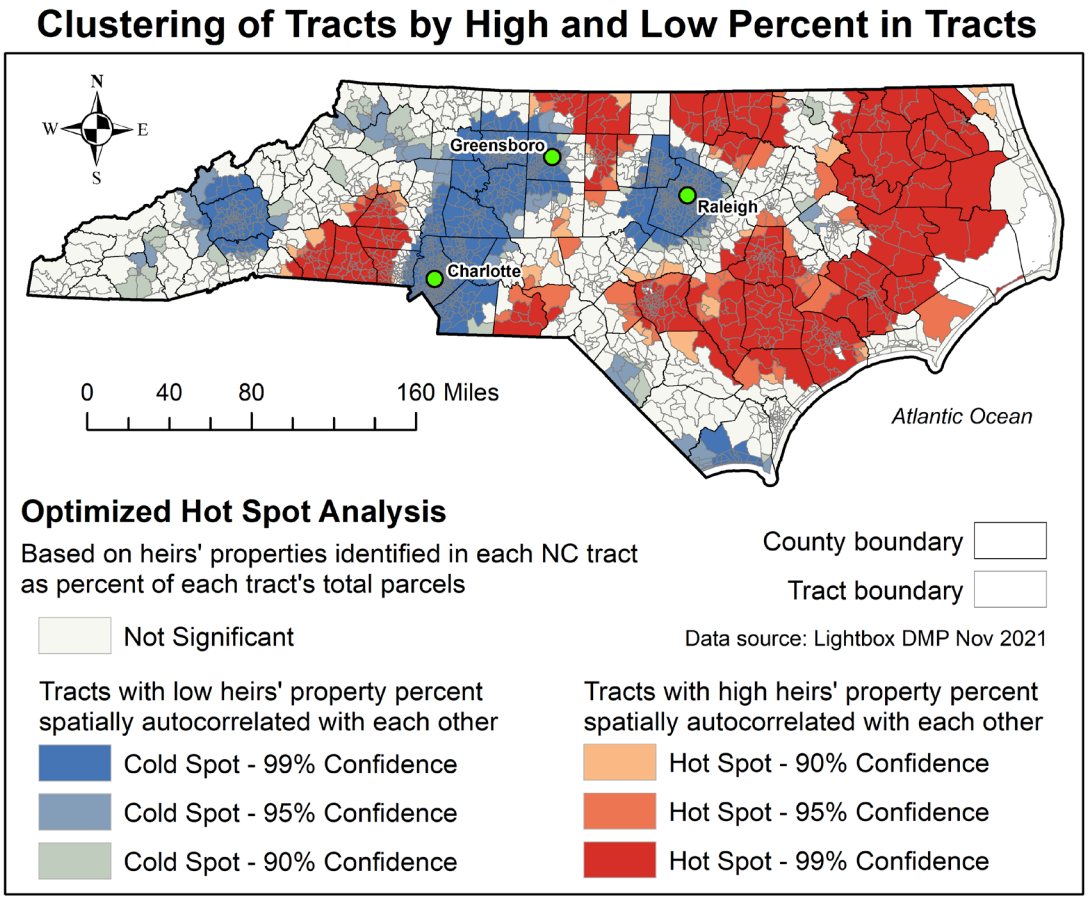
Figure 4: Heirs' Properties Parcel Densities in North Carolina



Heirs' properties parcel points in North Carolina have been processed with the kernel density tool in ArcGIS to produce this representation of distribution and density of heirs' parcels without regard to county or tract boundaries. County boundaries are shown for the viewer's orientation only.

The second (figure 5) uses the Getis-Ord G_i^* calculation to find "hot spots" and "cold spots" of heirs' property percent at the tract level (Johnson Gaither 2017). This is a univariate spatial autocorrelation metric identifying tracts that are both similar in value of the variable and close in spatial proximity. Because we used the Optimized Hot Spot Analysis tool to generate this example, ArcGIS calculated the best parameters, including contiguity type, based on the input data; a fixed-distance band was used as a result. The results of the process broadly reinforce the patterns seen in figure 4, with agricultural and major mill areas hot and major urban areas cold.

Figure 5: Clustering of Heirs' Property Tracts in North Carolina



Getis-Ord G_i^* analysis of heirs' properties in North Carolina at the tract level. The technique identifies tracts that are both similar in value of heirs' properties percent and in proximity. Red shades reflect high percentages and blue shades reflect low percentages.

Beyond identifying the presence and location of heirs' property, the outputs of our automated process will make a substantial contribution to research associating heirs' property with various types of vulnerability. For example, the Federal Emergency Management Agency (FEMA) has produced a composite risk index that combines expected economic loss from multiple physical hazards with social vulnerability (using SoVI) (Hazards Vulnerability & Resilience Institute, n.d.*b*) and then mediates the result based on community resilience (using BRIC) (Hazards Vulnerability & Resilience Institute, n.d.*a*). This National Risk Index (NRI) is downloadable for both counties and census tracts and includes separate scores for each component as well as the composite score (Zuzak et al. 2021).

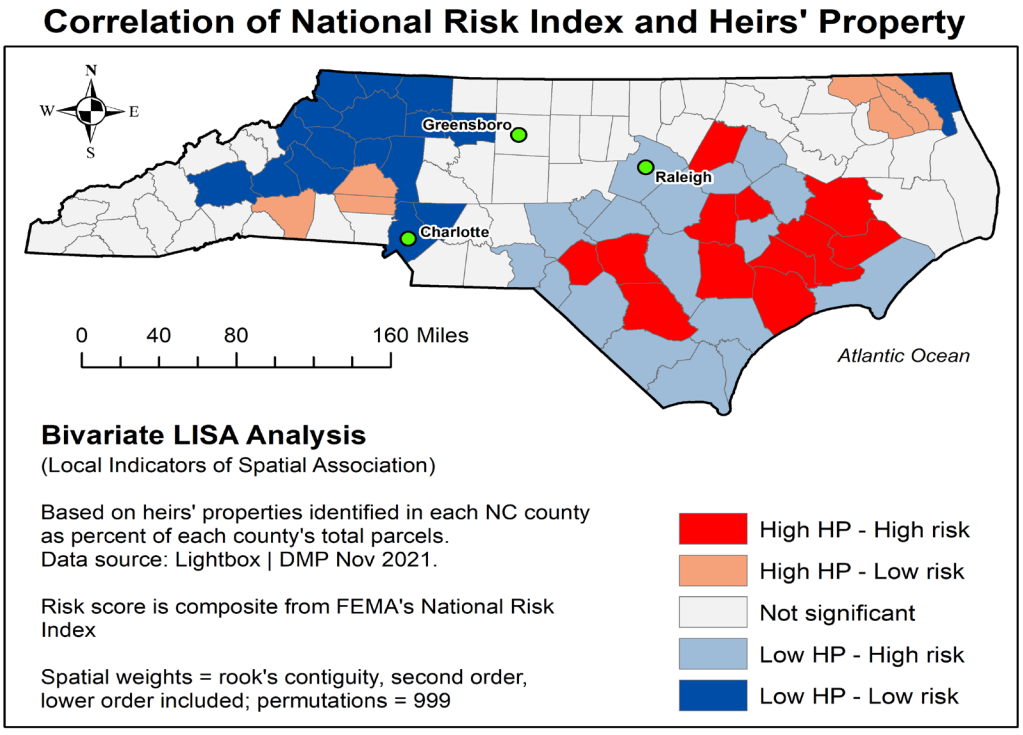
In figure 6, we demonstrate the feasibility of analyzing heirs' property outputs in conjunction with vulnerability indices. In this example we use North Carolina county-level heirs' property percent and the NRI composite risk score. The analysis method is Bivariate Local Moran's I, one of several techniques known collectively as Local Indicators of Spatial Association (LISA), which identify locations that have both similarity of attribute values and proximity in space as opposed to random spatial distribution.[3]

Results as shown in figure 6 indicate a strong correlation between heirs' property percent and risk for several counties in eastern North Carolina. The red polygons can be interpreted again as "hot spots," where counties have both higher-than-average percent heirs' and risk values; and the dark blue indicates

the opposite ("cold spots"), with both lower-than-average heirs' and risk values. Such an analysis could be repeated with different combinations of scales and indices and different spatial statistical methods. Variation in any of these may produce outputs that illuminate some particular aspect of the problem in a new way. Scale, in particular, can affect not only the patterns revealed but the questions that could be asked. In this context we refer both to the scale of data units (e.g., parcel, tract, county, state) and the scale of the study area (local, county, state, nation). Analysis of heirs' property parcels at a local scale might reveal, for instance, that particular parcels have become heirs' properties through mechanisms different from the county-scale results and processes discussed in relation to figure 3.

Further, heirs' parcel identification can be incorporated into existing vulnerability indices, not only correlated with them. This is important given the centrality of such measures for understanding people's ability to prepare for, respond to, and rebound from disasters. A central component of vulnerability analyses is identification of the "architecture of entitlement" or a determination of which societal groups have access (both de jure and de facto) to key resources and information flows (Kelly and Adger 2000), as this access largely determines the extent to which populations are vulnerable or resilient. Existing social vulnerability indices involve identifying variables of exposure (e.g., physical indicators of risk), sensitivity, and adaptive capacity (those factors that enhance a place's ability to lessen the effects of disturbance—for example, wealth, hospital facilities) (Cutter, Boruff, and Shirley 2003; Polsky, Neff, and Yarnal 2007). The sensitivity component typically includes sociodemographic variables representing different markers of sensitivity to adverse outcomes. However, we are not aware of any sensitivity measures that operationalize the construct in terms of the ability or inability of people to leverage real property assets either before or in the wake of natural disasters. Such capacity is most crucial in the preparedness and disaster recovery phases, where home ownership allows access to resources unavailable to those who rent or cannot prove ownership. An heirs' property indicator could be included in a sociogeophysical vulnerability index that includes standard sociodemographic variables measuring sensitivity and a measure of housing vulnerability, denoting *clarity* of homeownership.

Figure 6: Correlation of National Risk Index and Heirs' Property in North Carolina



Example of incorporating automated heirs' property outputs into analysis with additional variables. In this instance, heirs' property percent by county in North Carolina is analyzed in conjunction with a composite score from the NRI, using bivariate LISA analysis in GeoDa software.

Discussion and Conclusion

We recognize that one of the challenges of any estimation technique is verification of the methodology with real-world conditions. As discussed, our methods build upon prior efforts, but those methods, for the most part, have also not been subjected to ground truthing, for instance with the use of household surveys. The one exception that we know of is Johnson Gaither and Zarnoch's (2017) comparison of results obtained from a model they used to predict heirs' parcels (using indicators such as "heirs of" and "et al."), with "known" heirs' parcels for Macon-Bibb County, Georgia, and Leslie County, Kentucky. For both counties "true" or "known" heirs' parcels were obtained from county-level taxing authorities that used "heirs of" and "et al." notation to indicate heirs' parcel status.

Our attempt at ground truthing draws on results from the case studies of heirs' property identification conducted by the Pew Charitable Trust and the University of Pennsylvania in Philadelphia, PA. Again, "tangled titles" or heirs' parcels in the Pew study were identified by using the Social Security Administration's Death Master File, which provide indisputable evidence of whether the property owner of record was alive. As discussed, this method identified 10,407 properties for Philadelphia, and the earlier Philadelphia study found 14,001 tangled titles. These numbers are much larger than the 471 heirs' parcels we identified for Philadelphia (Philadelphia County). There were only 4,801 heirs' parcels identified for the entire state of Pennsylvania using our method. Although the methods were not identical, the large differences in findings between our study that relied solely on owner name notation and these prior studies, suggest that aggregated "big data" may severely undercount heirs' parcel counts. We can only speculate that all the associated details of county-level data, including heirs' notation, may not always be transferred to the purchasers of this data. In the case of the FIA data we obtained, heirs' measures and their proxies are incidental components of these datasets. FIA purchasers use the data primarily for identifying forestland parcels to inventory, and not for assessing ownership aspects of the property.

We also discovered that the LightBox data contains fields indicating vesting, which means how the local tax assessor recorded the title. Descriptors include "tenant in common" (TIC). The explicitly named "tenant in common" can indicate heirs' status. A look at how well this field was populated across each state revealed that in all states no more than about one-half of the parcel records had any vesting indicator. This reduced our confidence in this field as a sole indicator of heirs' status, although TIC was indicated to some degree in all states. Initially, it appeared that the vesting code could be an additional way of identifying heirs' parcels. However, the problem with relying on this variable is that it describes the property at the time of the last sale, rather than at periodic intervals throughout the year, which is when the notation in the owner field is updated.[4] The TIC status could have been resolved since the sale occurred, even if the sale were relatively recent.

The lack of consistency in heirs' property descriptors across states is also remarkable. There is no standard for delineating these properties, if they are marked at all. For instance, in some states like North Carolina and Kentucky, "heirs" or "heirs of" seems to be a more common way of identifying heirs' parcels, but this descriptor is rarely used in Georgia. We also suspect there may be numerous heirs' parcels in some rural Black Belt counties like Taliaferro County, Georgia, where we identified only three. This may

have to do with a lack of priority placed on explicitly naming such parcels or the lack of staff to do so. As mentioned, in many states, various indicators are used, but there is no explanation for why this is the case. The naming convention does not seem to follow a logical pattern. This lack of accounting for uniformity has implications for disaster response, as noted by Pippin, Jones, and Johnson Gaither (2017). According to the National Research Council, uniform accounting of parcel data would have improved the federal government's response both to survivors Hurricane of Katrina and the 2007–2008 mortgage crisis.

Despite the data limitations, we believe our technique offers a transparent process for assessing heirs' property extent at broad scales. The patterns that we saw in the distribution of these data across the country are consistent with places of historical marginalization and with prior efforts locating heirs' parcels for specific places. The fact that the LightBox data undercounts these estimates is less important than the patterning and associations found, which again, support the contention that heirs' property ownership compounds vulnerability in places contending with a variety of other social stressors. This is the first such effort that provides counts for the entire U.S. and thus represents an advance in heirs' property scholarship.

Endnotes

1 Land market value is the estimated price that land only would sell for in a competitive and open market. The market value is the estimated selling price for the entire parcel, including land and any improvements. The assessed land value is an estimate of the tax value of the land only; the assessed value is the amount of estimated tax value for the entire parcel. All values were provided by the county or local taxing/assessing authority.

2 Market values were not populated in the LightBox data for California, Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, South Dakota, and Vermont.

3 Because we are using all the counties in the state, there is no sample population on which to apply p-values. Instead, the procedure runs a large number of permutations with small variations in order to approximate a normal distribution and derives "significance" from the pseudo-p-values associated with these permutations. Note that the usual way of interpreting significance does not apply to this analysis technique; instead the strength of the technique is the categorization (different pairings of low and high relative values) made possible by combining the pseudo-p-value with location on a scatterplot (Anselin 1995, 2019, 2020; Anselin and Li 2020). In this instance we designated a "rook's contiguity" of second order (extending the analysis to the tracts contiguous to those first identified as contiguous with the analysis county) for the spatial relation between counties. We used 999 as the number of permutations because, as Anselin (2020) has shown, specifying any other number produces very little change in the output. We ran the analysis using GeoDa 1.18.0 software (GeoDa on GitHub).

4 In support of this information, Taylor et al.'s (2021) survey of Kentucky PVA officers revealed that county tax assessors do periodic updates of heirs' status (in Leslie County the office conducts a weekly obituary check primarily for the purpose of removing homestead exemptions for properties whose owners are deceased. This also seemed to trigger changing owner names or listing something as heirs' property if there is adequate documentation to do so. Also, like the other offices, it is also common for families to come in after someone has passed away and bring a will, deed, or affidavit of descent to get the property put in the living heir's name. Sometimes, properties stay in the deceased person's name if no heir makes the office aware of a death. We cannot be certain that all tax assessor's offices follow the same protocol.

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