Spatial Variations in Population Change: A GIScience and GWR Perspective using a Case Study of Ireland 1841-1851

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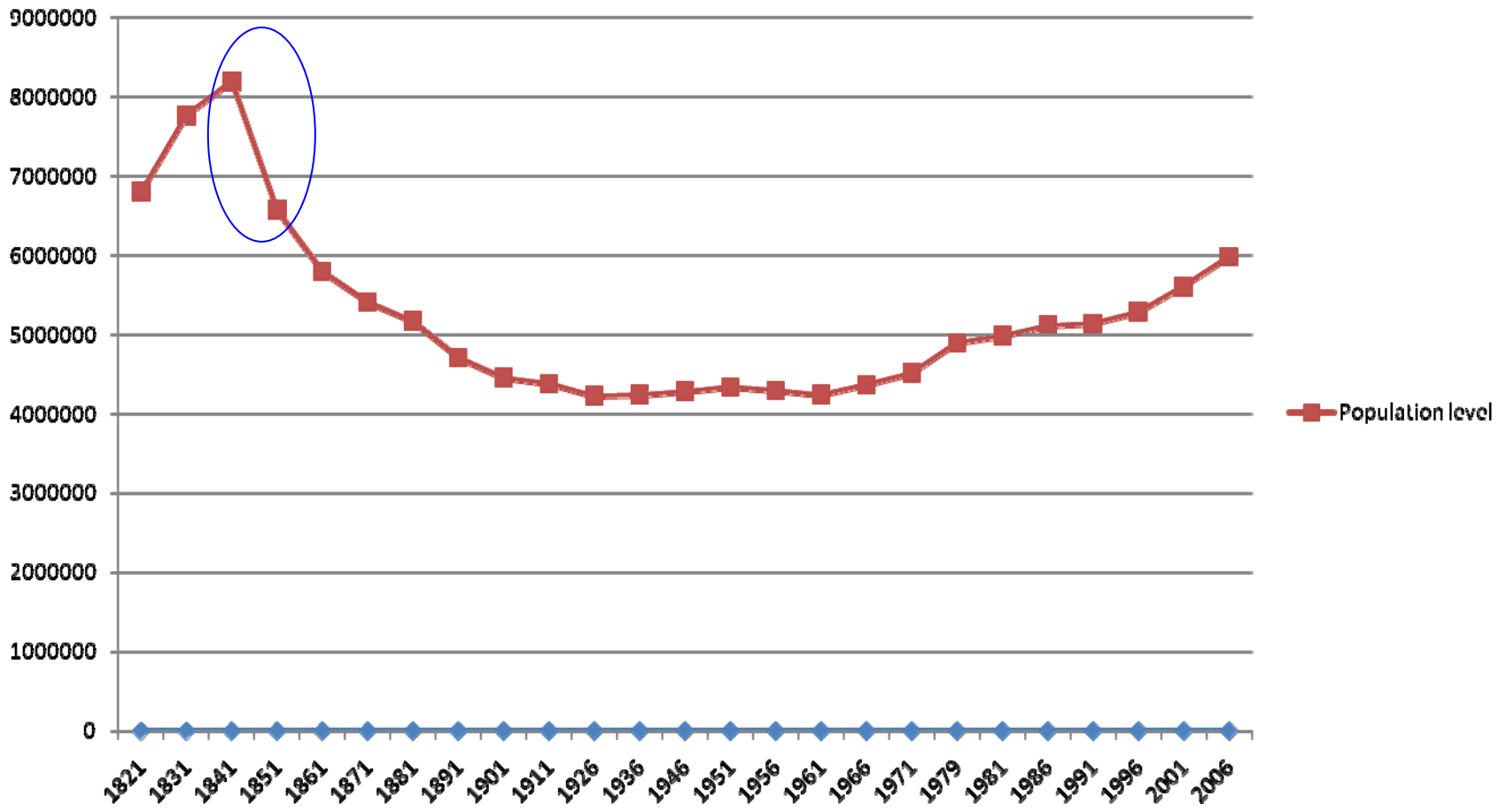
Outline

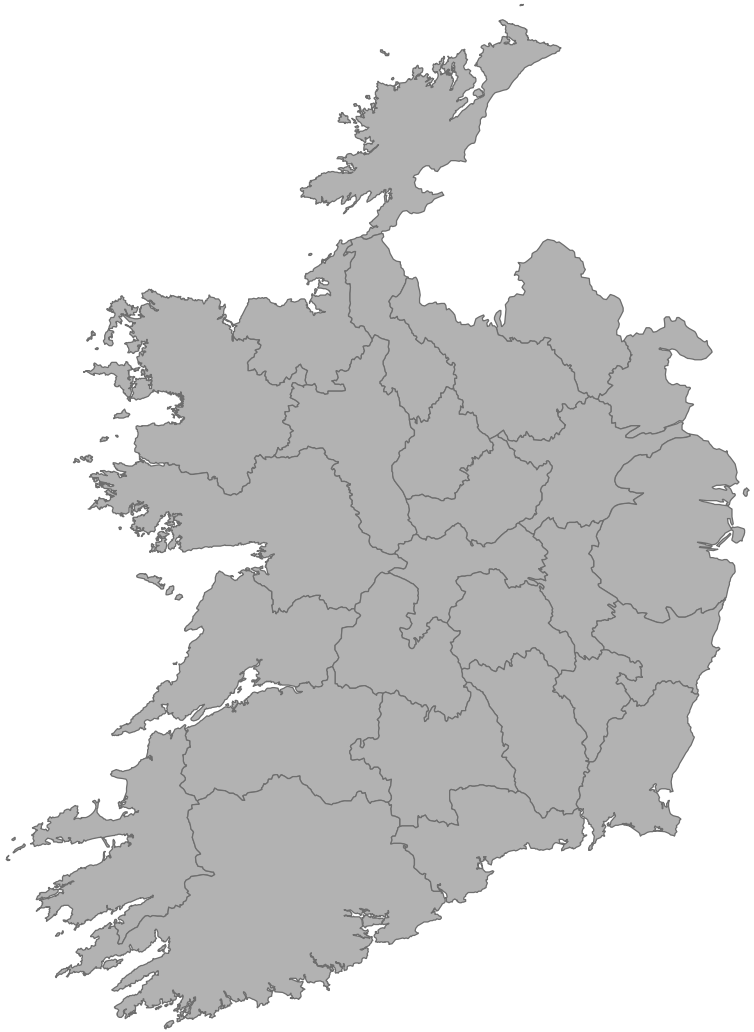
- The Irish famine 1846-49
- Famine research so far
- Relevance of GIS for analysis of the population famine decade 1841-51



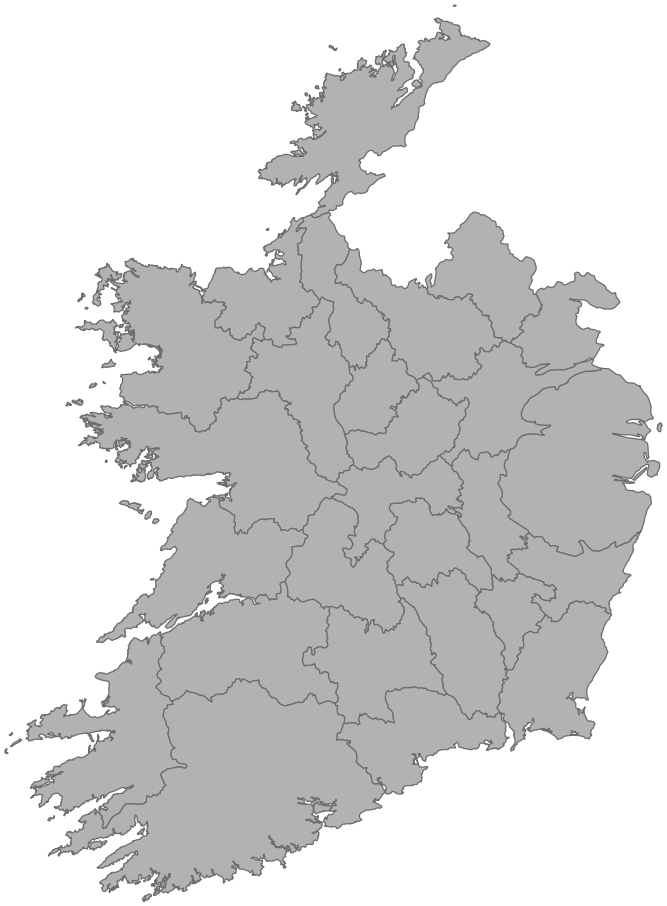
Population change 1821 – 2006

The Irish famine 1847-9

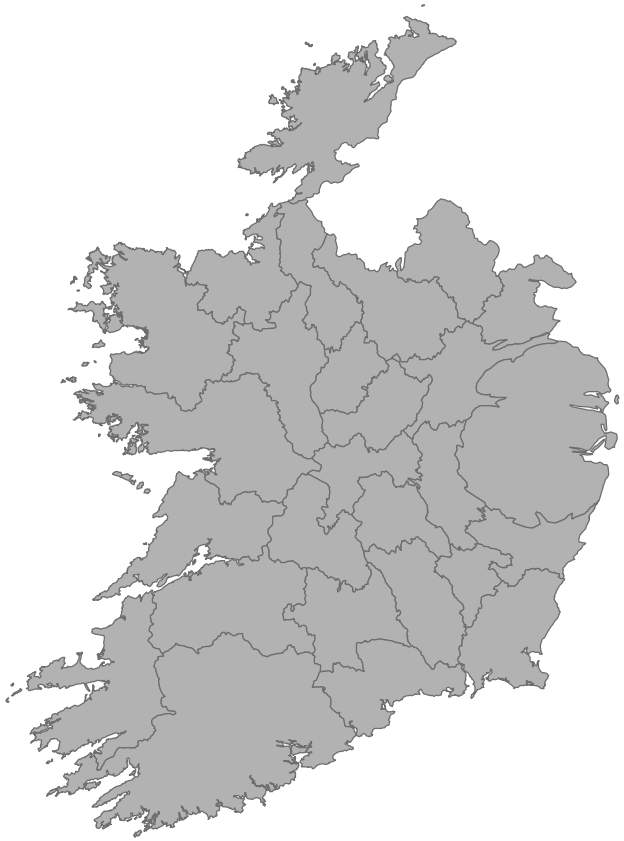
Populations change 1821 to 1911	
1821	6,801,827
1831	7,767,401
1841	8,196,597
1851	6,574,278
1861	5,798,967
1871	5,412,377
1881	5,174,836
1891	4,706,162
1901	4,458,775
1911	4,381, 951



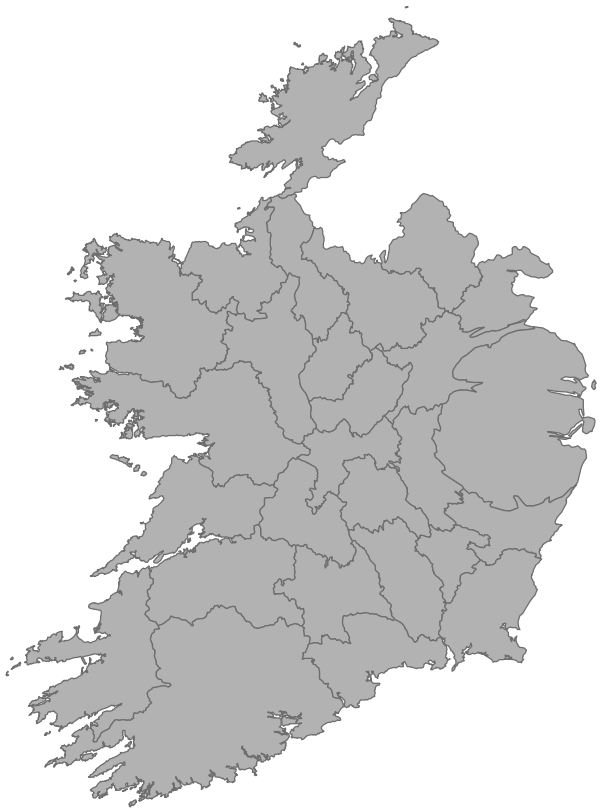
1841



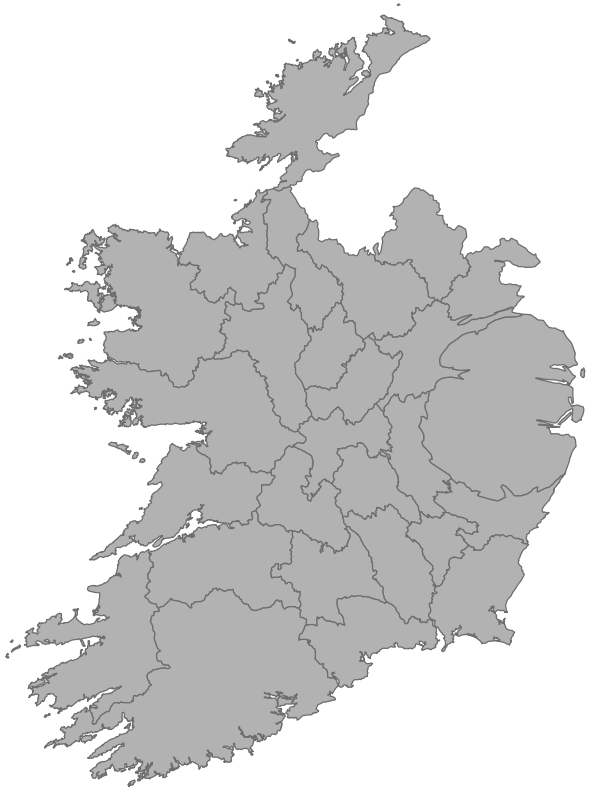
1851



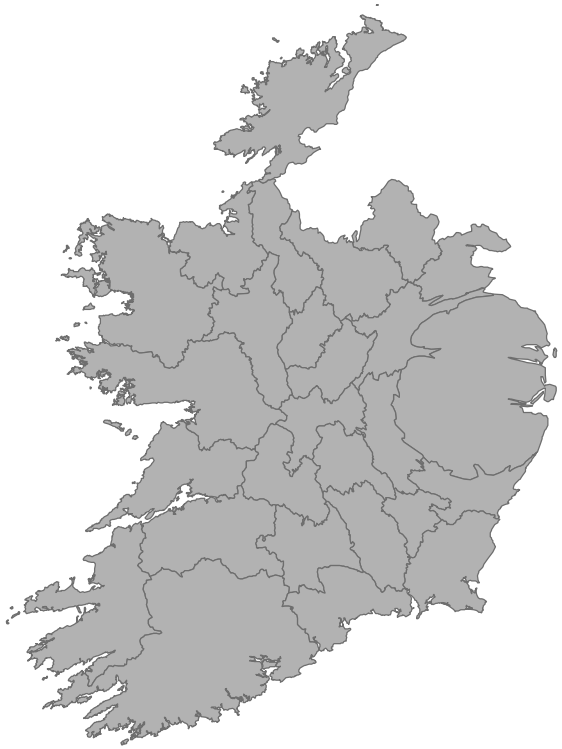
1861



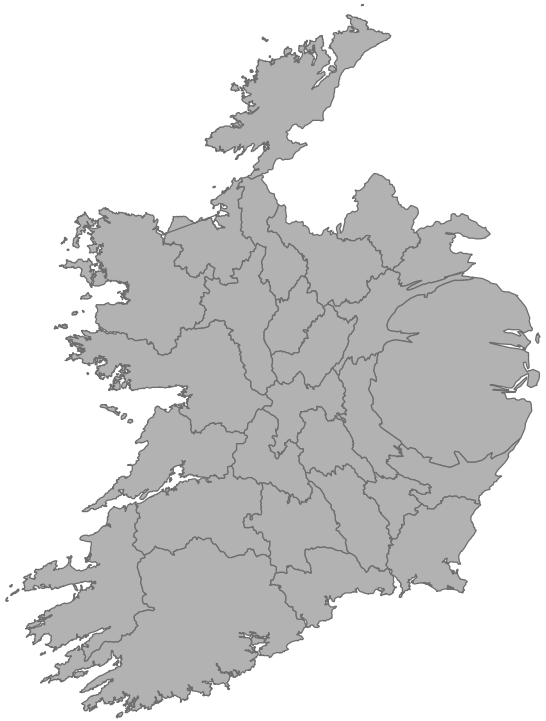
1871



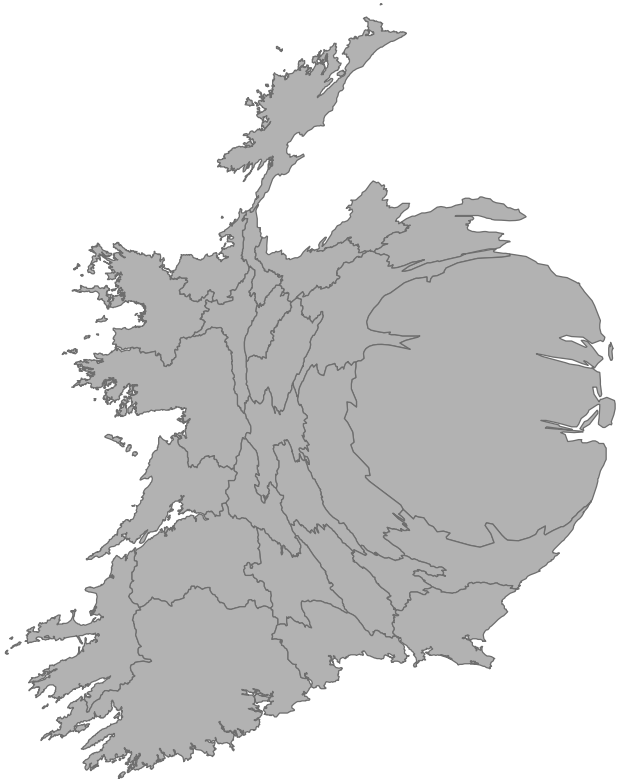
1881



1891



1901



2002

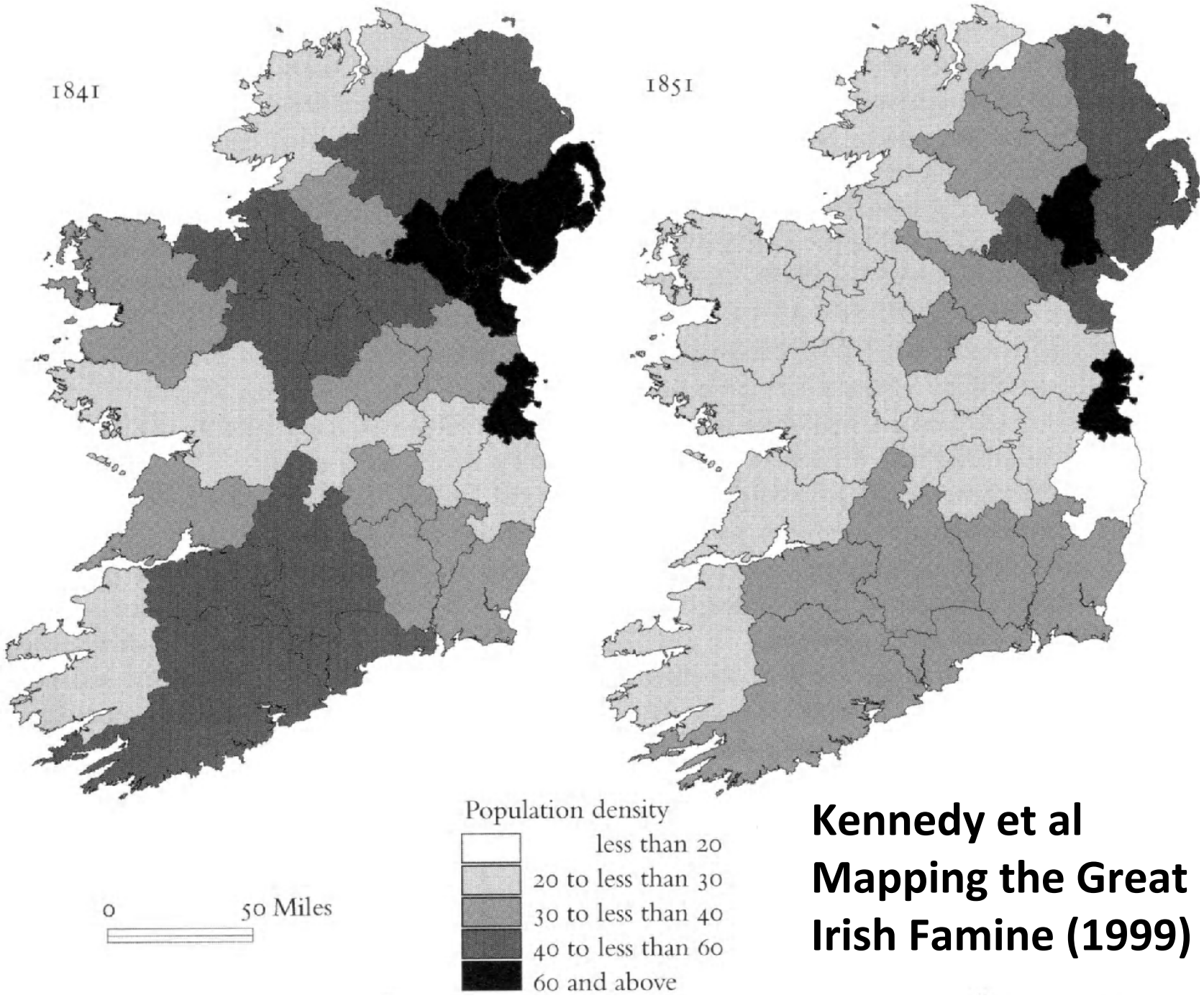
Famine Historiography

- The Famine is a hugely emotive event in Irish history and consequently has been subject to a large volume of research – most of it being qualitative

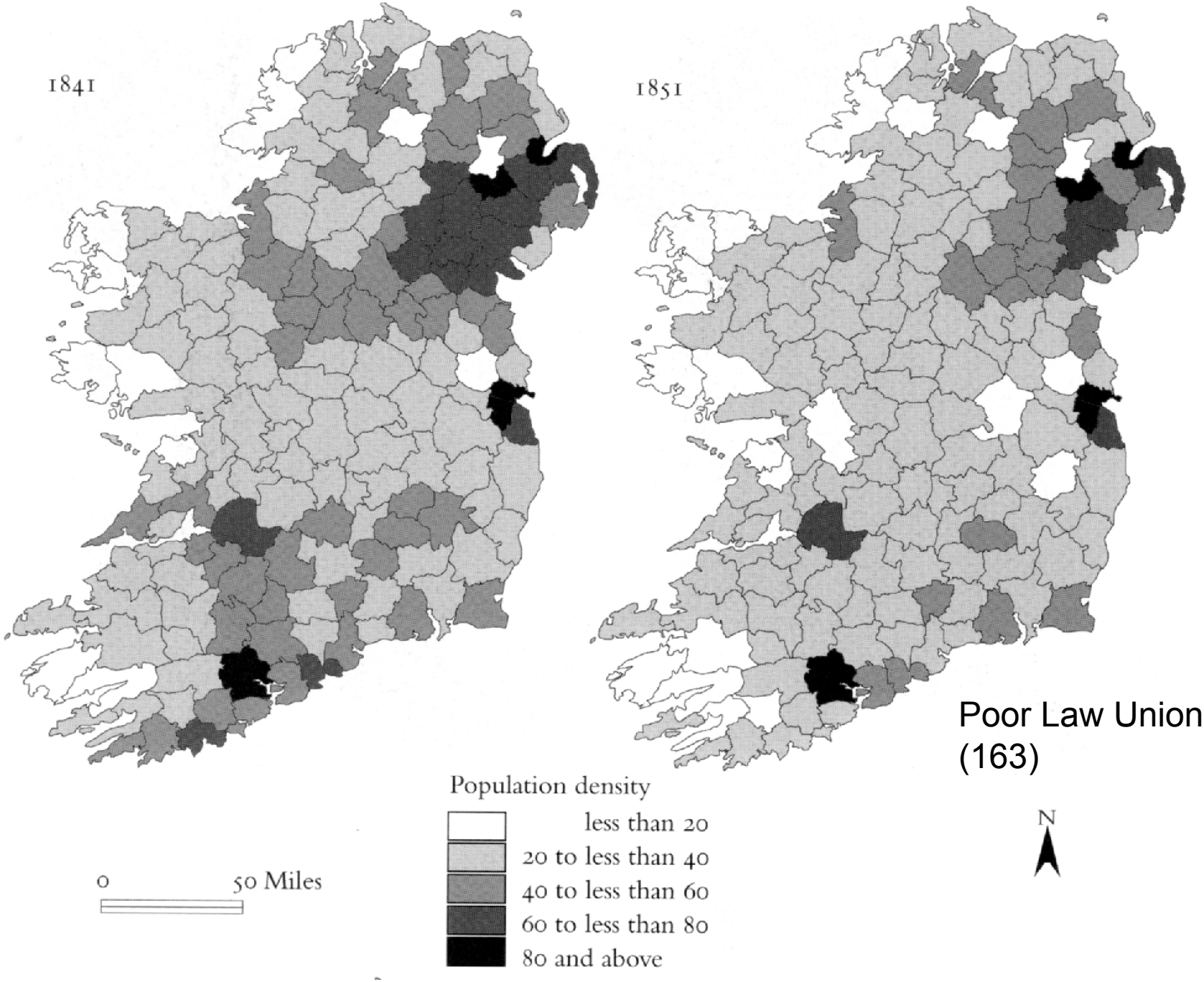
- Additionally, as outlined by Gregory and Ell (2005), research on the *geography* of the famine is limited and very few analyses contain maps

- Much of the famine research is at a local rather than a national level

- This is beginning to change

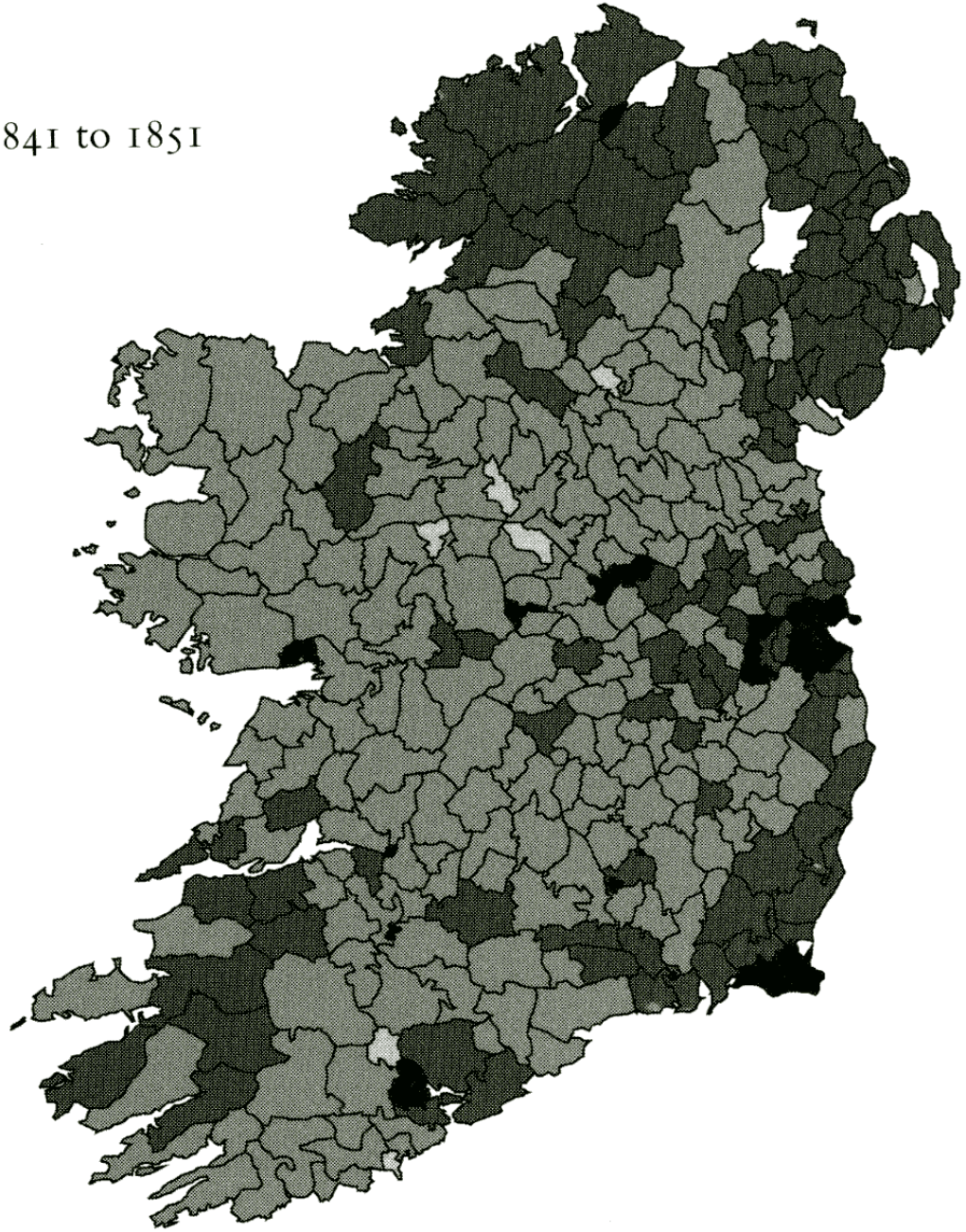


Kennedy et al Mapping the Great Irish Famine (1999)


1841
1851
Poor Law Union
(163)
Population density
less than 20
20 to less than 40
40 to less than 60
60 to less than 80
80 and above
0
50 Miles
N

1841 to 1851

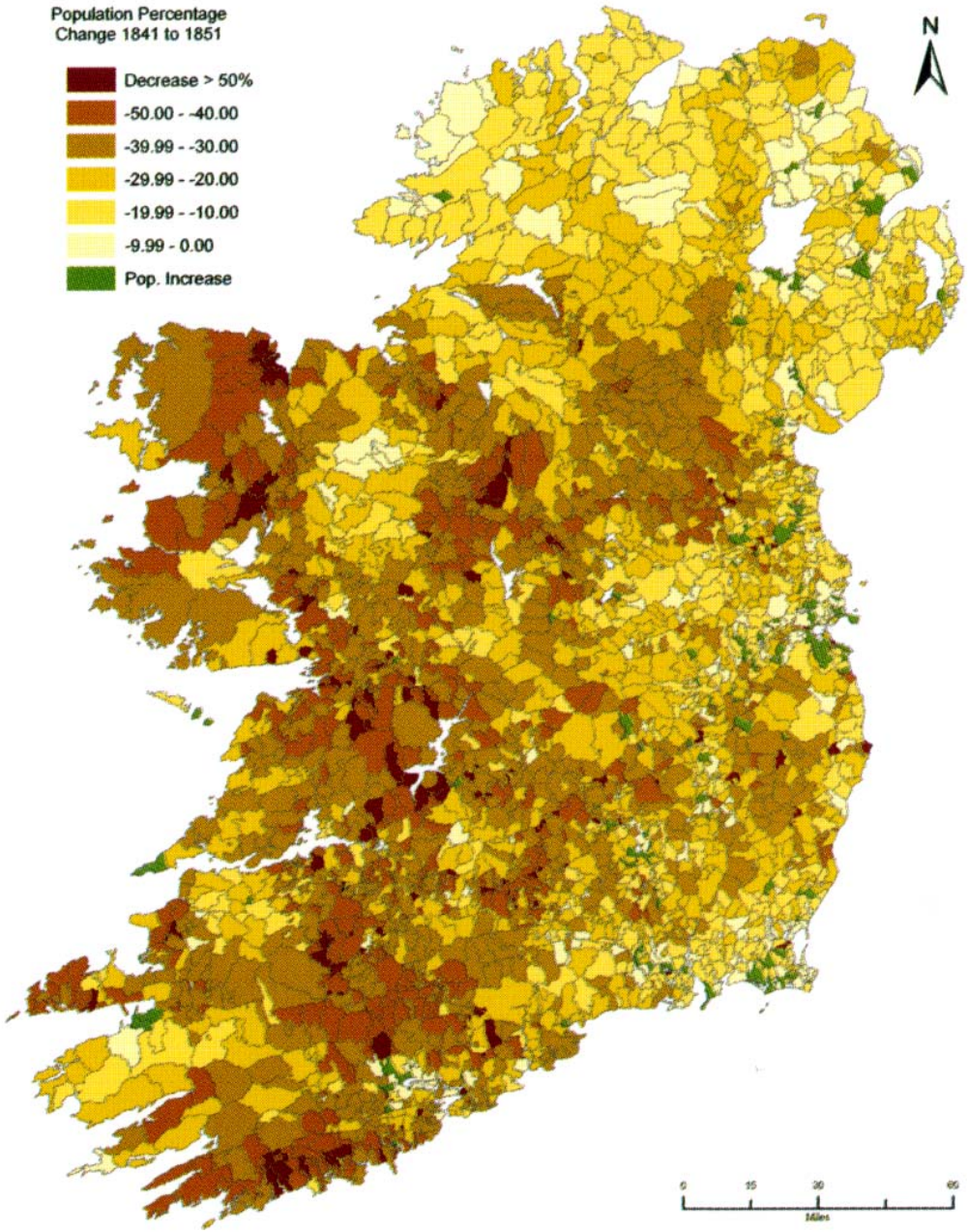
Barony (320)



Population loss (%)

- 60 and above
- 40 to less than 60
- 20 to less than 40
- 0 to less than 20
- Population gain

Smyth (2007)
Pop Change
1841-51
Parishes



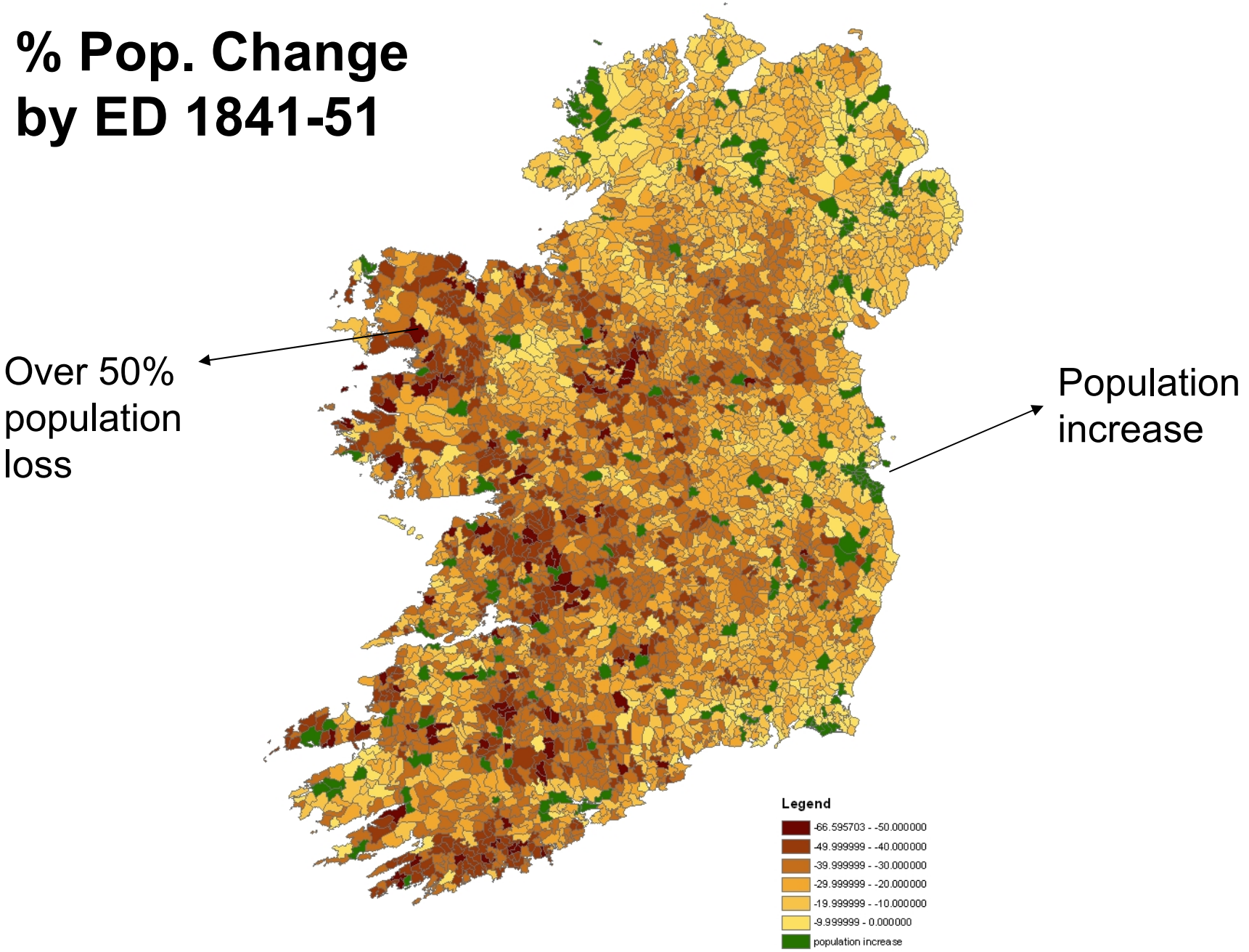
So how can GIS contribute to famine research?

- Display spatial variation at increasingly finer scales
- Build a database of possible explanatory variables
- Measure the relationship between these variables and population change
- Establish the extent to which these relationships varied across space
- Asking new questions on a traditionally qualitative research topic

Displaying the effects of the Famine at a more detailed spatial scale (EDs)

Irish territorial divisions in 1841-51	
Counties	32 √
Poor Law Unions	163 √
Baronies	323 √
Parishes	2,426 √
Electoral divisions	3,439
Townlands	60,915

% Pop. Change by ED 1841-51



The BIG question:

We know that the effects of the Famine were not experienced equally across space …

but how can we measure the determinants of population change?

The literature suggests the following possible explanations

- Population density – over-population thesis
- Poverty levels
- Land fertility and agricultural patterns
- Accessibility to towns and relief schemes
- Accessibility to other sources of food supply
- Assisted migration schemes applied unevenly

The challenges

1. Pop change results from births, deaths, internal migration, net external migration. Data are not availability on each of these individual elements.

2. The answer seems to vary locally

3. Data on explanatory variables at this scale and for this time period are limited

Methodology

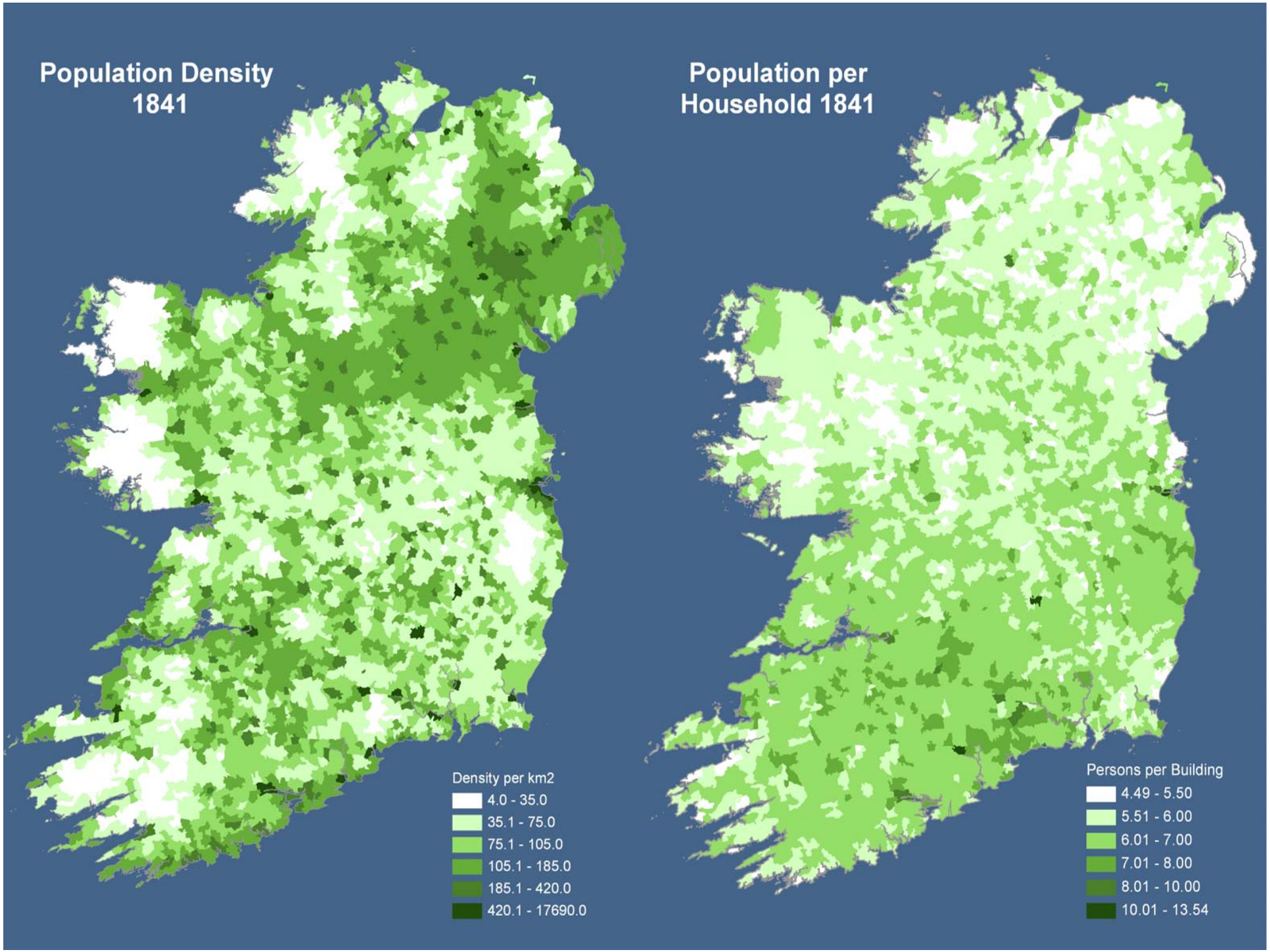
1. Guided by the literature, common sense, and data availability, construct a set of potential explanatory variables of pop change 1841-1851 for the approx 3,400 EDs.

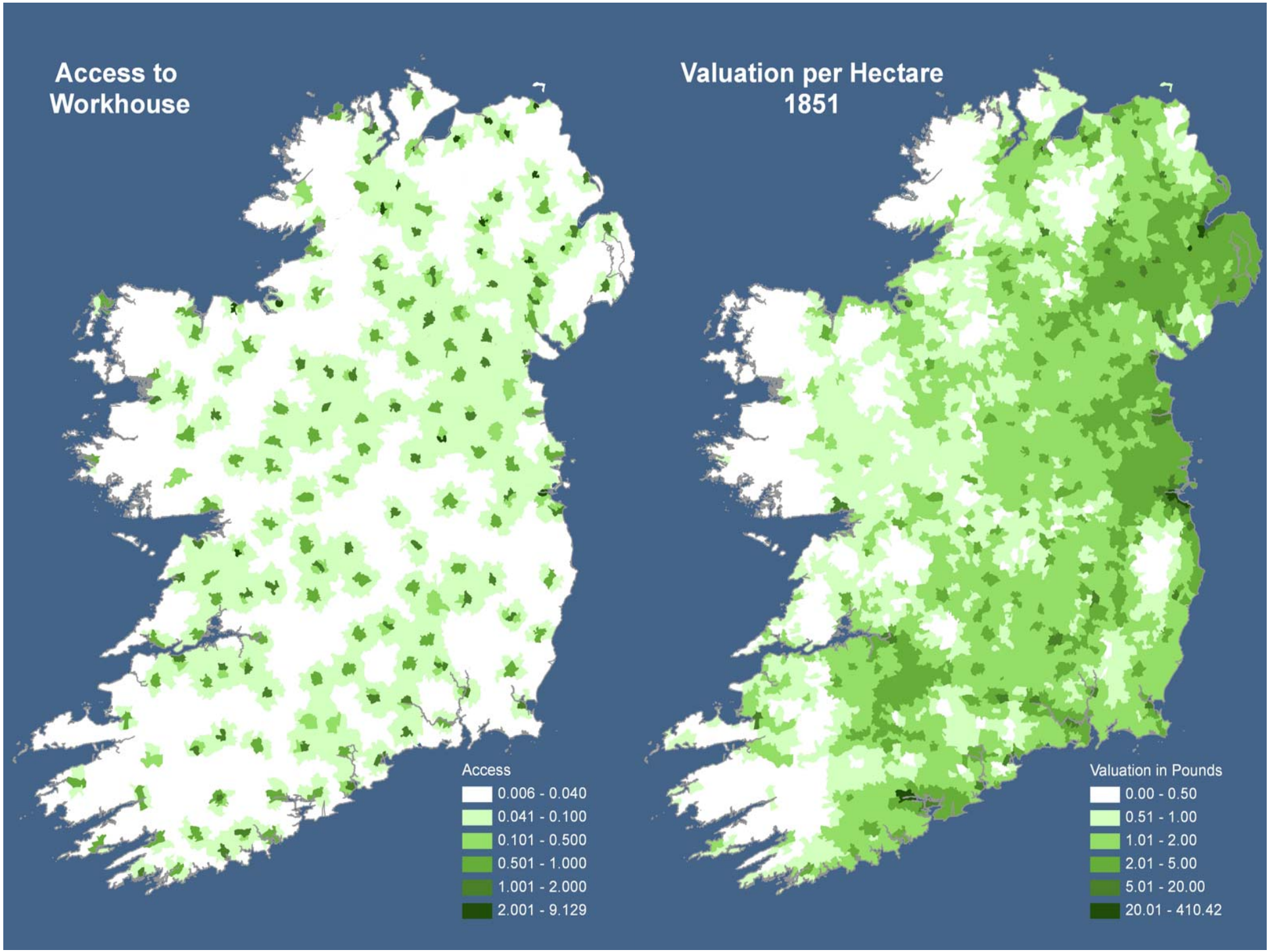
2. Run a set of global regressions to assess the national picture

3. Run a series of Geographically Weighted Regressions (GWR) to examine possible spatial variations in relationships.

1. Data Assembly and Construction

- Census of Population 1851 (1841)
- Agricultural Census 1851
- Constructed set of ED boundaries as they existed in 1851 to match historical records.
- Some variables such as distance to coast, accessibility to urban areas and workhouses were constructed

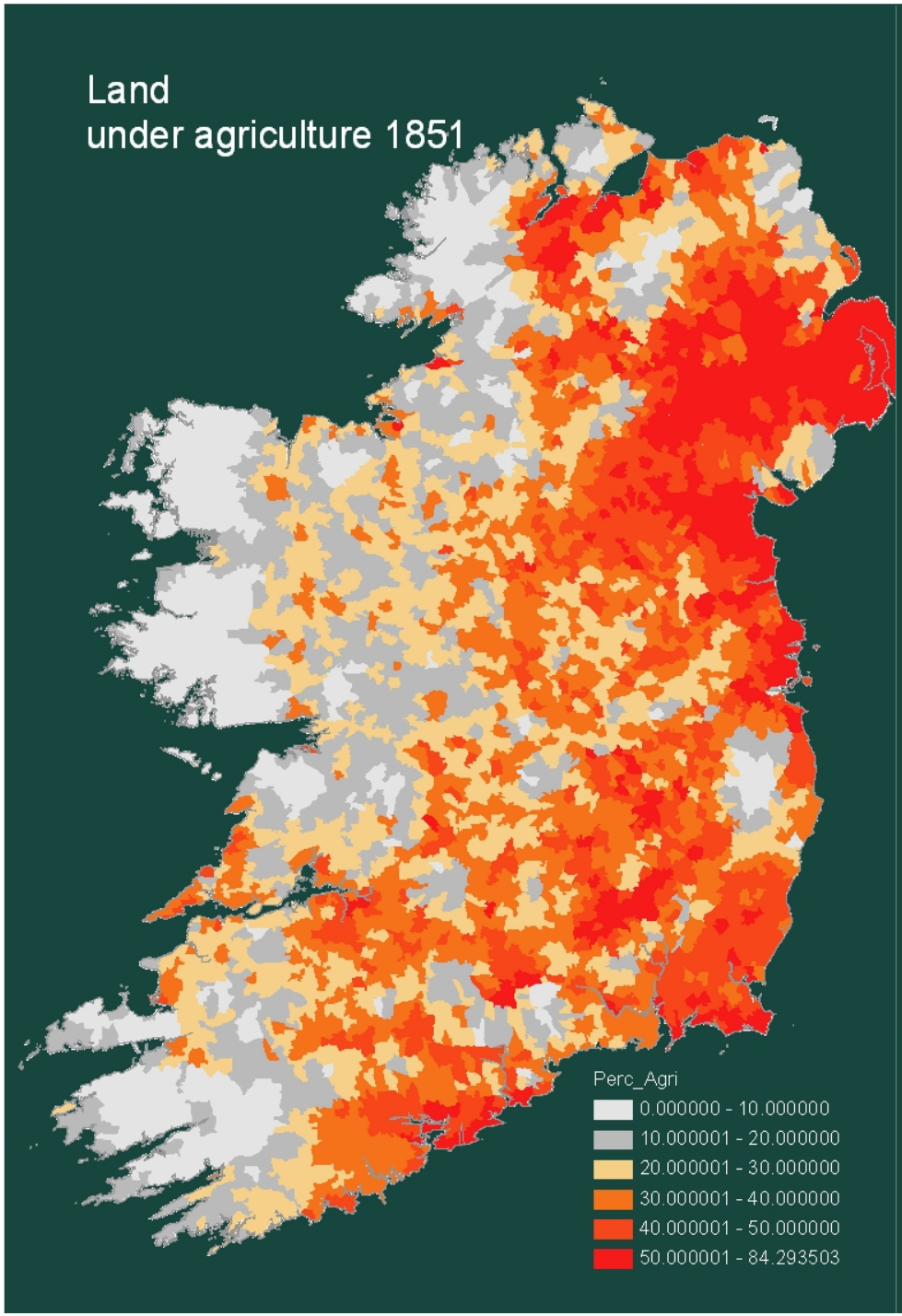

Population Density
1841
Density per km2
4.0 - 35.0
35.1 - 75.0
75.1 - 105.0
105.1 - 185.0
185.1 - 420.0
420.1 - 17690.0
Population per
Household 1841
Persons per Building
4.49 - 5.50
5.51 - 6.00
6.01 - 7.00
7.01 - 8.00
8.01 - 10.00
10.01 - 13.54

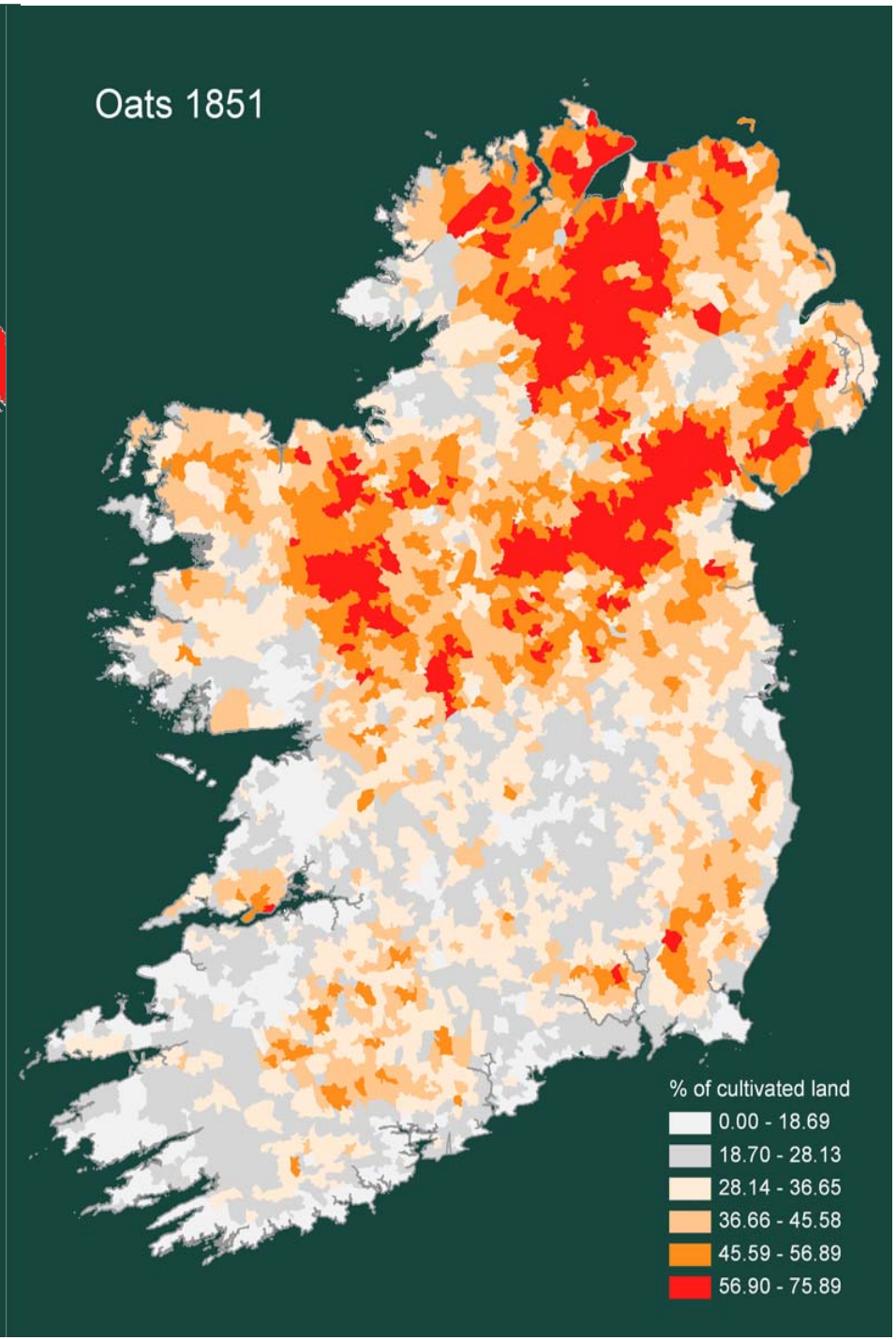

Access to Workhouse
Access
0.006 - 0.040
0.041 - 0.100
0.101 - 0.500
0.501 - 1.000
1.001 - 2.000
2.001 - 9.129
Valuation per Hectare 1851
Valuation in Pounds
0.00 - 0.50
0.51 - 1.00
1.01 - 2.00
2.01 - 5.00
5.01 - 20.00
20.01 - 410.42

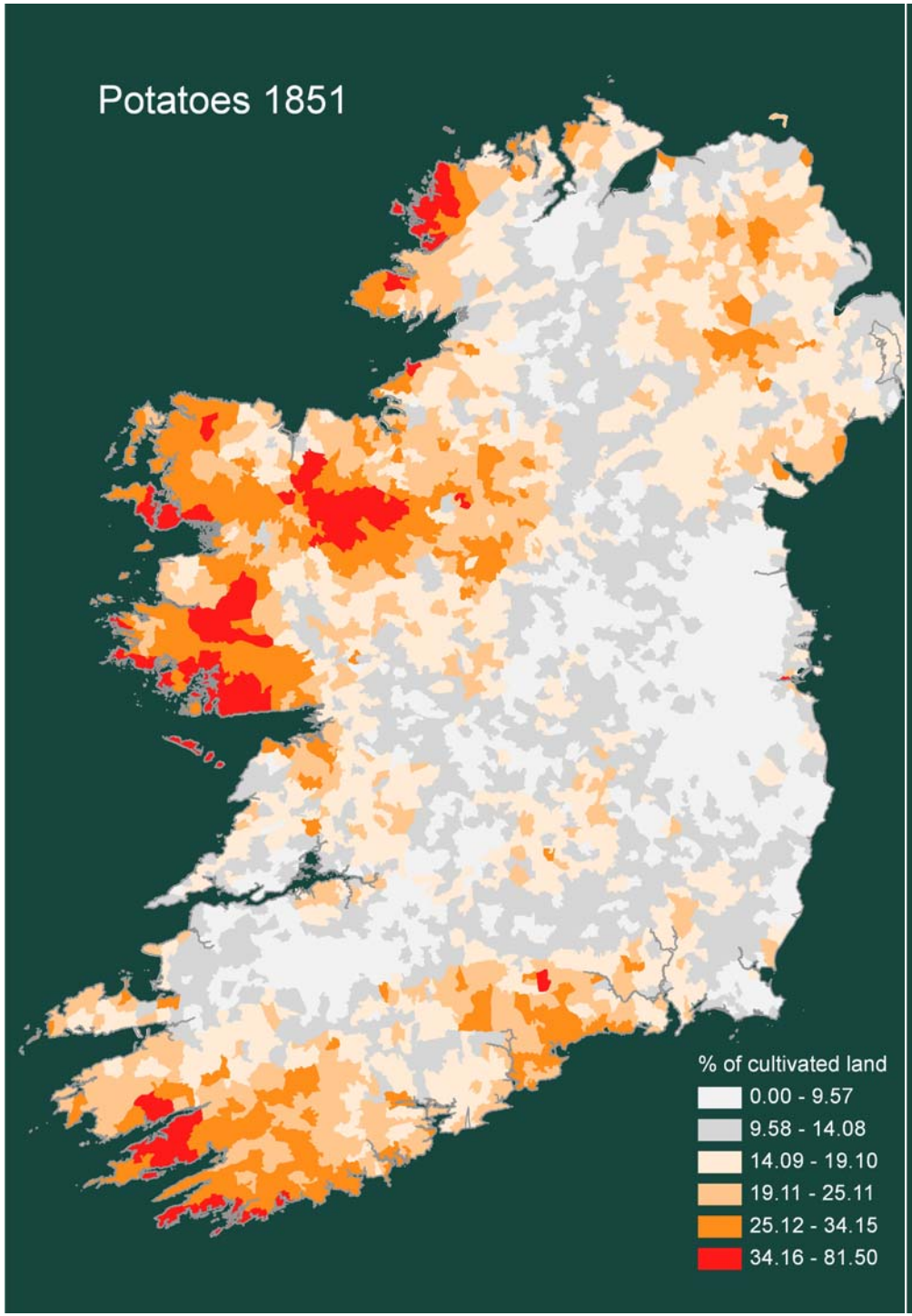
2. Global Regression Results

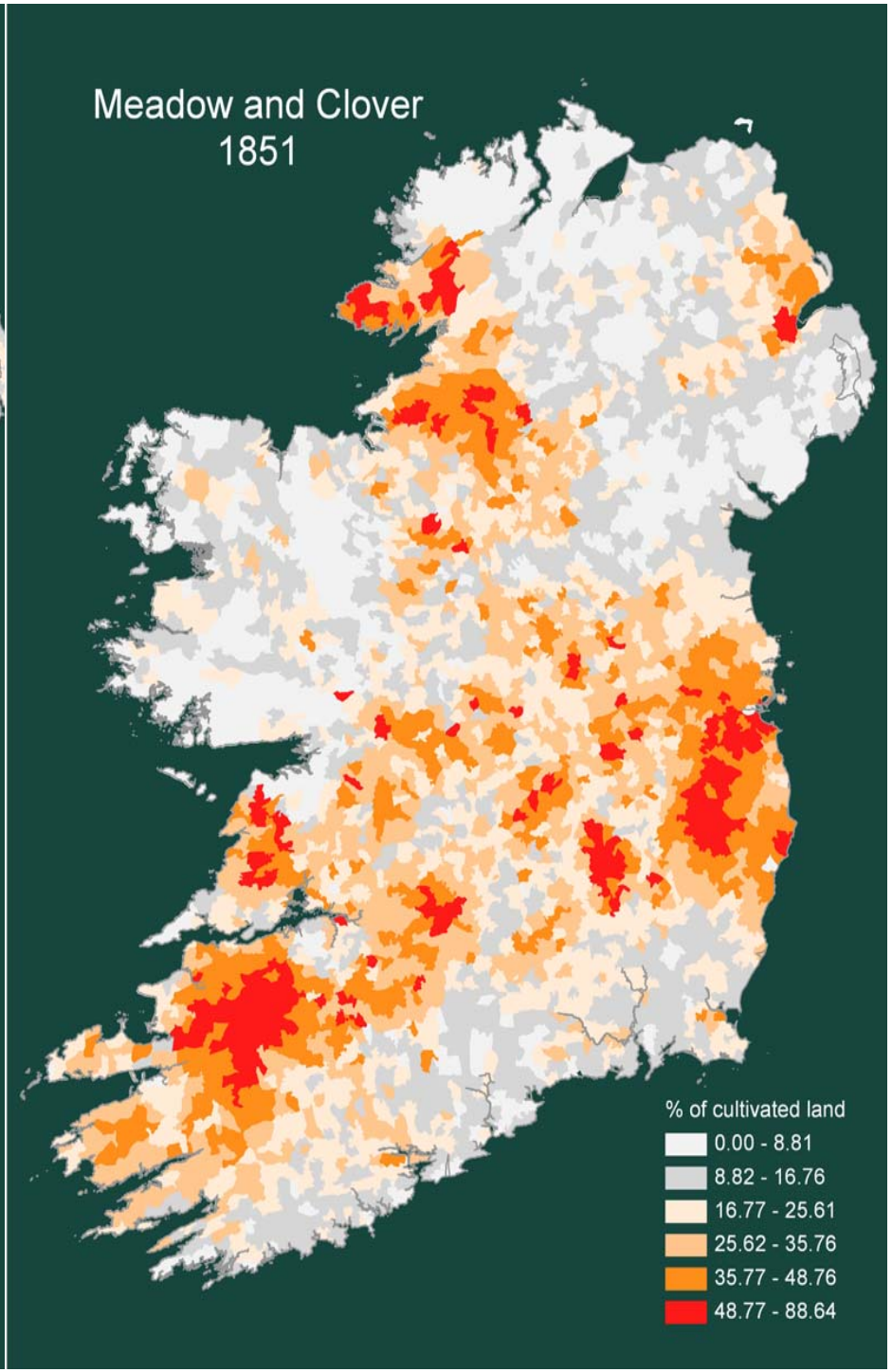
R square = .28

Effect	T value	Effects more severe when…
MF Ratio	-7.8	More males than females
Pop Dens	-12.1	High pop density on land
Unoccupied Housing	12.0	Low % of unoccupied housing
Persons per Building	0.9	
Value per Ha.	11.4	Land value low
Percent Agric	8.9	Land less fertile
Oats Cul	9.2	Oats not grown
Potato Cul	12.4	Potatoes not grown
Meadow	10.5	In non-dairy areas
Distance to Coast	-4.8	Further from the coast
Proximity to Workhouse	14.5	No workhouse close by
Proximity to Towns	-8.5	Near to towns (migration)


Land
under agriculture 1851
Perc_Agri
0.000000 - 10.000000
10.000001 - 20.000000
20.000001 - 30.000000
30.000001 - 40.000000
40.000001 - 50.000000
50.000001 - 84.293503


Oats 1851
% of cultivated land
0.00 - 18.69
18.70 - 28.13
28.14 - 36.65
36.66 - 45.58
45.59 - 56.89
56.90 - 75.89


Potatoes 1851
% of cultivated land
0.00 - 9.57
9.58 - 14.08
14.09 - 19.10
19.11 - 25.11
25.12 - 34.15
34.16 - 81.50

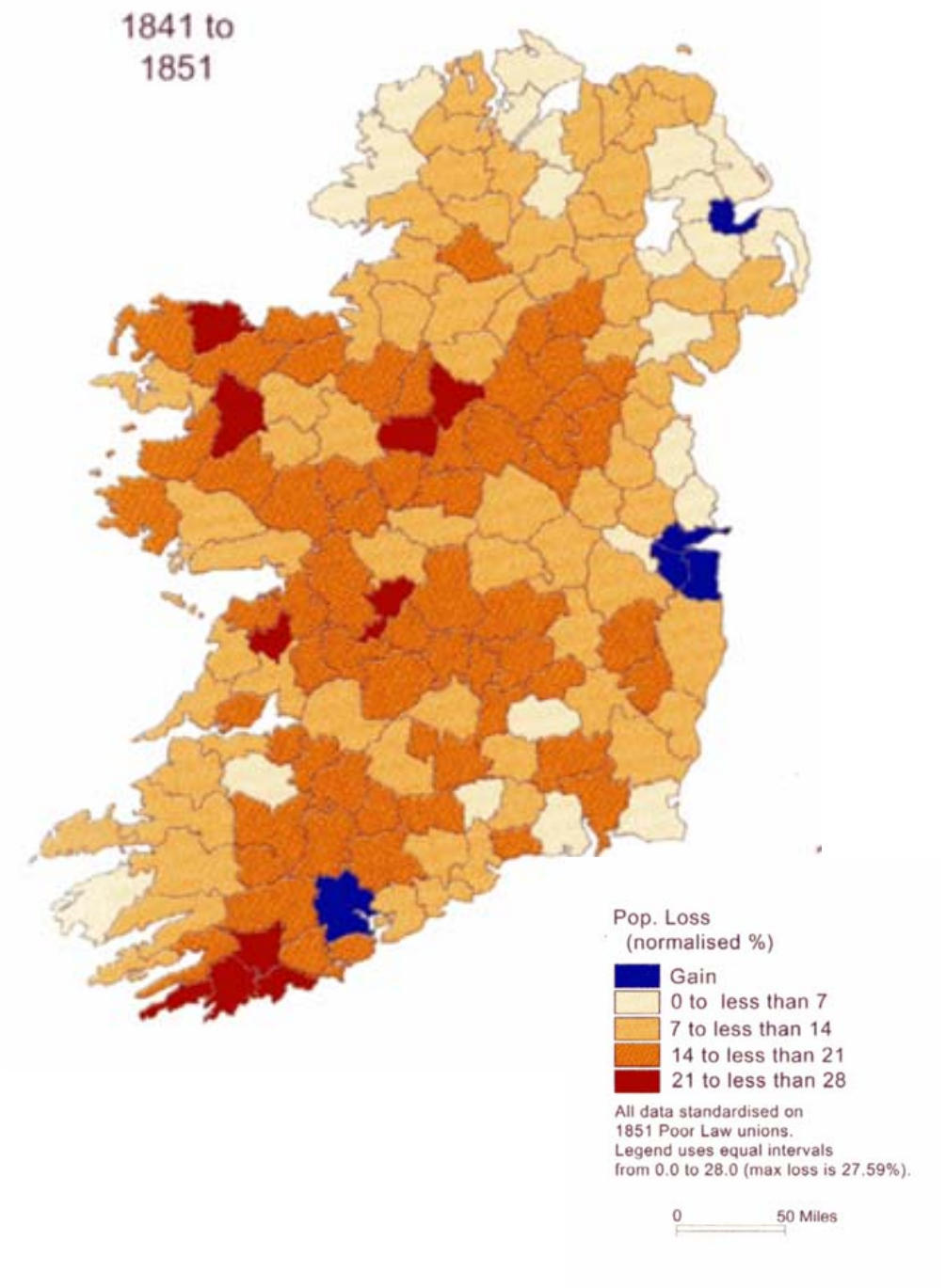

Meadow and Clover
1851
% of cultivated land
0.00 - 8.81
8.82 - 16.76
16.77 - 25.61
25.62 - 35.76
35.77 - 48.76
48.77 - 88.64

BUT… what if there are spatial variations in the way these variables affected susceptibility to the Famine…?? Why should we assume the relationships are the same everywhere?

Such interesting variations would be completely masked by these 'averages'

To investigate possible spatial variations in the determinants of the effects of the Famine, we need to turn to Geographically Weighted Regression (GWR)

Fotheringham, Brunsdon and Charlton (2002)



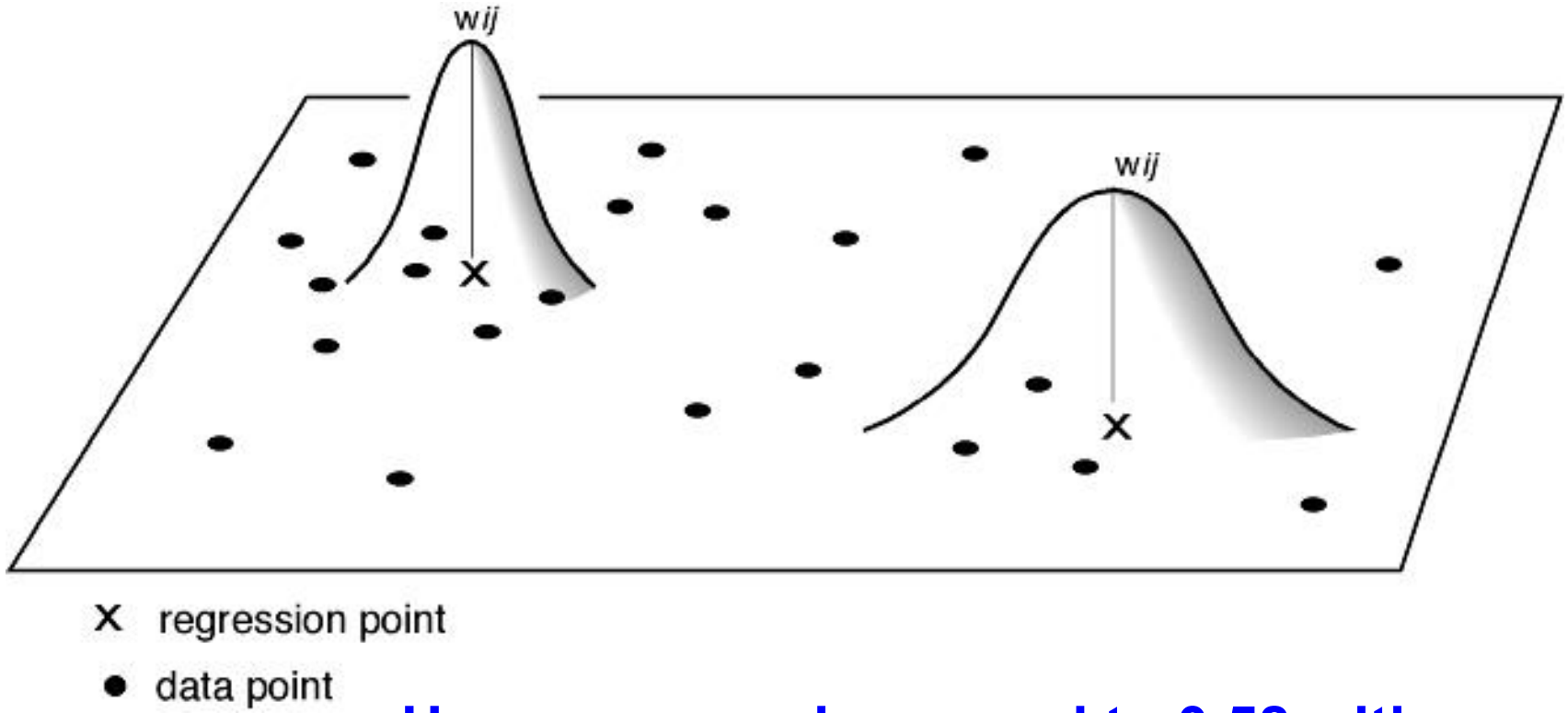
Ell and Gregory (2005)

Also map at Poor Law Union and Barony Level

Undertook regression analysis using variables at this scale

And also carry out GWR analysis to identify more specific regional patterns

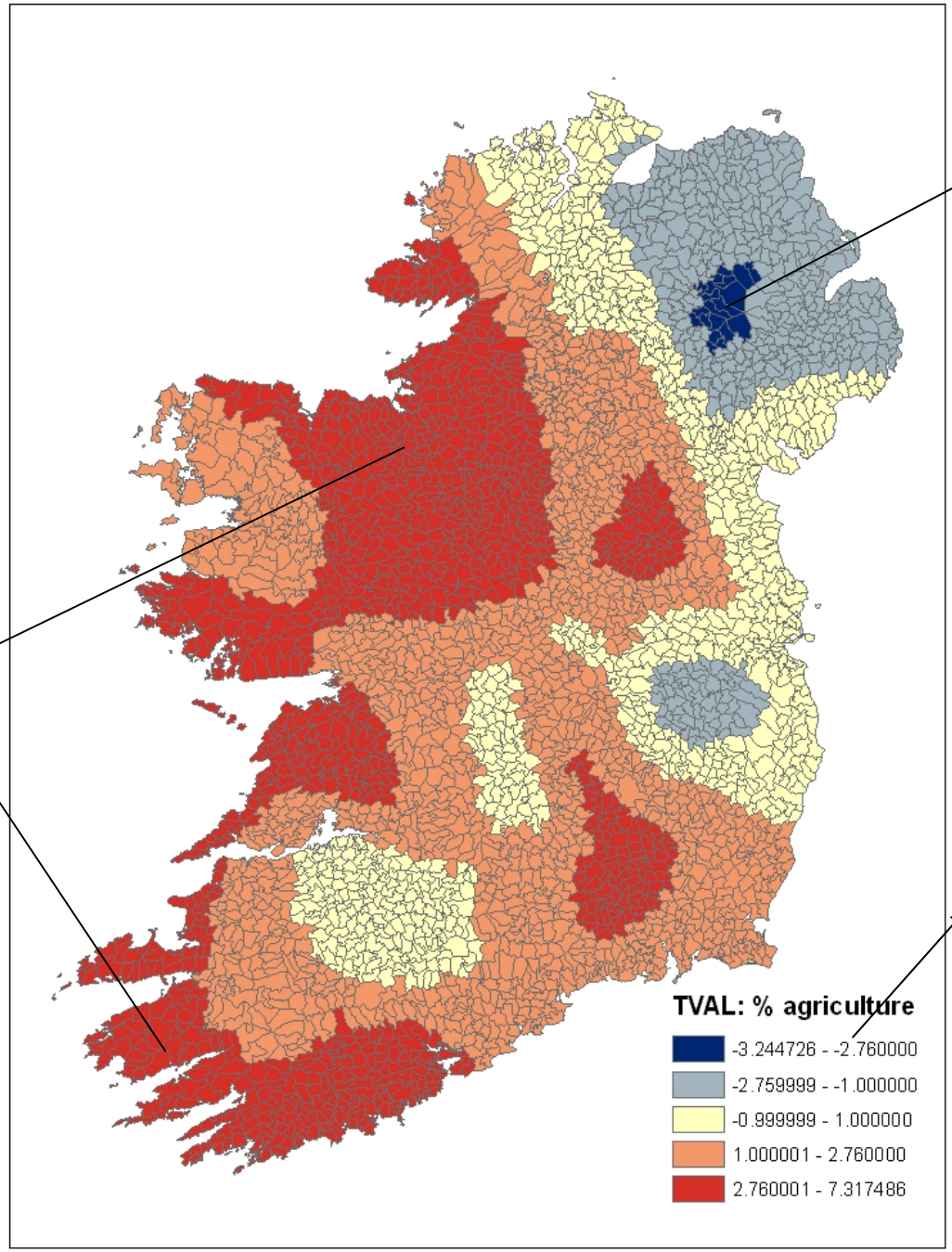
The Essence of GWR



Here, r square increased to 0.58 with a bandwidth of 448 (out of 3417 locations). Can produce maps of local effects (t values)

Global t = 8.9

High % ED in agric → less severe effects

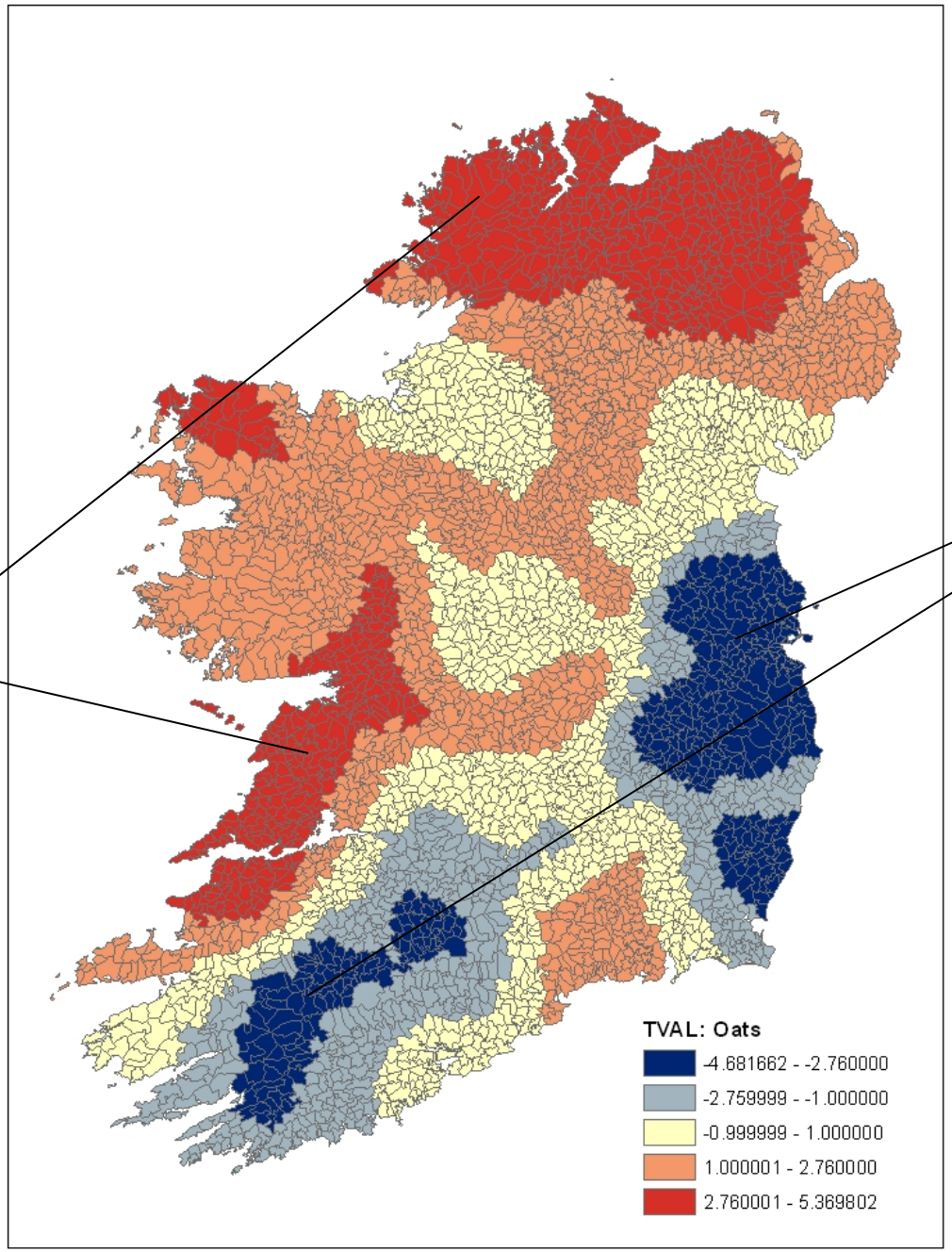


Higher % of ED in agric → more severe effects Agriculture vs ind ?

Correction for multiple hypothesis testing

Global t = 9.2

High % agric land under oats → less severe effects

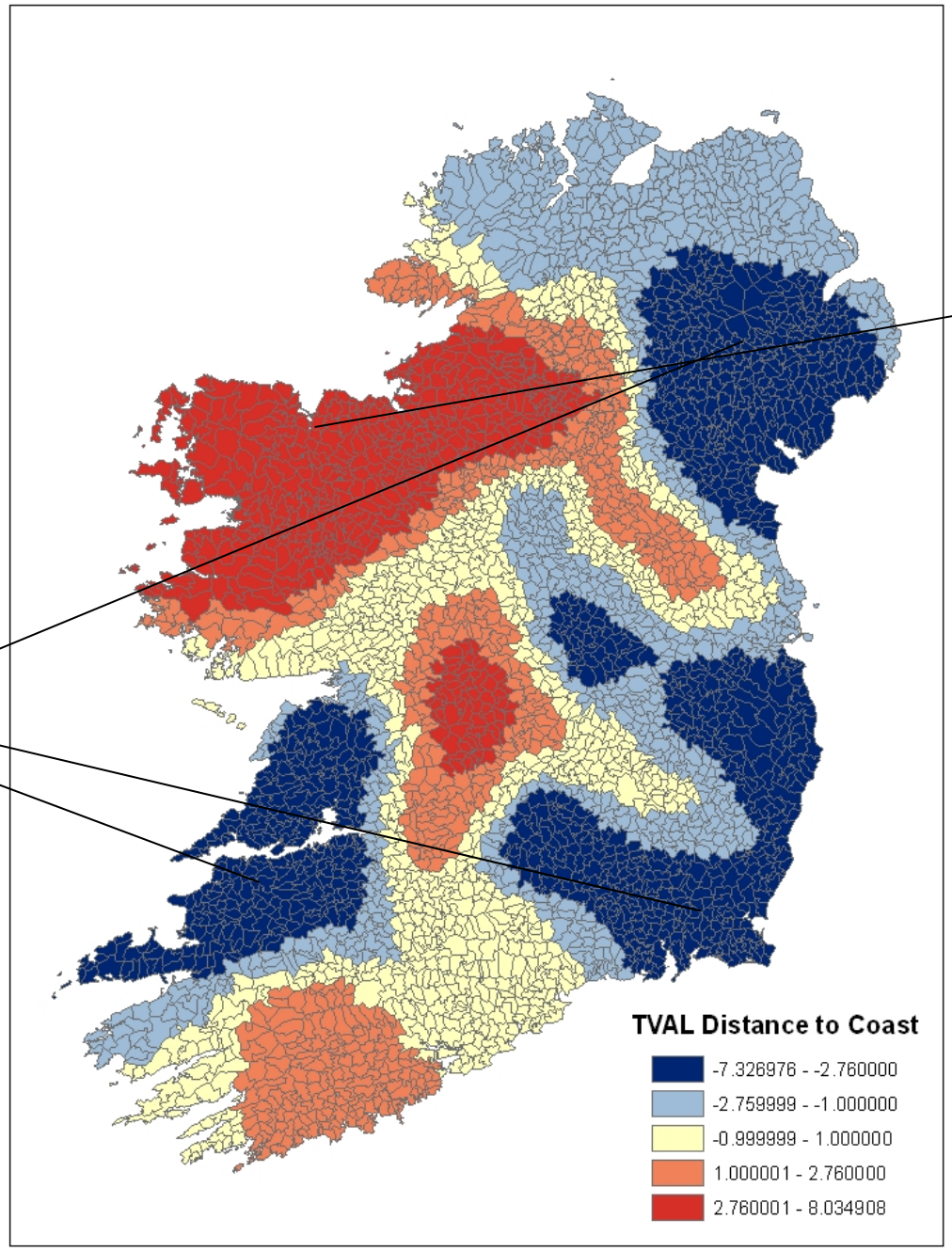


High % agric land under oats → more severe effects

Oats grown on relatively poor ground locally?

Global t
= -4.8

Further inland → effects more severe



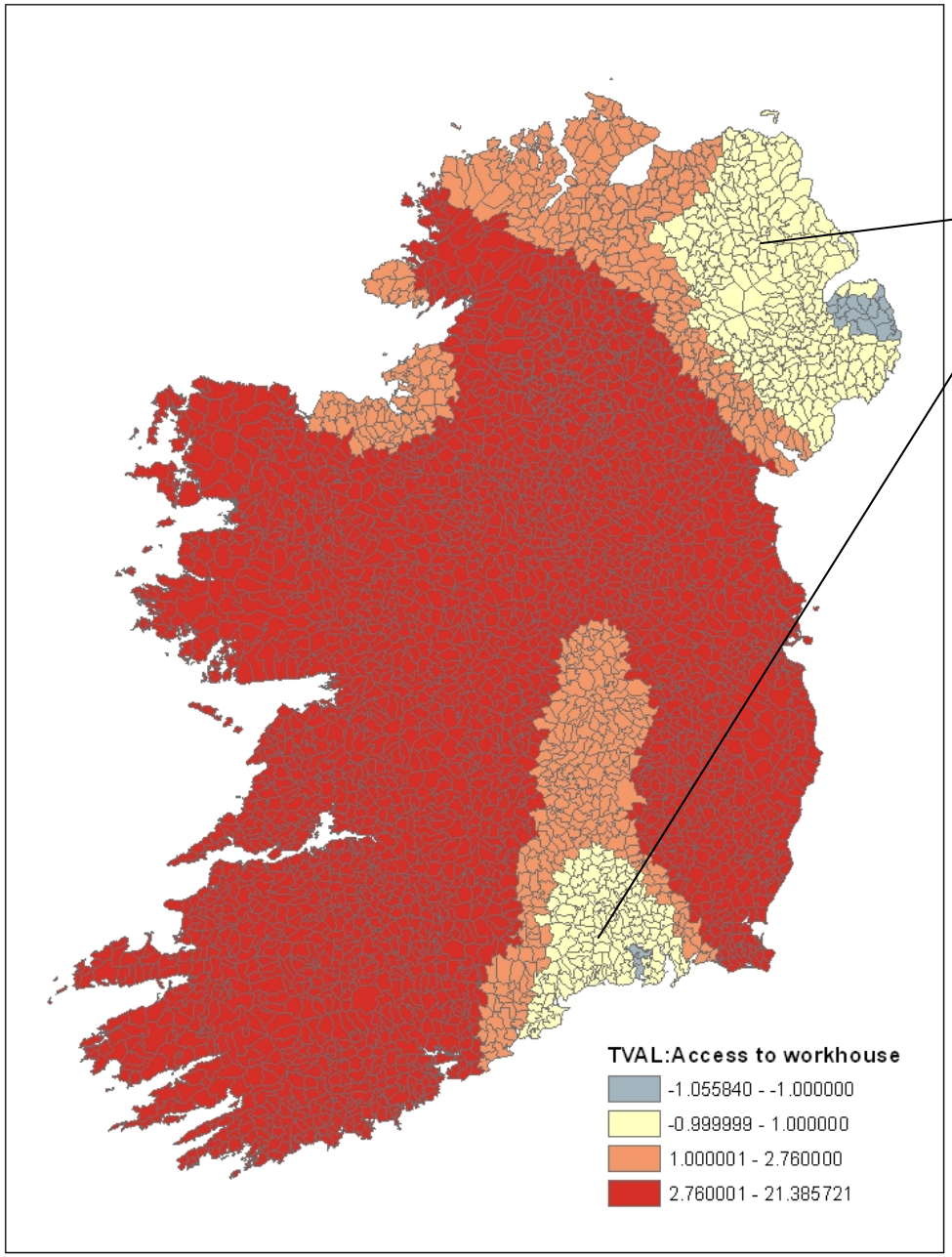
Further inland effects less severe

Easier to emmigrate from coast? Fever more prevalent on coast?

Global t
= 14.5

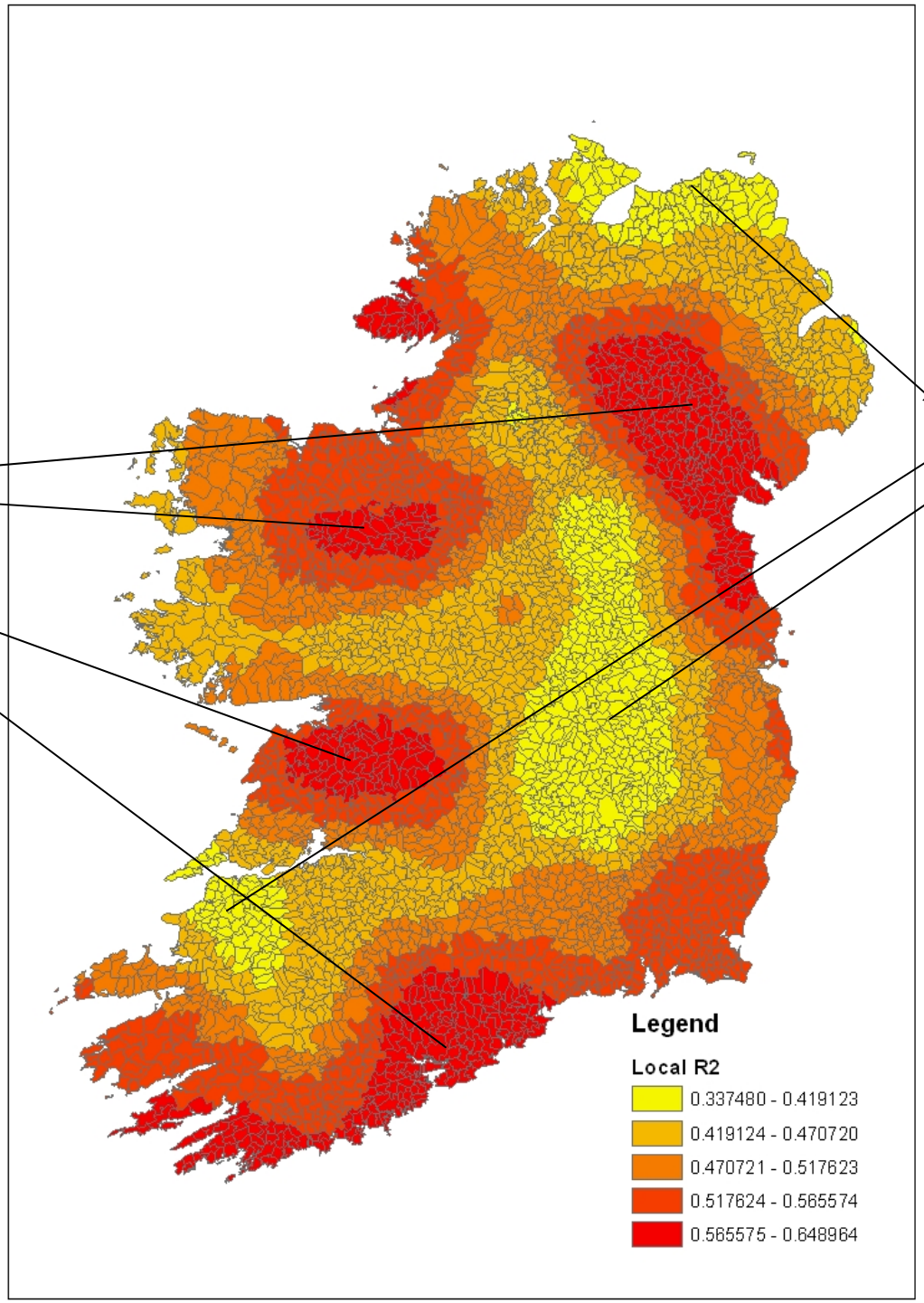
Closer to workhouses → effects less severe

Internal migration?



Workhouses had little impact

Model working relatively well



Model working relatively poorly

Summary

- There were large spatial variations in the impacts of the Famine on Irish pop. dynamics. Through GIS these impacts have now been mapped at a very fine spatial scale.
- However, use of GIS has allowed us to go further than description and to examine possible explanations for these spatial variations through data assembly and construction and the application of spatial analysis
- It appears that the determinants of the impacts of the Famine were not constant across the country. Some significant and intriguing variations exist and have been mapped. GWR provides us with new lines of enquiry.
- The effective use of GIS in the Humanities and Soc. Sciences needs to demonstrate it provides greater insights than were otherwise available

End of Presentation

Thank you for your attention

For further information, please contact:

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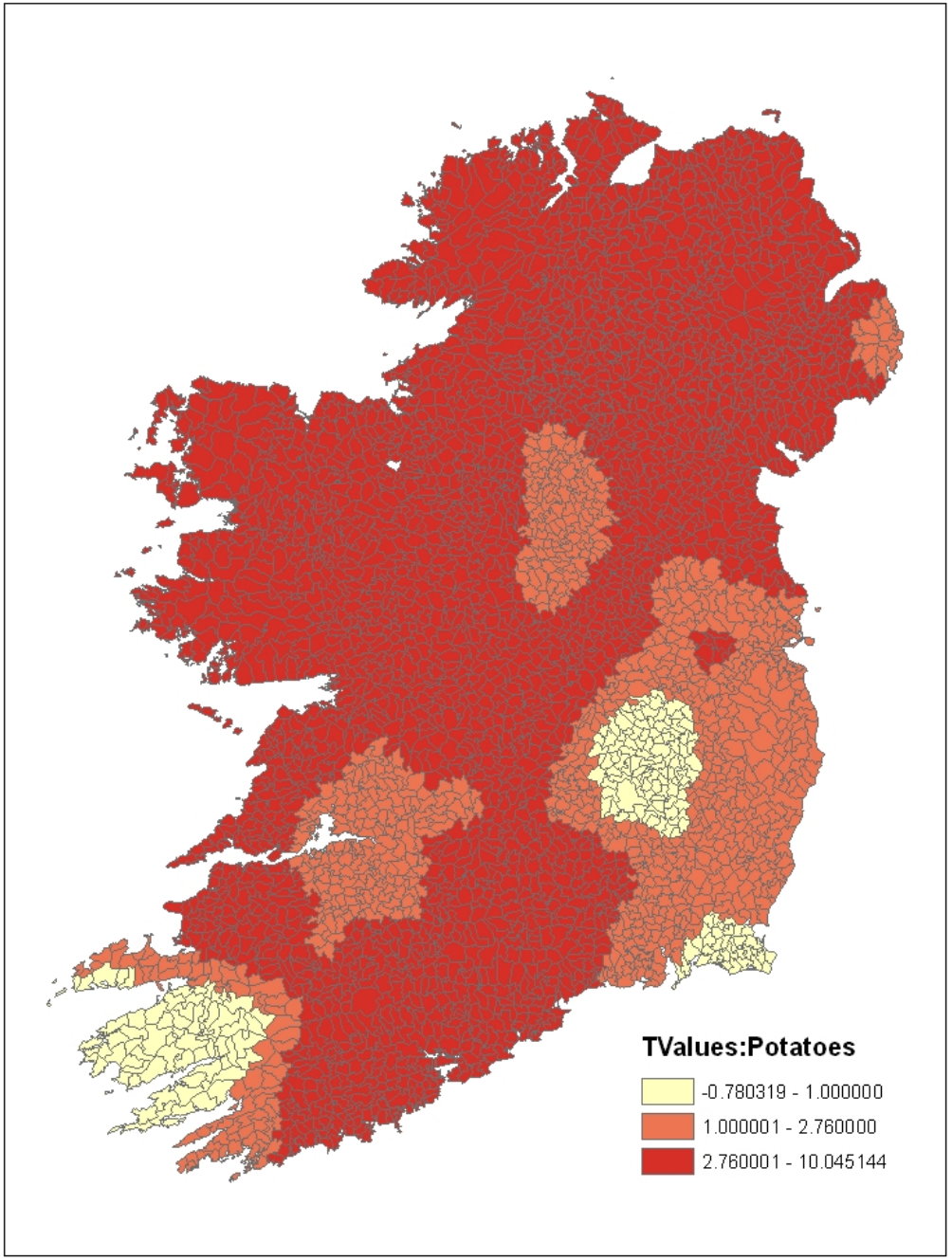
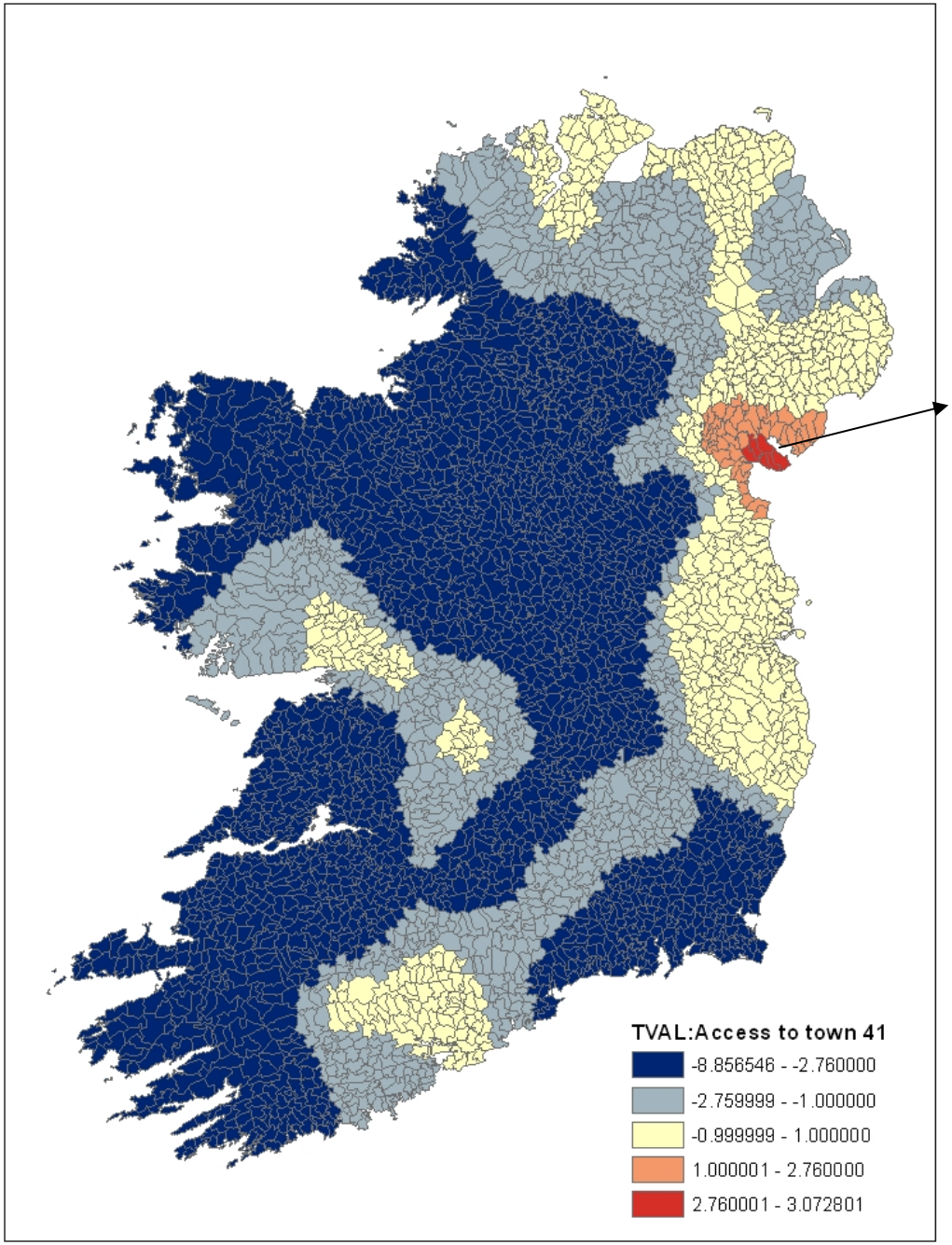
Global t = 12.4

High % agric land under potatoes→ less severe effects

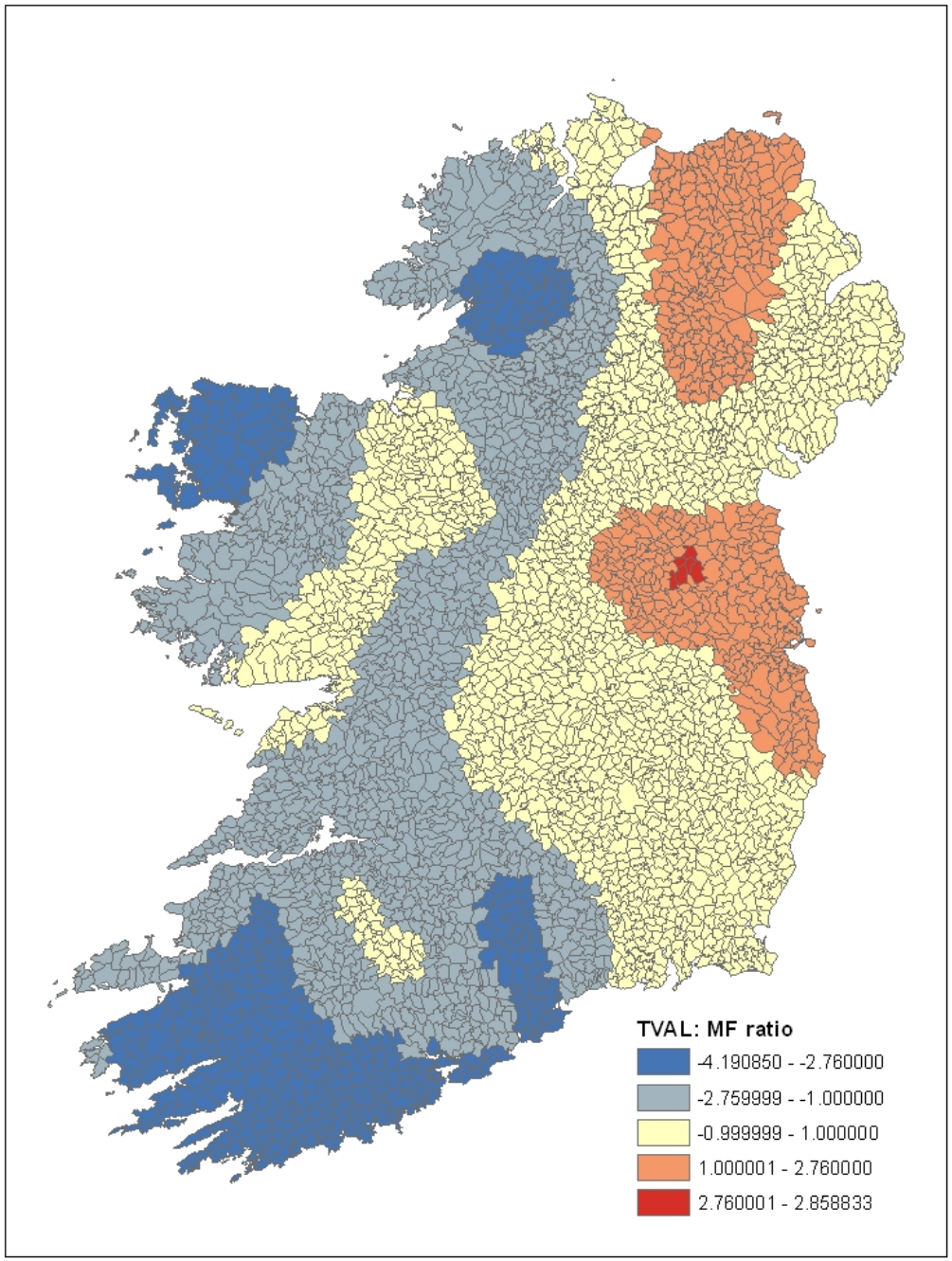


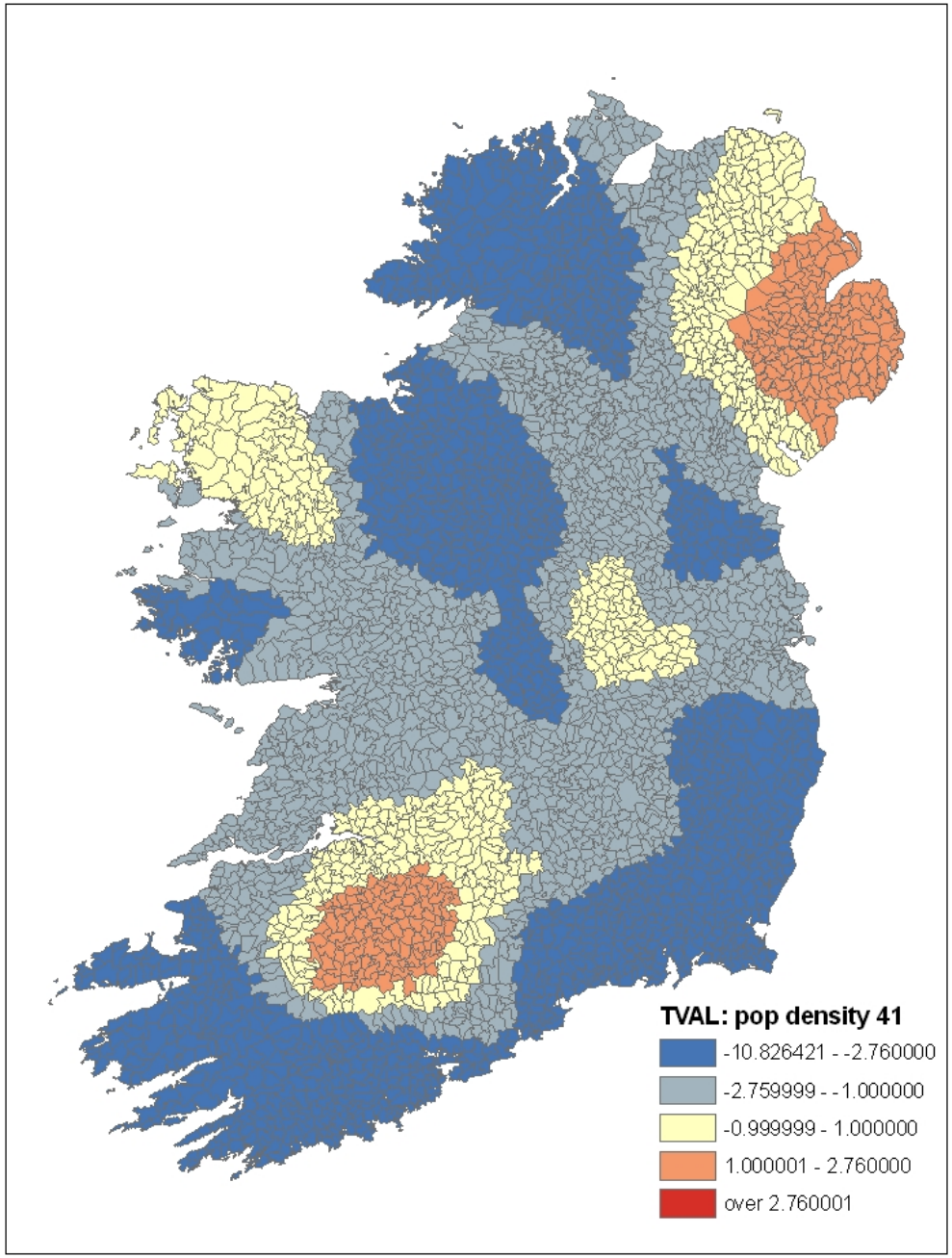
Global t = -8.5

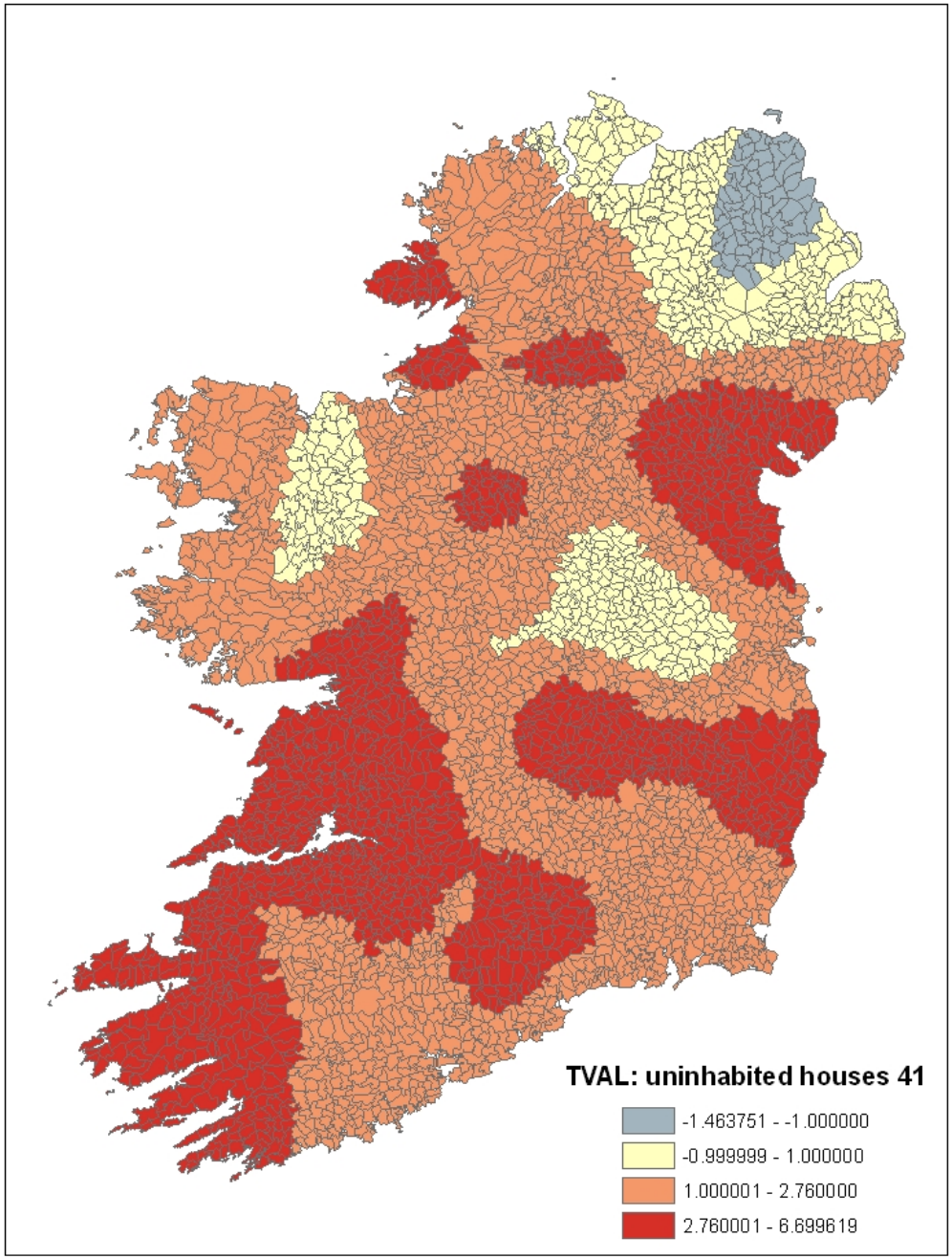
Closer to urban areas → effects more severe

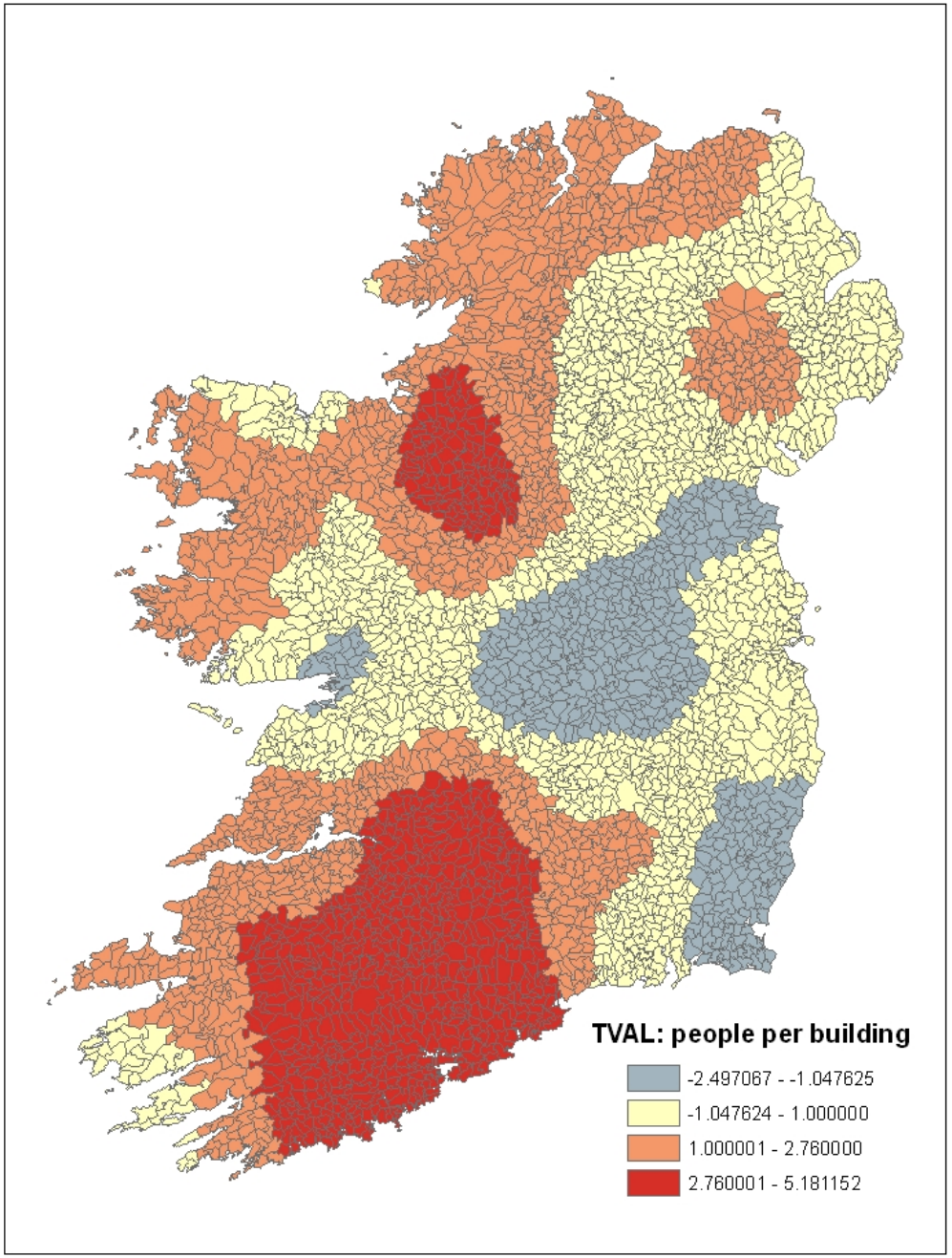


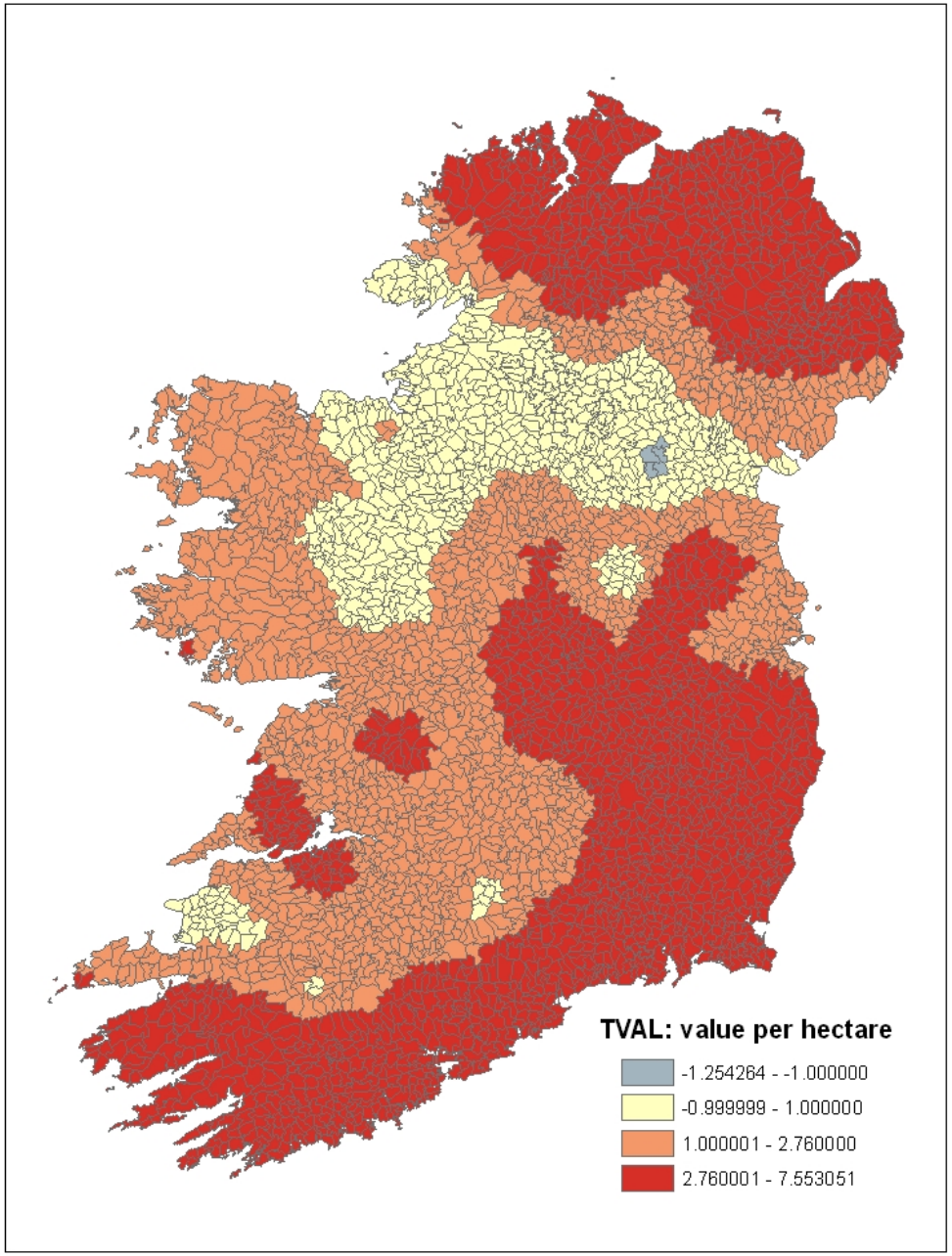
Closer to urban area → effects less severe

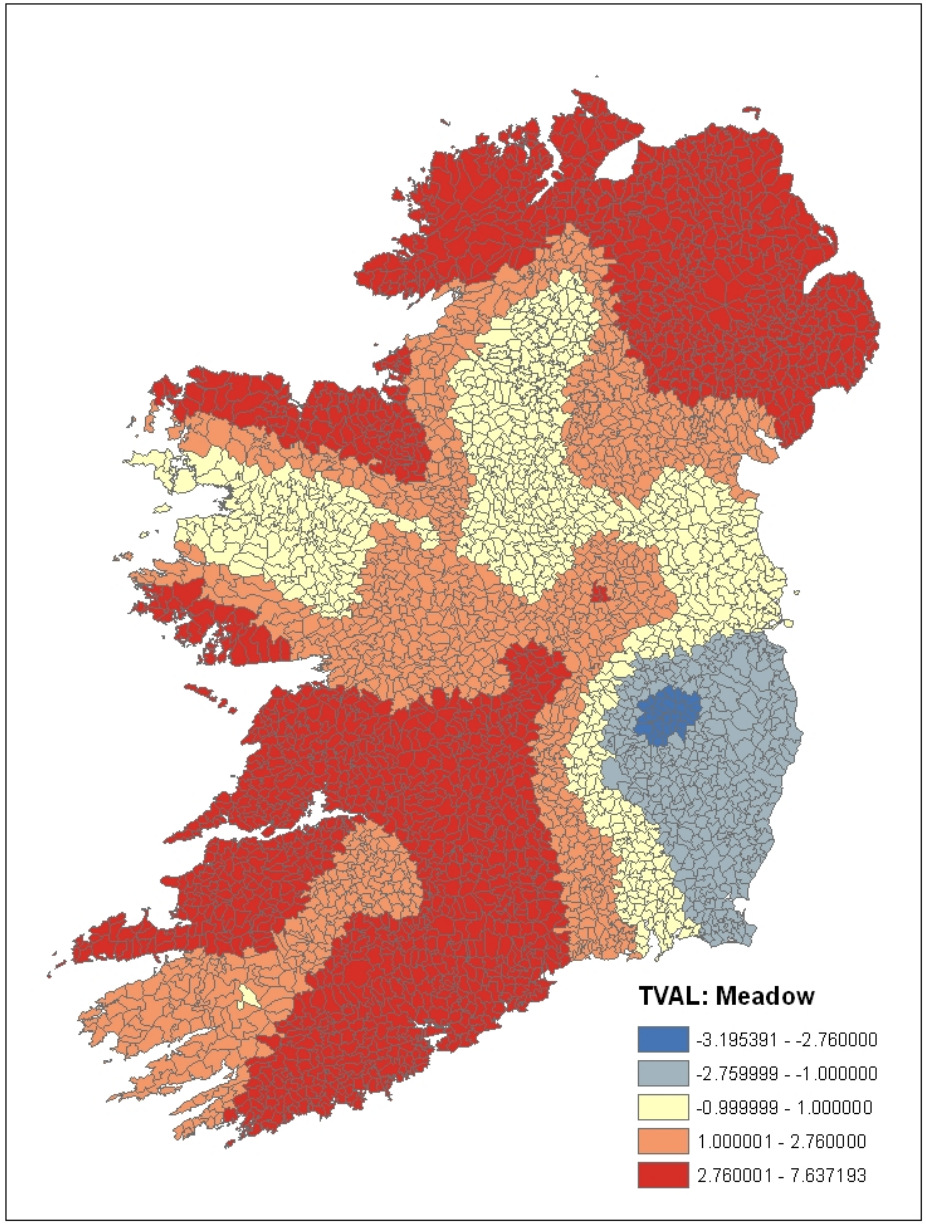

TVAL: MF ratio
-4.190850 - -2.760000
-2.759999 - -1.000000
-0.999999 - 1.000000
1.000001 - 2.760000
2.760001 - 2.858833

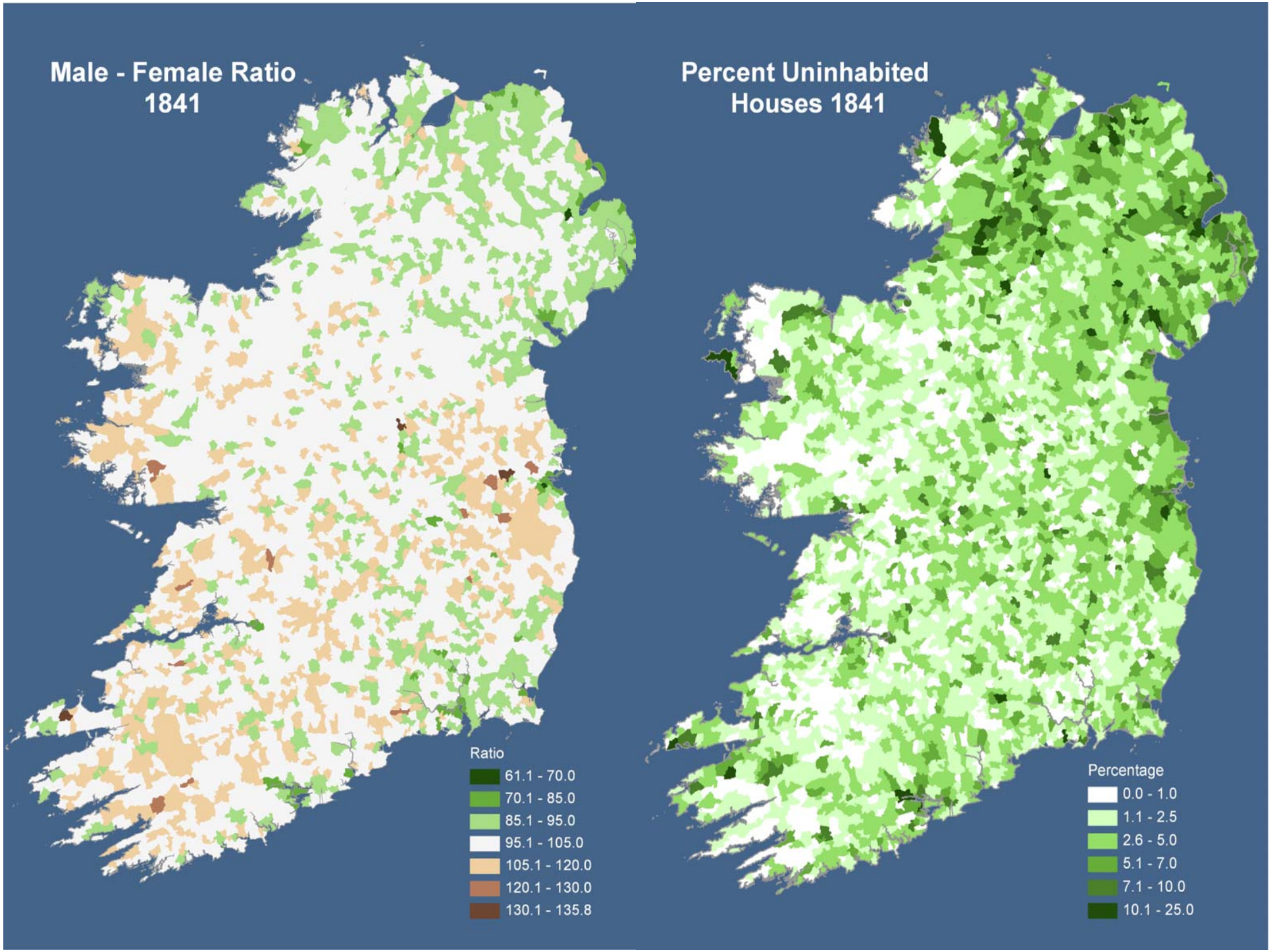

TVAL: pop density 41
-10.826421 - -2.760000
-2.759999 - -1.000000
-0.999999 - 1.000000
1.000001 - 2.760000
over 2.760001


TVAL: uninhabited houses 41
-1.463751 - -1.000000
-0.999999 - 1.000000
1.000001 - 2.760000
2.760001 - 6.699619


TVAL: people per building
-2.497067 - -1.047625
-1.047624 - 1.000000
1.000001 - 2.760000
2.760001 - 5.181152


TVAL: value per hectare
-1.254264 - -1.000000
-0.999999 - 1.000000
1.000001 - 2.760000
2.760001 - 7.553051


TVAL: Meadow
-3.195391 - -2.760000
-2.759999 - -1.000000
-0.999999 - 1.000000
1.000001 - 2.760000
2.760001 - 7.637193


Male - Female Ratio
1841
Ratio
61.1 - 70.0
70.1 - 85.0
85.1 - 95.0
95.1 - 105.0
105.1 - 120.0
120.1 - 130.0
130.1 - 135.8
Percent Uninhabited
Houses 1841
Percentage
0.0 - 1.0
1.1 - 2.5
2.6 - 5.0
5.1 - 7.0
7.1 - 10.0
10.1 - 25.0