

Biodiversity and economic connectedness: what's the relation? In five results.

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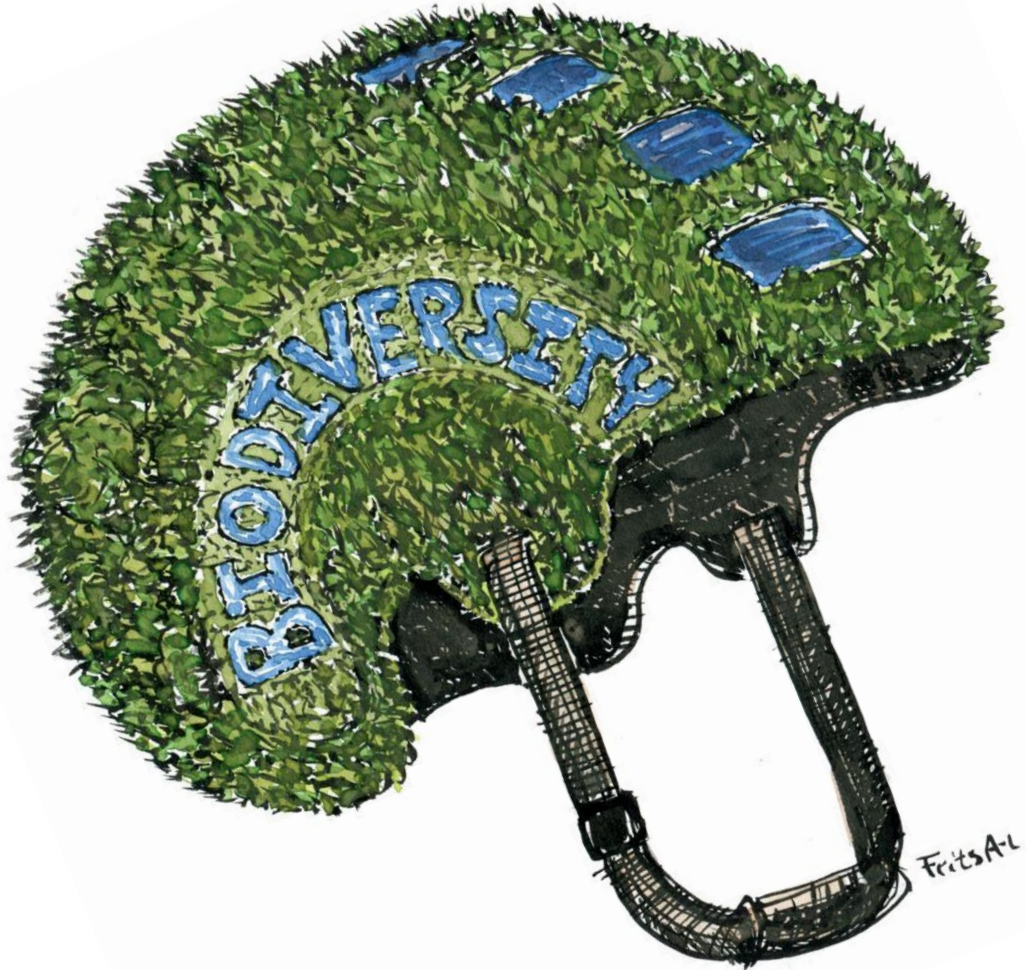
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Tremendous help: Nuno Silva, FEUC

Part I

The importance to study

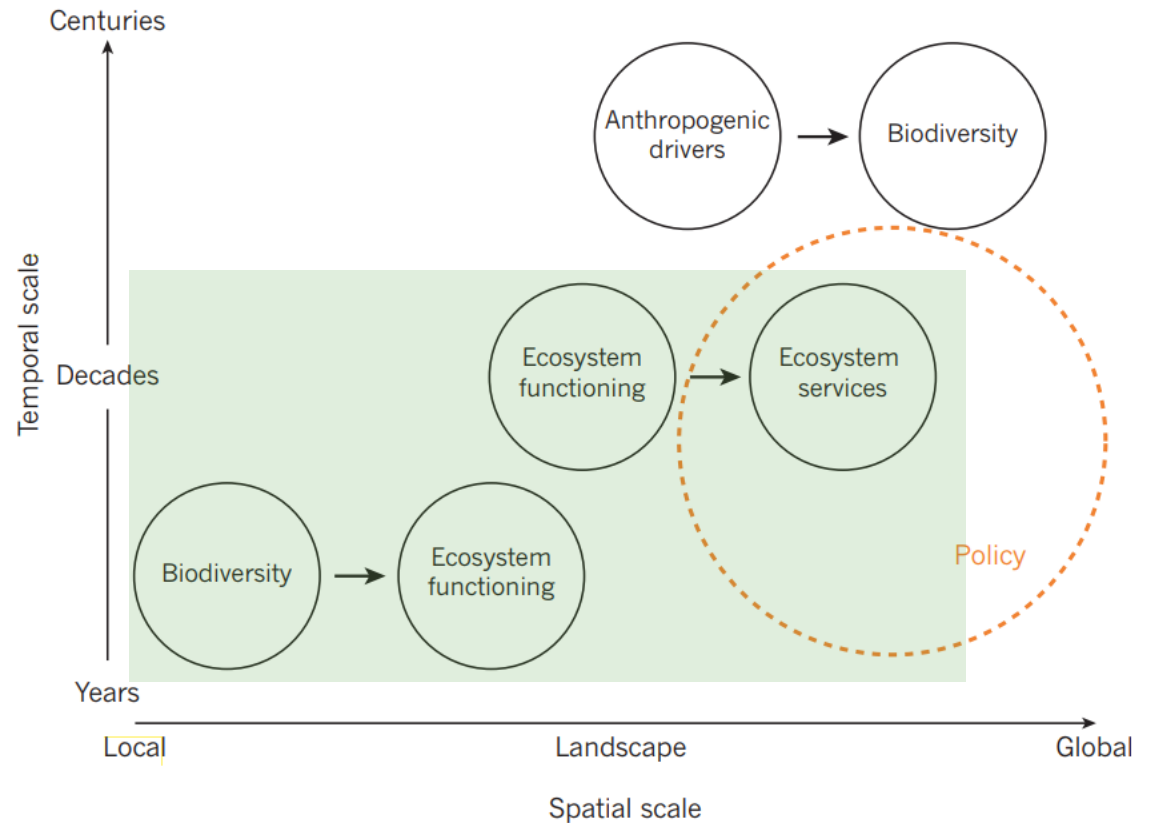
Biodiversity



- variety of life on earth
- there are ongoing and upcoming changes
- immediate local effects are overstudied
- need to understand the bigger picture

Frits Ahlefeldt

In decades' time, these changes are going to haunt back.



And we have a say.

Social capital (and economic connectedness)

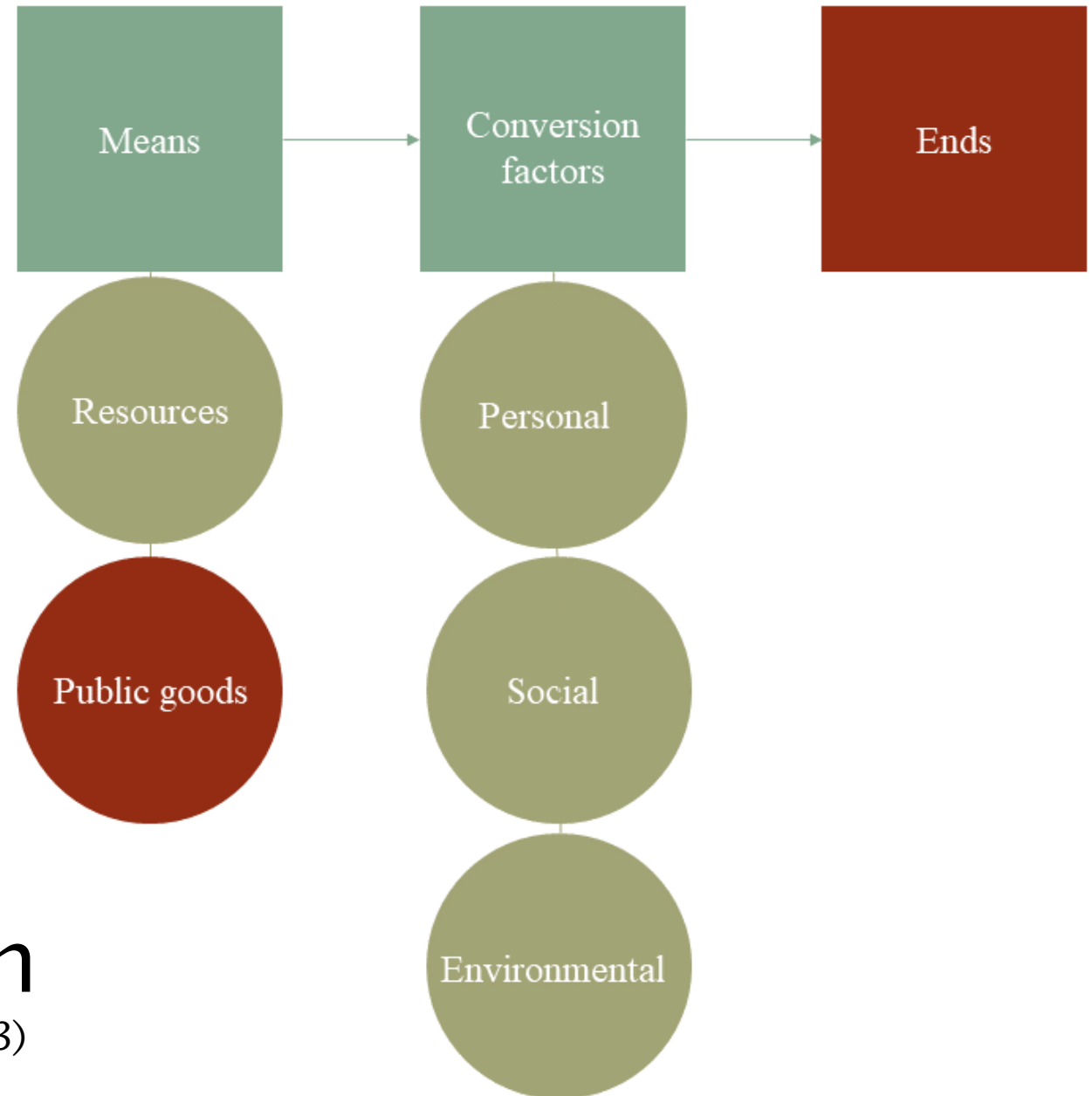
- Social networks have value and affect productivity of individuals and groups – Putnam, 2000
- It can be a policy tool: public policymaking can benefit from existing or building new social capital
- Social capital promotes successful policy implementation
- Economic connectedness is a measure of social capital (later)

The need for modelling for biodiversity effects on social capital directly stems indirectly from the salience of social capital, as getting ahead, or upward income mobility, is strongly predicted by economic connectedness (Chetty et al., 2022).

Part II

The idea of the linkage

How are the two related?



Capabilities approach

Source: based on (Robeyns & Fibieger Byskov, 2023)

Part III

What's done

Method: fuzzy set Qualitative Comparative Analysis

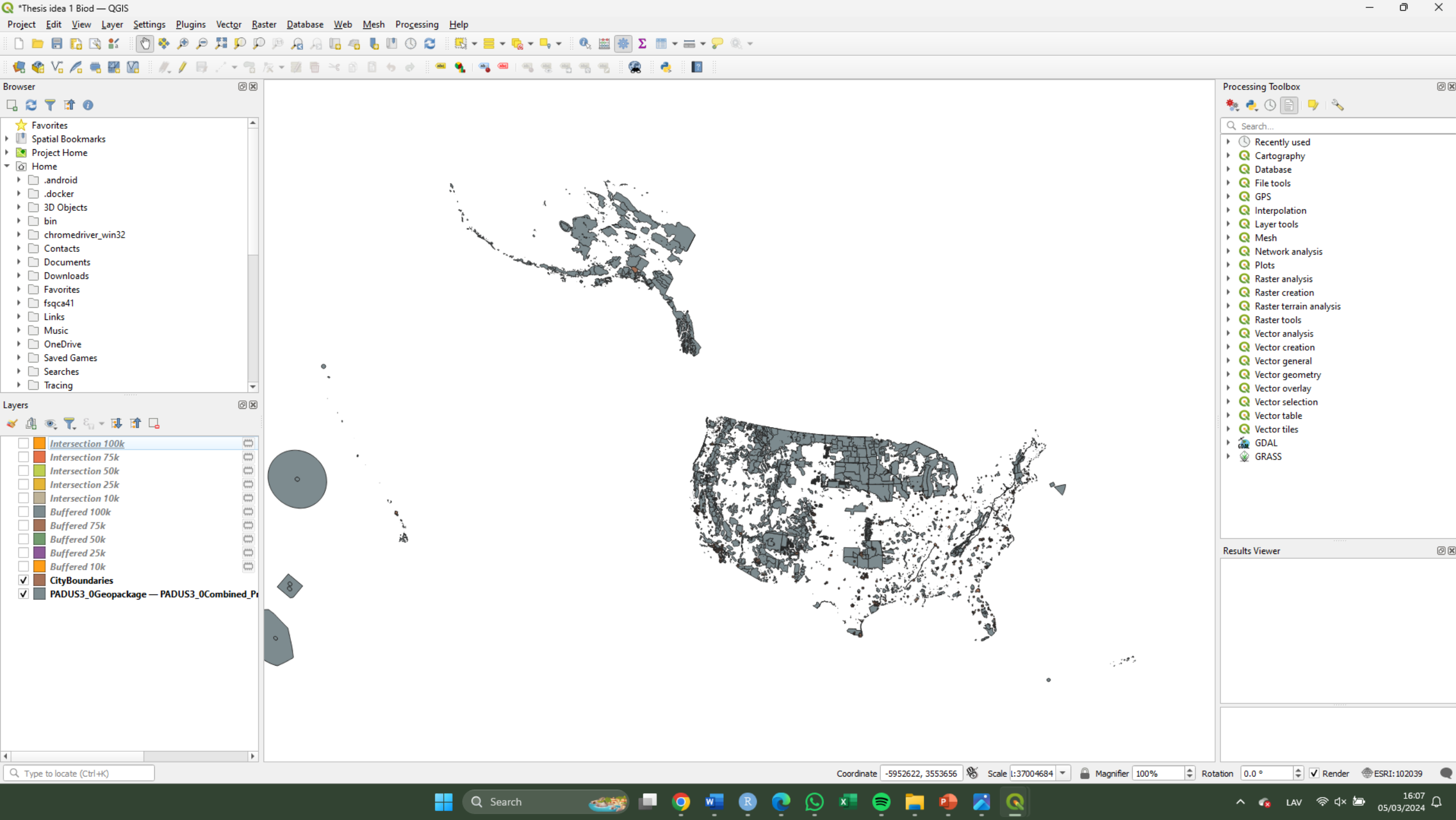
- Conjunctural causation
- Equifinality
- Causal asymmetry
- Well-fit for few cases, but current use: ~1900 cases

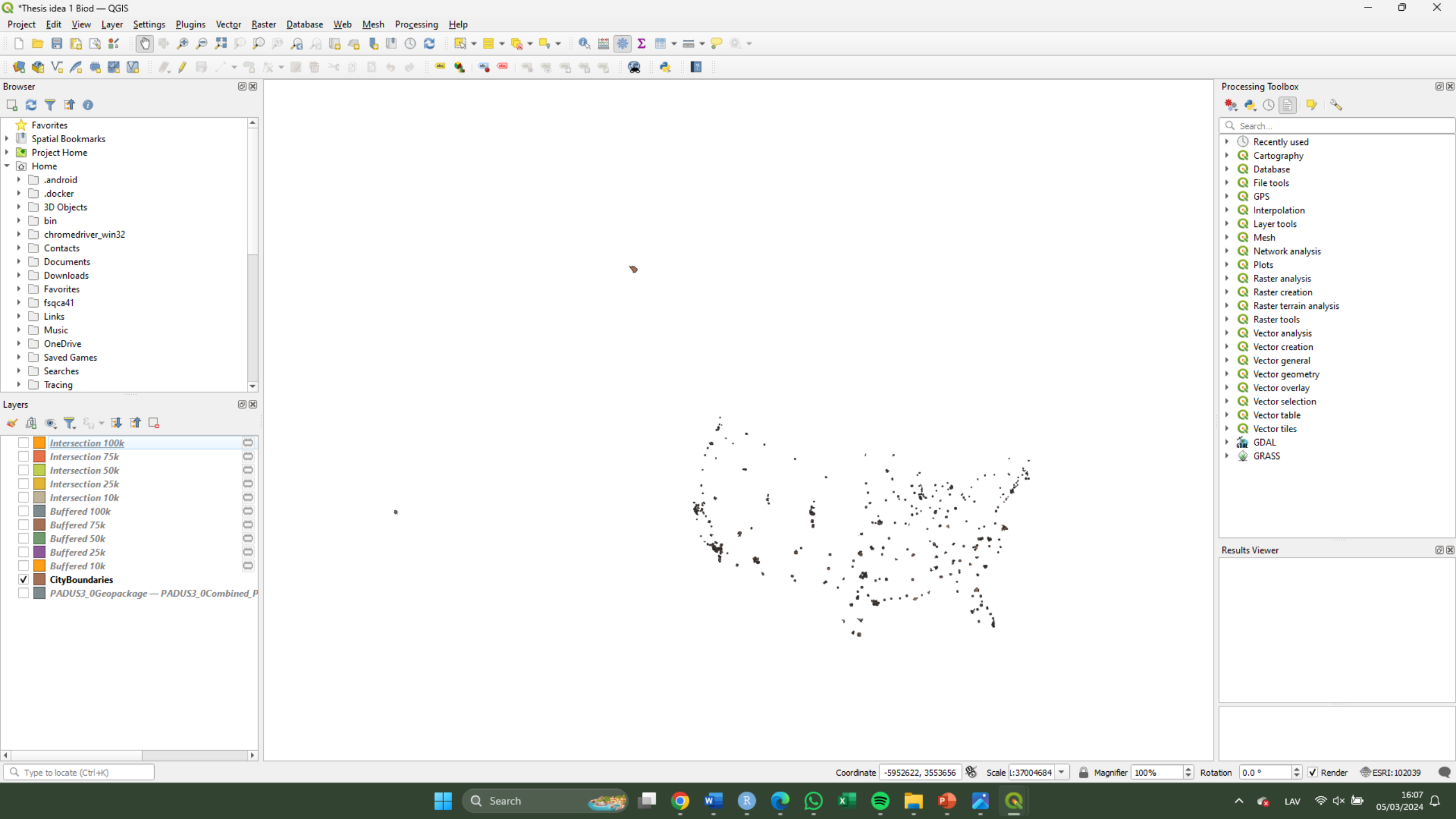
(Data sources)

Dataset name	Source	Variable/-s	Type	Spatiality	Temporality
Economic Connectedness	Opportunity Insights	EC; NBHD_EC; EC_GRP_MEM	Numerical	ZIP code	instant
Protected Areas Database (PAD-US) 3.0 Data	U.S. Geological Survey (USGS) Gap Analysis Project (GAP)	BIOD; DIST	Geospatial	m ²	instant ¹
500Cities: City Boundaries	US Centers for Disease Control and Prevention	construction factor for BIOD; DIST	Geospatial	m ²	instant
US Major Cities	ArcGIS HUB	BIOD; DIST	Geospatial	m ²	instant
American Community Survey (ACS): Financial Characteristics	US Census Bureau (2021)	INC_SKEW; INC_MEAN INC_HH	Numerical	ZCTA5 ²	2011-2020
ACS: Age and Sex	US Census Bureau (2021)	POP, AGE_SIM	Numerical	ZCTA5 ²	2011-2020
ACS: Educational Attainment	US Census Bureau (2021)	EDU_SIM	Numerical	ZCTA5 ²	2011-2020
US Cities Database Basic	SimpleMaps	conversion factor (see Table A1)	Numerical	ZCTA5 ^{2,3}	instant

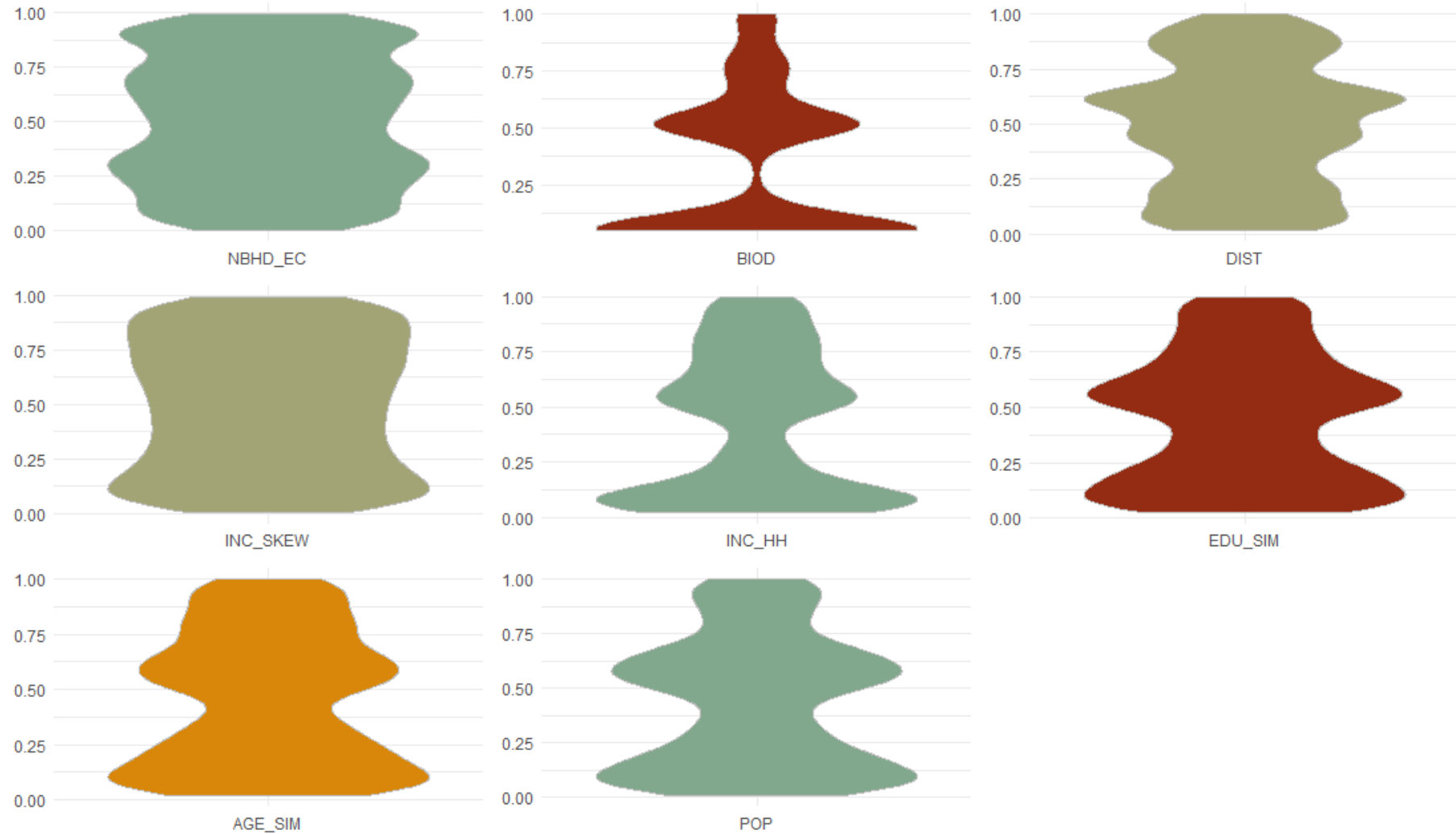
Dataset

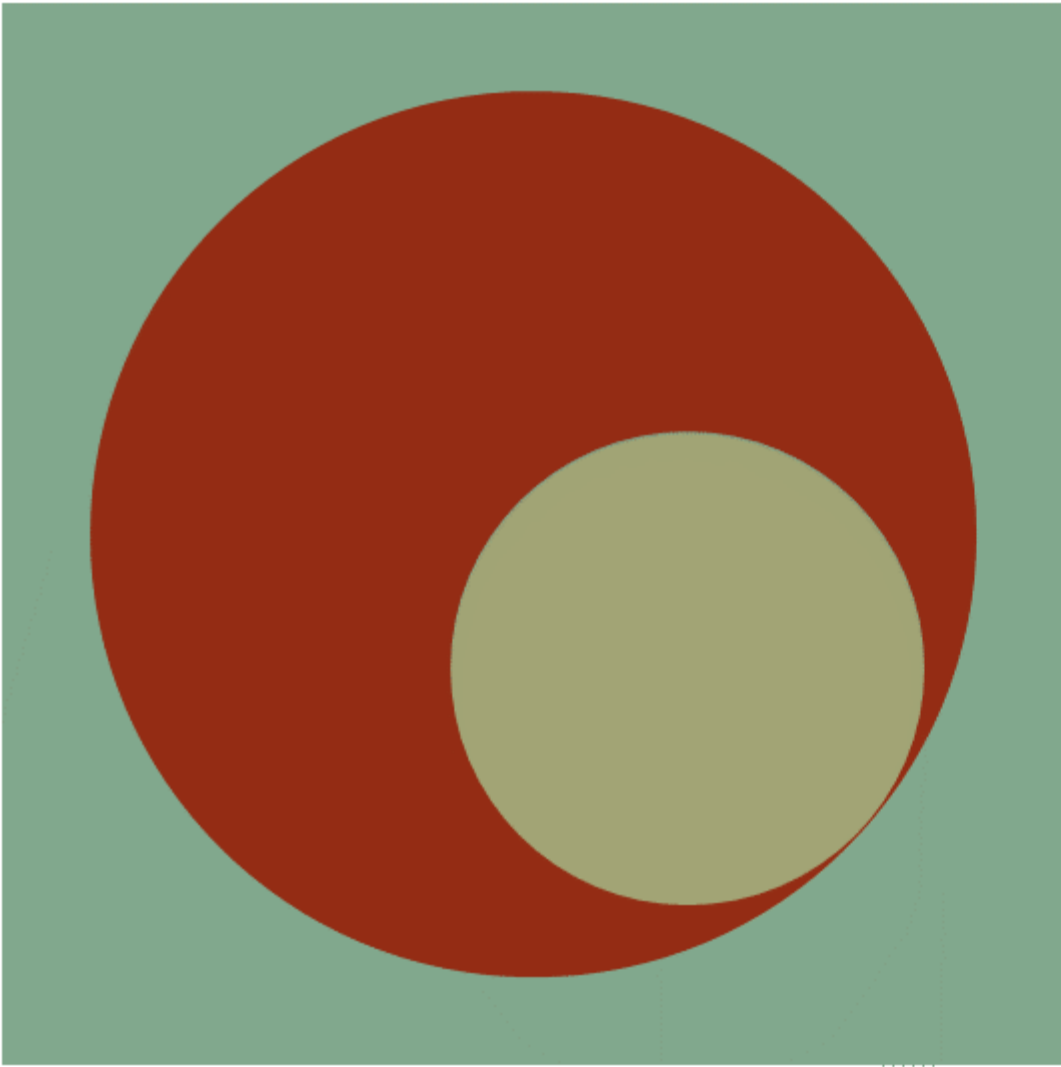
- BIOD biodiversity
- DIST distance to a major city
- INC_SKEW skewness of income similarities between income groups
- INC_HH income similarity between households
- EDU_SIM education similarity
- AGE_SIM age similarity
- POP population within the city



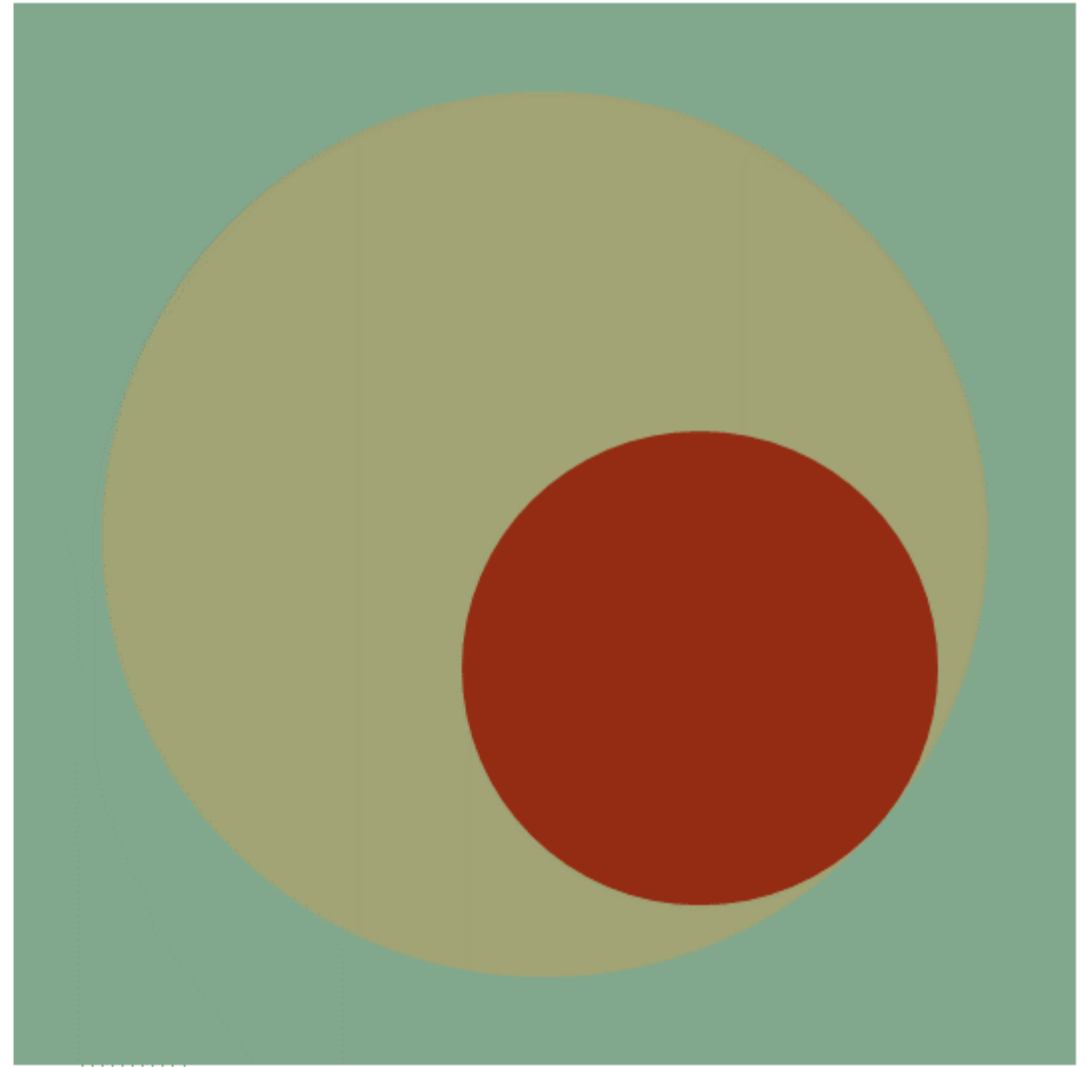


Data calibration and distributions





Necessary conditions
(superset of outcome)



Sufficient conditions
(subset of outcome)

None of conditions are individually necessary.

	Economic connectedness		Non-economic connectedness	
Conditions	Consistency	Coverage	Consistency	Coverage
BIOD	0.502	0.699	0.504	0.704
~BIOD	0.787	0.613	0.785	0.612
DIST	0.721	0.726	0.602	0.608
~DIST	0.611	0.605	0.729	0.724
INC_SKEW	0.708	0.718	0.589	0.599
~INC_SKEW	0.605	0.595	0.723	0.713
INC_HH	0.547	0.637	0.596	0.698
~INC_HH	0.741	0.647	0.690	0.604
EDU_SIM	0.583	0.647	0.646	0.720
~EDU_SIM	0.748	0.678	0.683	0.621
AGE_SIM	0.573	0.628	0.654	0.719
~AGE_SIM	0.744	0.682	0.662	0.609
POP	0.573	0.649	0.633	0.716
~POP	0.749	0.670	0.690	0.620

Truth table for the outcome

	Conditions for high economic connectedness within neighbourhood friends							Freq.	Out.	Consistency	
	BIOD	DIST	INC_SKEW	INC_HH	EDU_SIM	AGE_SIM	POP			Raw	PRI
1	1	1	1	0	0	0	0	27	1	0.930	0.680
2	1	1	1	0	1	0	0	18	1	0.930	0.663
3	1	1	1	0	0	0	0	49	1	0.915	0.704
4	0	1	1	1	0	0	0	19	1	0.914	0.698
5	0	1	1	0	0	0	0	123	1	0.878	0.702
6	1	1	1	0	1	1	1	24	0	0.924	0.569
7	1	1	1	1	1	1	1	22	0	0.920	0.557
8	1	1	0	1	0	0	0	25	0	0.911	0.602
9	0	1	1	1	1	1	1	42	0	0.907	0.608
10	1	1	0	1	1	1	1	74	0	0.897	0.491
11	0	1	1	0	0	1	1	27	0	0.892	0.601
12	1	0	1	1	0	0	0	21	0	0.890	0.514
13	0	1	1	0	1	1	1	46	0	0.887	0.586
14	0	0	1	1	0	0	0	15	0	0.887	0.589
15	1	1	0	0	0	0	0	76	0	0.886	0.606
16	1	0	1	0	0	1	1	22	0	0.882	0.376
17	1	0	1	0	0	0	0	77	0	0.877	0.602
18	0	0	1	1	1	1	1	36	0	0.873	0.452
19	1	0	1	0	1	1	1	46	0	0.872	0.354
20	0	1	0	1	0	0	0	32	0	0.872	0.535
21	0	0	1	0	0	1	1	19	0	0.866	0.478
22	1	0	1	1	1	1	1	74	0	0.866	0.343
23	1	0	0	1	1	1	0	19	0	0.866	0.307
24	0	0	1	0	1	1	1	30	0	0.860	0.452
25	1	0	0	1	0	0	0	35	0	0.844	0.371
26	0	1	0	1	1	1	1	94	0	0.840	0.438
27	1	0	0	0	0	0	0	53	0	0.831	0.443
28	0	0	1	0	0	0	0	60	0	0.830	0.548
29	0	1	0	0	0	0	0	93	0	0.829	0.520
30	1	0	0	1	1	1	1	136	0	0.813	0.237
31	0	0	0	1	1	1	1	97	0	0.799	0.291
32	0	0	0	0	0	0	0	41	0	0.781	0.367
33-128	Logical reminders							?			

Intermediate solution for EC

Outcome	Economic connectedness			Non-economic connectedness					
Path	P1	P2	S1P1	S1P2	S2P1	S2P2	S2P3		
BIOD	•	•	●		●	●			
DIST	●	●	⊗	⊗	⊗	⊗	⊗	⊗	
INC_SKEW	●	●		⊗		⊗	⊗	⊗	
INC_HH		•	●	●	●	●	●	●	
EDU_SIM	•		•	•	•	•	•	•	
AGE_SIM	•	⊗	•	•	•	•	•	•	
POP	⊗	•		•	•			•	
Consistency	0.877	0.914	0.921	0.893	0.928	0.930	0.893		
Raw coverage	0.441	0.260	0.285	0.339	0.269	0.255	0.339		
Unique coverage	0.186	0.005	0.045	0.099	0.029	0.015	0.099		
Solution metrics	Cons.	PRI	CovS	Cons.	PRI	CovS	Cons.	PRI	CovS
	0.877	0.720	0.446	0.887	0.687	0.383	0.887	0.687	0.383

Distant cities make for economic connectedness within neighbourhoods.

Outcome	Economic connectedness			Non-economic connectedness					
Path	P1	P2	S1P1	S1P2	S2P1	S2P2	S2P3		
BIOD	•	•	●		●	●			
DIST	●	●	⊗	⊗	⊗	⊗	⊗	⊗	
INC_SKEW	●	●		⊗		⊗	⊗	⊗	
INC_HH		•	●	●	●	●	●	●	
EDU_SIM	•		•	•	•	•	•	•	
AGE_SIM	•	⊗	•	•	•	•	•	•	
POP	⊗	•		•	•			•	
Consistency	0.877	0.914	0.921	0.893	0.928	0.930	0.893		
Raw coverage	0.441	0.260	0.285	0.339	0.269	0.255	0.339		
Unique coverage	0.186	0.005	0.045	0.099	0.029	0.015	0.099		
Solution metrics	Cons.	PRI	CovS	Cons.	PRI	CovS	Cons.	PRI	CovS
	0.877	0.720	0.446	0.887	0.687	0.383	0.887	0.687	0.383

Skewed income similarities allow for social capital to build up, and vice versa!

Outcome	Economic connectedness			Non-economic connectedness					
Path	P1	P2	S1P1	S1P2	S2P1	S2P2	S2P3		
BIOD	•	•	●		●	●			
DIST	●	●	⊗	⊗	⊗	⊗	⊗	⊗	
INC_SKEW	●	●		⊗		⊗	⊗	⊗	
INC_HH		•	●	●	●	●	●	●	
EDU_SIM	•		•	•	•	•	•	•	
AGE_SIM	•	⊗	•	•	•	•	•	•	
POP	⊗	•		•	•			•	
Consistency	0.877	0.914	0.921	0.893	0.928	0.930	0.893		
Raw coverage	0.441	0.260	0.285	0.339	0.269	0.255	0.339		
Unique coverage	0.186	0.005	0.045	0.099	0.029	0.015	0.099		
Solution metrics	Cons.	PRI	CovS	Cons.	PRI	CovS	Cons.	PRI	CovS
	0.877	0.720	0.446	0.887	0.687	0.383	0.887	0.687	0.383

Biodiverse areas nearby lead to low economic connectedness.

Outcome	Economic connectedness			Non-economic connectedness					
Path	P1	P2	S1P1	S1P2	S2P1	S2P2	S2P3		
BIOD	•	•	●		●	●			
DIST	●	●	⊗	⊗	⊗	⊗	⊗	⊗	
INC_SKEW	●	●		⊗		⊗	⊗	⊗	
INC_HH		•	●	●	●	●	●	●	
EDU_SIM	•		•	•	•	•	•	•	
AGE_SIM	•	⊗	•	•	•	•	•	•	
POP	⊗	•		•	•			•	
Consistency	0.877	0.914	0.921	0.893	0.928	0.930	0.893		
Raw coverage	0.441	0.260	0.285	0.339	0.269	0.255	0.339		
Unique coverage	0.186	0.005	0.045	0.099	0.029	0.015	0.099		
Solution metrics	Cons.	PRI	CovS	Cons.	PRI	CovS	Cons.	PRI	CovS
	0.877	0.720	0.446	0.887	0.687	0.383	0.887	0.687	0.383

Large cities nearby lead to low economic connectedness.

Outcome	Economic connectedness			Non-economic connectedness					
Path	P1	P2	S1P1	S1P2	S2P1	S2P2	S2P3		
BIOD	•	•	●		●	●			
DIST	●	●	⊗	⊗	⊗	⊗	⊗	⊗	
INC_SKEW	●	●		⊗		⊗	⊗	⊗	
INC_HH		•	●	●	●	●	●	●	
EDU_SIM	•		•	•	•	•	•	•	
AGE_SIM	•	⊗	•	•	•	•	•	•	
POP	⊗	•		•	•			•	
Consistency	0.877	0.914	0.921	0.893	0.928	0.930	0.893		
Raw coverage	0.441	0.260	0.285	0.339	0.269	0.255	0.339		
Unique coverage	0.186	0.005	0.045	0.099	0.029	0.015	0.099		
Solution metrics	Cons.	PRI	CovS	Cons.	PRI	CovS	Cons.	PRI	CovS
	0.877	0.720	0.446	0.887	0.687	0.383	0.887	0.687	0.383

Income similarity between households lead to low economic connectedness.

Outcome	Economic connectedness			Non-economic connectedness					
Path	P1	P2	S1P1	S1P2	S2P1	S2P2	S2P3		
BIOD	•	•	●		●	●			
DIST	●	●	⊗	⊗	⊗	⊗	⊗	⊗	
INC_SKEW	●	●		⊗		⊗	⊗	⊗	
INC_HH		•	●	●	●	●	●	●	
EDU_SIM	•		•	•	•	•	•	•	
AGE_SIM	•	⊗	•	•	•	•	•	•	
POP	⊗	•		•	•			•	
Consistency	0.877	0.914	0.921	0.893	0.928	0.930	0.893		
Raw coverage	0.441	0.260	0.285	0.339	0.269	0.255	0.339		
Unique coverage	0.186	0.005	0.045	0.099	0.029	0.015	0.099		
Solution metrics	Cons.	PRI	CovS	Cons.	PRI	CovS	Cons.	PRI	CovS
	0.877	0.720	0.446	0.887	0.687	0.383	0.887	0.687	0.383

Robustness testing

Outcome		Economic connectedness		Non-economic connectedness				
Paths		P1	P2	S1P1	S1P2	S2P1	S2P2	S2P3
Consistency > 0.8		✓	✓	✓	✓	✓	✓	✓
Consistency > 0.9		(✓)	✓	✓	✓	✓	✓	✓
Frq. 20, cons. >0.8		(✓)	(✓)			✓		✓
PRI > 0.7		(✓)				(✓)		
Crisp set								

P1:

$\text{DIST} \cdot \sim \text{POP} \cdot \sim \text{AGE_SIM} \cdot \text{INC_SKEW} \cdot \sim \text{EDU_SIM} \rightarrow \text{EC_NBHD}$

Robustness testing

Outcome		Economic connectedness		Non-economic connectedness				
Paths		P1	P2	S1P1	S1P2	S2P1	S2P2	S2P3
Consistency > 0.8		✓	✓	✓	✓	✓	✓	✓
Consistency > 0.9		(✓)	✓	✓	✓	✓	✓	✓
Frq. 20, cons. >0.8		(✓)	(✓)			✓		✓
PRI > 0.7		(✓)				(✓)		
Crisp set								

S2P1:

BIOD · ~DIST · ~POP · AGE_SIM · EDU_SIM · INC_HH → ~ EC_NBHD

Part IV

Where to go

Further steps

- Compare with datasets for different BIOD proximities
- Compare with different economic connectedness measures
- Robustness analysis with permutations and crisp set QCA values

The end.

Questions and suggestions
very welcomed.