

Using deep learning to identify (urban) form and function in satellite imagery

The case of Great Britain

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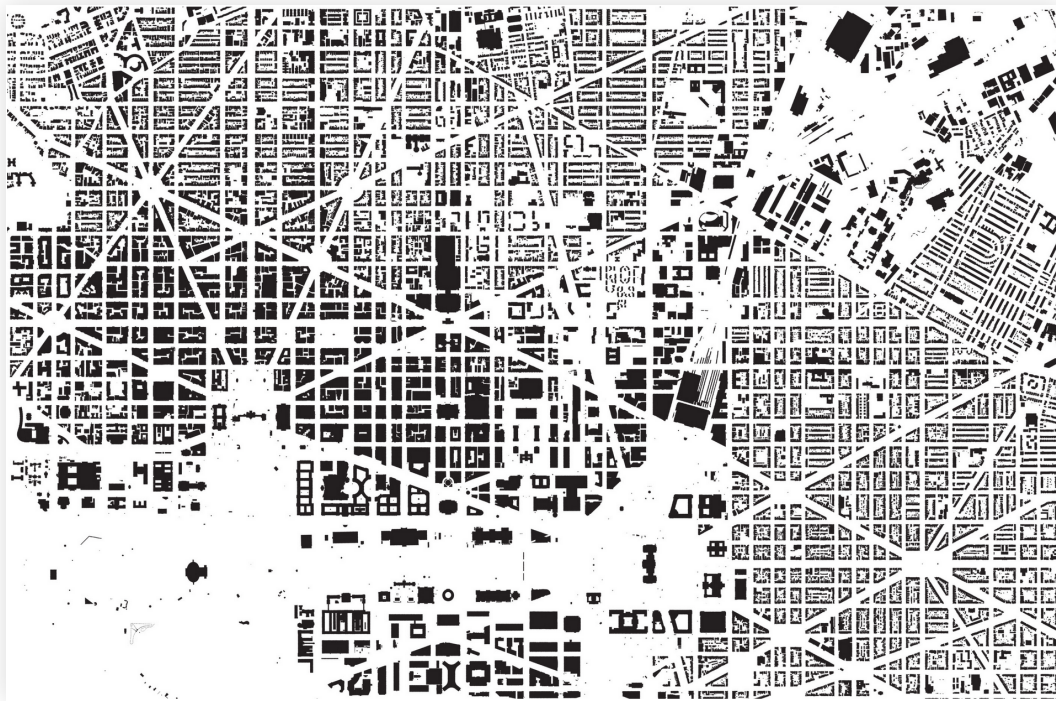
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Geographic
Data Science
Lab

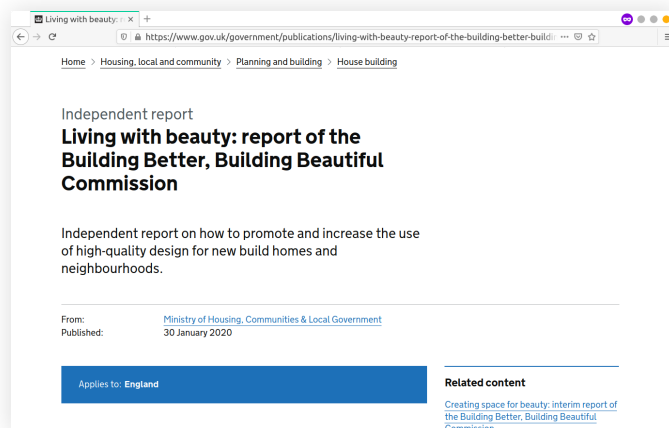
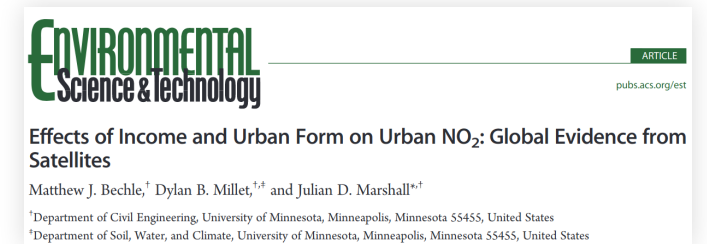
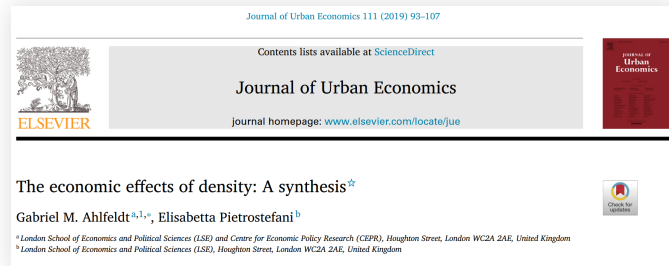
“The point”

How we arrange “stuff” in cities matters...



Source: *A map of every building in America* (New York Times)

... it matters *a lot*



Form & Function

Form

What does it look like?

“Physical structure and appearance of cities”

Function

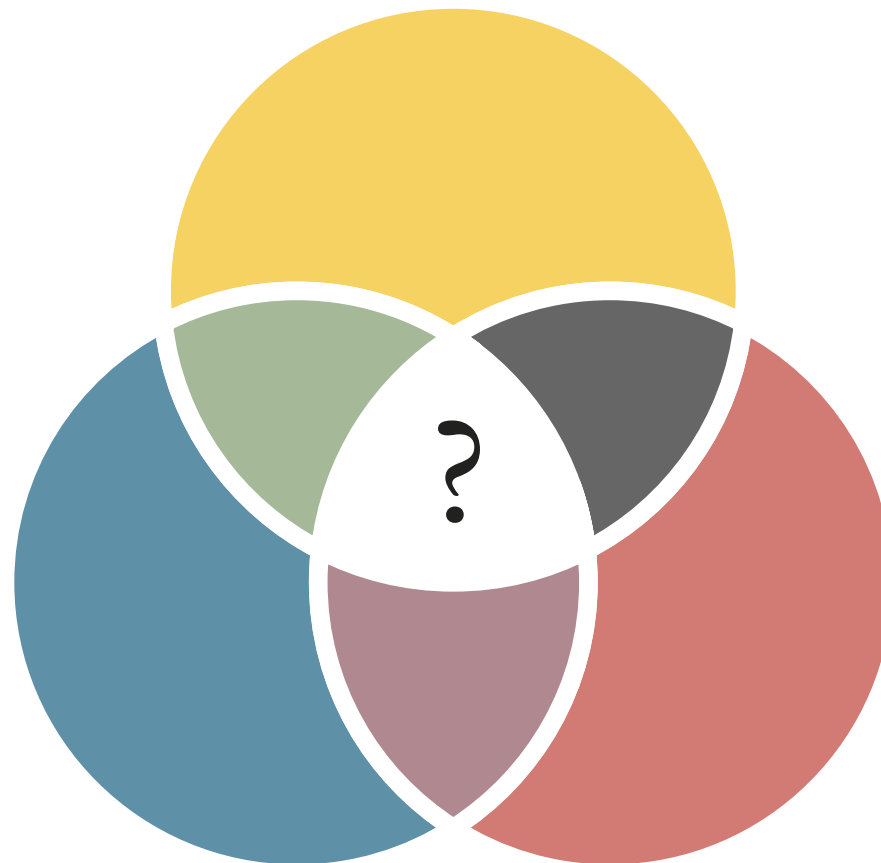
What is it used for?

“Activities that take place within an environment”

detailed

scalable

consistent

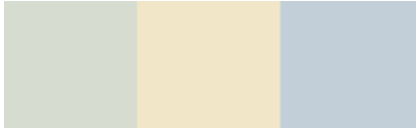


Spatial Signatures

*A characterisation of space based on form and function
designed to understand urban environments*

British Signatures

BRITISH SIGNATURES

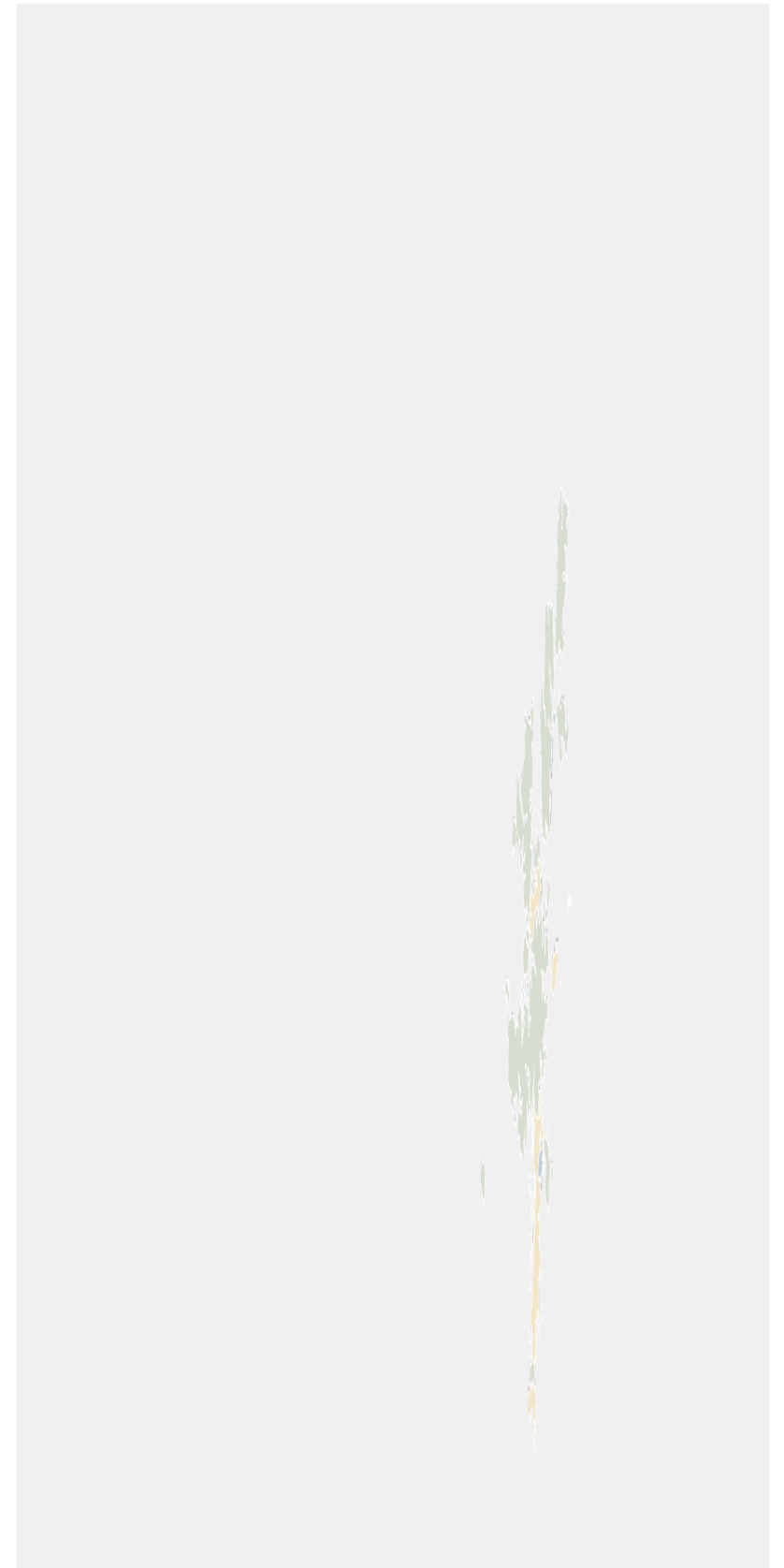
Countryside (3) 

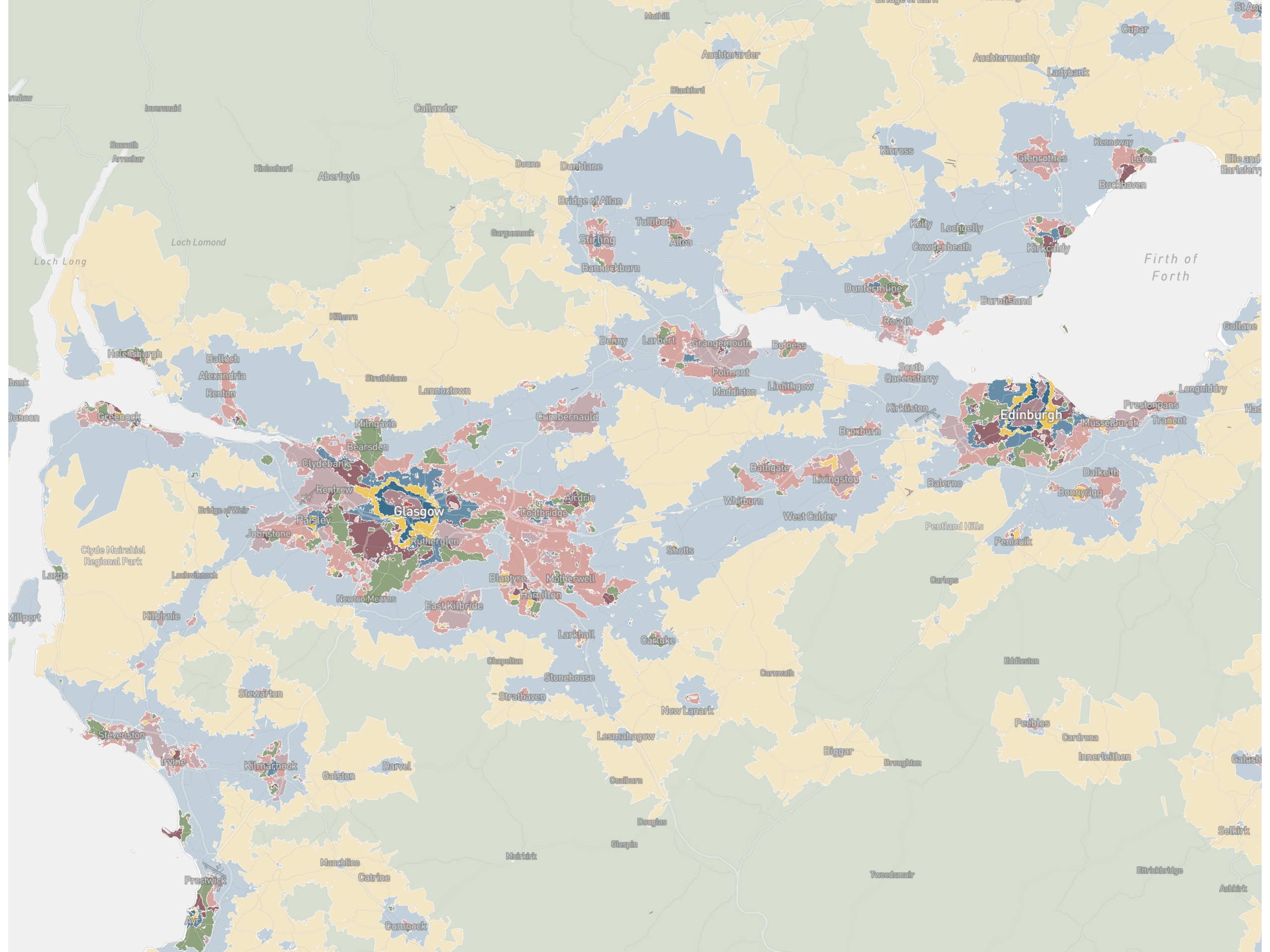
Periphery (4) 

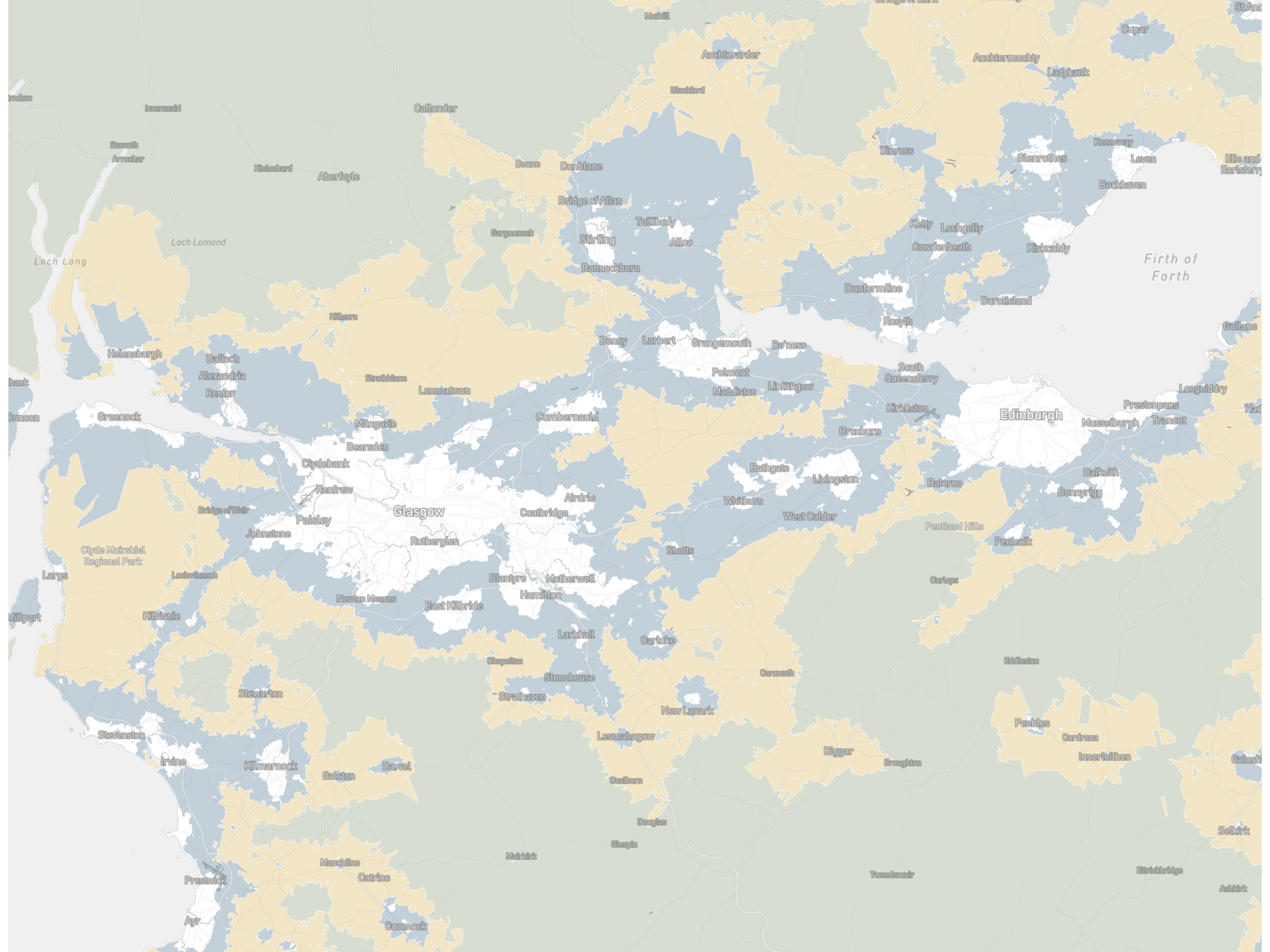
Urban (9)

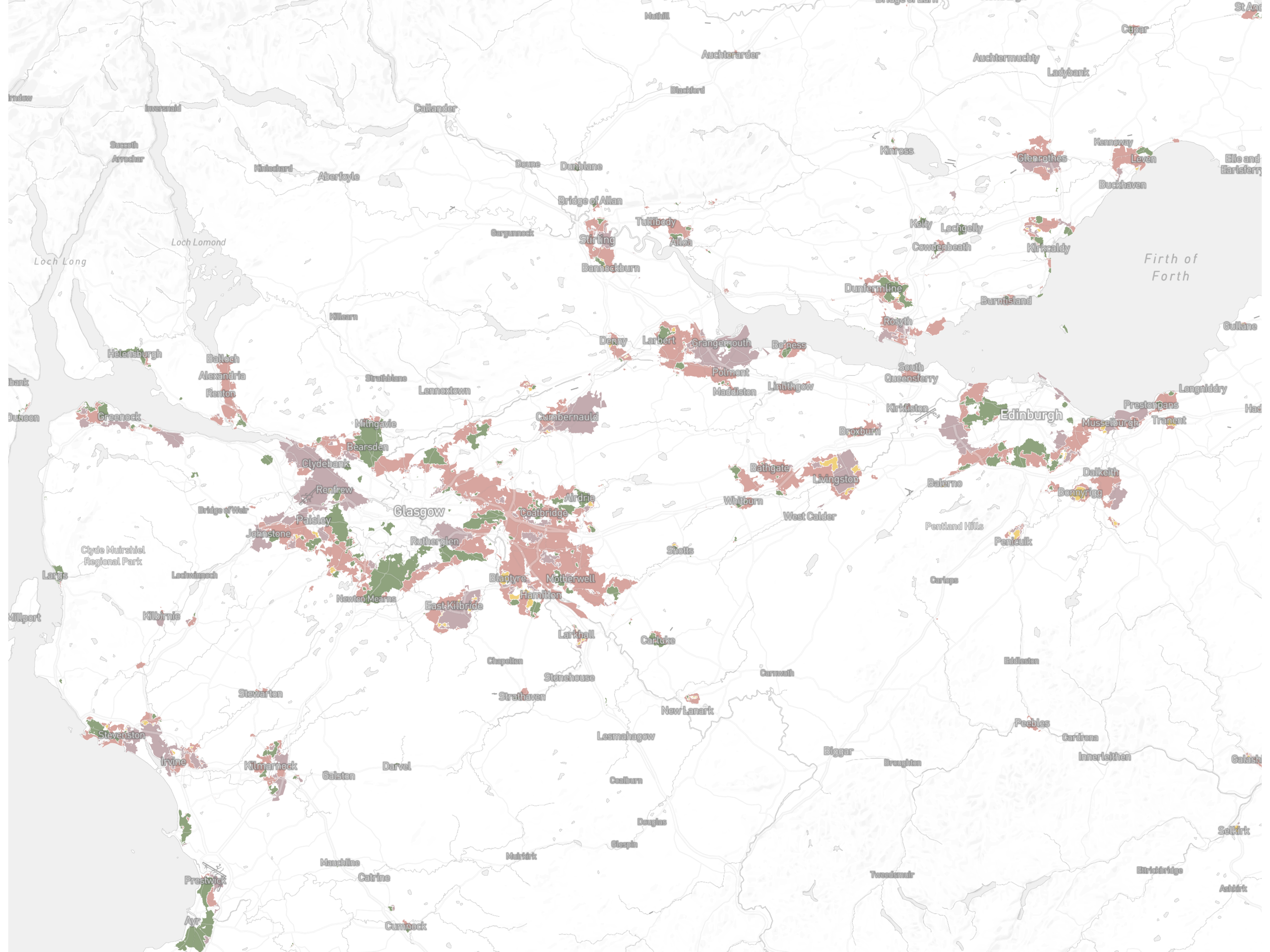


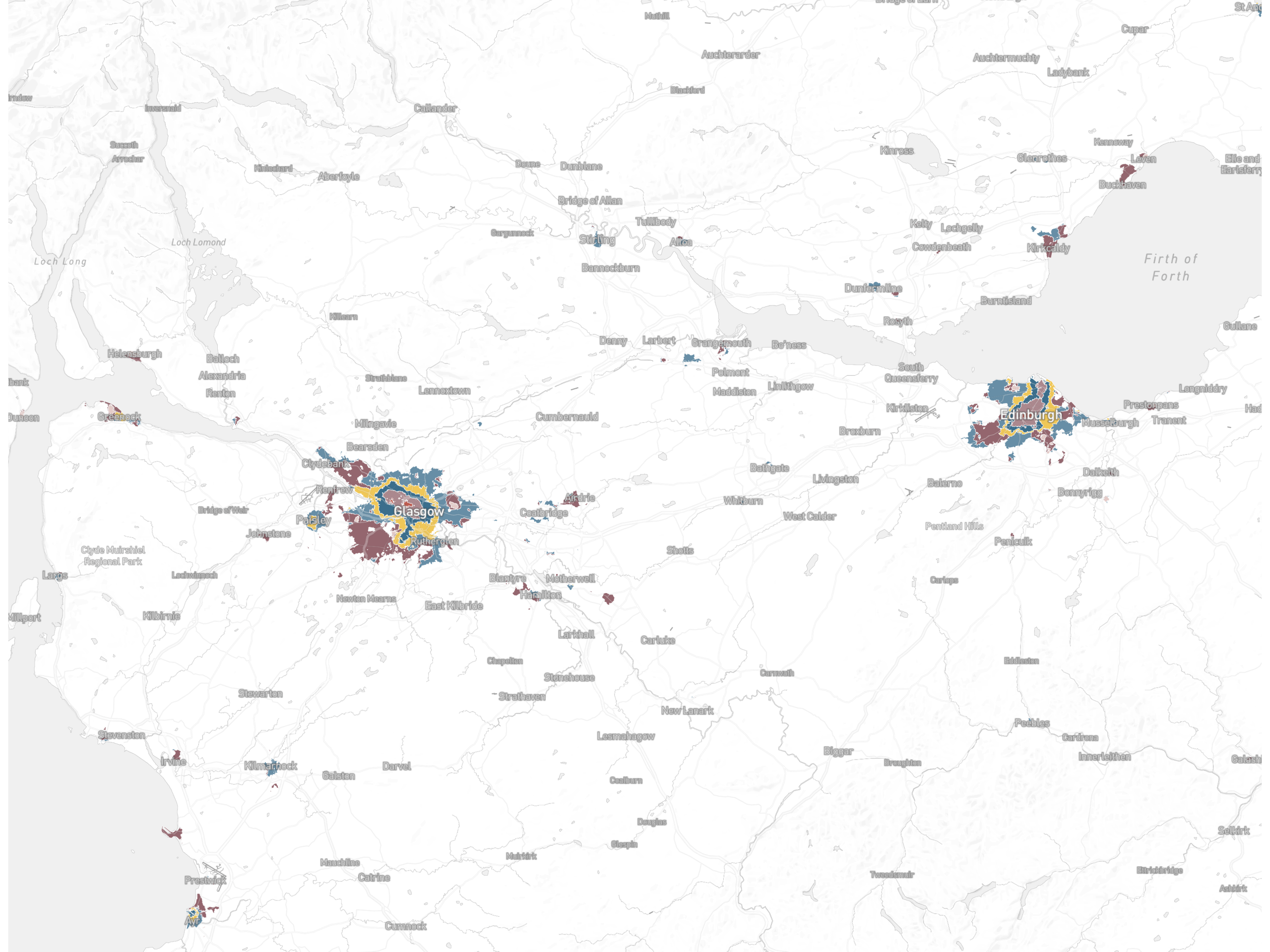
urbangrammarai.xyz/great-britain/

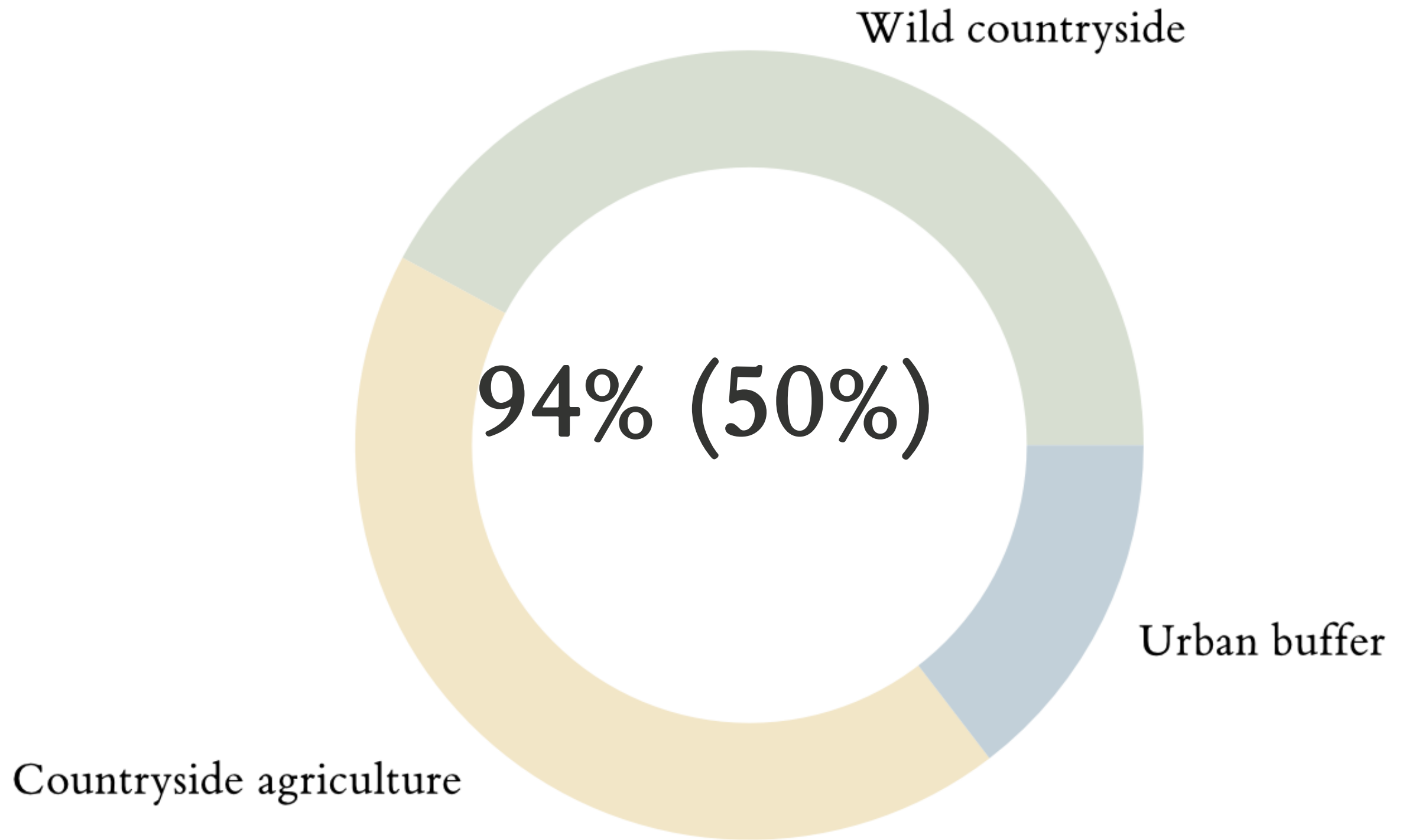












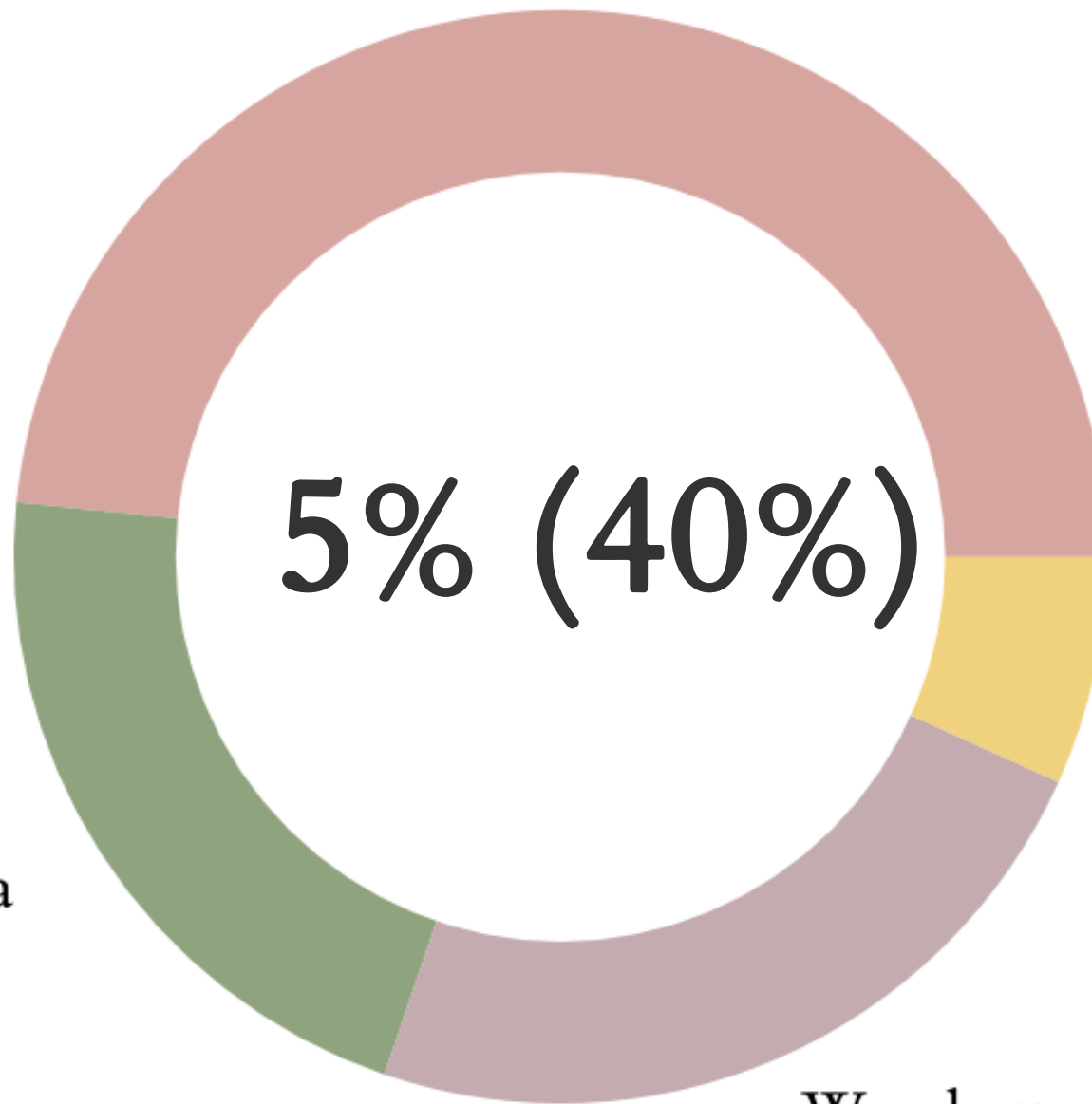
Open sprawl

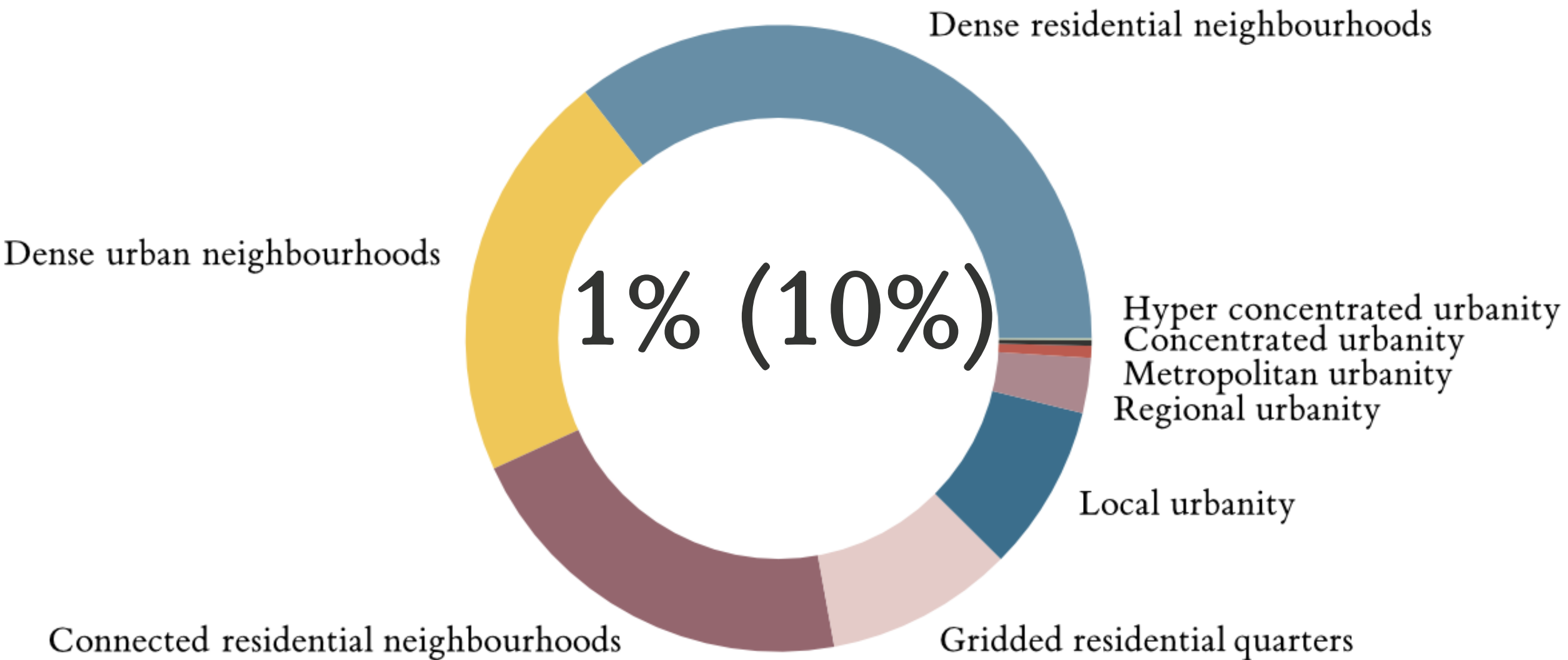
5% (40%)

Disconnected suburbia

Accessible suburbia

Warehouse/Park land

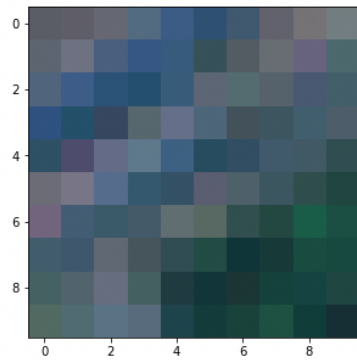




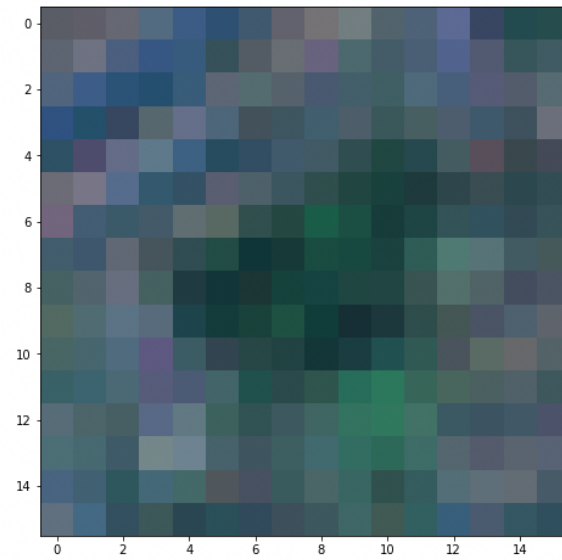


Sentinel 2

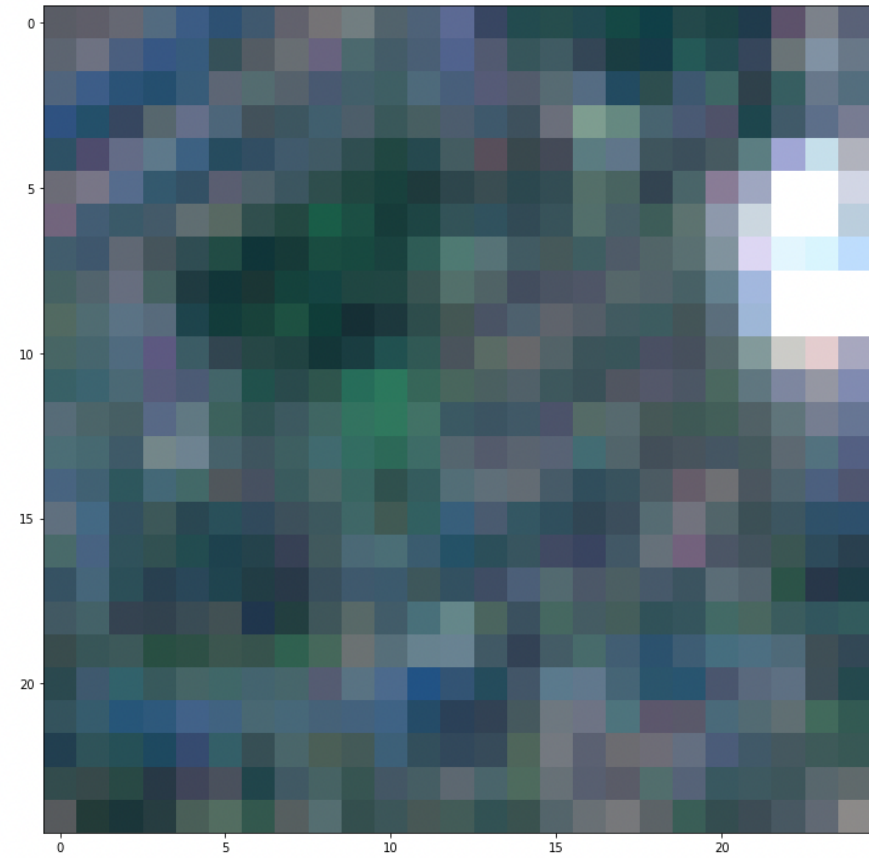
100x100



160x160



250x250



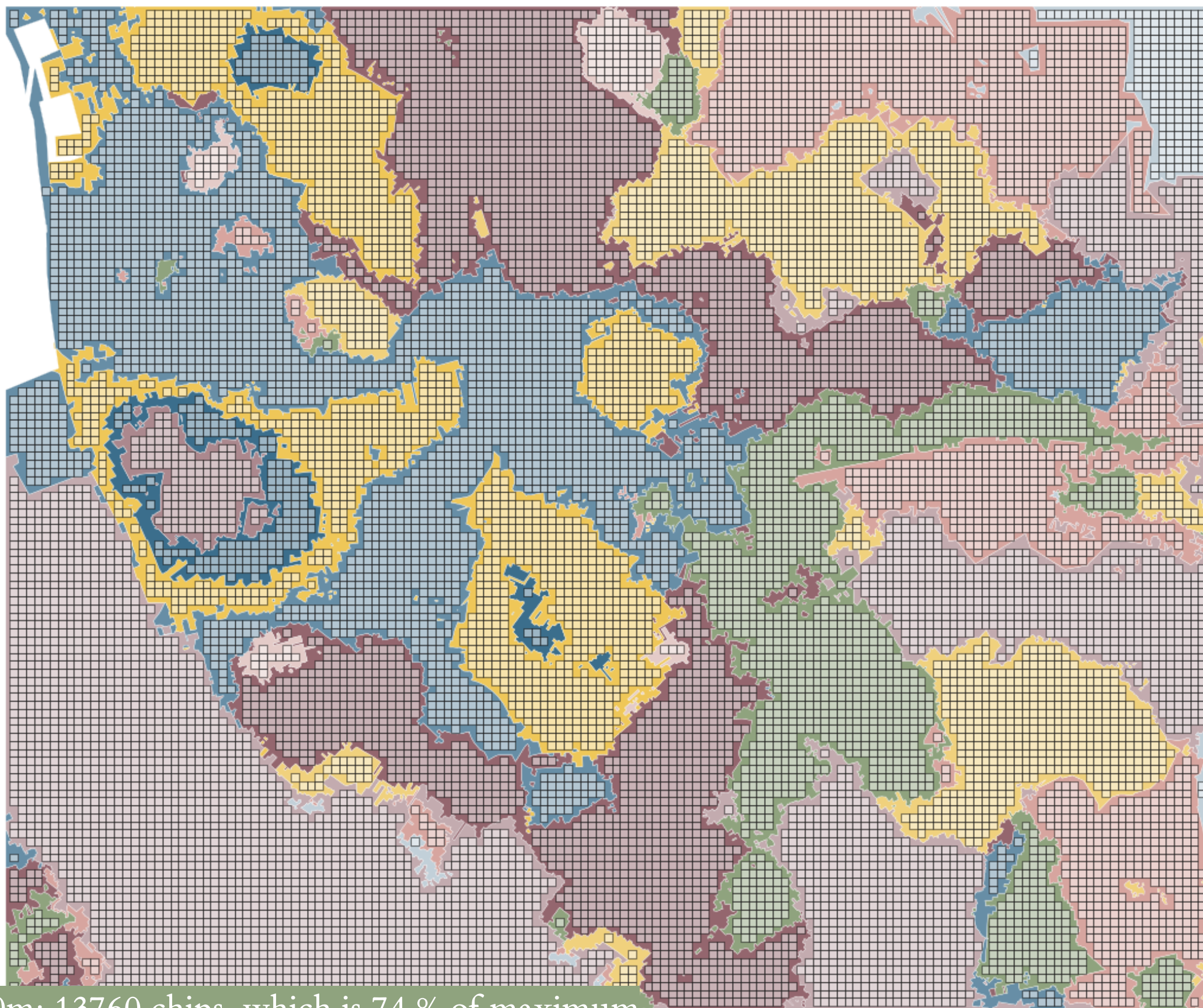
What do we want to do?

train a neural network

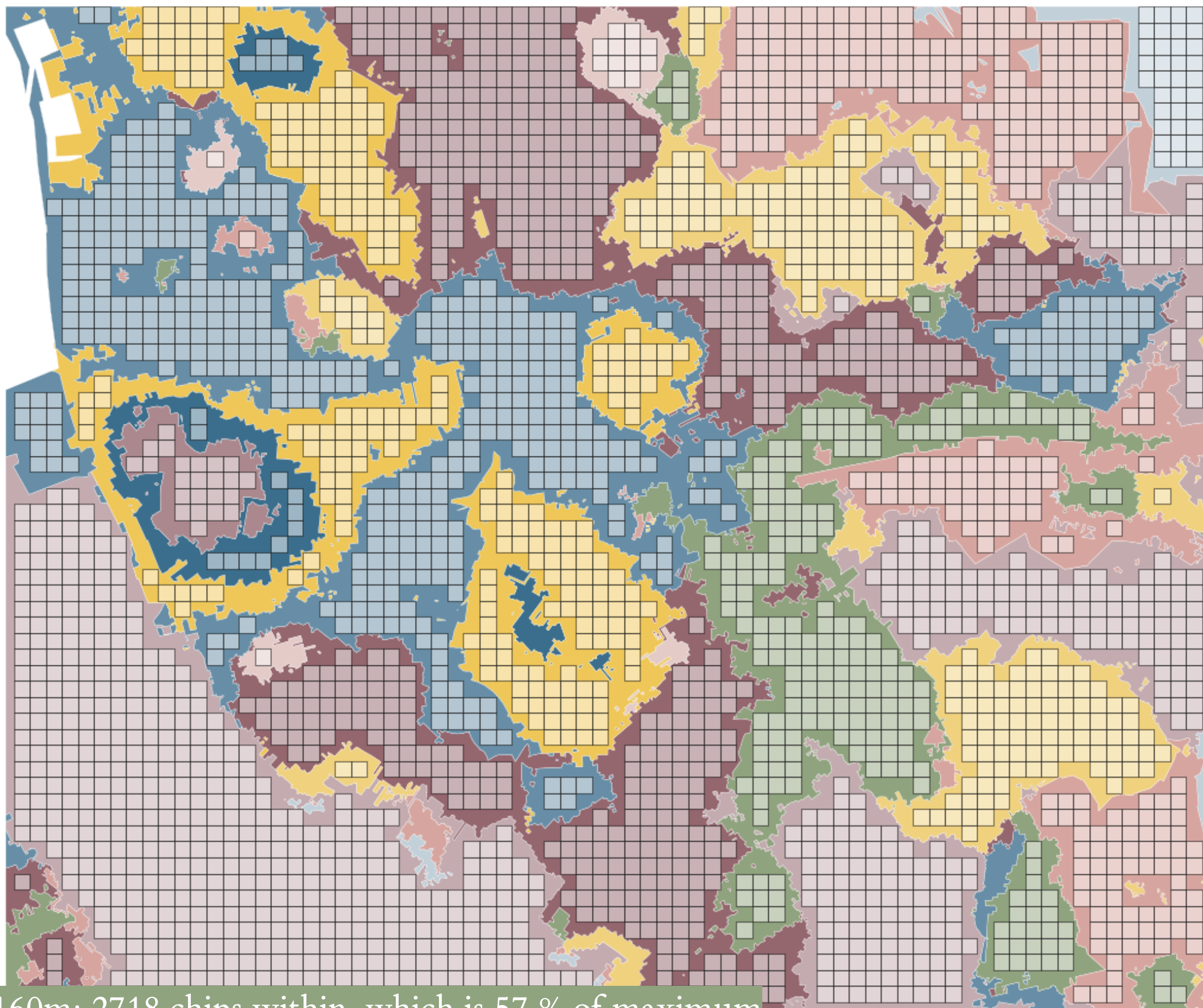
understand the role of geography

Exploration

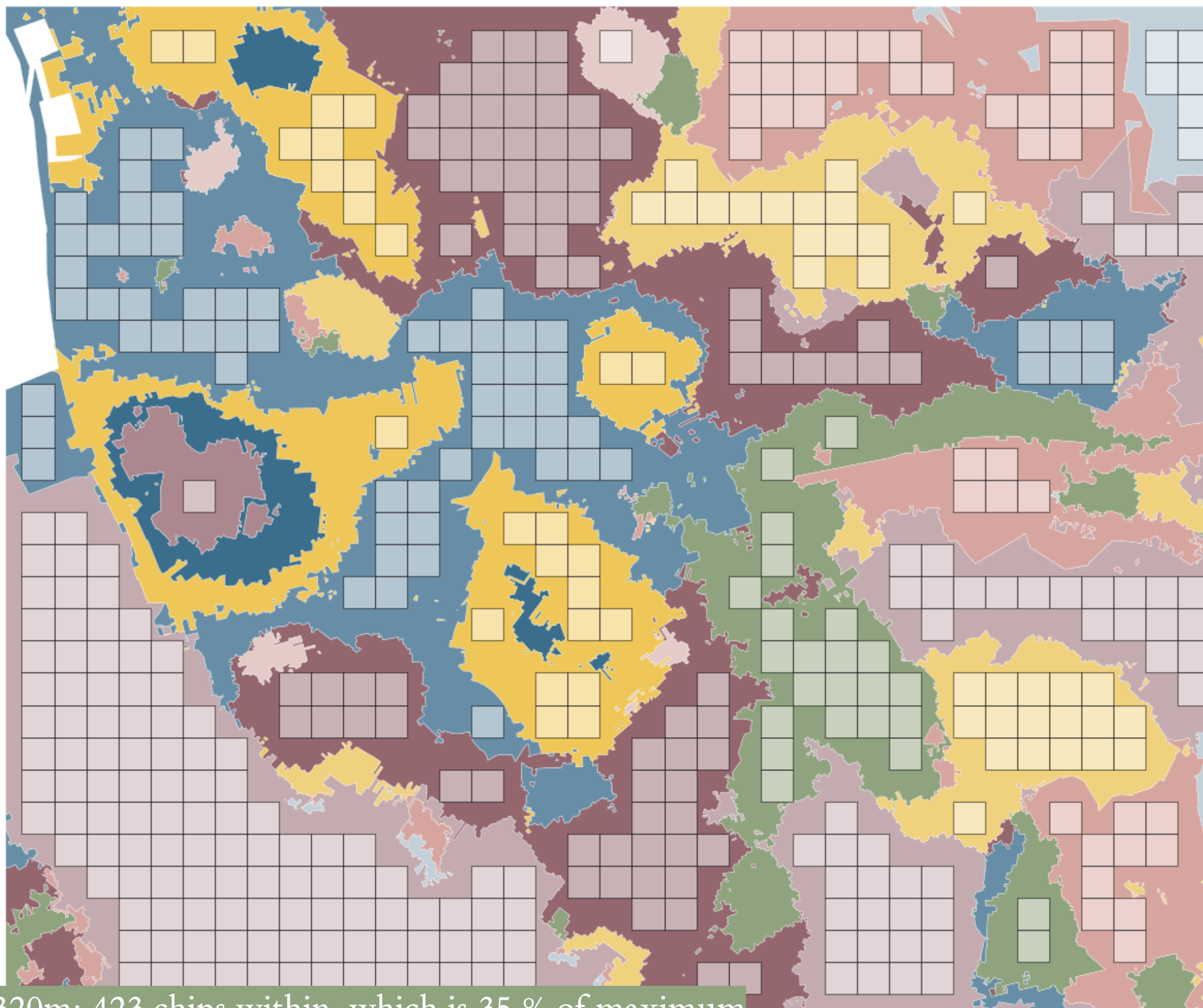
Chip size effect



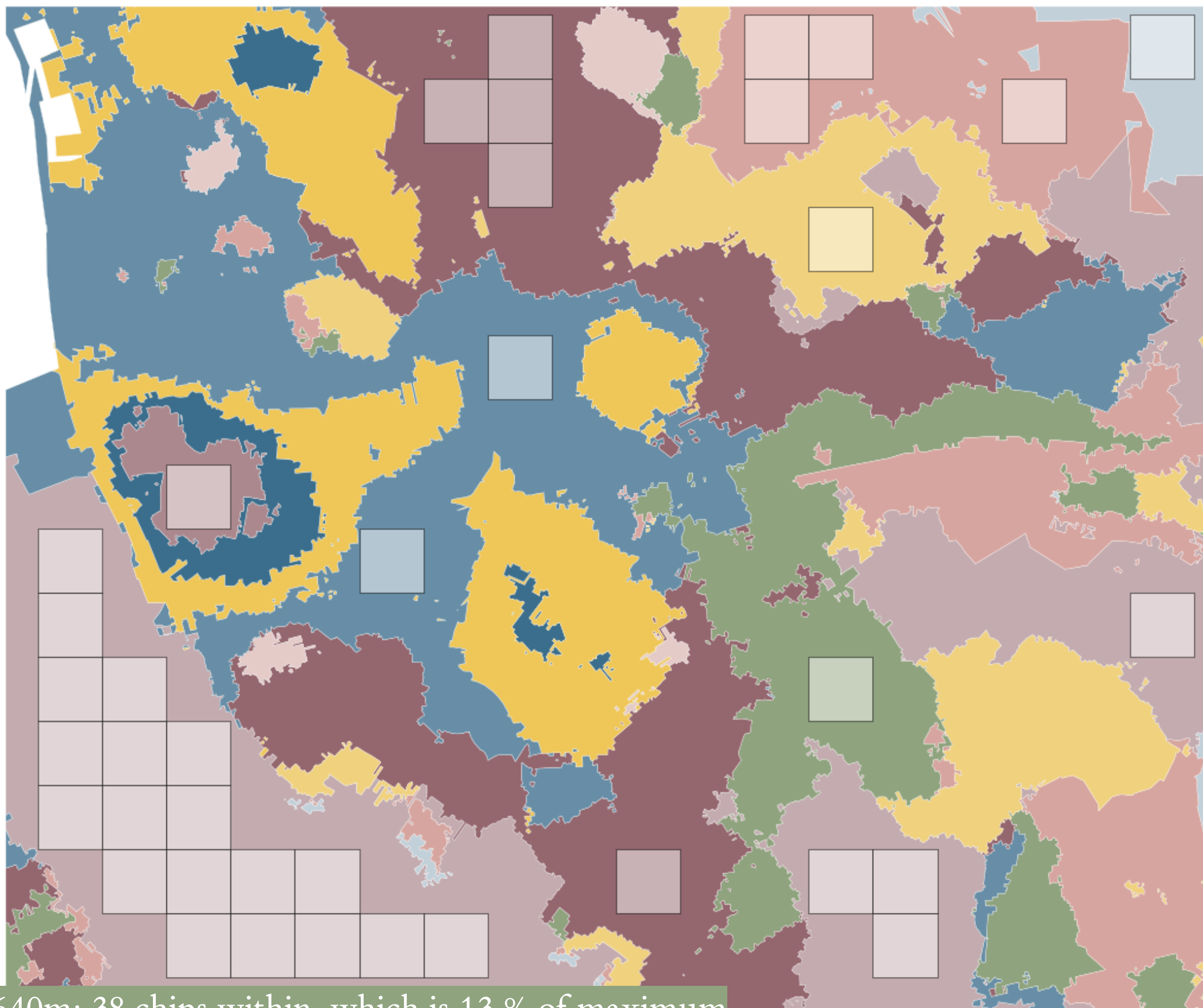
80x80m: 13760 chips, which is 74 % of maximum



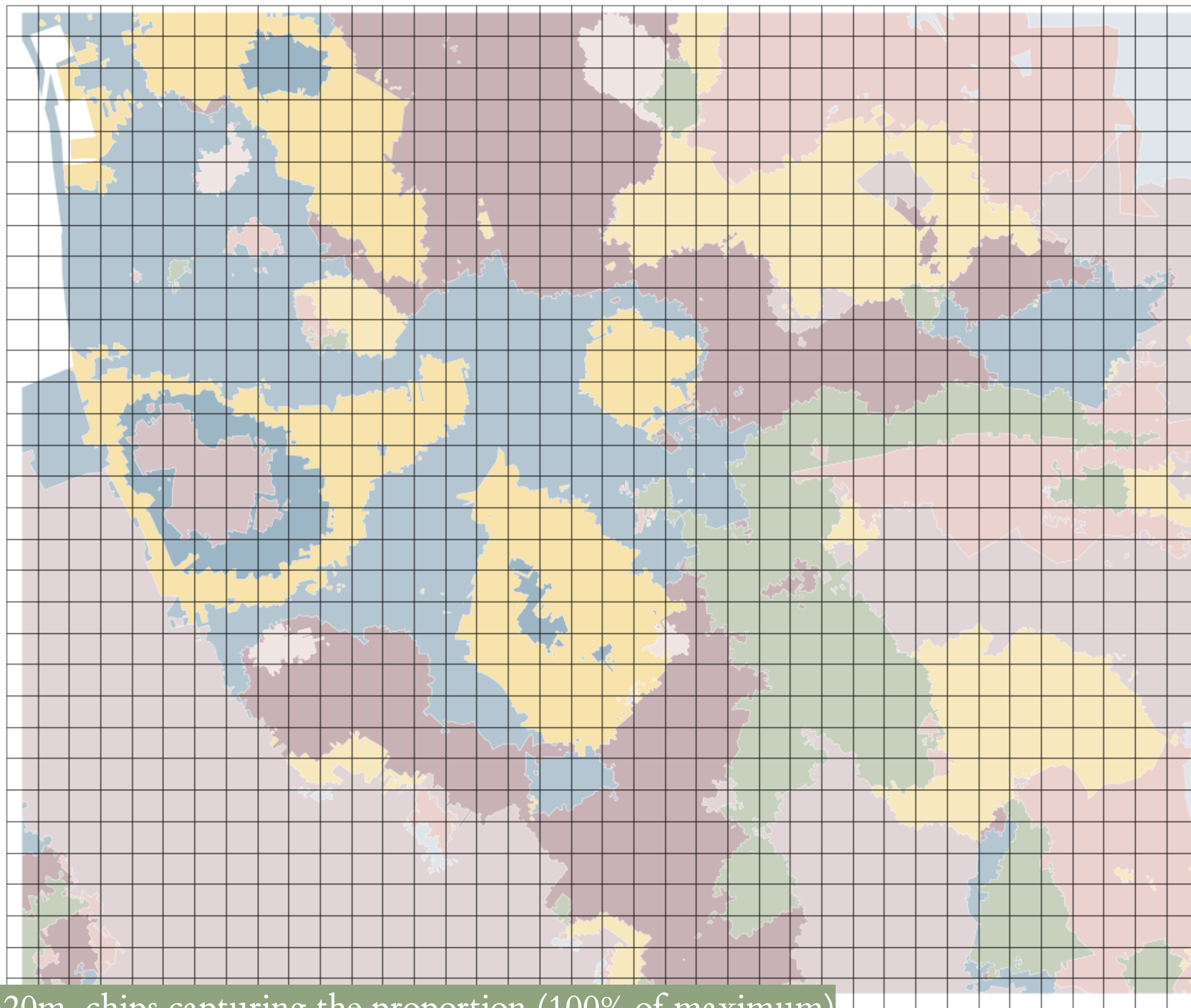
160x160m: 2718 chips within, which is 57 % of maximum



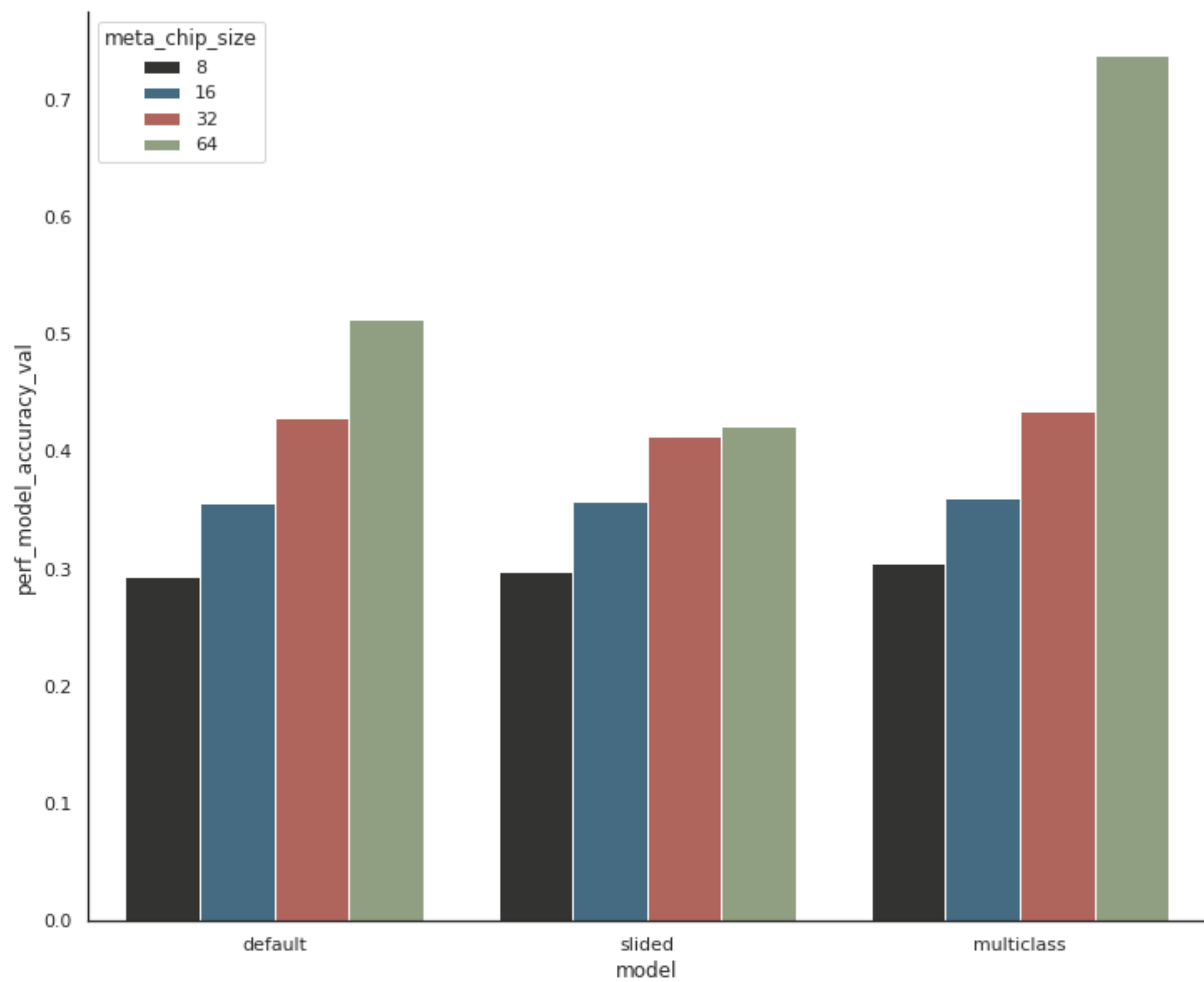
320x320m: 423 chips within, which is 35 % of maximum



640x640m: 38 chips within, which is 13 % of maximum



320x320m, chips capturing the proportion (100% of maximum)



Current work

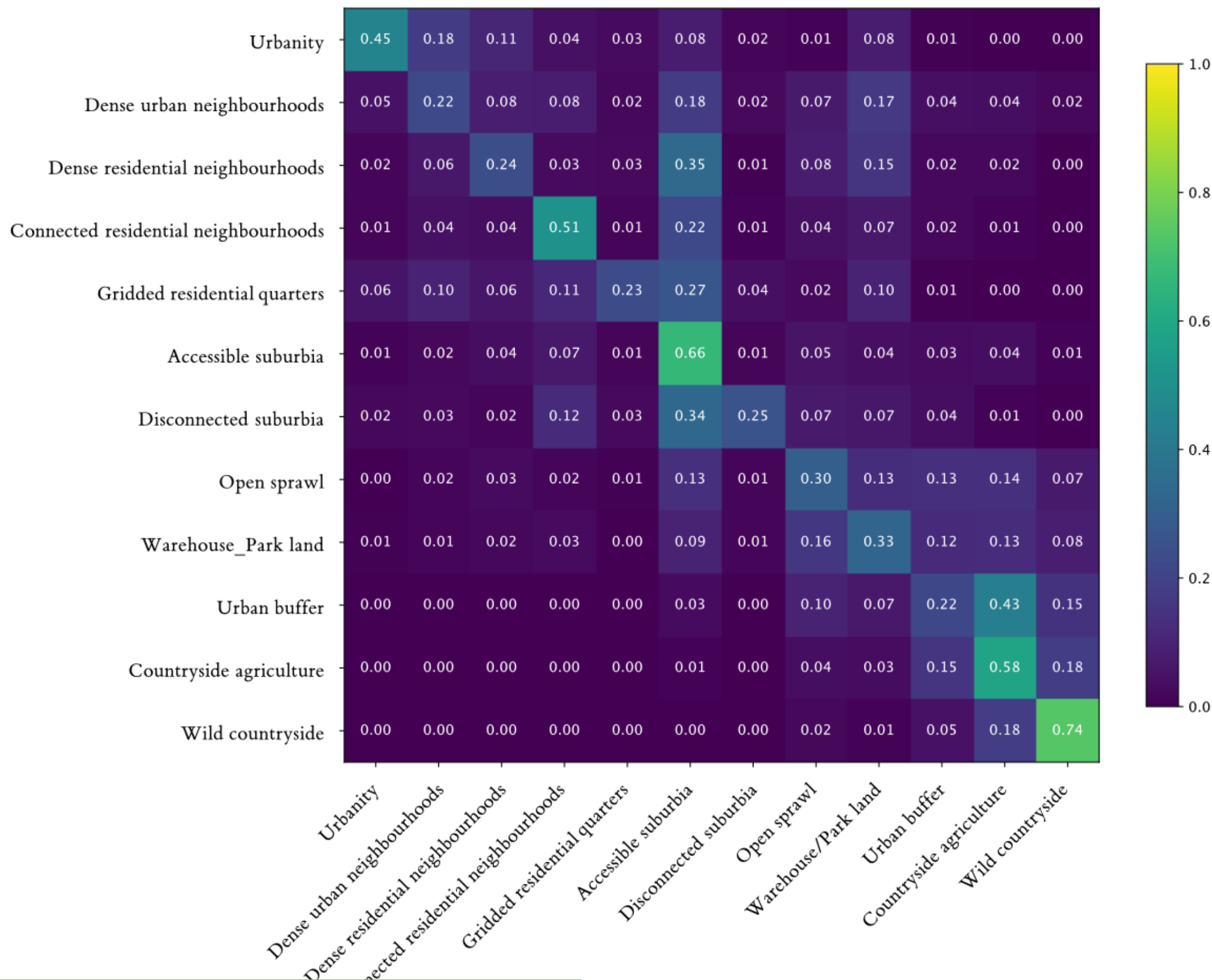
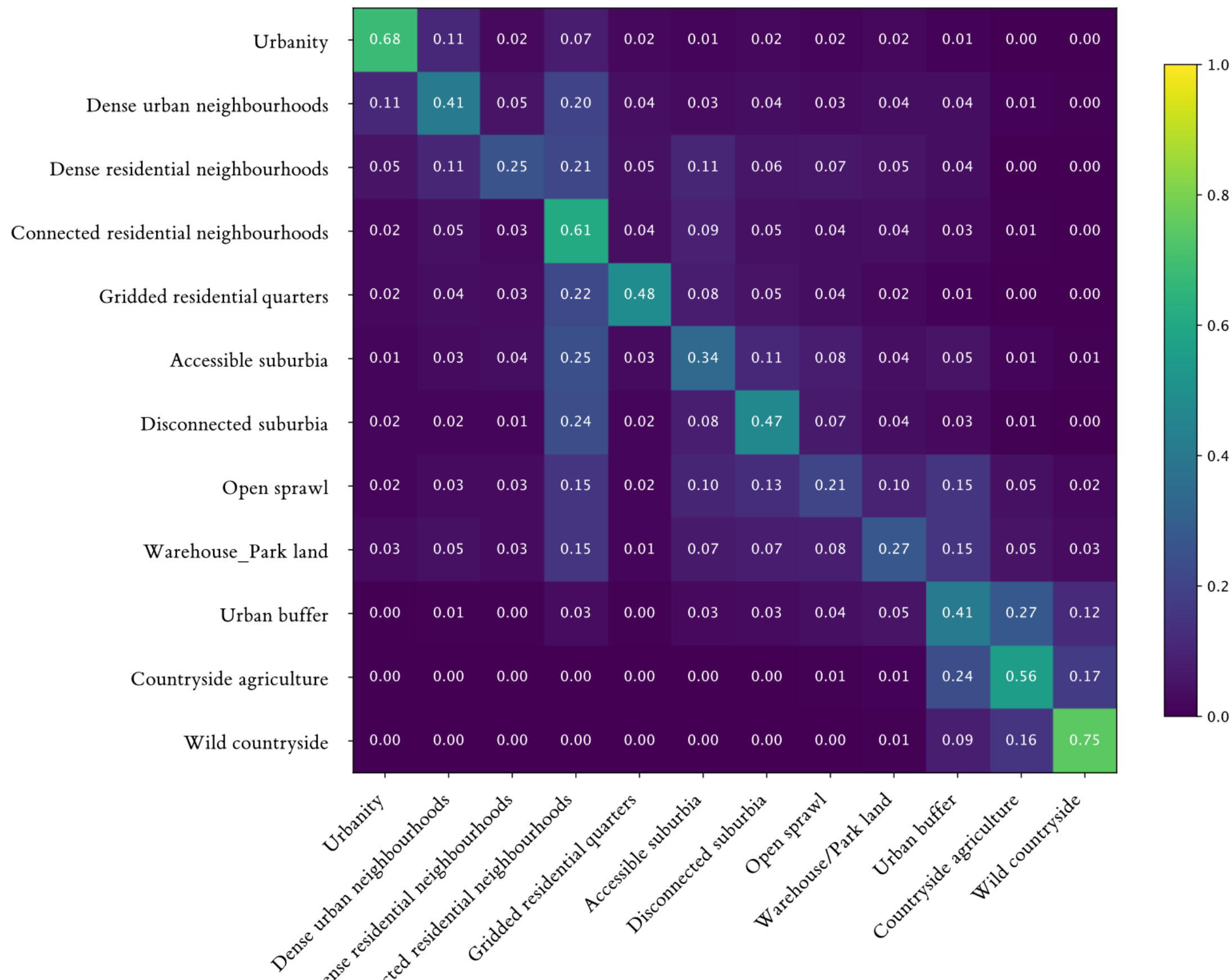


Image classification – Overall accuracy 42.8%



Multi-output regression – Overall accuracy 43.5%

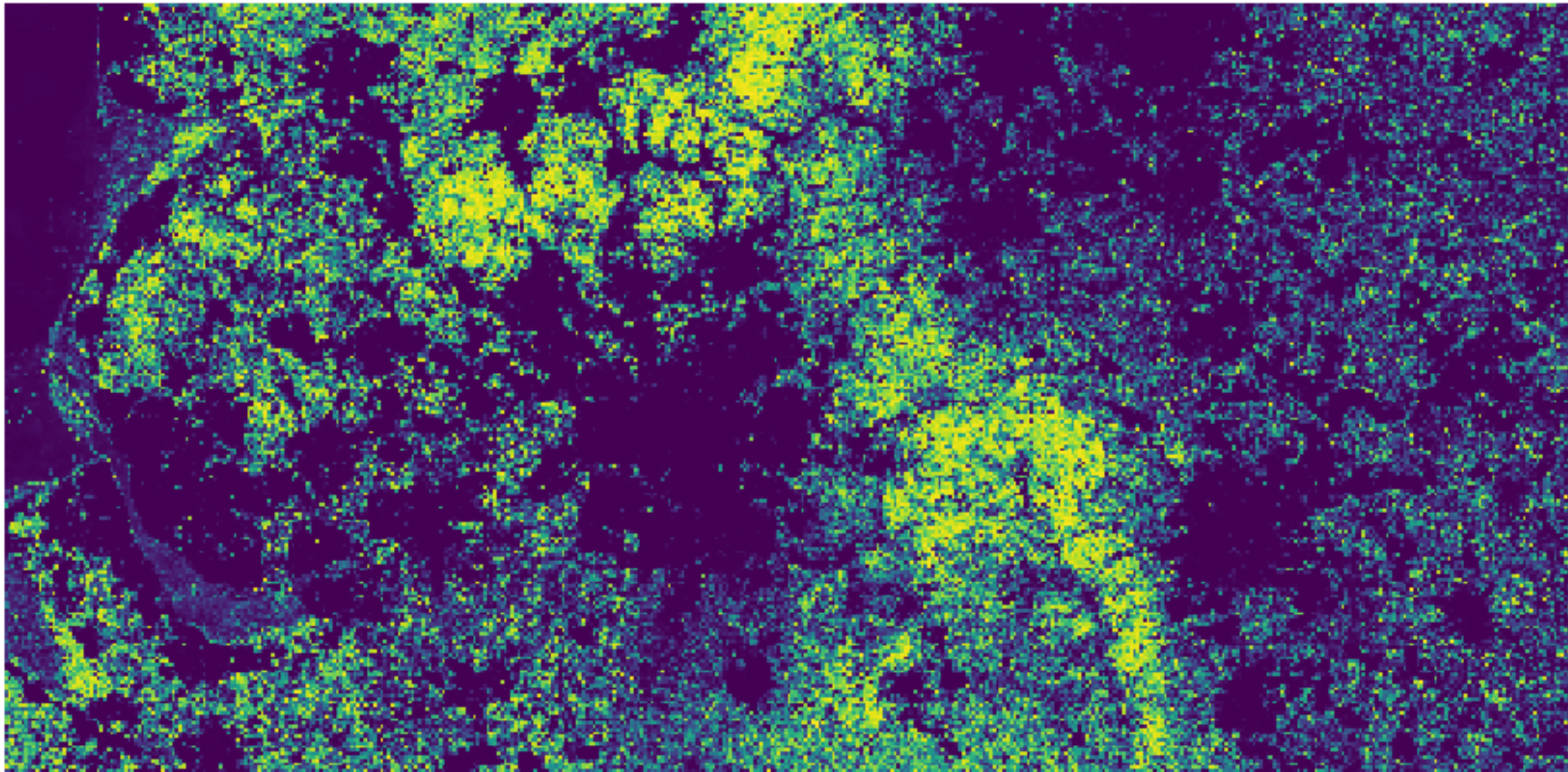
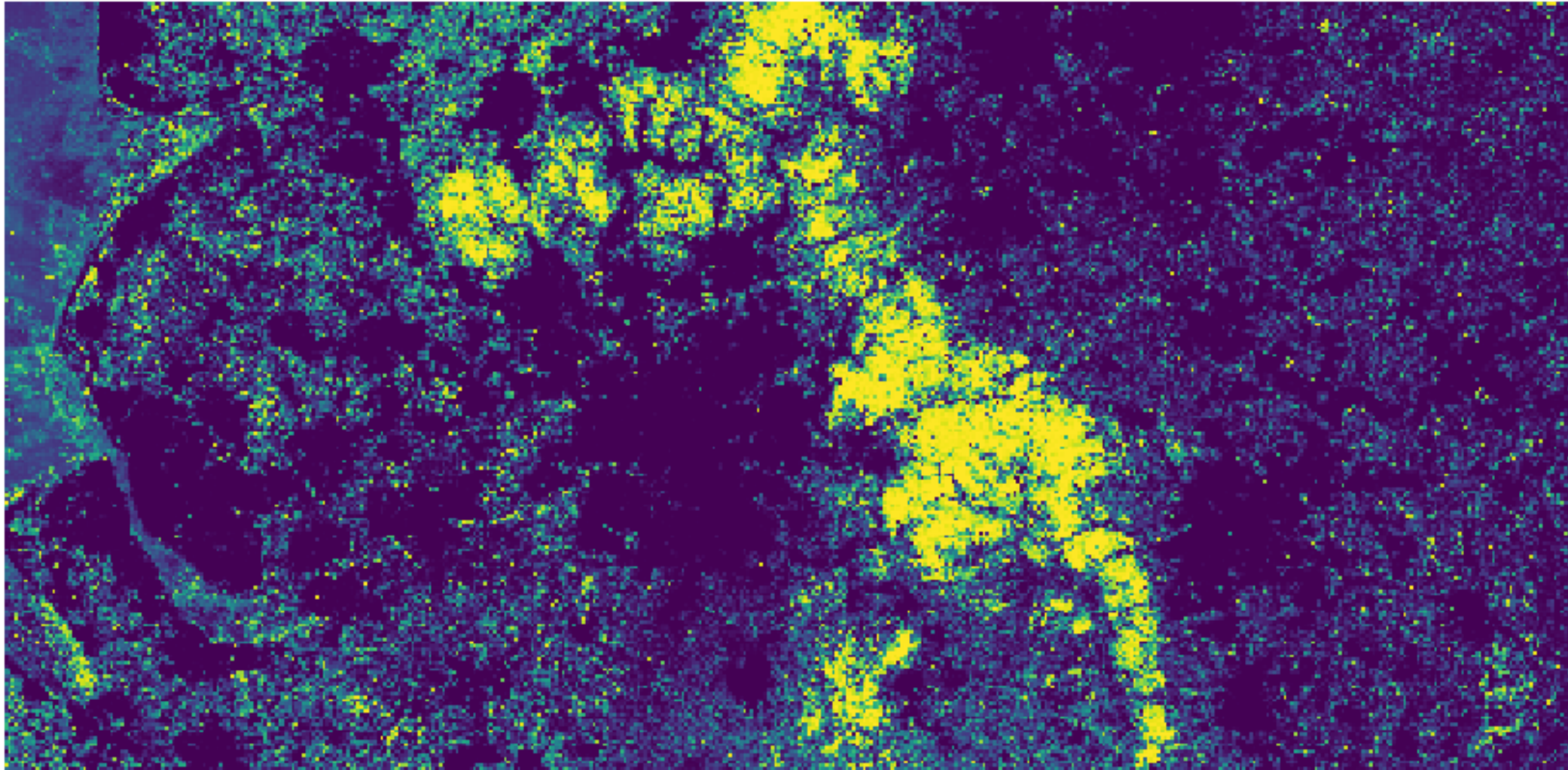


Image classification - Wild countryside



Multi-output regression - Wild countryside

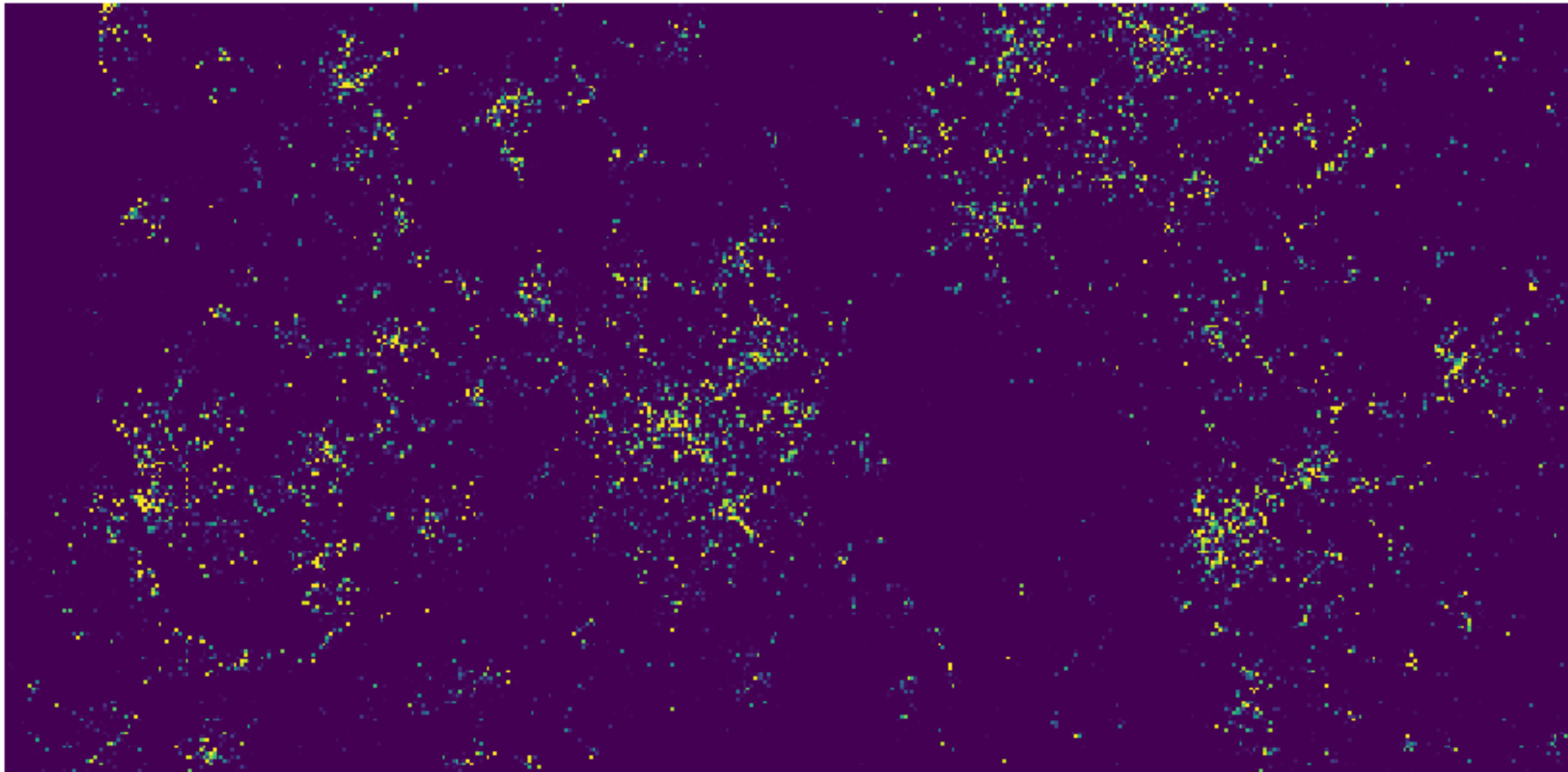
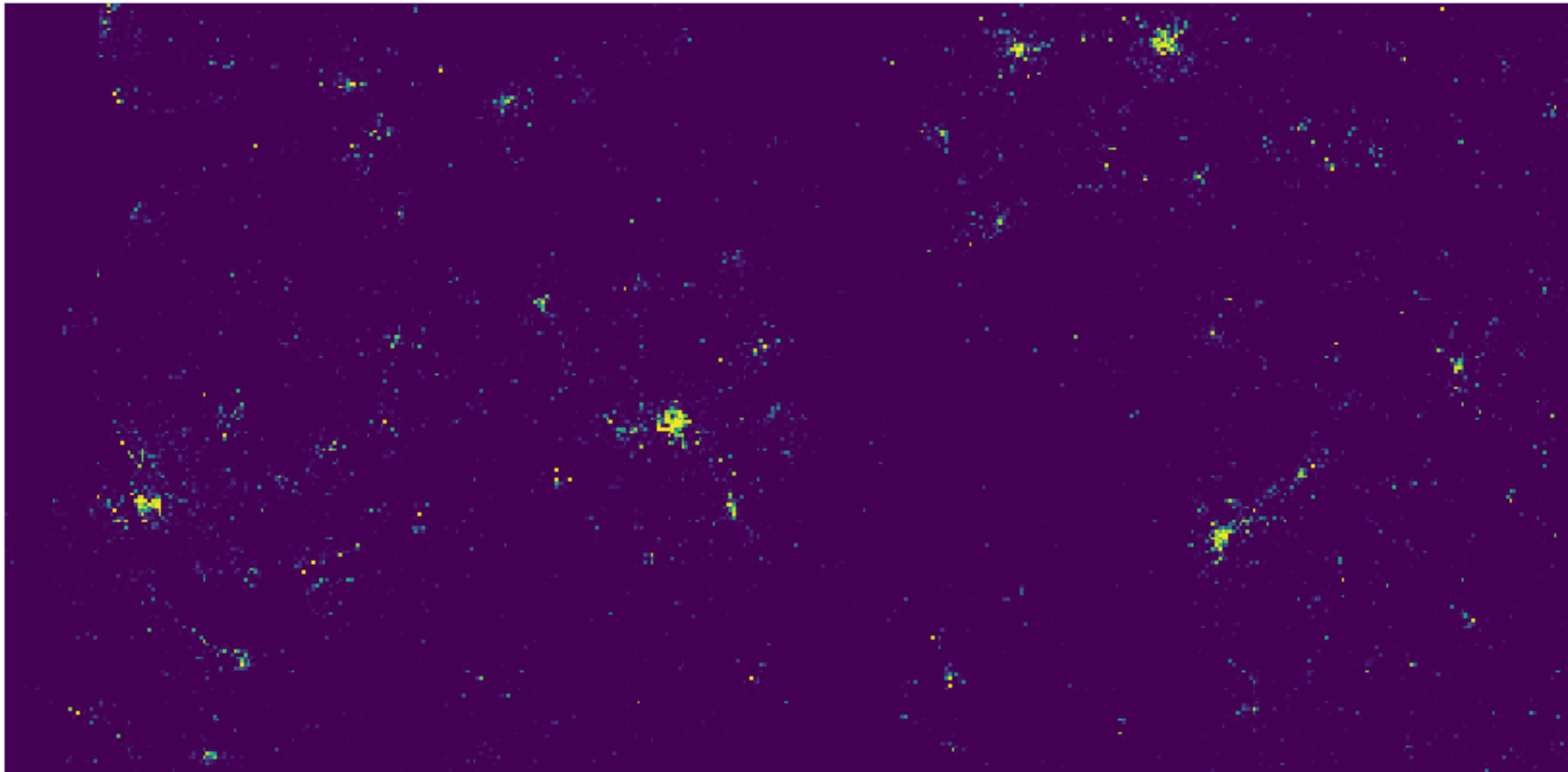


Image classification - Urbanity

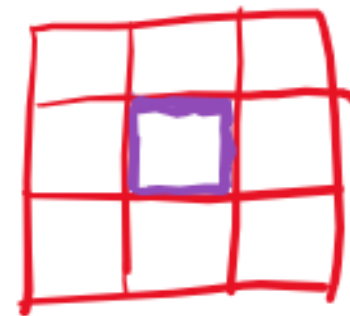


Multi-output regression - Urbanity

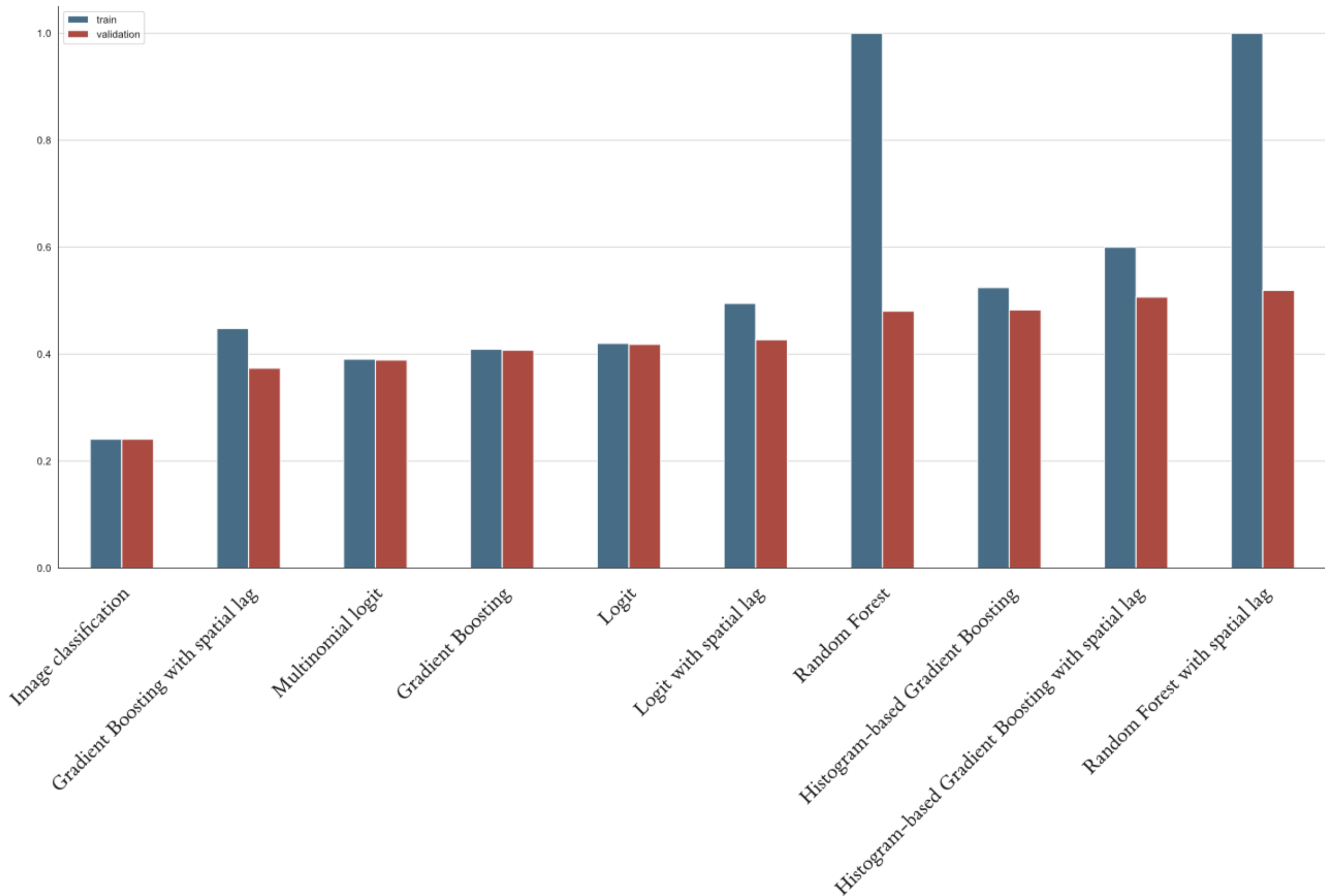
Probability modelling

$$S_i = f \left(\sum_k P_k + \sum_k W P_k \right)$$

- f {
1. Argmax
 2. (MN) Logit
 3. Random Forest
 4. Grad. Boosted Trees



$$W P_{ki} = \sum_j w_{ij} P_k$$



*the accuracy is based on a different sample than in previous cases (WIP)

Feedback?

- Better (spatial) evaluation of model performance
- Probability modeling: *does it make (any) sense?*
- Anything else?

Using deep learning to identify (urban) form and function in satellite imagery

The case of Great Britain

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Data Science
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Great Britain

Characters

Form

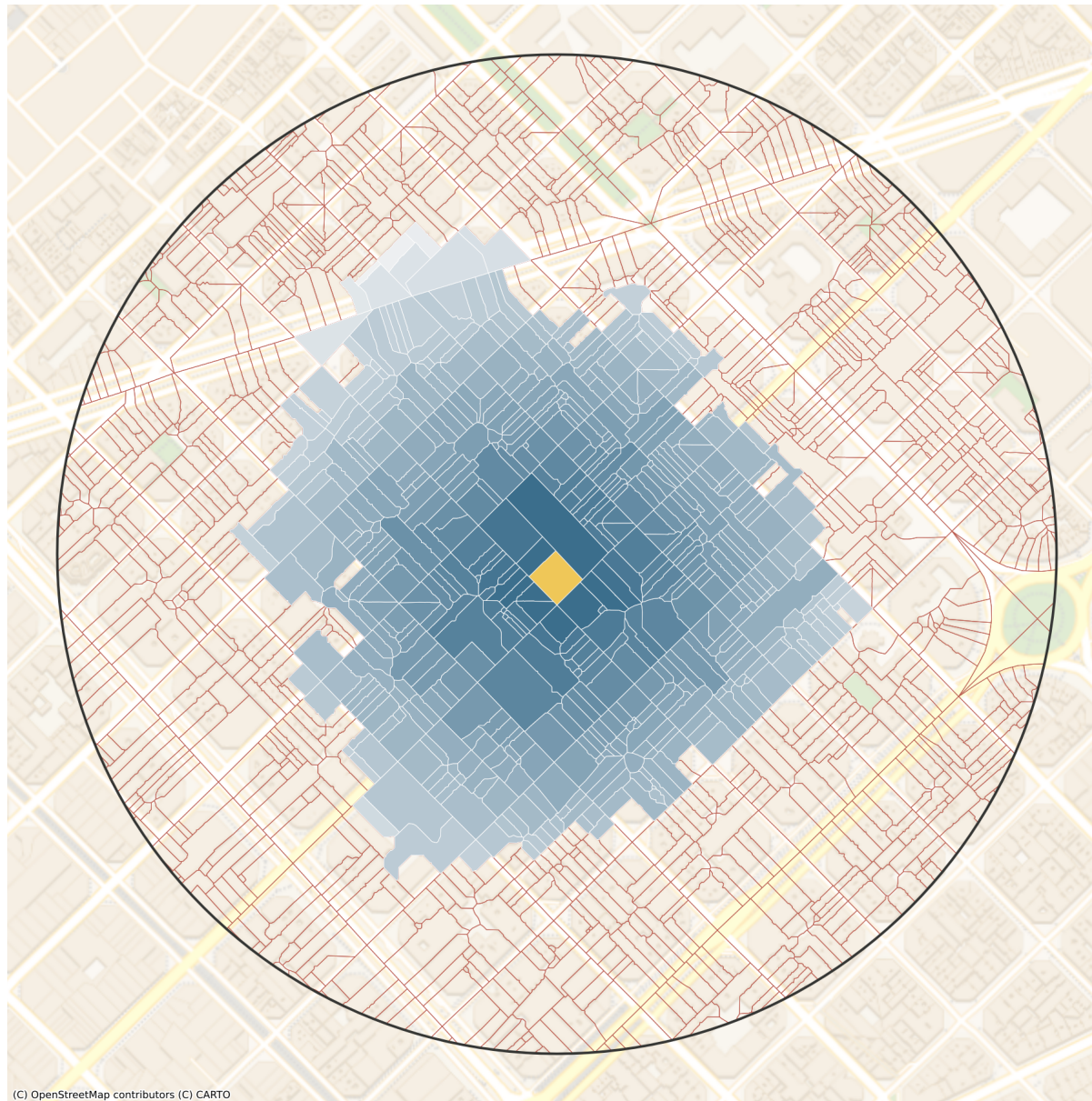
- Dimension
- Shape
- Intensity
- Connectivity
- Diversity

Function

- Population
- Employment
- Industry
- Land
use/cover
- Amenity access

$N \approx 300$

Context



Data

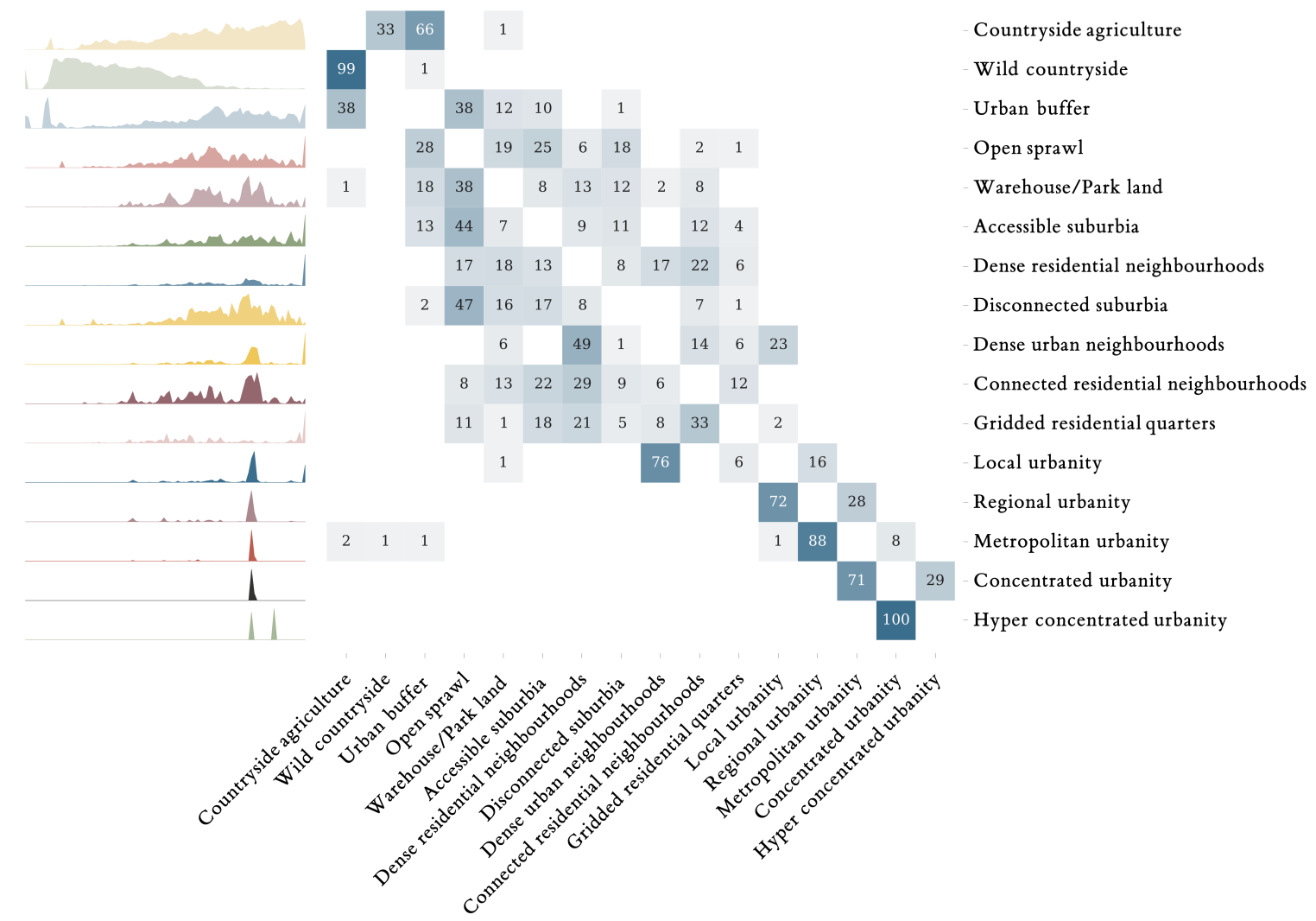
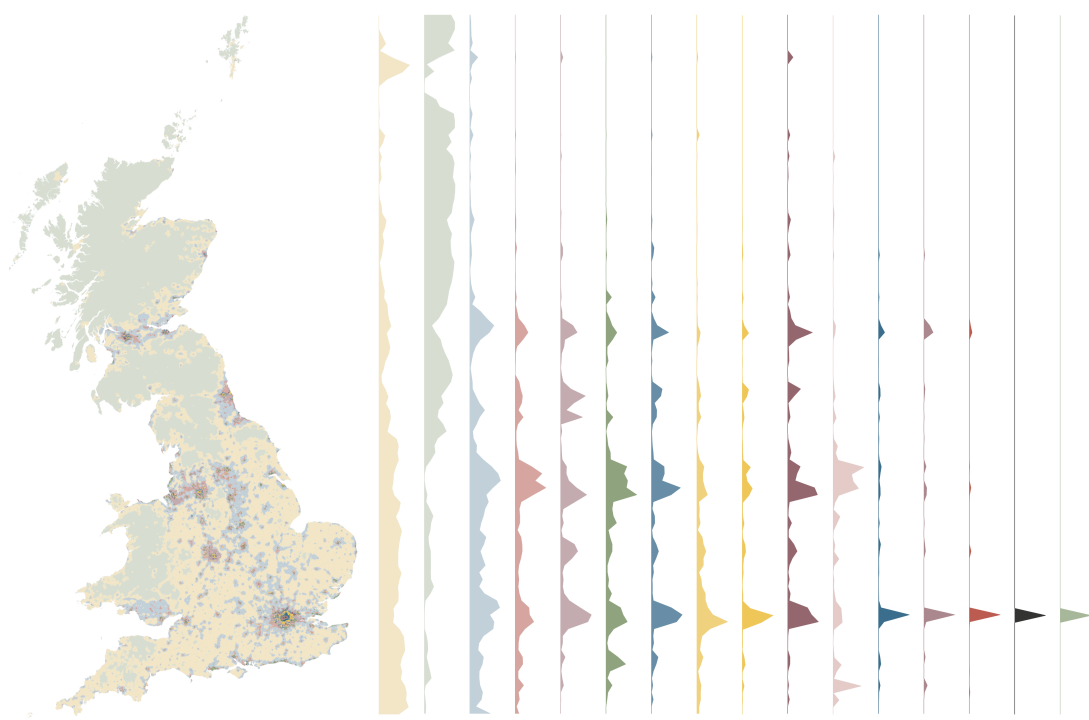
Form

- OS OpenMap
- OS OpenRoads

Function

- (Business) Census
- OpenStreetMap
- Geolytix
- Listed buildings
- CDRC
- CORINE /
Sentinel 2
- VIIRS

Distribution/co-occurrence



Urban hierarchy

