

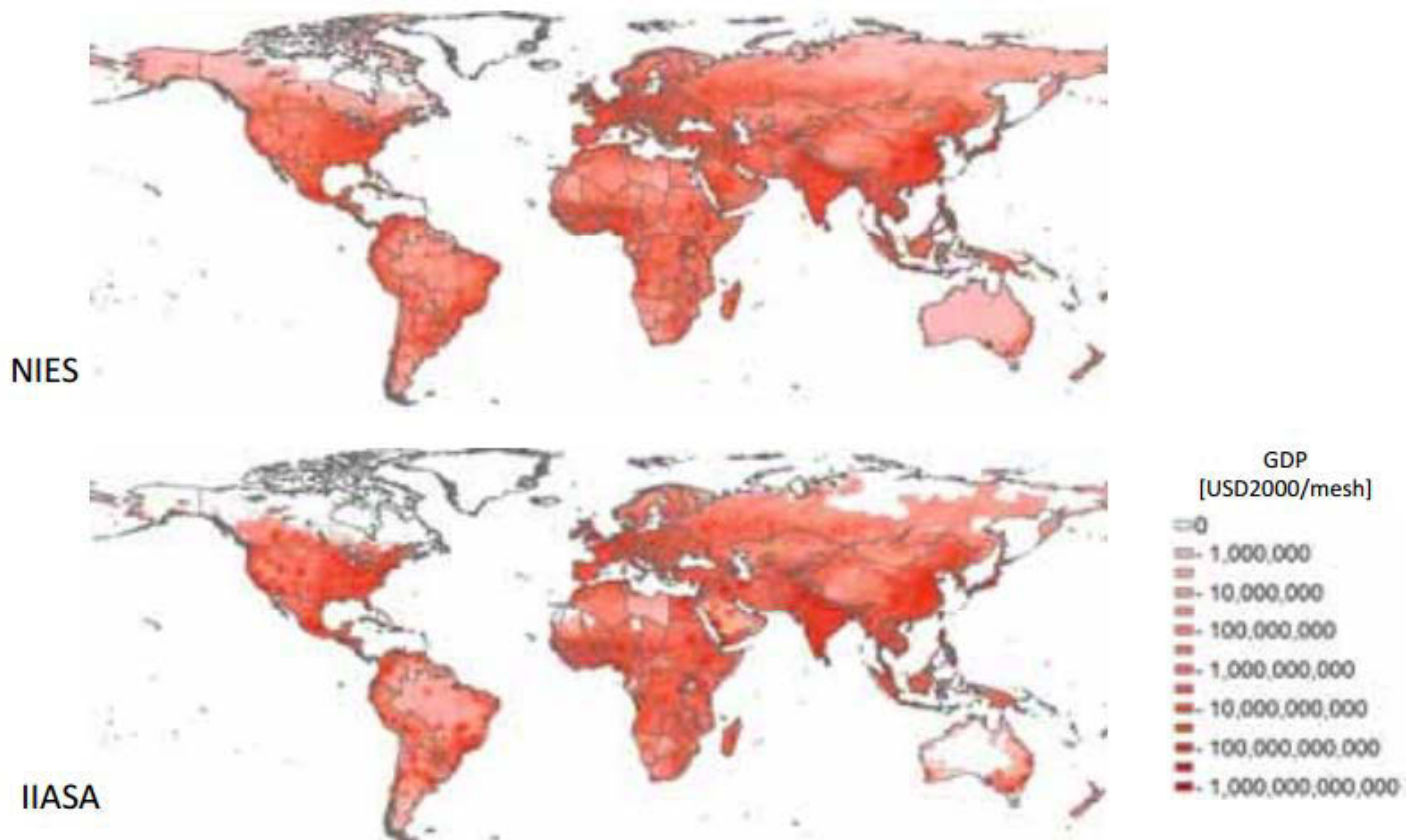
# 高分解能リモートセンシング 解析情報を用いた 土地利用モデルシミュレーション

課題代表者：山形 与志樹

瀬谷 創

# Objective

- Creation of future gridded population, GDP and urban land cover maps of the world

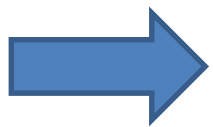


# Database for gridded population

**Table 1 Gridded population datasets and their characteristics**

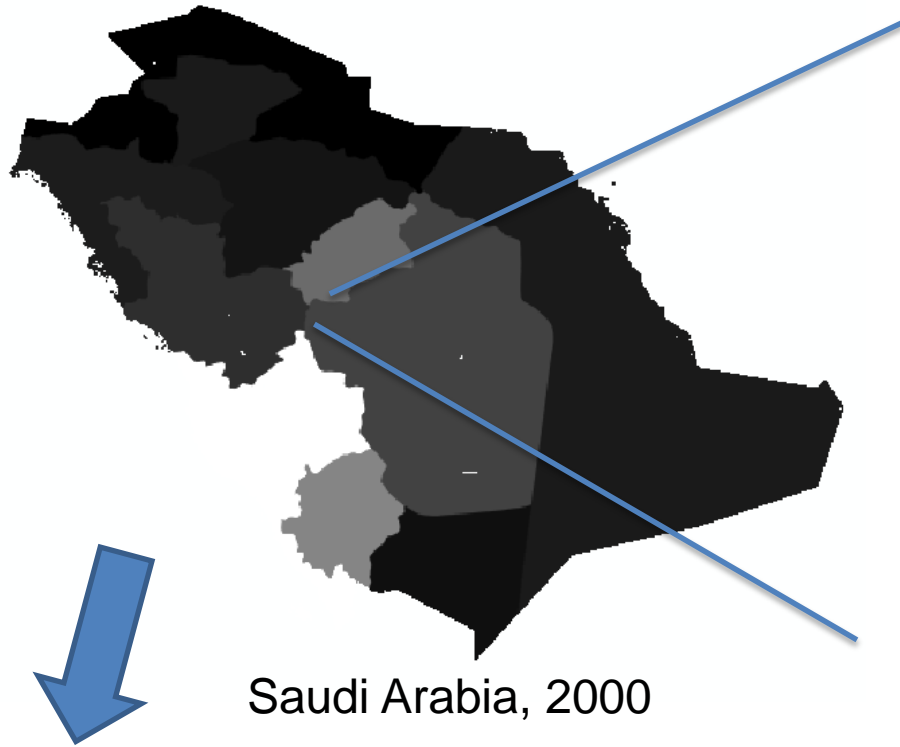
Dataset	Year(s) represented	Spatial resolution	Input data used	Data source for national pop total adjustments	Source
LandScan	2008	30 arcseconds (~1 km)	Census, land cover, elevation, slope, roads, populated areas/ points	CIA [23]	[11]; <a href="http://www.ornl.gov/sci/landscan/">http://www.ornl.gov/sci/landscan/</a>
Gridded Population of the World (GPW)	1990/1995/2000/2005/2010/2015	2.5 arcminutes (~5 km)	Census, water bodies (for masking)	UNPD [22]	[12]; <a href="http://sedac.ciesin.columbia.edu/gpw/global.jsp">http://sedac.ciesin.columbia.edu/gpw/global.jsp</a>
Global Rural Urban Mapping Project (GRUMP)	1990/1995/2000	30 arcseconds (~1 km)	Census, populated areas, water bodies (for masking)	UNPD [22]	[13]; <a href="http://sedac.ciesin.columbia.edu/gpw/global.jsp">http://sedac.ciesin.columbia.edu/gpw/global.jsp</a>
United Nations Environment Programme (UNEP) Global Population Databases	2000	2.5 arcminutes (~5 km)	Census, populated points, roads	UNPD [22]	[14]; <a href="http://na.unep.net/siouxfalls/datasets/datalist.php">http://na.unep.net/siouxfalls/datasets/datalist.php</a>

Tatem, A. J., Campiz, N., Gething, P. W., Snow, R. W., & Linard, C. (2011). The effects of spatial population dataset choice on estimates of population at risk of disease. *Population health metrics*, 9(1), 4.

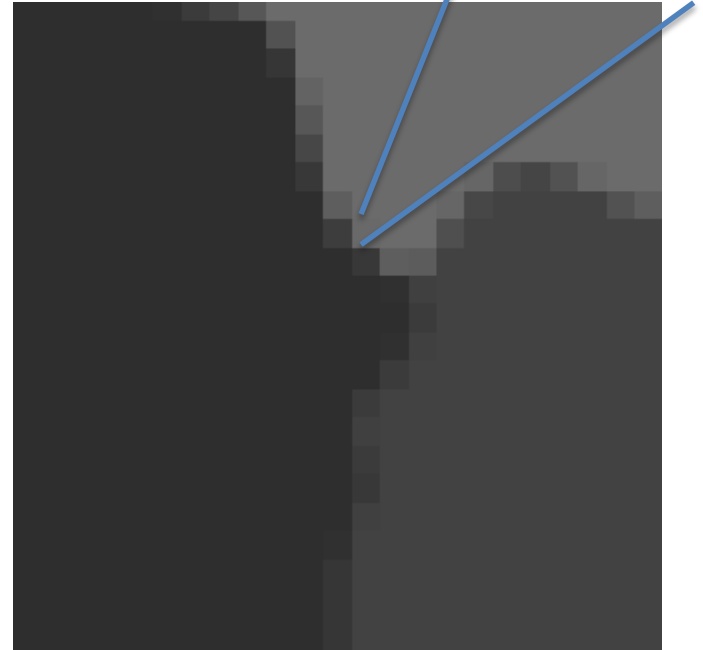


Population Count Grid v3 (2.5 arc-min ~5km)  
Population Count Grid v1 (0.5 arc-min ~1km)  
by SEDAC is freely available, and most widely used.

# Problem of SEDAC PCG3

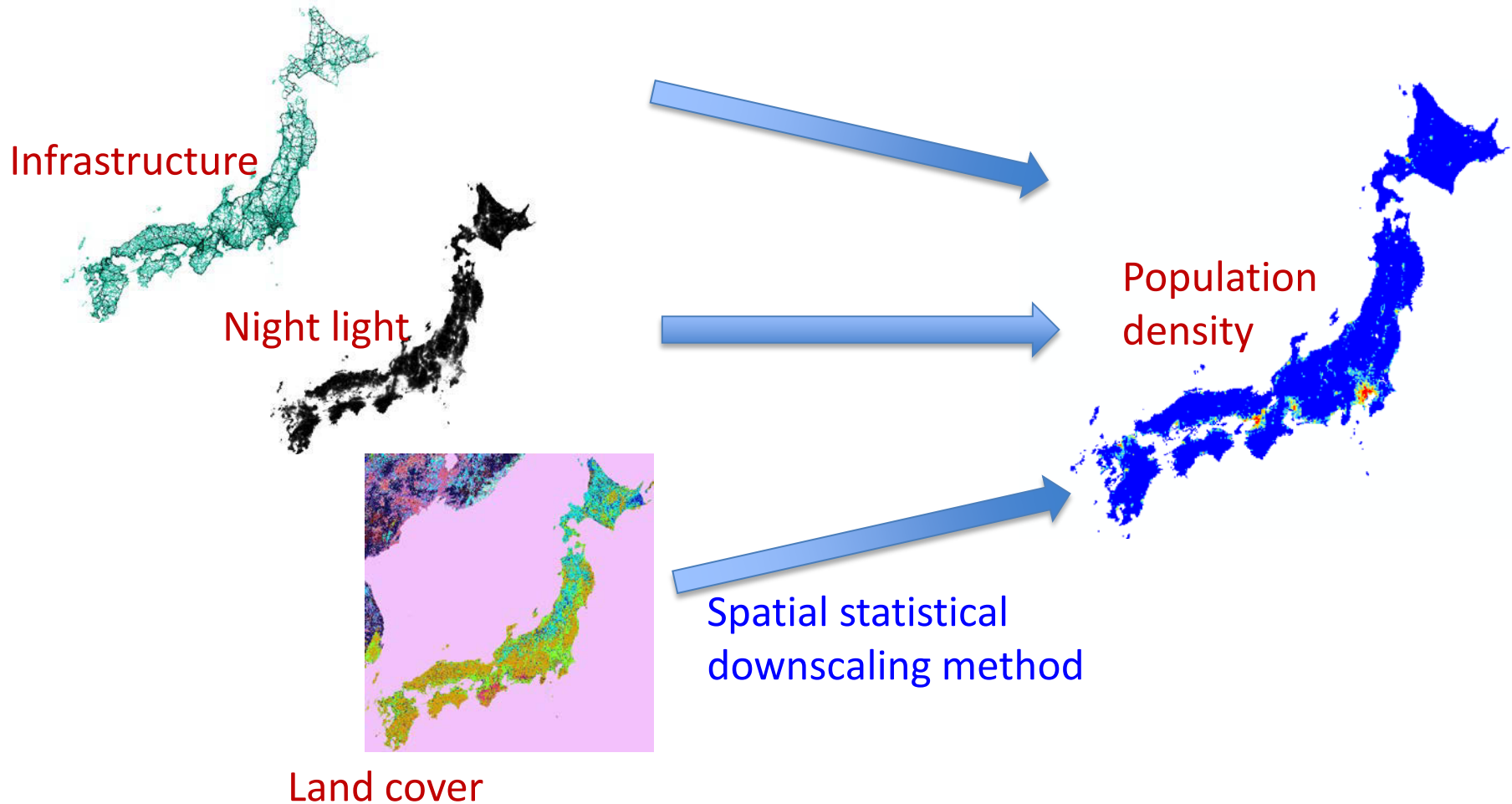


Mesh block size is about 4 km x 4km



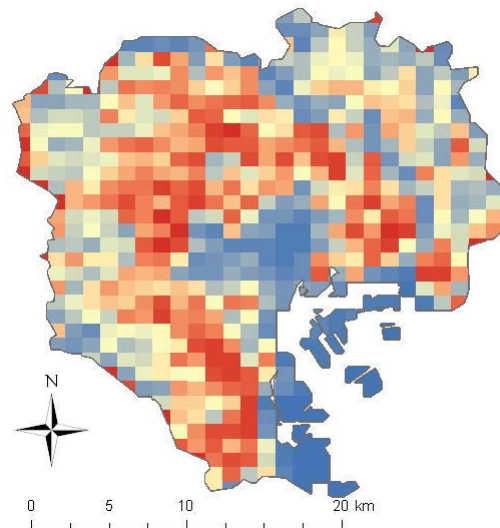
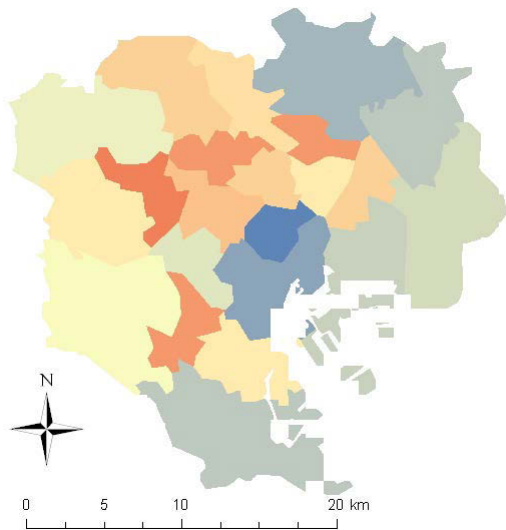
Created using areal weighting method, and therefore overly smoothed.

# Refinement of PCG3 using auxiliary data based on statistical approach



# Downscaling / Areal interpolation

- Pycnophylactic property / mass balance  
Sum of all the sub-regional estimates in a given region must equal the known regional total



Pop. Dens.  
(10000/km<sup>2</sup>)

10.0

5.0

2.0

1.5

1.0

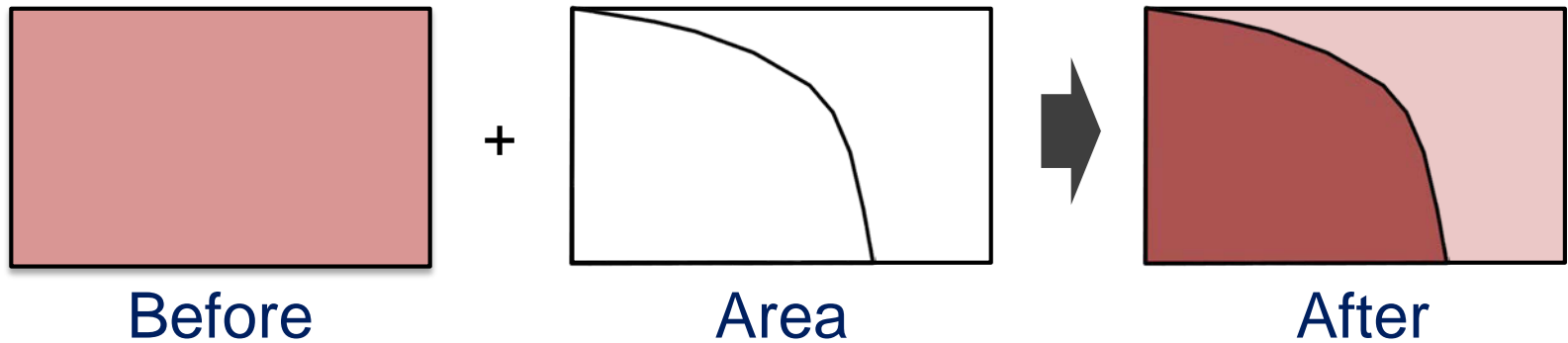
0.5

0.0

# Some representative downscaling methods

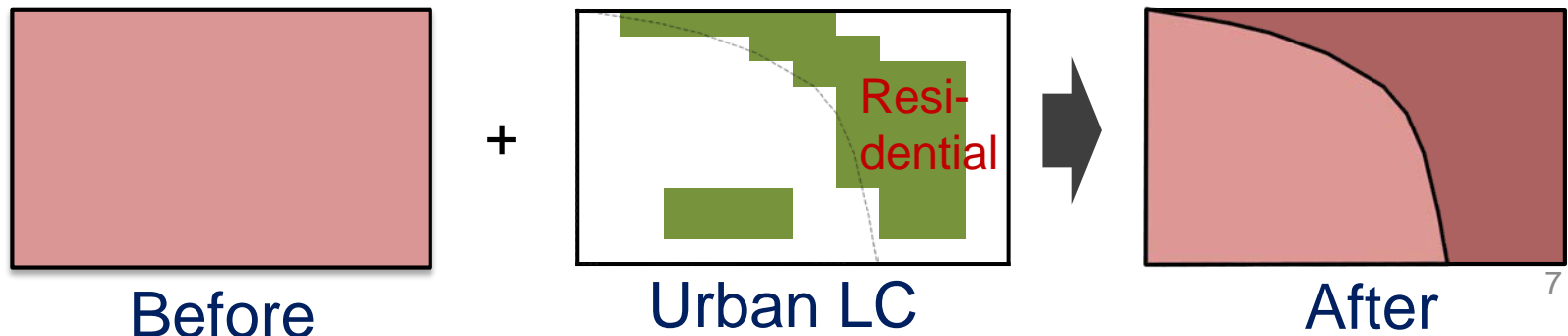
- Areal weighting

- allocation proportional to area



- Dasymetric method

- allocation proportional to auxiliary information such as land cover



# Spatial autocorrelation

- First law of geography

according to Waldo Tobler

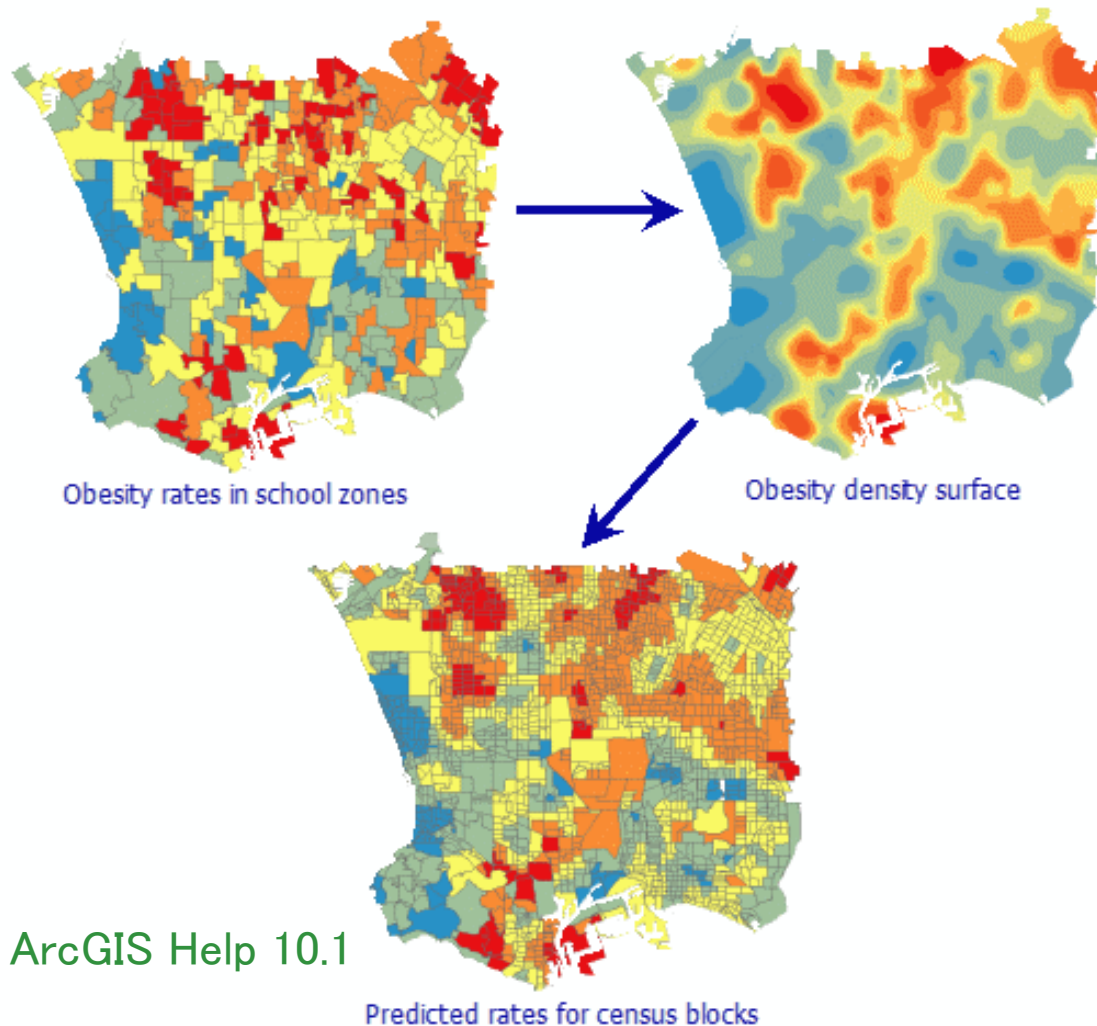
– Everything is related to everything else, but near things are more related than distant things

-> Near mesh blocks tend to take similar value

Areal interpolation incorporating spatial autocorrelation information

# Adding “spatial” information

- Area to point Kriging



Source: ArcGIS Help 10.1

# Classification of representative areal interpolation method

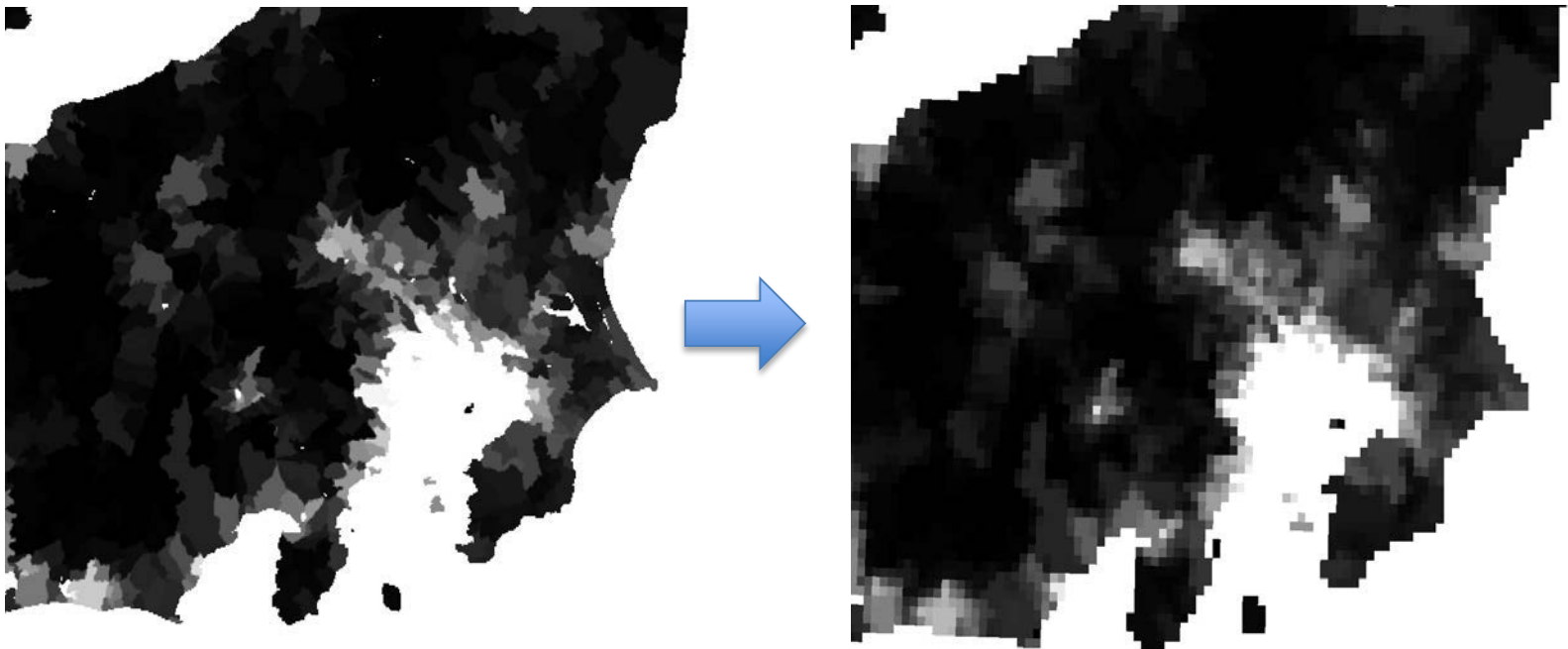
	Auxiliary information	Spatial autocorrelation
Areal weighting	Area	×
Dasymetric	Land use	×
Area to Point Kriging (ArcGIS)	NA	○
Regression based (Flowerdew and Green, 1992)	Arbitrary (possibly multiple)	×
<b>Spatial regression based (Gotway and Young, 2007)</b>	<b>Arbitrary (possibly muptiple)</b>	<b>○</b>



We added non-negative constraint of interpolated value to the method proposed by Gotway and Young (2007)

# Empirical verification using Japanese grid-square statistics

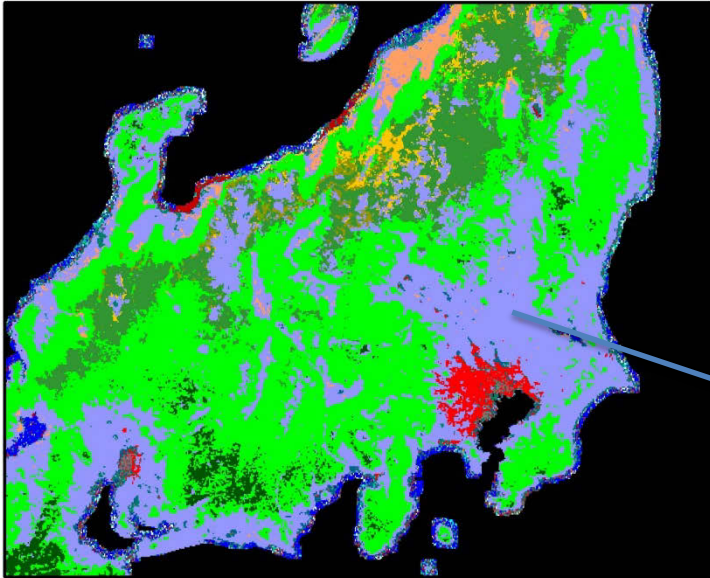
- We performed areal interpolation of Japanese **municipality level** population data in 2000 into **grid level** (2.5 arc-min  $\sim$ 5km).



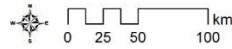
# Auxiliary information

- Land cover (ration of urban, ratio of forest)
  - CGER global land cover map
- Night light
  - DMSP
- Infrastructure
  - distance to railway (VMAP0)
  - Distance to road (Global Roads Open Access Data Set)

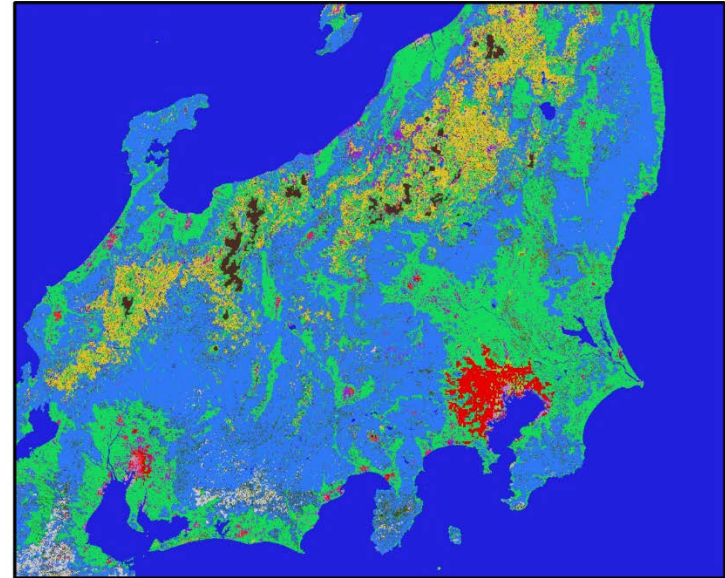
# Land cover data



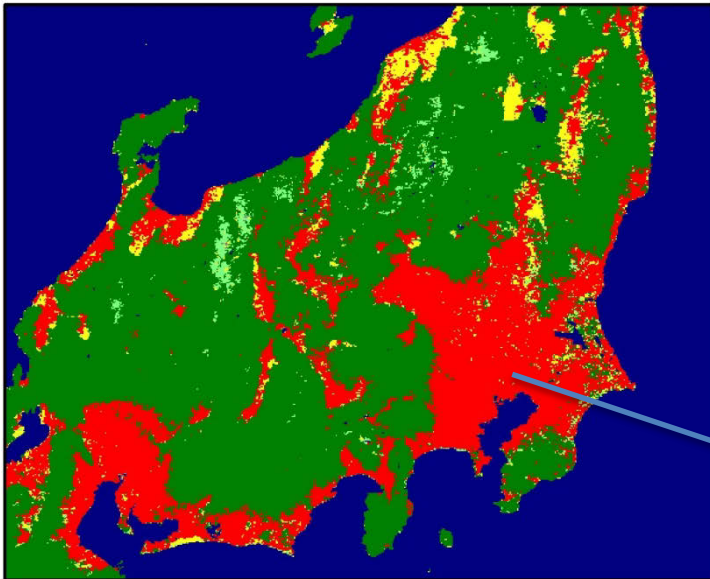
GLC2000



cropland



Global land cover product 05-06



CGER land cover



urban


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本ページにて提供する全球土地被覆図は、全球を緯度経度30秒メッシュでカバーするもので、WGS84 ellipsoidに基づいています。また本図の作成にあたり最新の衛星全球土地被覆図と地上トレーシングデータを組み、分画カテゴリーを6分組に絞ることで精度を向上させました。用いた既往土地被覆図は下記の通りです。

MOD12C4, MOD12C5 (Boston University), GLC2000 (Joint Research Center), Globcover (European Space Agency), UMD (The University of Maryland), GLCNMO (国土地理院)

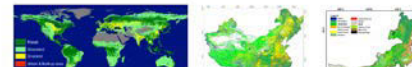
用いた地上トレーシングデータは、The Degree Confluence Project (DCP) から作成したものです。DCPに関しては、Iwao et al. (2006) を参照してください。

DCPのデータを用いて精度検証を行った結果を次に示します。

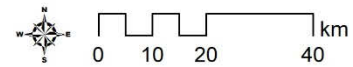
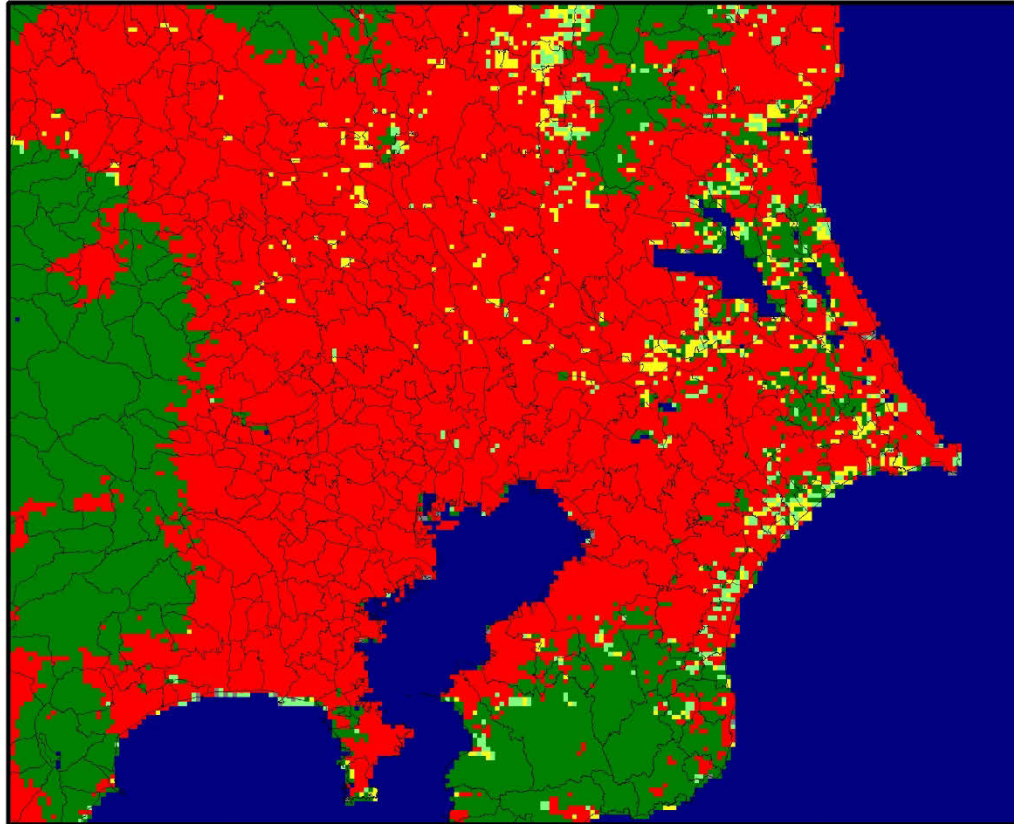
	精度	K係数
MOD12C4	69%	0.58
MOD12C5	72%	0.63
GLC2000	67%	0.57
Globcover	65%	0.54
UMD	65%	0.52
GLCNMO	62%	0.51
NHES Land cover map	76%	0.67

参考文献:

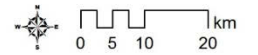
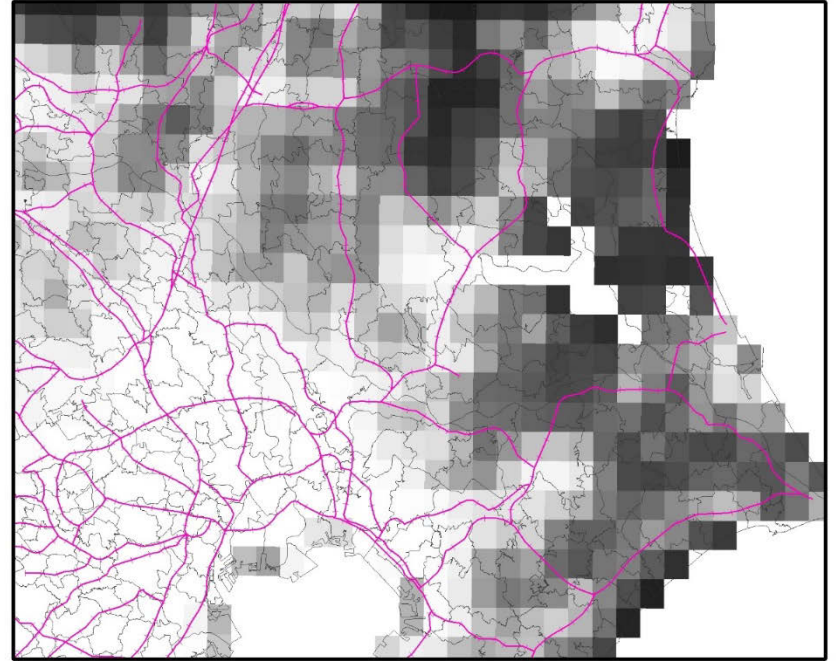
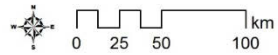
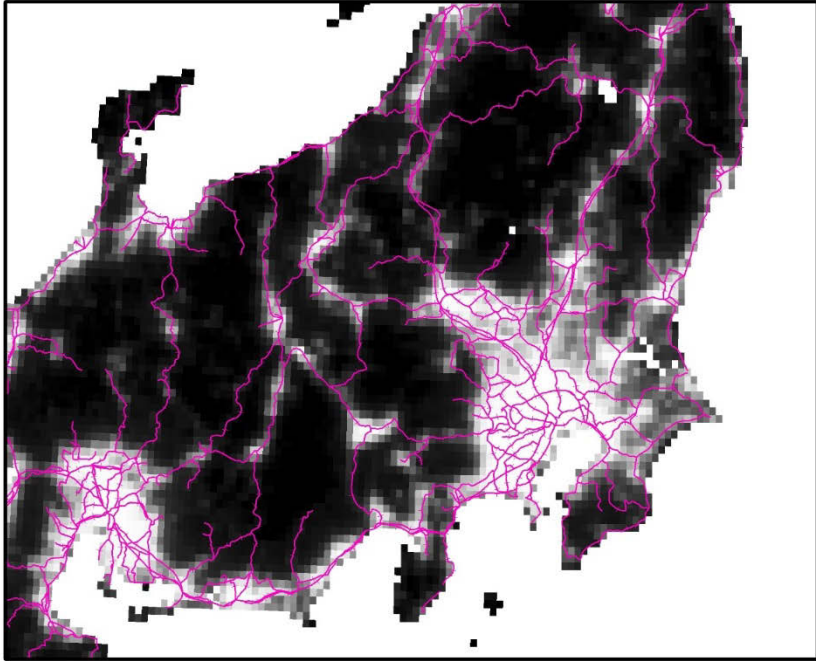
Iwao, K., K. Nishida, Y. Kinoshita, and Y. Yamagata (2006). Validating land cover maps with Degree Confluence Project information. *Geophys. Res. Lett.*, 33, L23404.



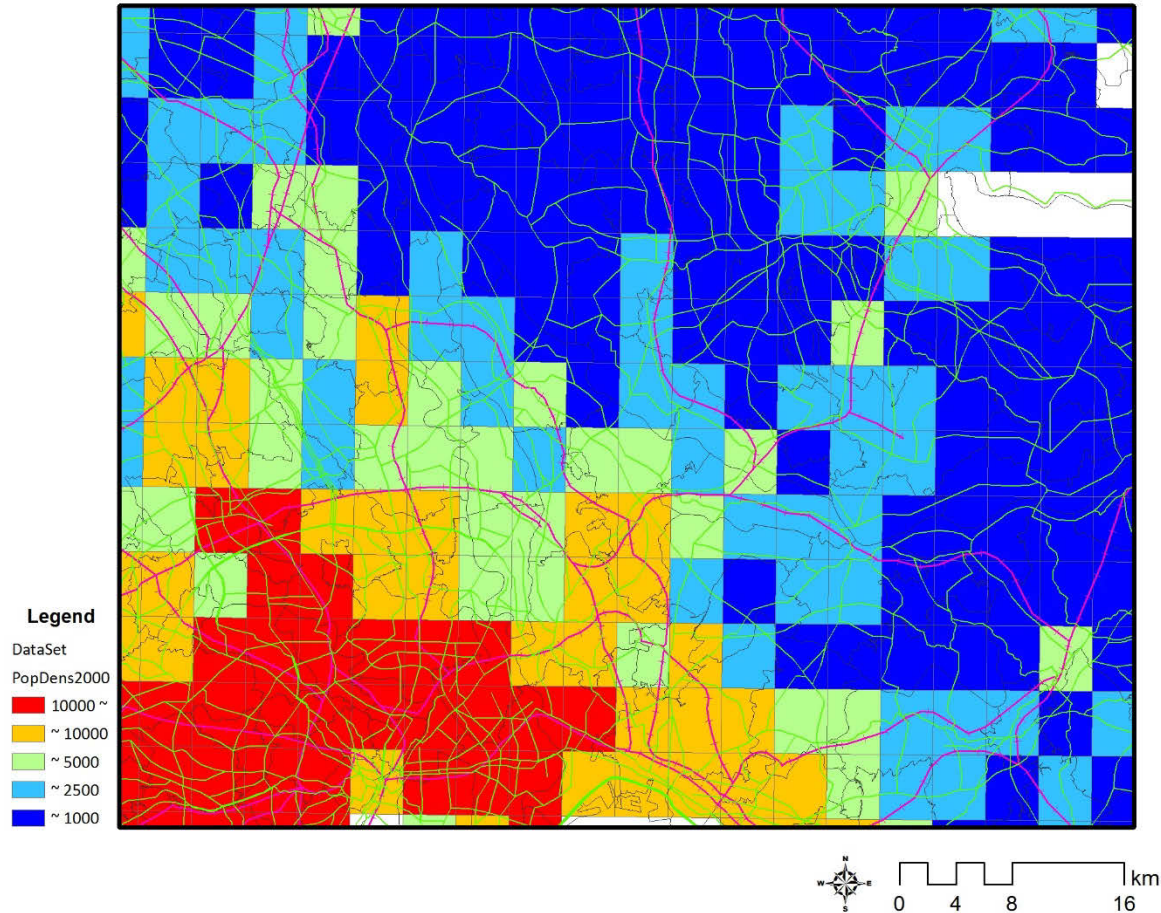
# CGER land cover around 2000



# DMSP

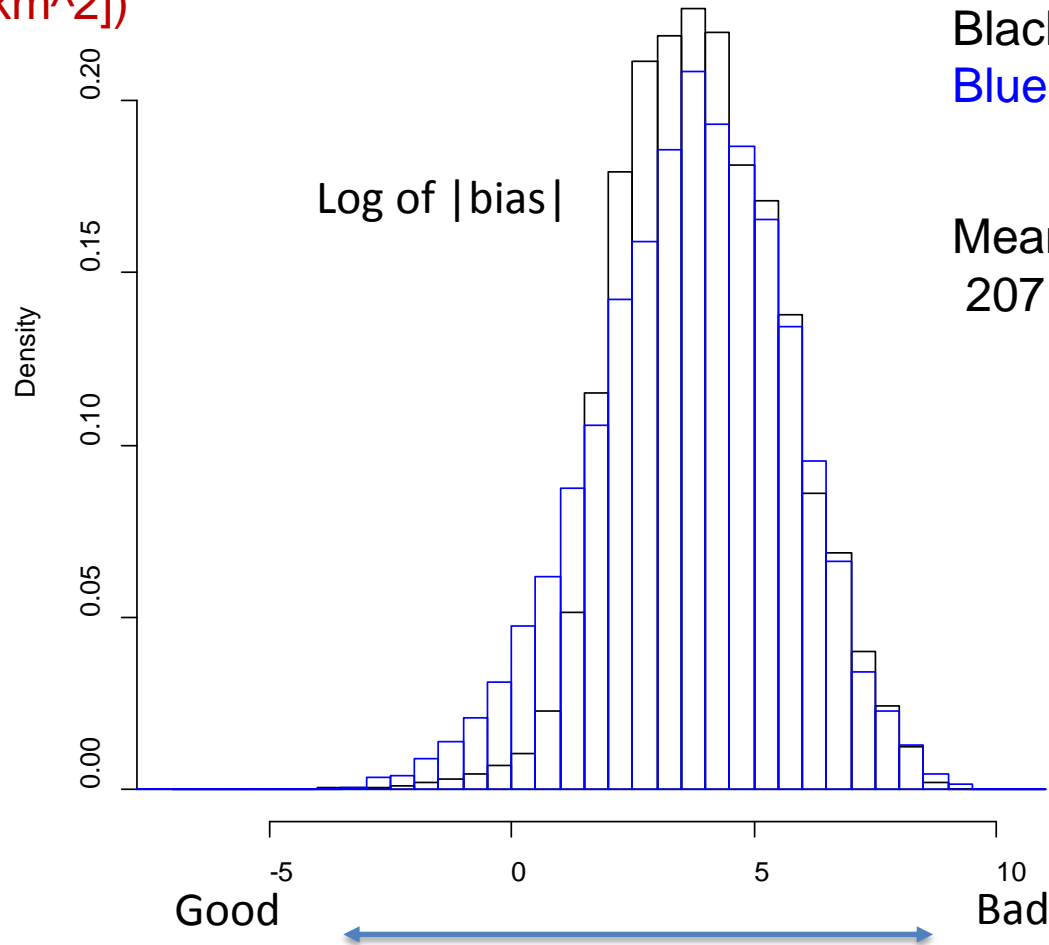


# Population density, railway, and road



# Results

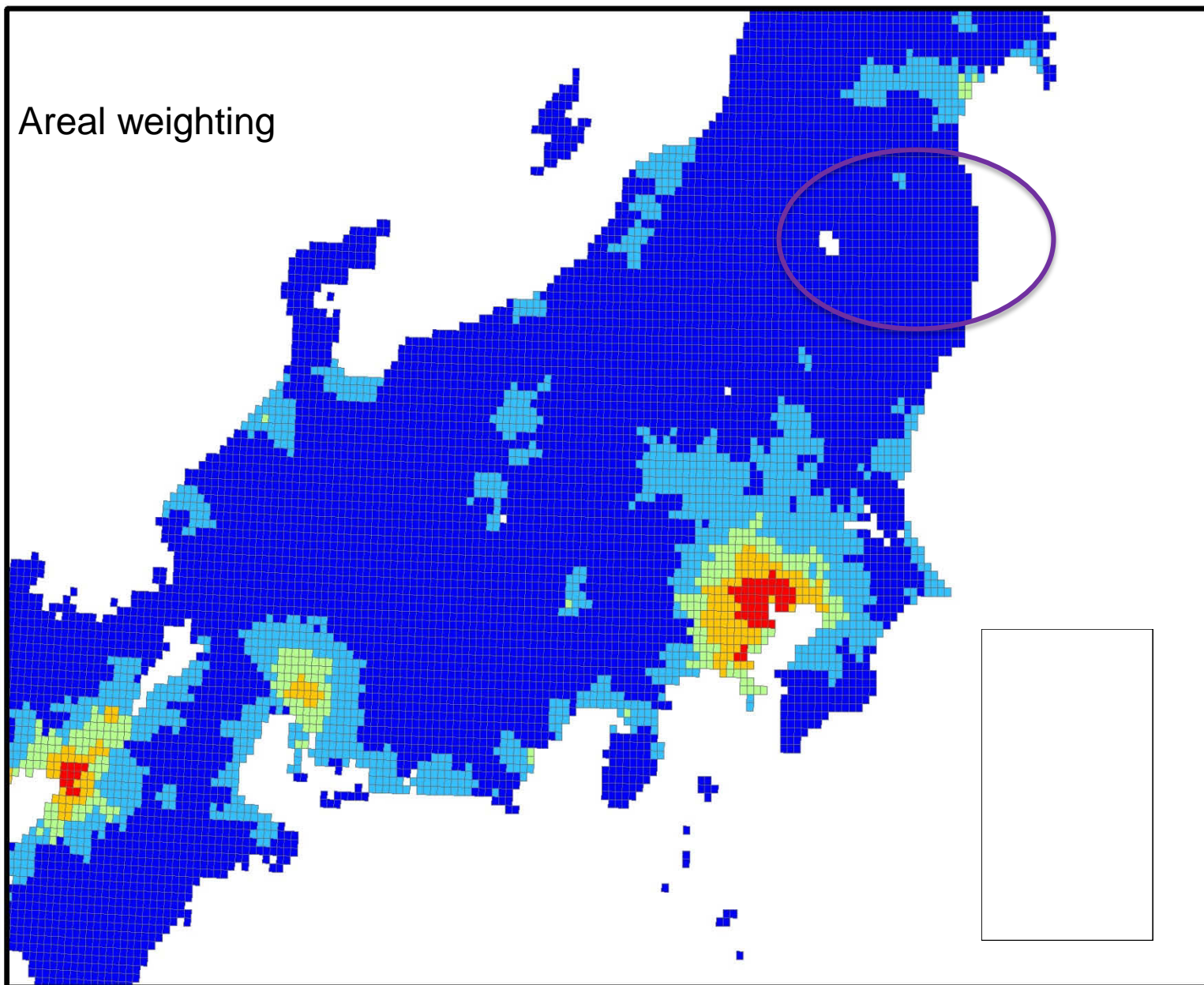
Compared to the observation  
(regional grid statistics of  
Japan [1km<sup>2</sup>])



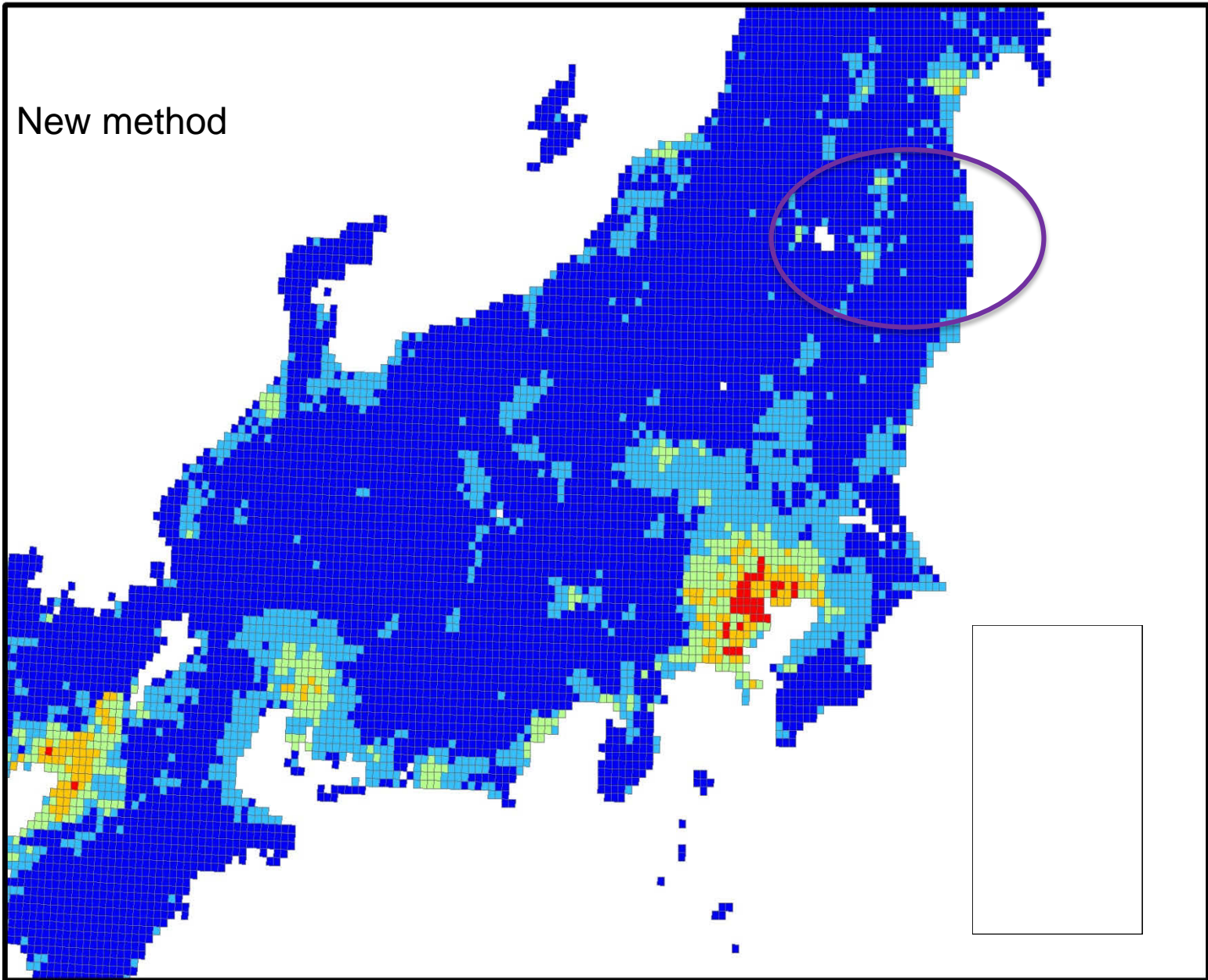
Black: areal weighting  
Blue: new method

Mean absolute error  
207 -> 168

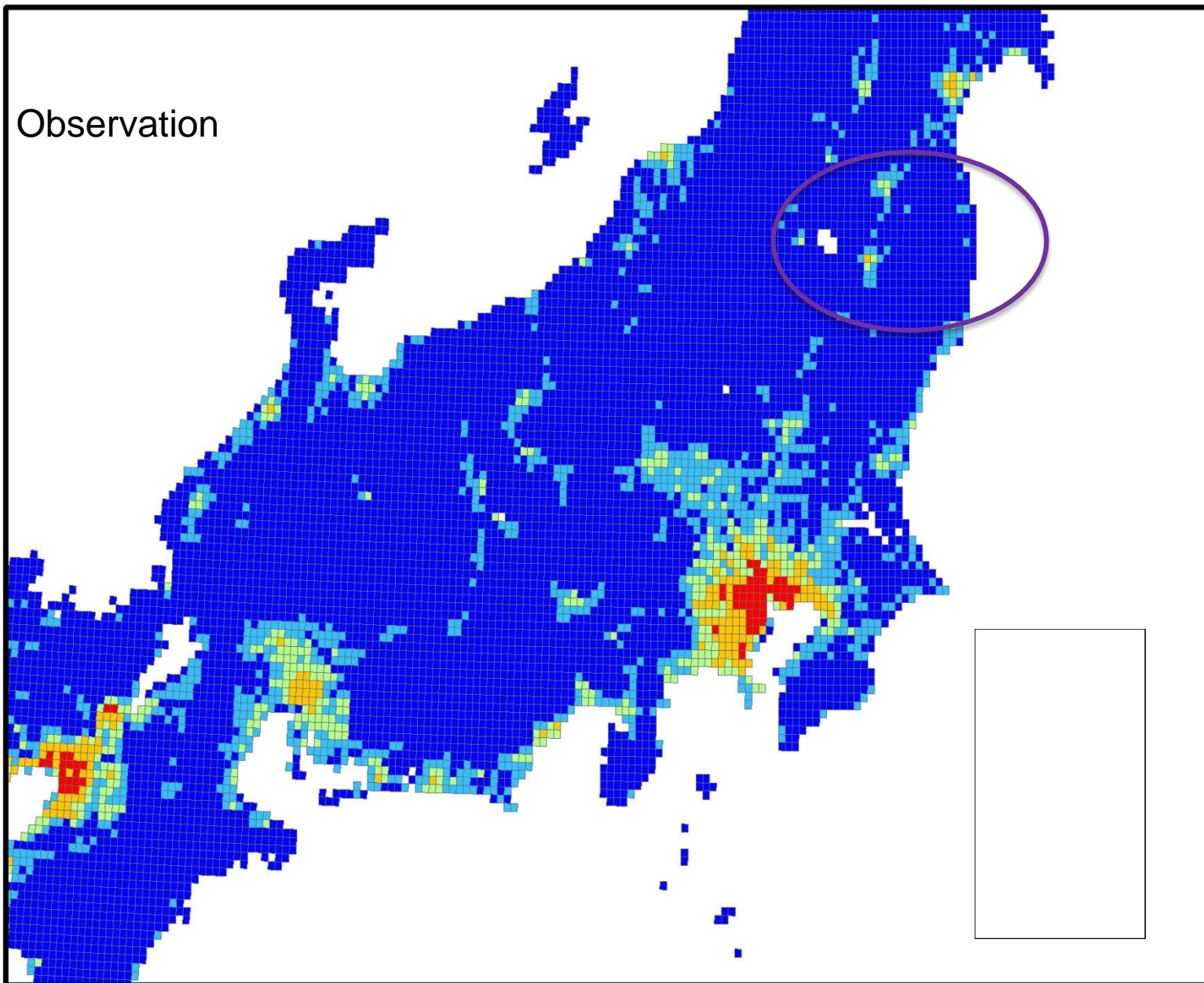
Areal weighting



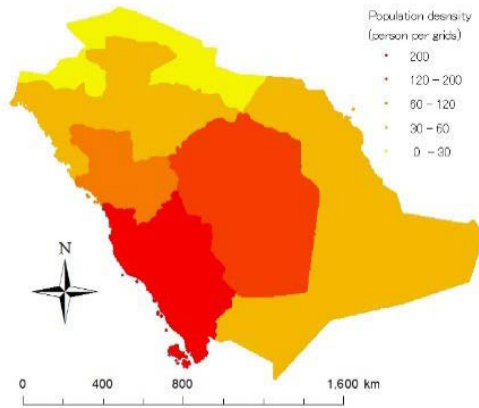
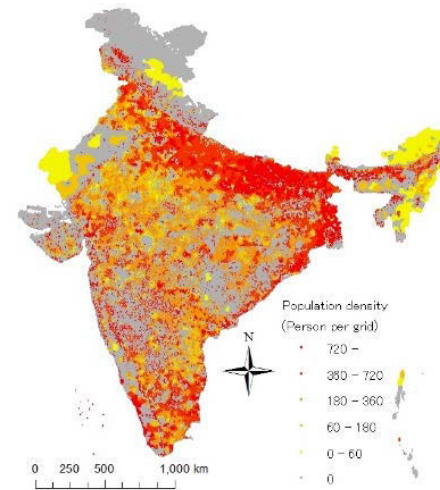
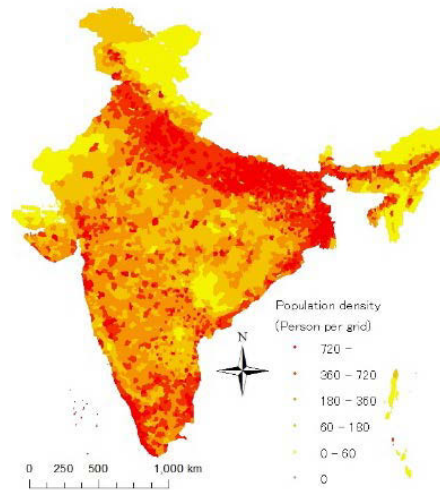
New method



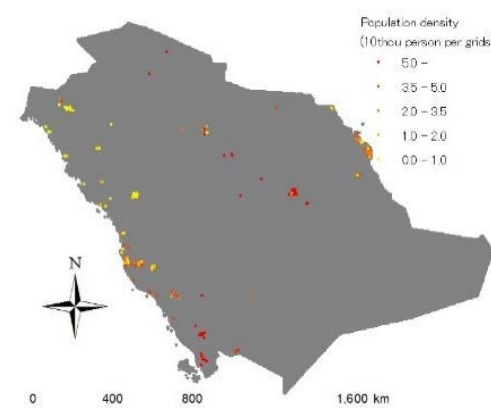
Observation



# New method applied to the SEDAC population database



PCGv3



Areal interpolation

Using Without refinement may leads to biased results, including future estimates.

# Future works

- Examining better auxiliary information which is globally available.
  - Using more spatially fine information for some developed cities.



- Application to the other countries.