China Data Institute

Center for Geographic Analysis
Harvard University

社会地理计算联合研究中心
Geocomputation Center for Social Science

NSF Spatiotemporal Innovation Center

题目1：基于全球不透水面数据提取城市边界的工作流实现
Lu Hao, Tsinghua University

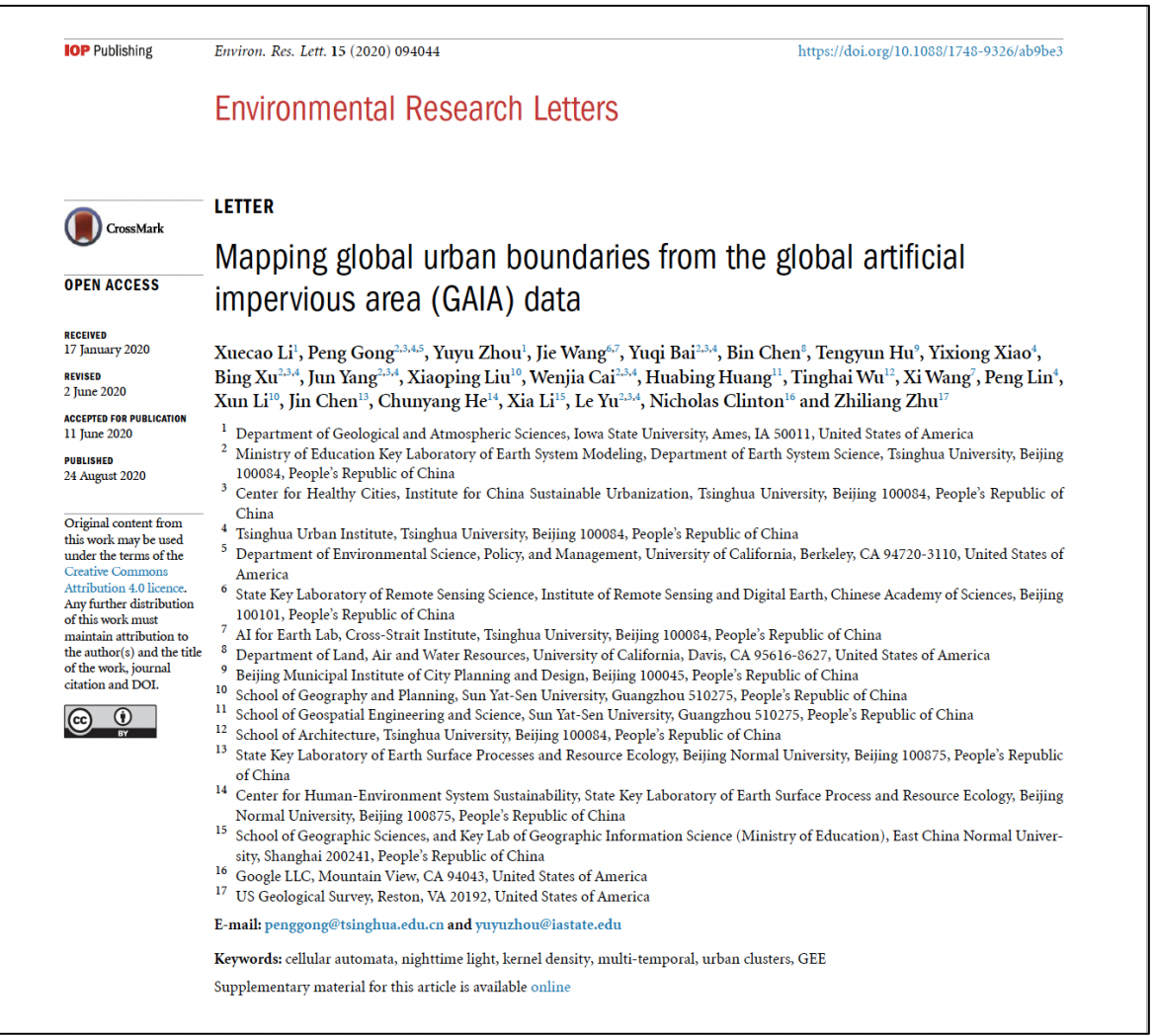
题目2：从 空间分布快照反演流模式
Dr. Di Zhu, University of Minnesota Twin Cities

主持人：Dr. Tao Hu, Harvard University

北京时间：2021年6月19日星期六 上午9:00-10:00
美国东岸时间: 9:00-10:00 PM, Friday, June 18, 2021 (US Eastern Time)

1. Mapping global urban boundaries from the global artificial impervious area (GAIA) data

Source: Li, X., Gong, P., Zhou, Y., Wang, J., Bai, Y., Chen, B., Hu, T., Xiao, Y., Xu, B., Yang, J., Liu, X., Cai, W., Huang, H., Wu, T., Wang, X., Lin, P., Li, X., Chen, J., He, C., Zhu, Z. (2020). Mapping global urban boundaries from the global artificial impervious area (GAIA) data. Environmental Research Letters, 15(9), 094044. https://doi.org/10.1088/1748-9326/ab9be3



IOP Publishing Environ. Res. Lett. 15 (2020) 094044 https://doi.org/10.1088/1748-9326/ab9be3

Environmental Research Letters

LETTER

Mapping global urban boundaries from the global artificial impervious area (GAIA) data

Xuecao Li[1], Peng Gong[2,3,4,5], Yuyu Zhou[1], Jie Wang[6,7], Yuqi Bai[2,3,4], Bin Chen[8], Tengyun Hu[9], Yixiong Xiao[4], Bing Xu[2,3,4], Jun Yang[2,3,4], Xiaoping Liu[10], Wenjia Cai[2,3,4], Huabing Huang[11], Tinghai Wu[12], Xi Wang[7], Peng Lin[4], Xun Li[10], Jin Chen[13], Chunyang He[14], Xia Li[15], Le Yu[2,3,4], Nicholas Clinton[16] and Zhiliang Zhu[17]

[1] Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011, United States of America
[2] Ministry of Education Key Laboratory of Earth System Modeling, Department of Earth System Science, Tsinghua University, Beijing 100084, People's Republic of China
[3] Center for Healthy Cities, Institute for China Sustainable Urbanization, Tsinghua University, Beijing 100084, People's Republic of China
[4] Tsinghua Urban Institute, Tsinghua University, Beijing 100084, People's Republic of China
[5] Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720-3110, United States of America
[6] State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, Beijing 100101, People's Republic of China
[7] AI for Earth Lab, Cross-Strait Institute, Tsinghua University, Beijing 100084, People's Republic of China
[8] Department of Land, Air and Water Resources, University of California, Davis, CA 95616-8627, United States of America
[9] Beijing Municipal Institute of City Planning and Design, Beijing 100045, People's Republic of China
[10] School of Geography and Planning, Sun Yat-Sen University, Guangzhou 510275, People's Republic of China
[11] School of Geospatial Engineering and Science, Sun Yat-Sen University, Guangzhou 510275, People's Republic of China
[12] School of Architecture, Tsinghua University, Beijing 100084, People's Republic of China
[13] State Key Laboratory of Earth Surface Processes and Resource Ecology, Beijing Normal University, Beijing 100875, People's Republic of China
[14] Center for Human-Environment System Sustainability, State Key Laboratory of Earth Surface Process and Resource Ecology, Beijing Normal University, Beijing 100875, People's Republic of China
[15] School of Geographic Sciences, and Key Lab of Geographic Information Science (Ministry of Education), East China Normal University, Shanghai 200241, People's Republic of China
[16] Google LLC, Mountain View, CA 94043, United States of America
[17] US Geological Survey, Reston, VA 20192, United States of America

E-mail: penggong@tsinghua.edu.cn and yuyuzhou@iastate.edu

Keywords: cellular automata, nighttime light, kernel density, multi-temporal, urban clusters, GEE

Supplementary material for this article is available online

RECEIVED 17 January 2020
REVISED 2 June 2020
ACCEPTED FOR PUBLICATION 11 June 2020
PUBLISHED 24 August 2020

Original content from this work may be used under the terms of the Creative Commons Attribution 4.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

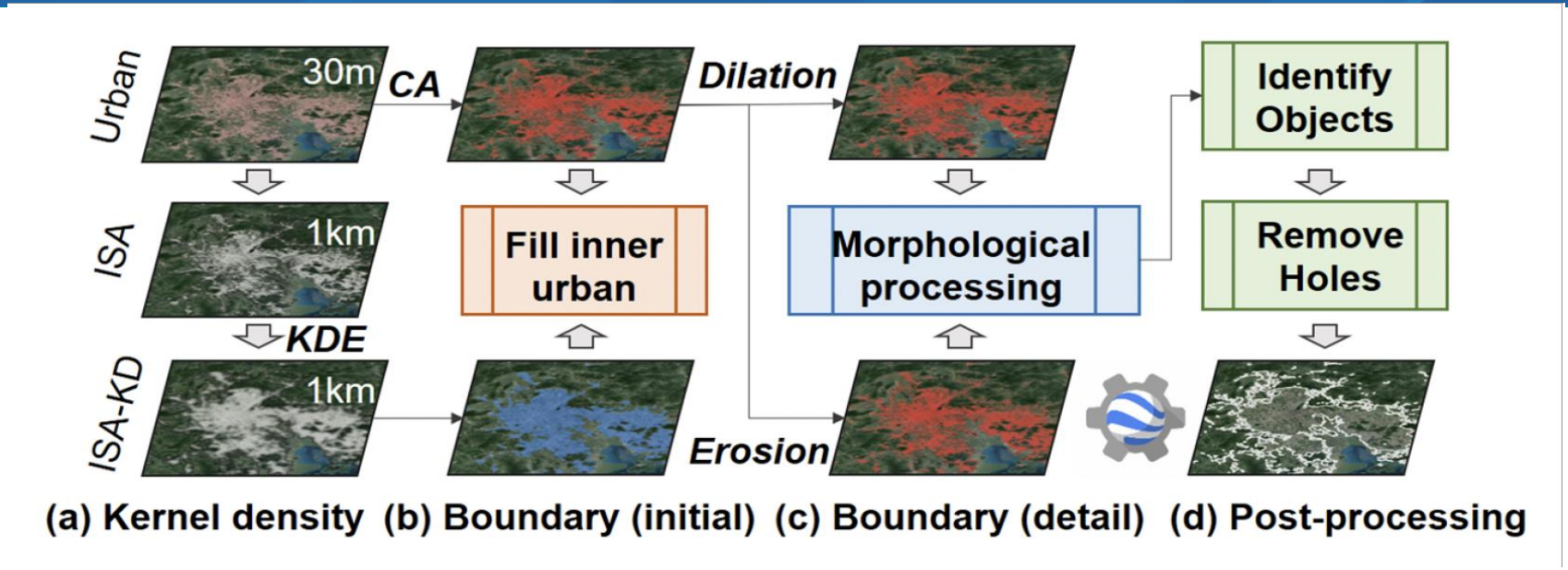
Objectives:

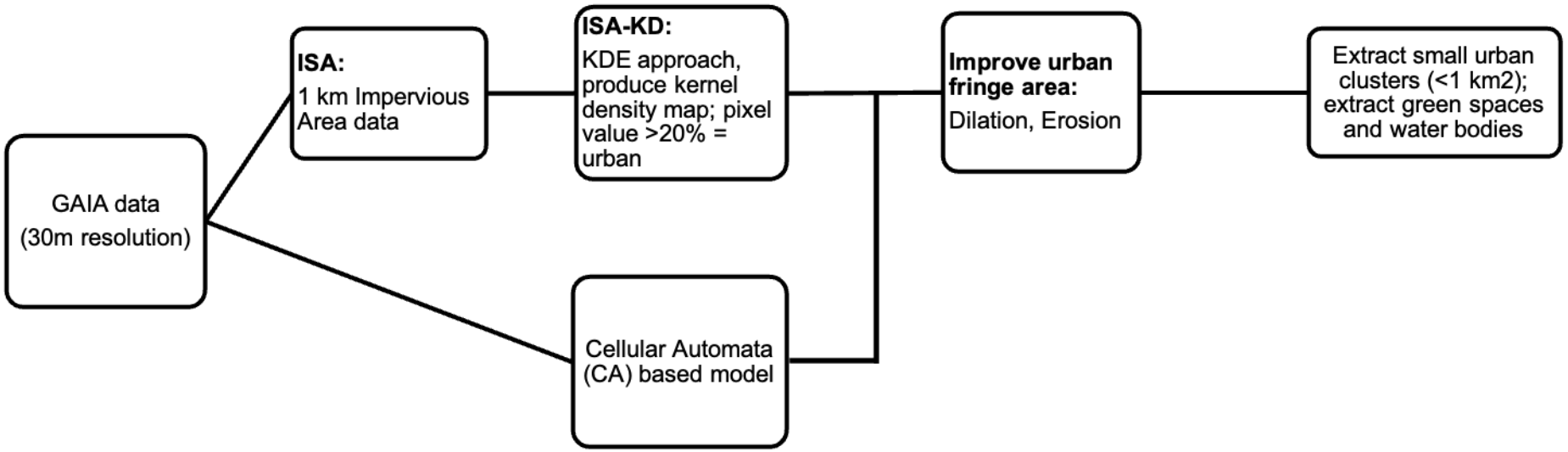
- Extract urban boundaries from satellite images at global scale and a fine resolution.
- Develop an automatic delineation framework to generate a dataset of global urban boundaries (GUB) in multiple years
  (1990, 1995, 2000, 2005, 2010, 2015, and 2018)

Data:

30m global artificial impervious area (GAIA) data (data can be accessed from http://data.ess.tsinghua.edu.cn.)

Methodology





Results and Discussion

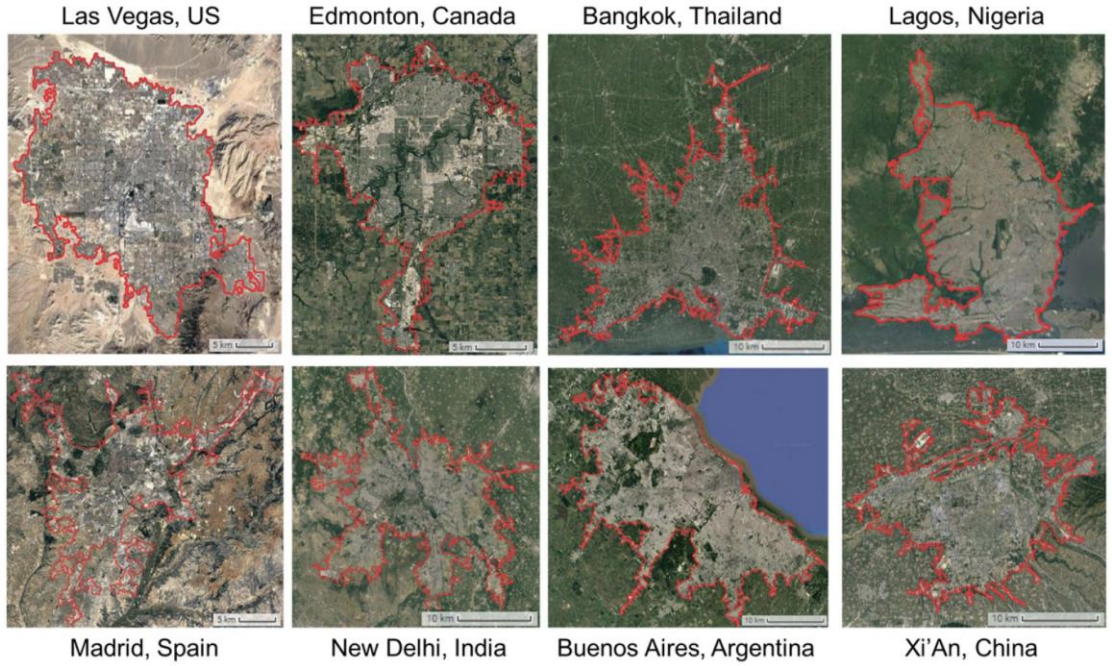
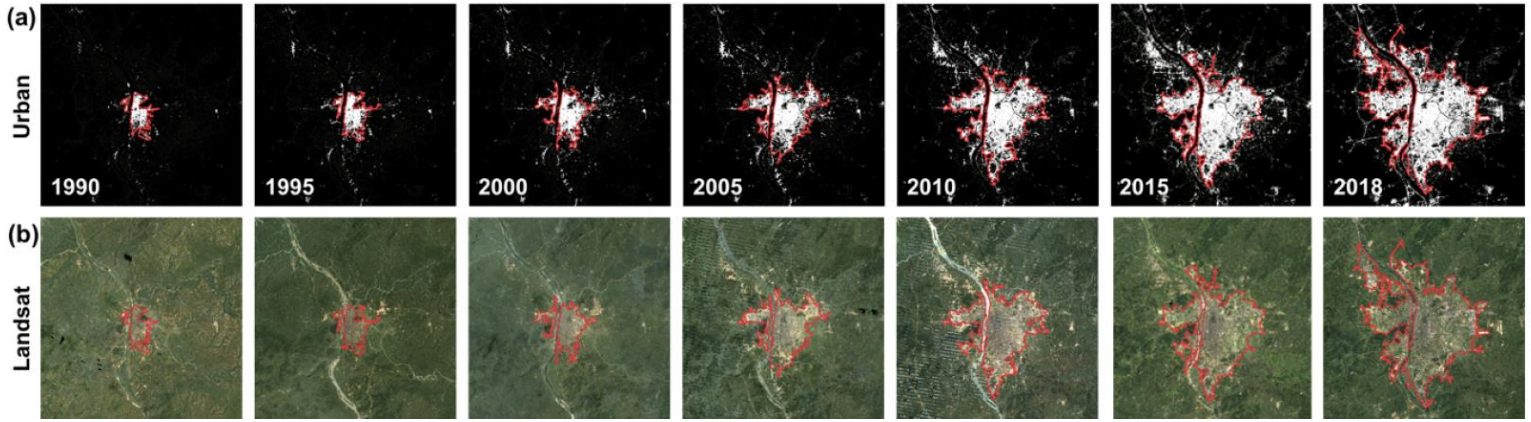
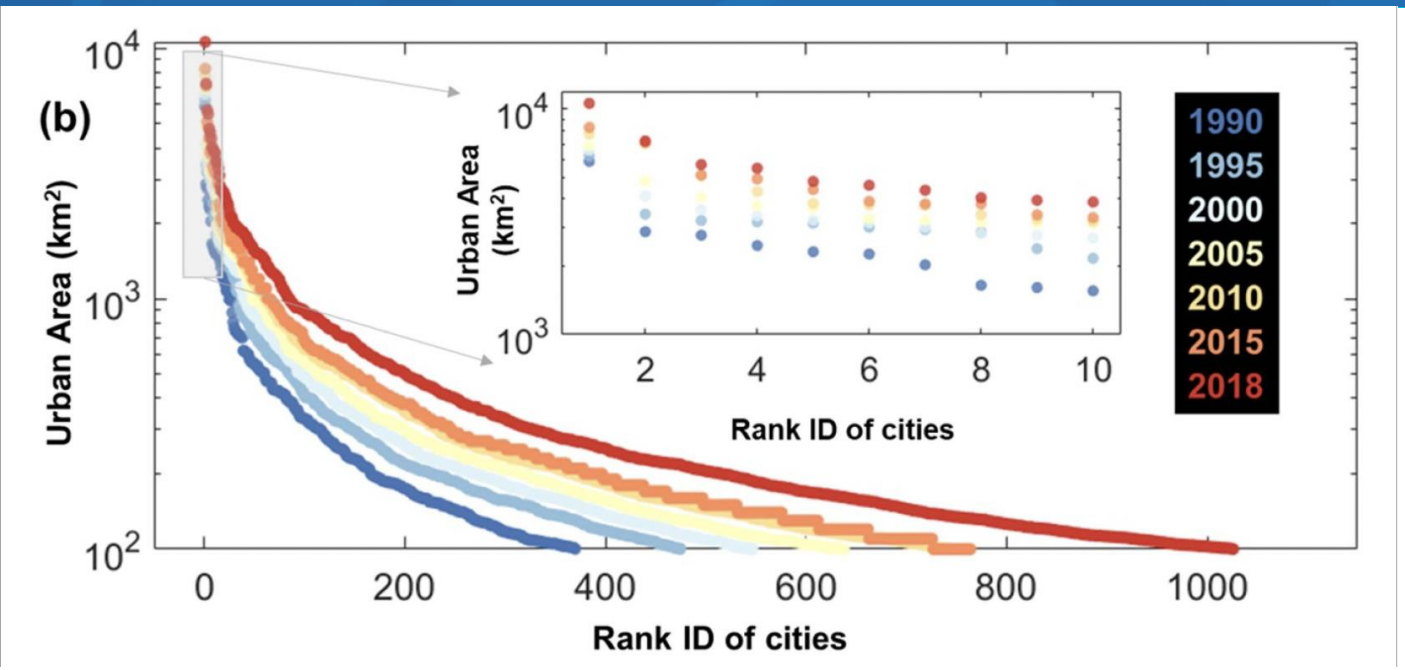


Figure 4. Delineated urban boundaries in eight selected cities in 2018.

- GUB can well capture the spatial extent of urban areas across cities globally; can well separate urban and non-urban areas.
- Compared to other product, GUB are advanced in the capacity of delineating detailed urban boundaries around the urban fringe areas.
- GUB also agrees well with actual urban extents for both aggregated and scattered cities.
- Capture the dynamics of urban extents.



Results and Discussion



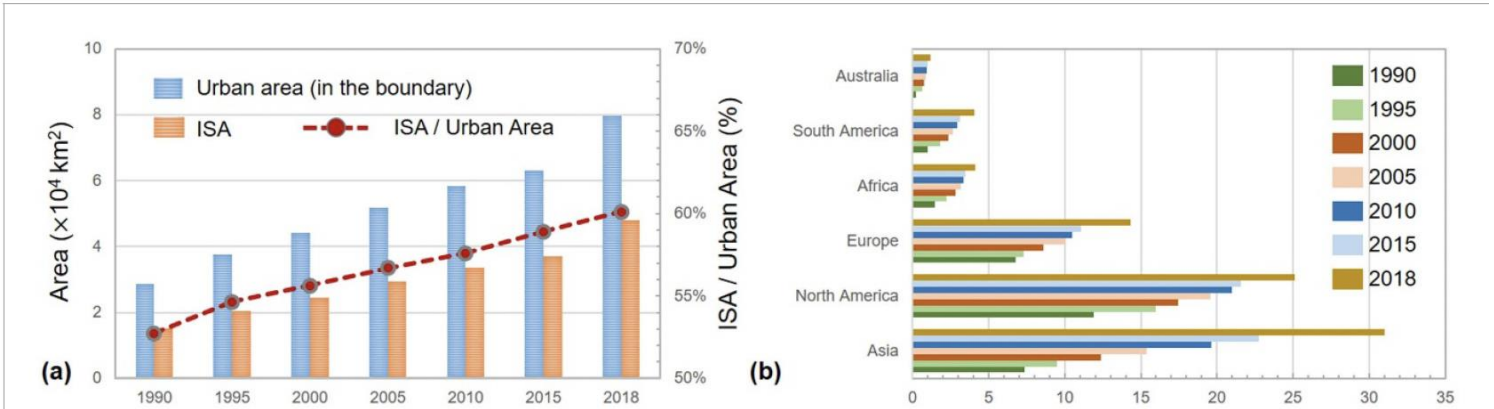


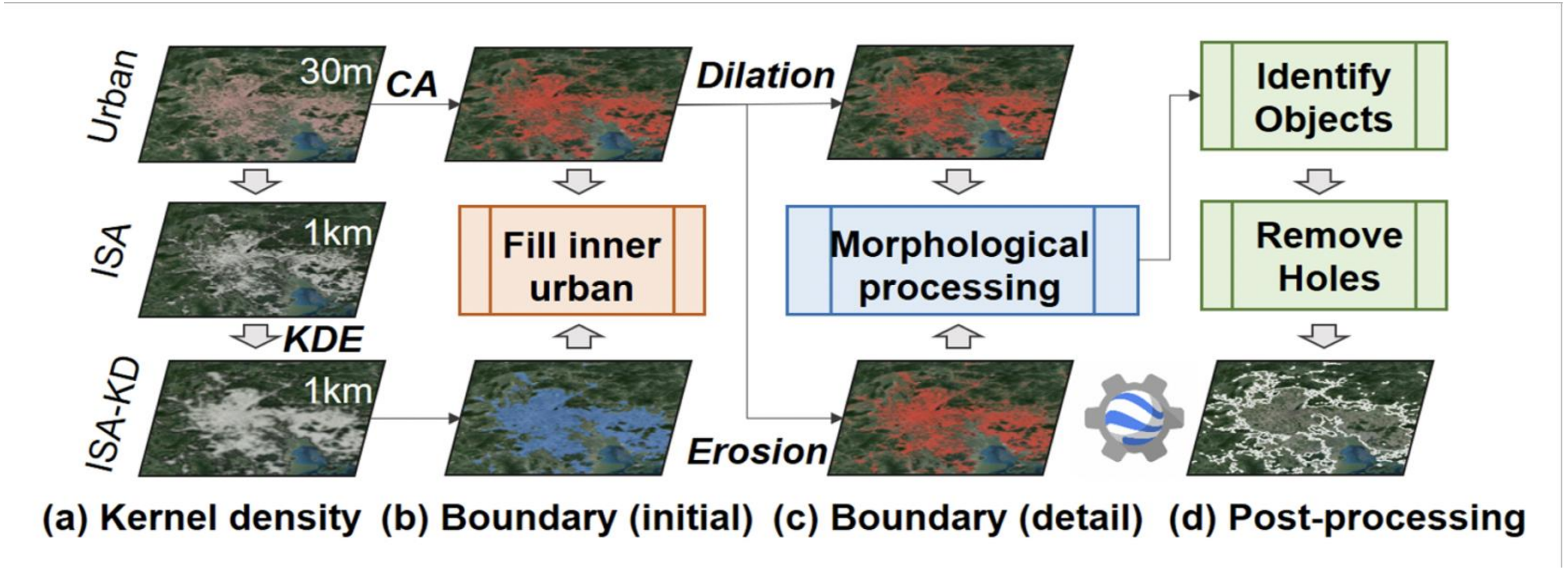
Figure 9. Change of urban areas within delineated boundaries. Comparison of urban areas and impervious surface areas (ISA) at the global (a) and continental scales (b).

- Expansion of urban areas over the past three decades.
- At the global scale, the proportion of ISA in delineated boundaries ranges from 53% to 60%, showing a consistently increasing trend from 1990 to 2018

Methodology and Steps分析方法与流程

- Google Earth Engine (GEE): global scale, multiple years

1. Aggregate 30m urban extent data to 1km ISA data
2. Apply CA to generate the urban extent map
3. Identify patches and remove smaller ones, and output the shapefile



Methodology and Steps 分析方法与流程

- Google Earth Engine (GEE): global urban boundaries in multiple years

GEE script (java script) >>> Python script (GEE. Python API) >>> KNIME

In [1]:
```
import ee
import os
os.environ['HTTP_PROXY'] = 'http://12[redacted]01'
os.environ['HTTPS_PROXY'] = 'http://1[redacted]1'
ee.Initialize()
```

In [2]:
```
import geemap
```

Obtain images

The module climada.util.earth_engine enables to select images from some collections of GEE and download them as Geotiff data

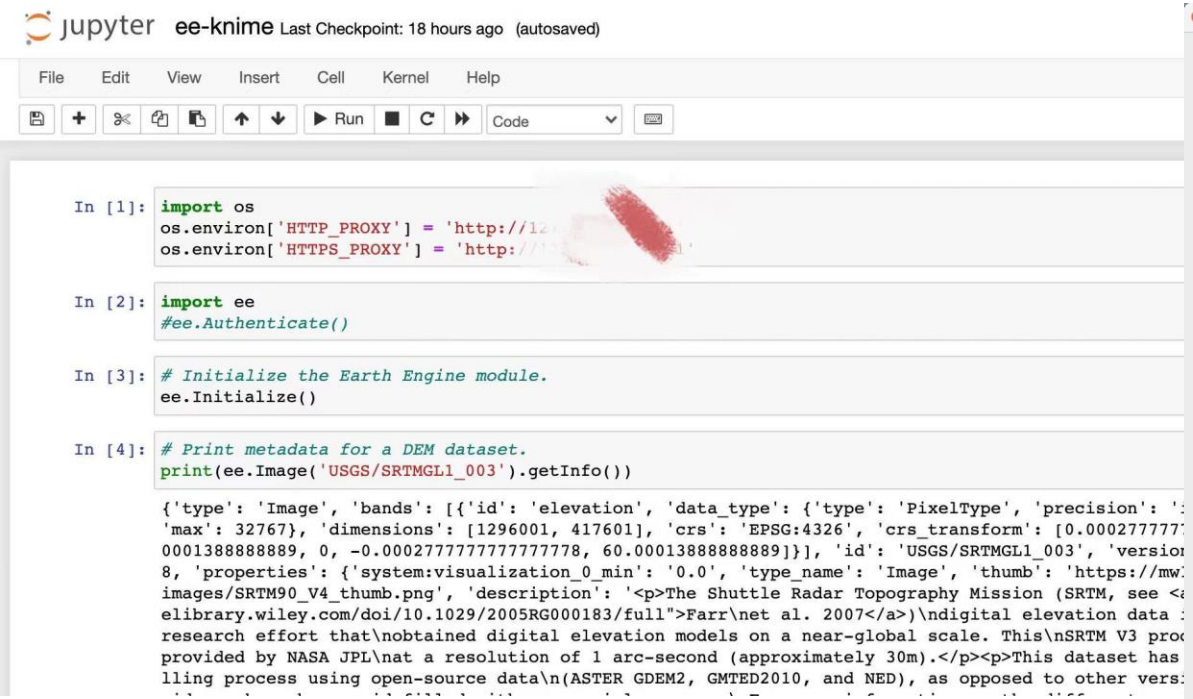
In [7]:
```
# Access a specific image
image = ee.Image('LANDSAT/LC08/C01/T1_TOA/LC08_044034_20140318'); #Landsat 8 image, with Top of

# Access a collection
collection = 'LANDSAT/LE07/C01/T1' #Landsat 7 raw images collection
```

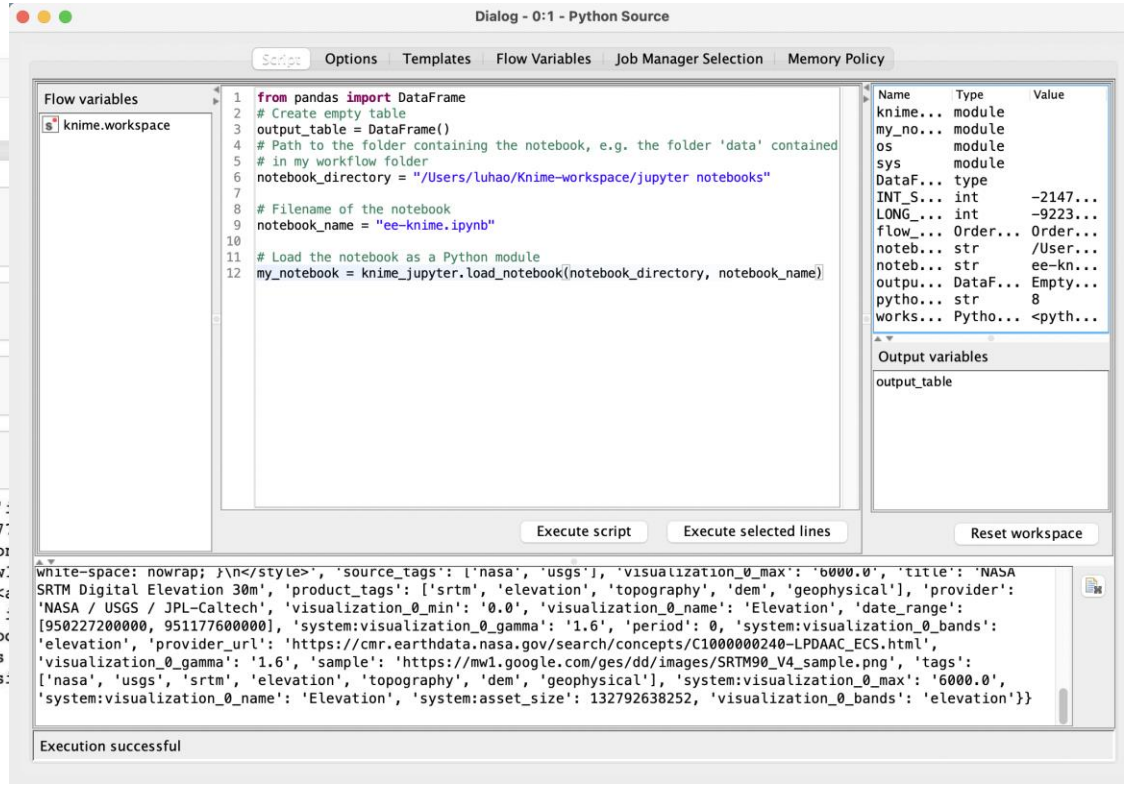
In [8]:
```
#Landsat_composite in Dresden area
area_dresden = list([(13.6, 50.96), (13.9, 50.96), (13.9, 51.12), (13.6, 51.12), (13.6, 50.96)]
area_dresden = ee.Geometry.Polygon(area_dresden)
time_range_dresden = ['2002-07-28', '2002-08-05']

collection_dresden = ('LANDSAT/LE07/C01/T1')
print(type(area_dresden))

#Population density in Switzerland
list_swiss = list([(6.72, 47.88),(6.72, 46.55),(9.72, 46.55),(9.72, 47.88),(6.72, 47.88)])
area_swiss = ee.Geometry.Polygon(list_swiss)
time_range_swiss=['2002-01-01', '2005-12-30']

collection_swiss = ee.ImageCollection('CIESIN/GPWv4/population-density') #Earth Engine Dataset:
print(type(collection_swiss))

#Sentinel 2 cloud-free image in Zürich
```

Methodology and Steps分析方法与流程

- Google Earth Engine (GEE): global urban boundaries in multiple years

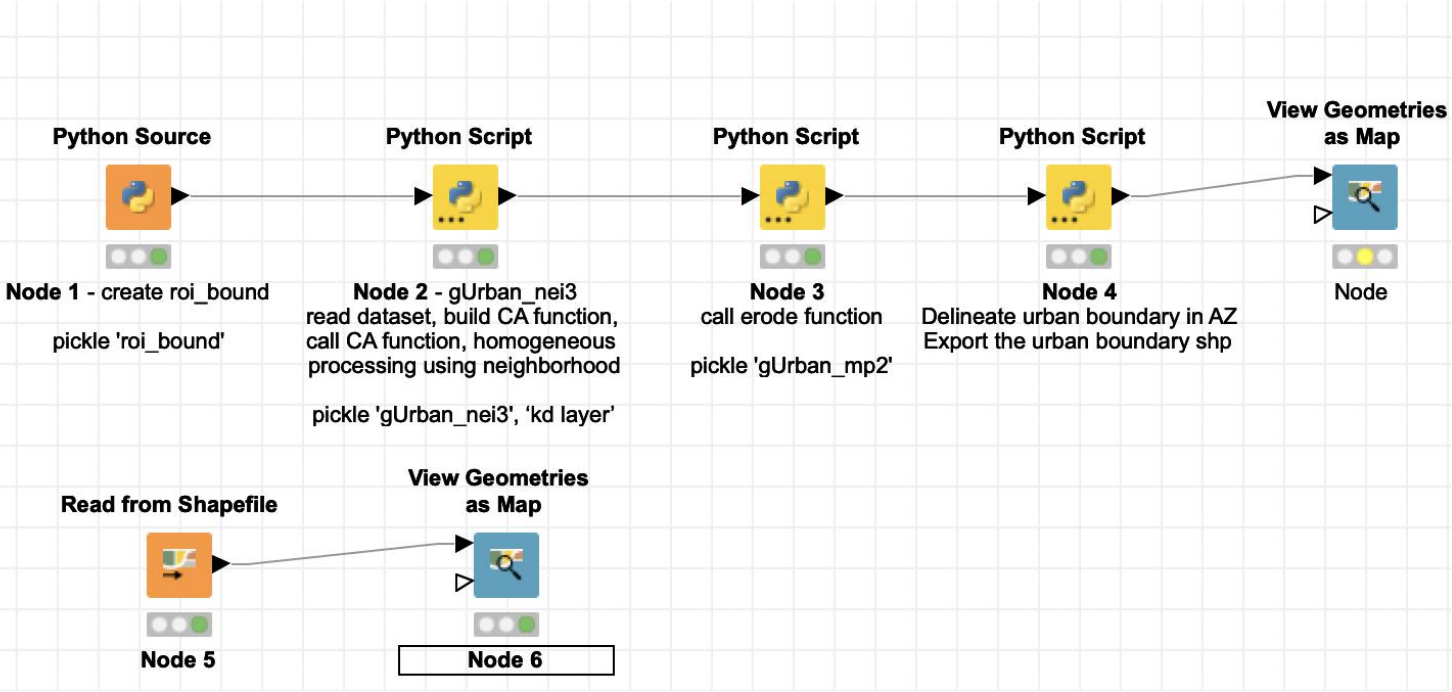
GEE script (java script) >>> Python script (GEE. Python API) >>> KNIME

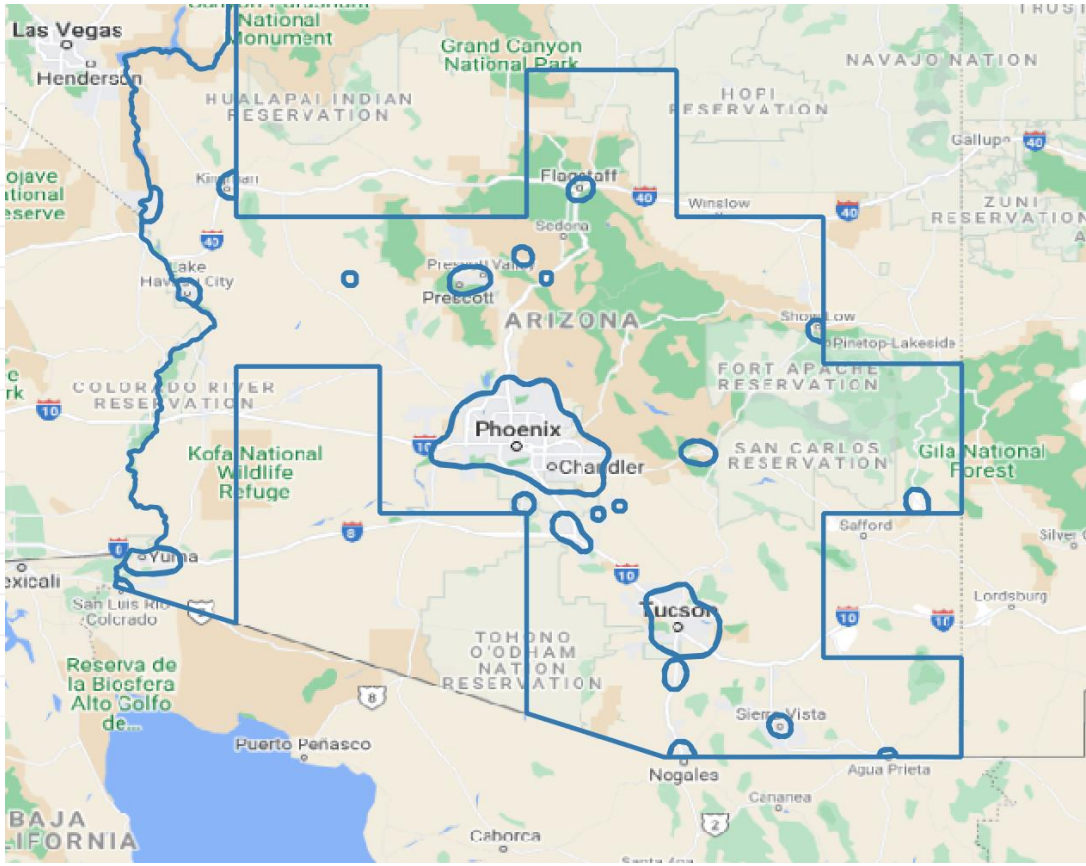




The Workflow for Data Analysis 数据分析工作流

- Selected Case: Arizona, US 2013





References 参考文献

Li, X., Gong, P., Zhou, Y., Wang, J., Bai, Y., Chen, B., Hu, T., Xiao, Y., Xu, B., Yang, J., Liu, X., Cai, W., Huang, H., Wu, T., Wang, X., Lin, P., Li, X., Chen, J., He, C., … Zhu, Z. (2020). Mapping global urban boundaries from the global artificial impervious area (GAIA) data. *Environmental Research Letters*, *15*(9), 094044. https://doi.org/10.1088/1748-9326/ab9be3

Wu, Q., (2020). geemap: A Python package for interactive mapping with Google Earth Engine. The Journal of Open Source Software, 5(51), 2305. https://doi.org/10.21105/joss.02305

https://github.com/giswqs/geemap#readme