人工智能与未来城市空间规划

Artificial Intelligence and the Future of Urban Spatial Planning

Otthein HERZOG

AI Analysis of City Changes

International Knowledge Centre
for Engineering Sciences and Technology
under the Auspices of UNESCO
联合国教科文组织国际工程科技知识中心

同濟大學
TONGJI UNIVERSITY

AI Analysis of City Changes

同济大学智能规划协同创新中心

China Intelligent Urbanization Co-creation Center

iCity Group

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United Nations World Geospatial Information Congress

Deqing, November 19, 2018

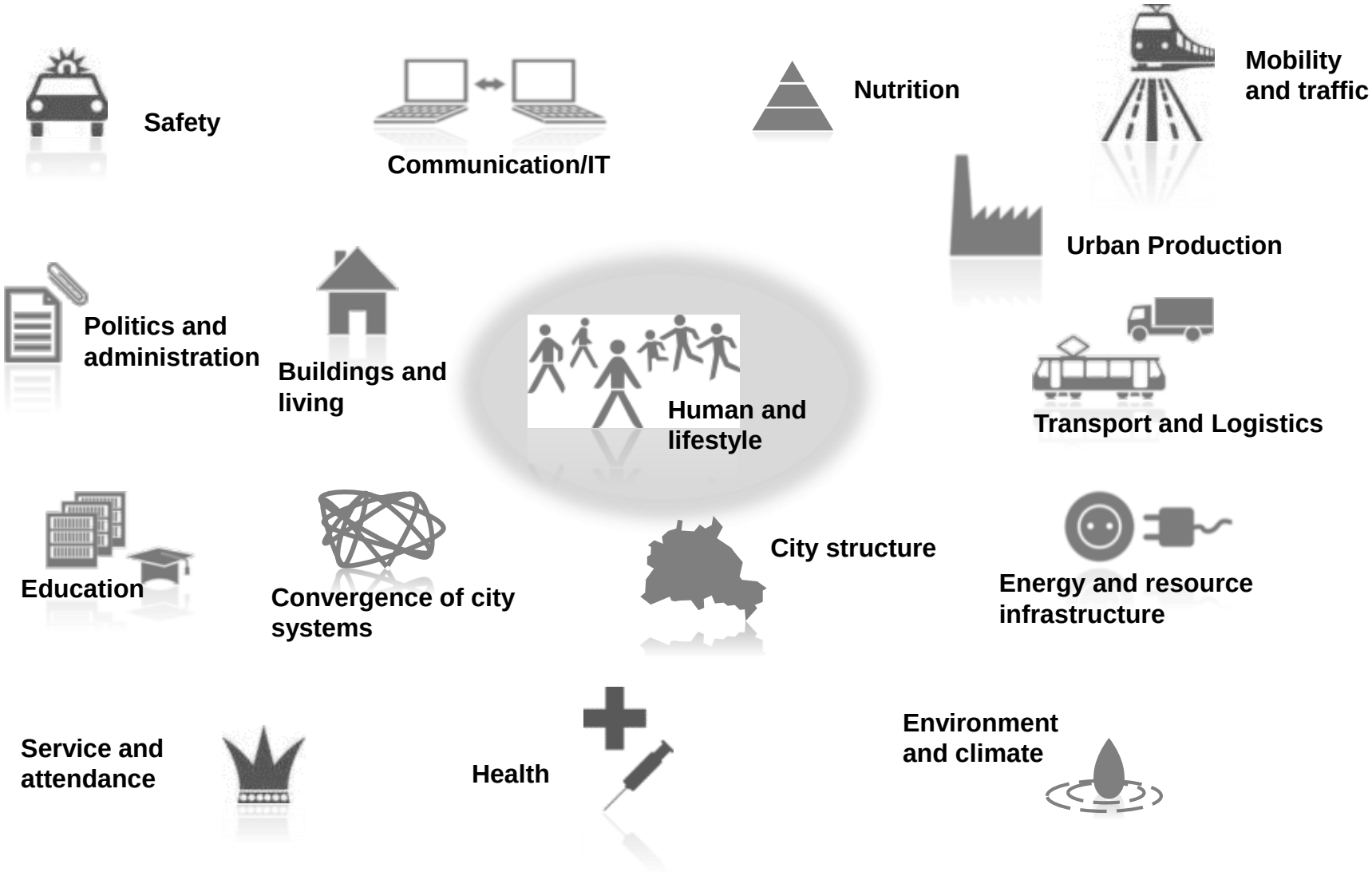
Outline

1. City Development Challenges and Artificial Intelligence

2. Analyzing and Classifying City Images with Deep Learning Methods
   (Work done at CIUC by iCity Group)

3. Examples

Challenges for Intelligent Cities: Activity Spheres



Artificial Intelligence Areas

The overall research goal of Artificial Intelligence is to create technology that allows computers and machines to function in an intelligent way.

AI system capabilities are:

1. Reasoning, Problem Solving, Decision support
2. Knowledge Representation/Engineering
3. Learning/Big Data Analytics
4. Planning
5. Natural Language Processing
6. Perception – Pattern Recognition – Multimodal Interfaces
7. Motion and Manipulation/Robotics
8. Social Intelligence
9. Creativity

Source: Wikipedia, "Artificial Intelligence"

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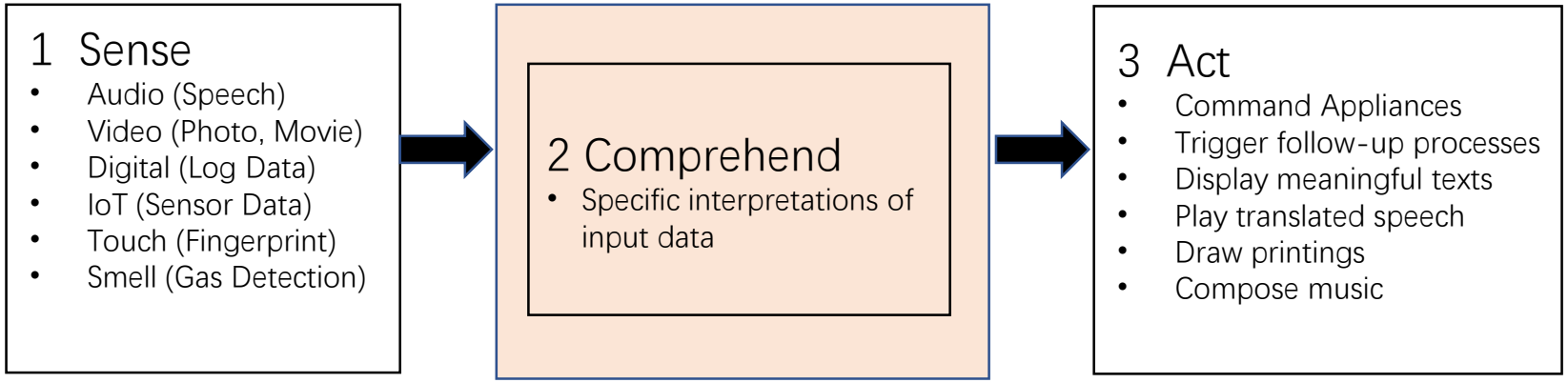
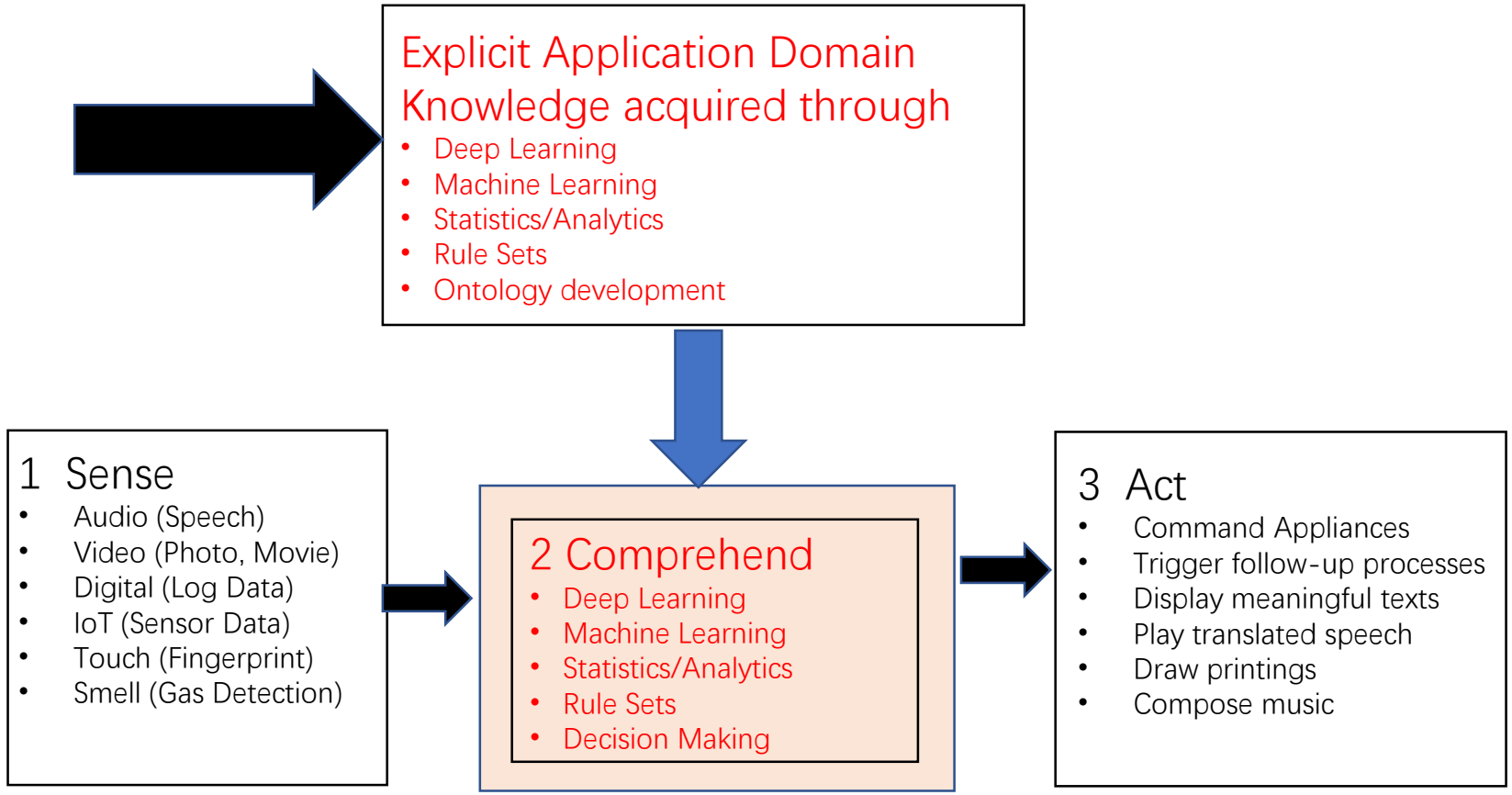
“Traditional” Software Systems



After Purdy, M., & Daugherty, P. (2016). Why Artificial Intelligence is the Future of Growth. Abgerufen am 8. Juni 2017 von https://www.accenture.com/lv-en/_acnmedia/PDF-33/Accenture Why-AI-is-the-Future-of-Growth.pdf

Knowledge-based Artificial Intelligence Systems



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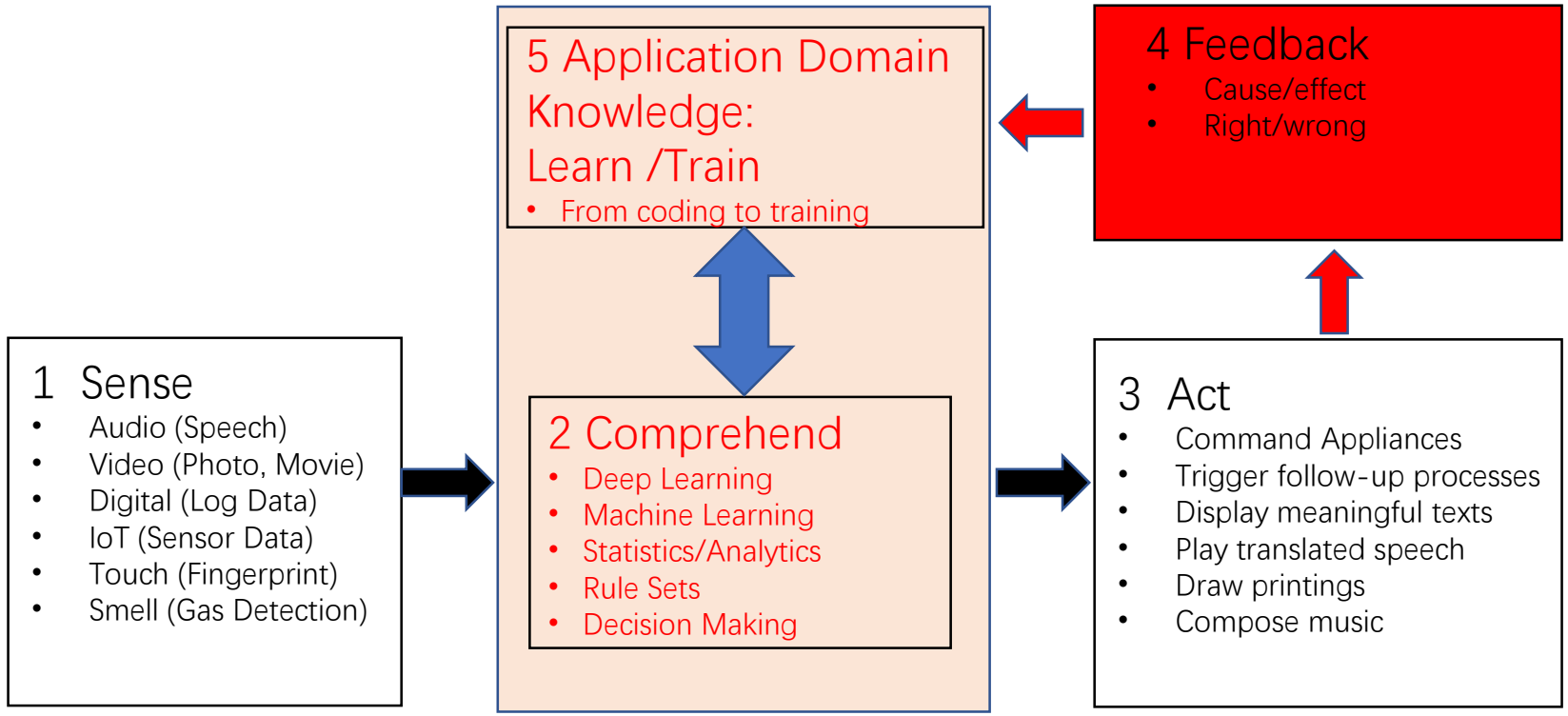
Learning Artificial Intelligence Systems



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Technological Innovation:
World Largest City Big Data Base constantly updated

技术创新：建立世界城市大数据，并持续升级 追踪超越原最大数据库

1988 — Quantitative Analysis of World Cities

1997 — 4 Generations of City Big Data Base

2007 — Media-Scale Cities Simulation

2016
- 12 Billion data records in 8 Categories
- 集聚了8类120亿条有效数据

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Spatial Law
空间规律

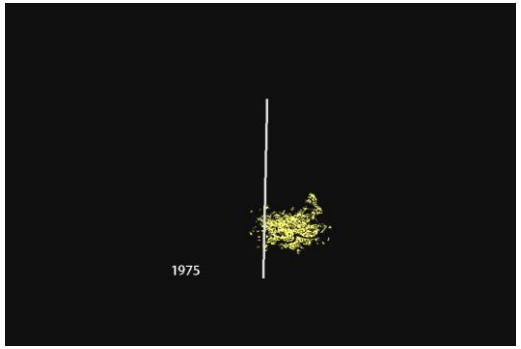
City Tree “城市树”

Satellite Images of Cities through 40 years
跨度40年城市卫片

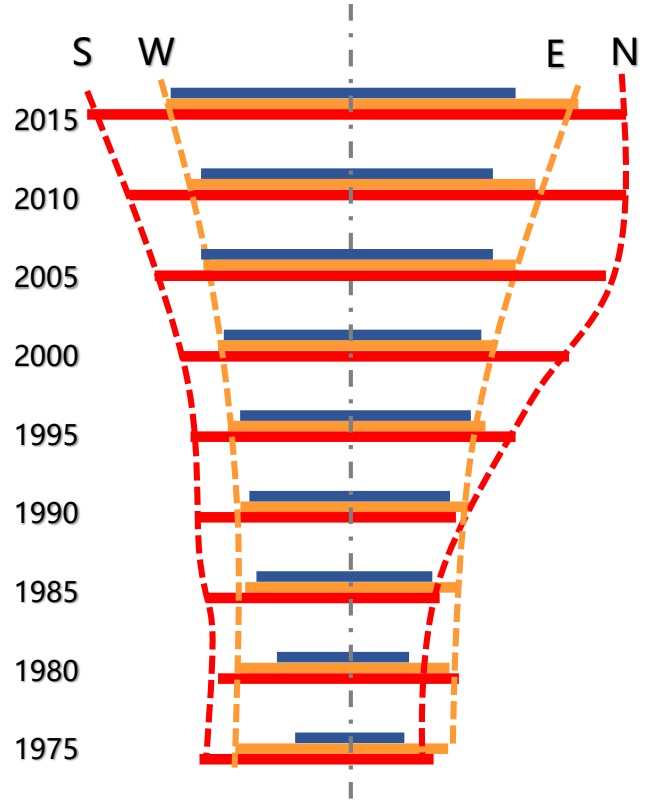
Super Precision:30mX30m
精度超越:30X30m

EU 1X1km^2
欧盟 1X1km^2

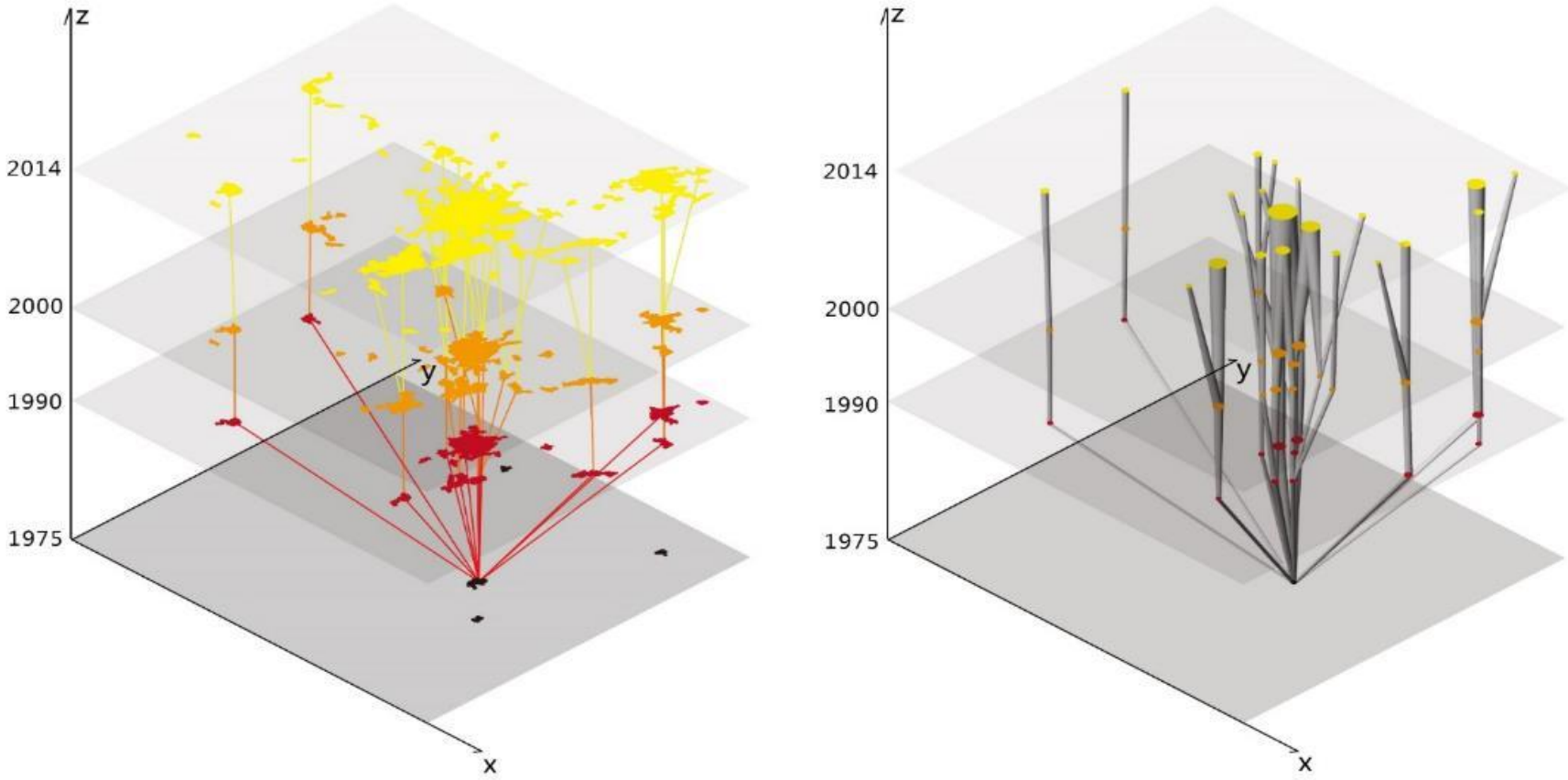
Super Speed: Intelligent Identification
速度超越:智能识别



New representation: City Tree
首创 “城市树”

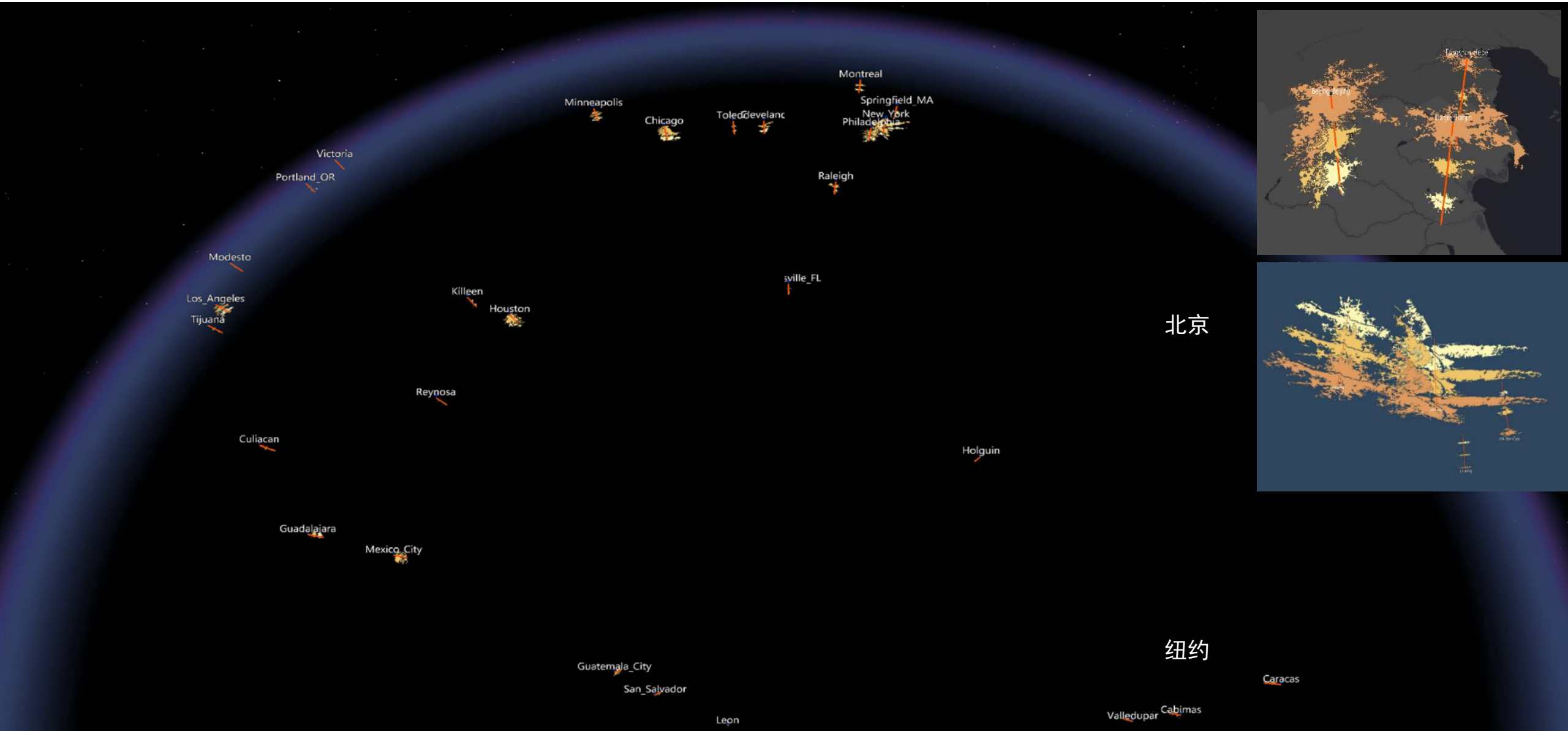


Spatial Law
空间规律



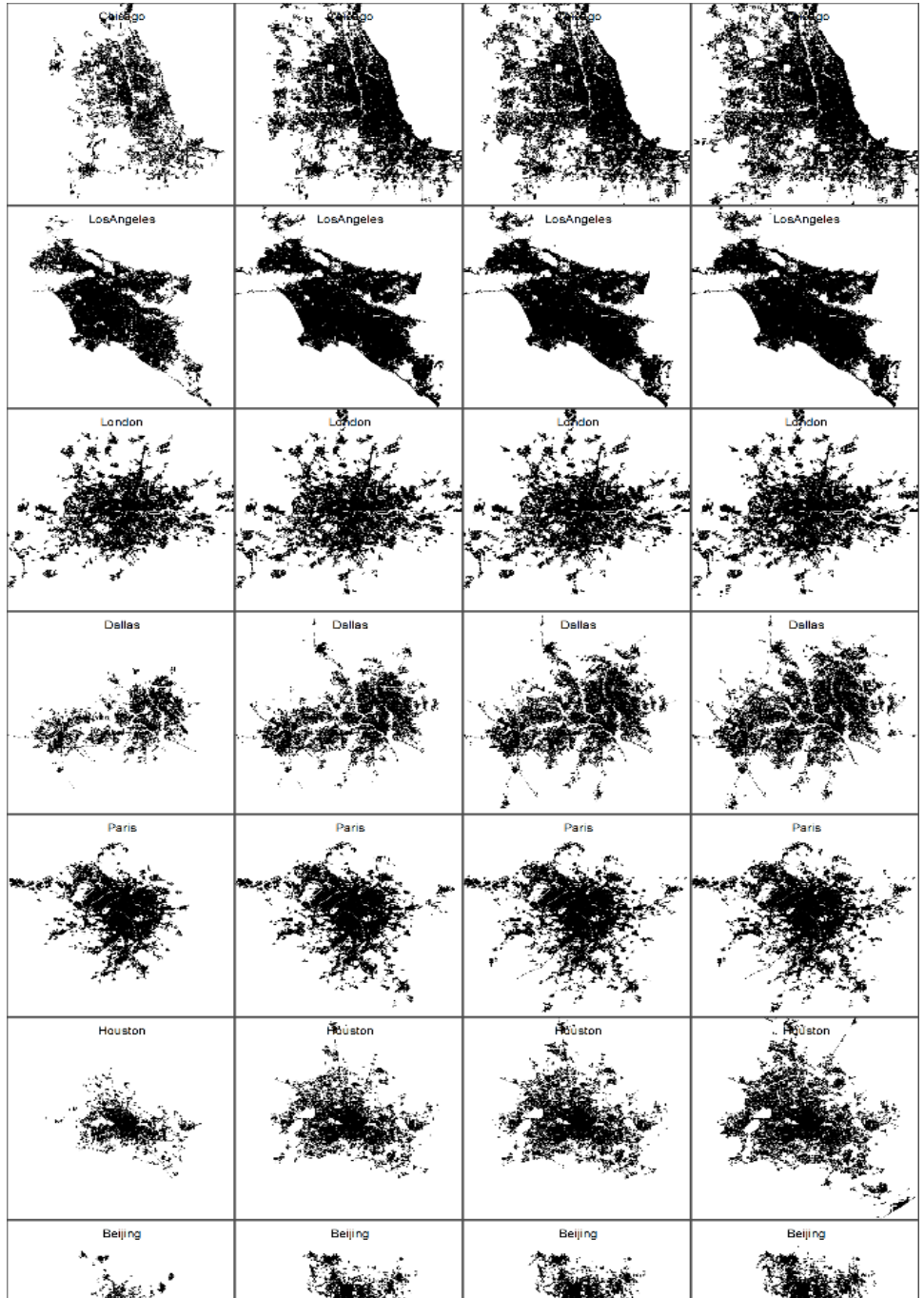
Ningbo

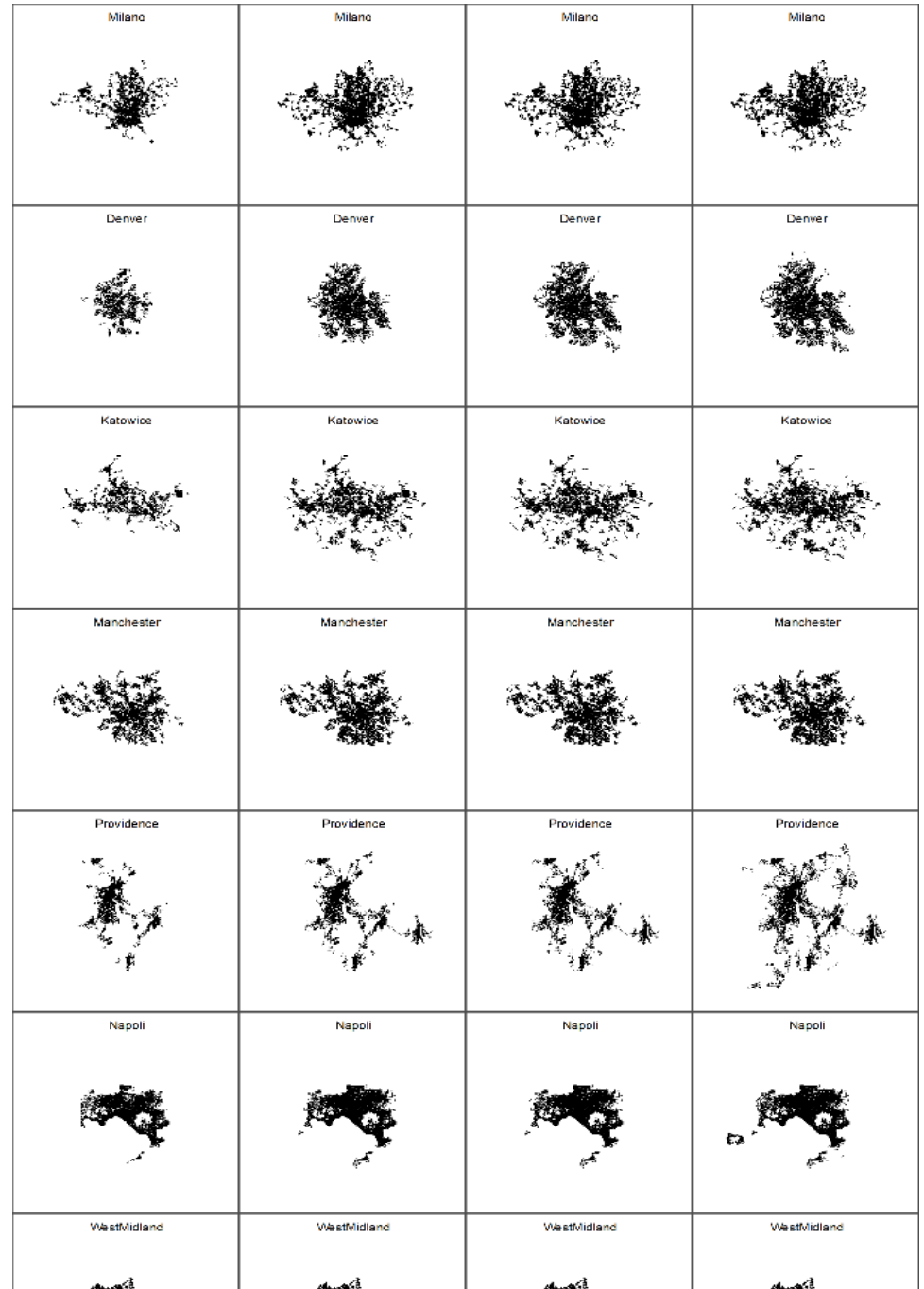
Spatial Law
空间规律



北京

纽约


Chicago
LosAngeles
London
Dallas
Paris
Houston
Beijing

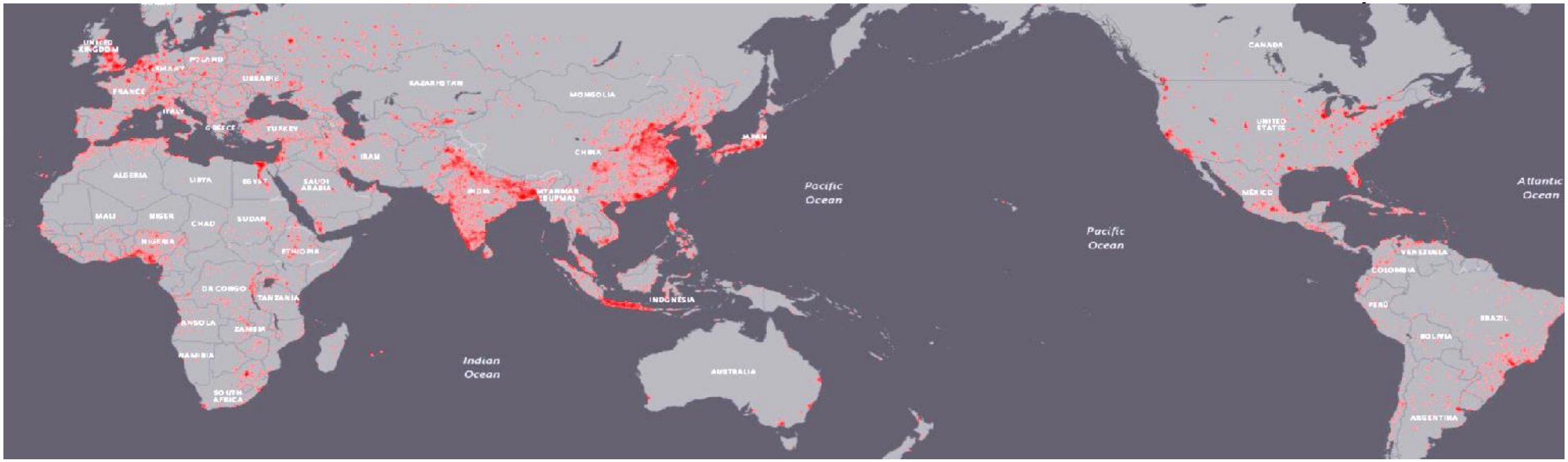

Milano
Denver
Katowice
Manchester
Providence
Napoli
WestMidland

City Trees for 13810 world cities

have been diagrammed by 2018 Jan 18

至2018年已绘制13810个城市的城市树

Cities over1km^2	13810
Cities over 2km^2	13343
Cities over 4km^2	11663
Cities over 5km^2	11071
Cities over 8km^2	10002
Cities over 9km^2	9516



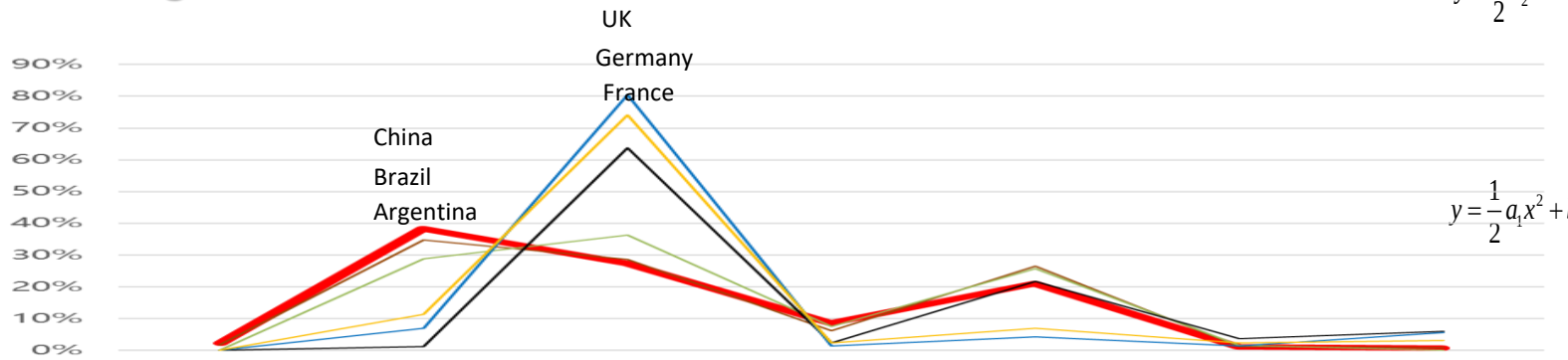
全样本
全球范围内识别独立建成区13810个
Full coverage
of 13810 independent built areas in the world
UNITED KINGDOM
FRANCE
ITALY
KAZAKHSTAN
MONGOLIA
CANADA
UNITED STATES
IRAN
CHINA
ALGERIA
LIBYA
EGYPT
SAUDI ARABIA
INDIA
MYANMAR (BURMA)
Pacific Ocean
Atlantic Ocean
MEXICO
MALI
NIGER
CHAD
SUDAN
NIGERIA
ETHIOPIA
Pacific Ocean
VENEZUELA
COLOMBIA
DR CONGO
TANZANIA
INDONESIA
PERU
BRAZIL
ANGOLA
ZAMBIA
BOLIVIA
NAMIBIA
Indian Ocean
AUSTRALIA
SOUTH AFRICA
ARGENTINA

Illustrating the Development courses of 13810 world’ s cities by City Trees

绘制“城市树” 完成了全球13810个城市发展历程的识别

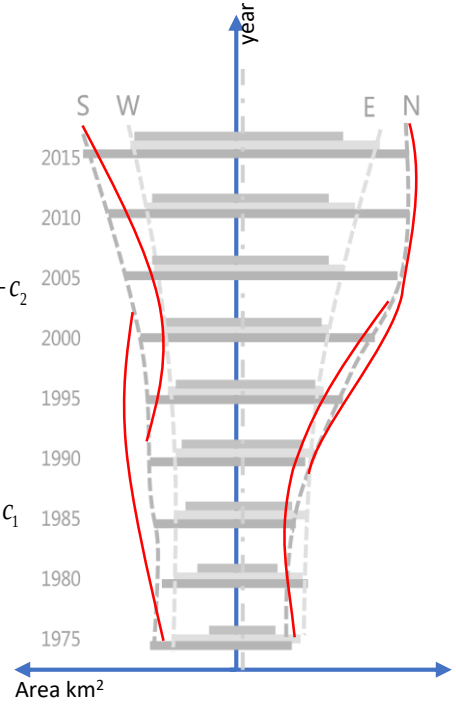
Sprouting 萌芽型 | Rickets 佝偻型 | Steady Growth 成长型 | Rapid Growth 发育型 | Matured 成熟型 | Regional 区域型 | Declining 衰退型

Findings: 7 Categories of Urban Development Modes and the related laws of growth. 发现并定义为7类城市发展类型及其特性，以及城市成长规律。



$$y=\frac{1}{2}a_2x^2+b_2x+c_2$$

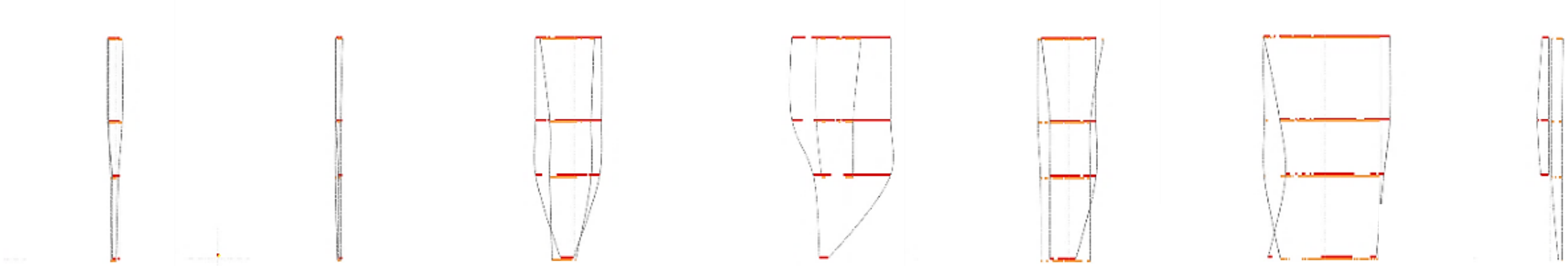
$$y=\frac{1}{2}a_1x^2+b_1x+c_1$$

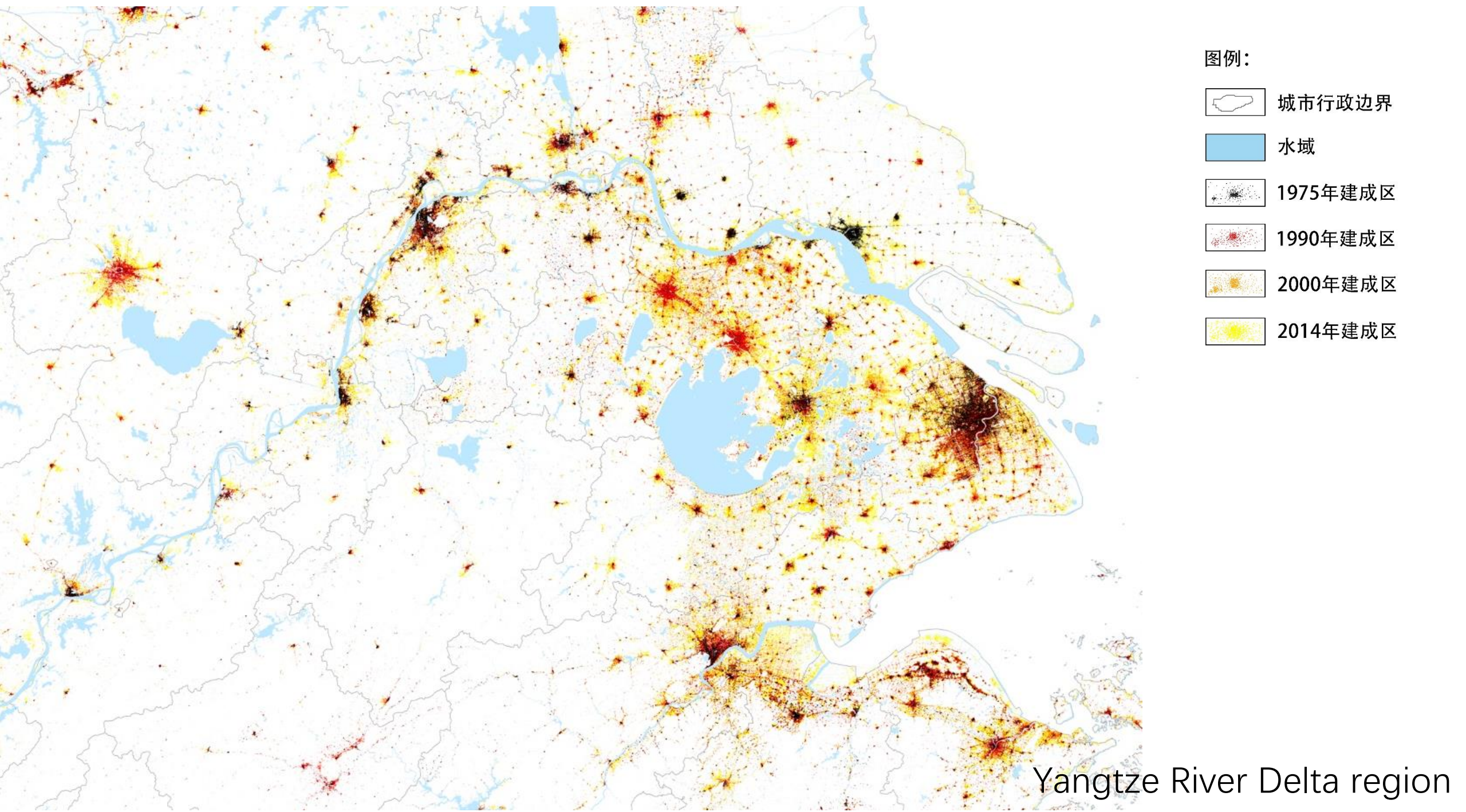


7种类型的城市分布

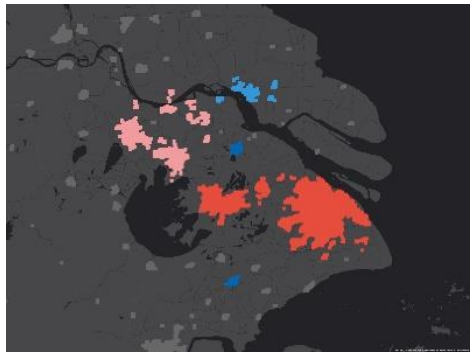
7 Categories of cities by the measure of “City Tree”

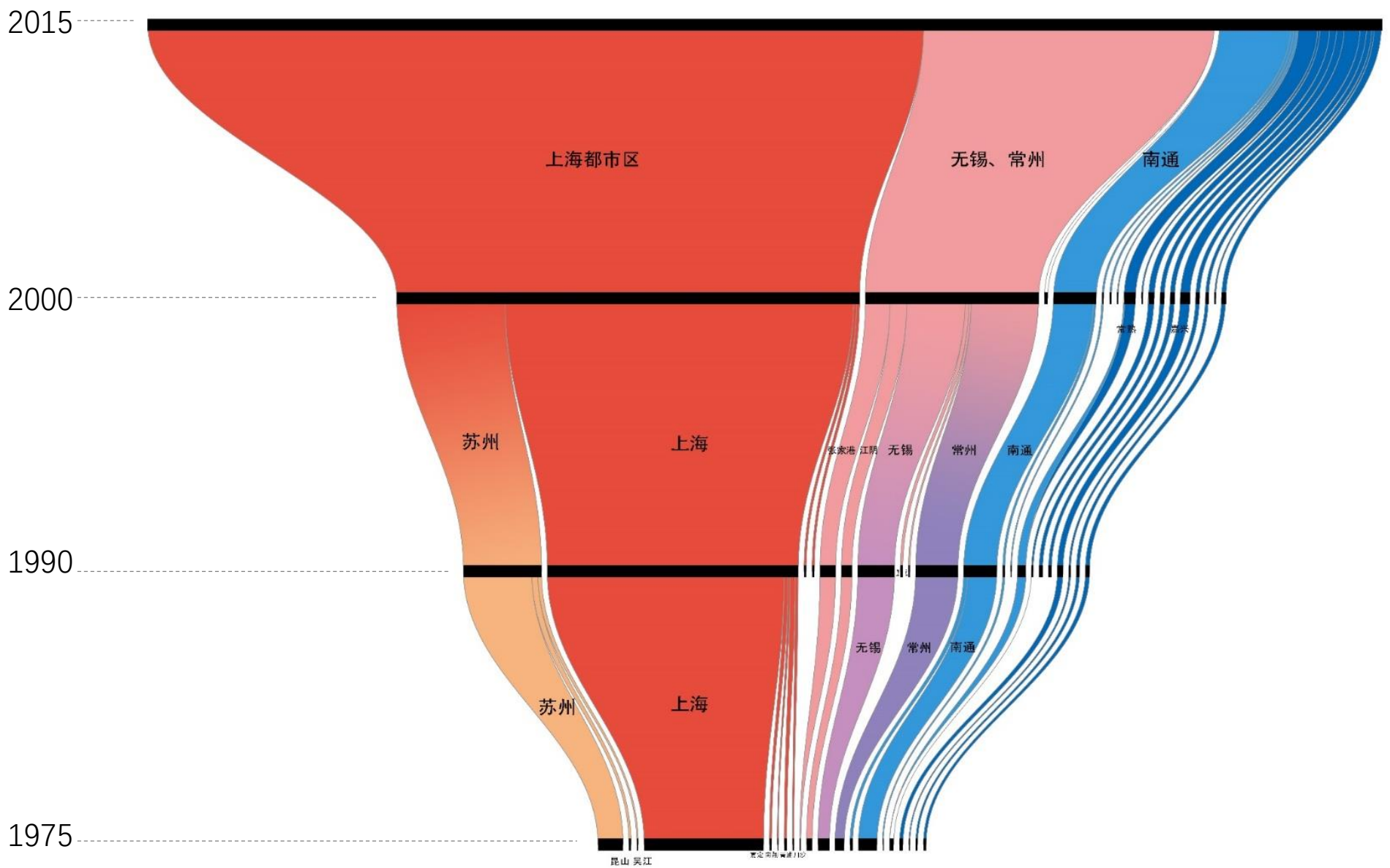
Spouting	Rickets	Steady	Rapid	Matured	Regional	Declining
萌芽型	佝偻型	成长型	发育型	成熟型	区域型	衰退型
435	3601	2365	831	1900	143	201





Yangtze River Delta region





■ 苏州、上海、无锡、常州、南通 城镇群集聚历程

Urban Agglomeration Process

Outline

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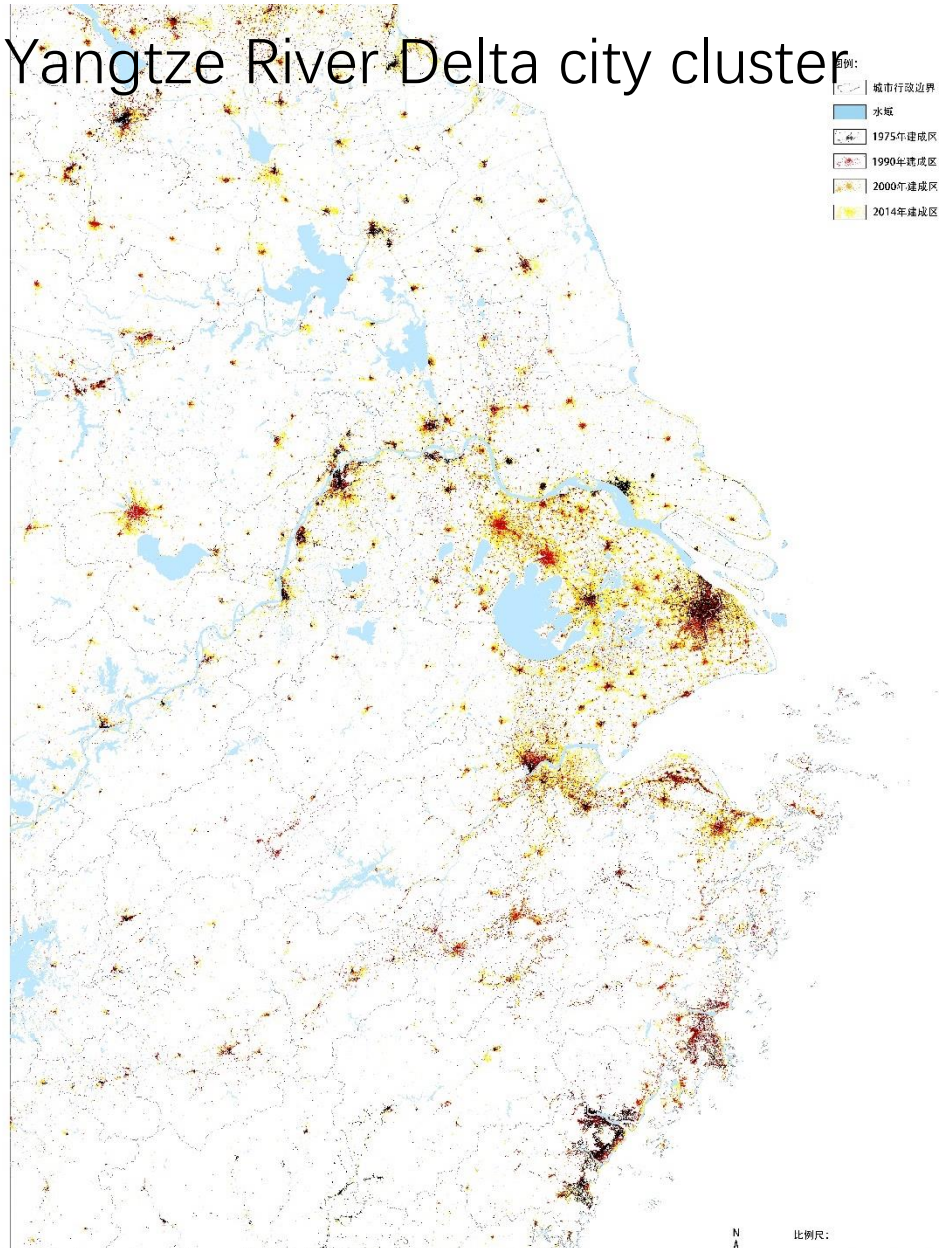
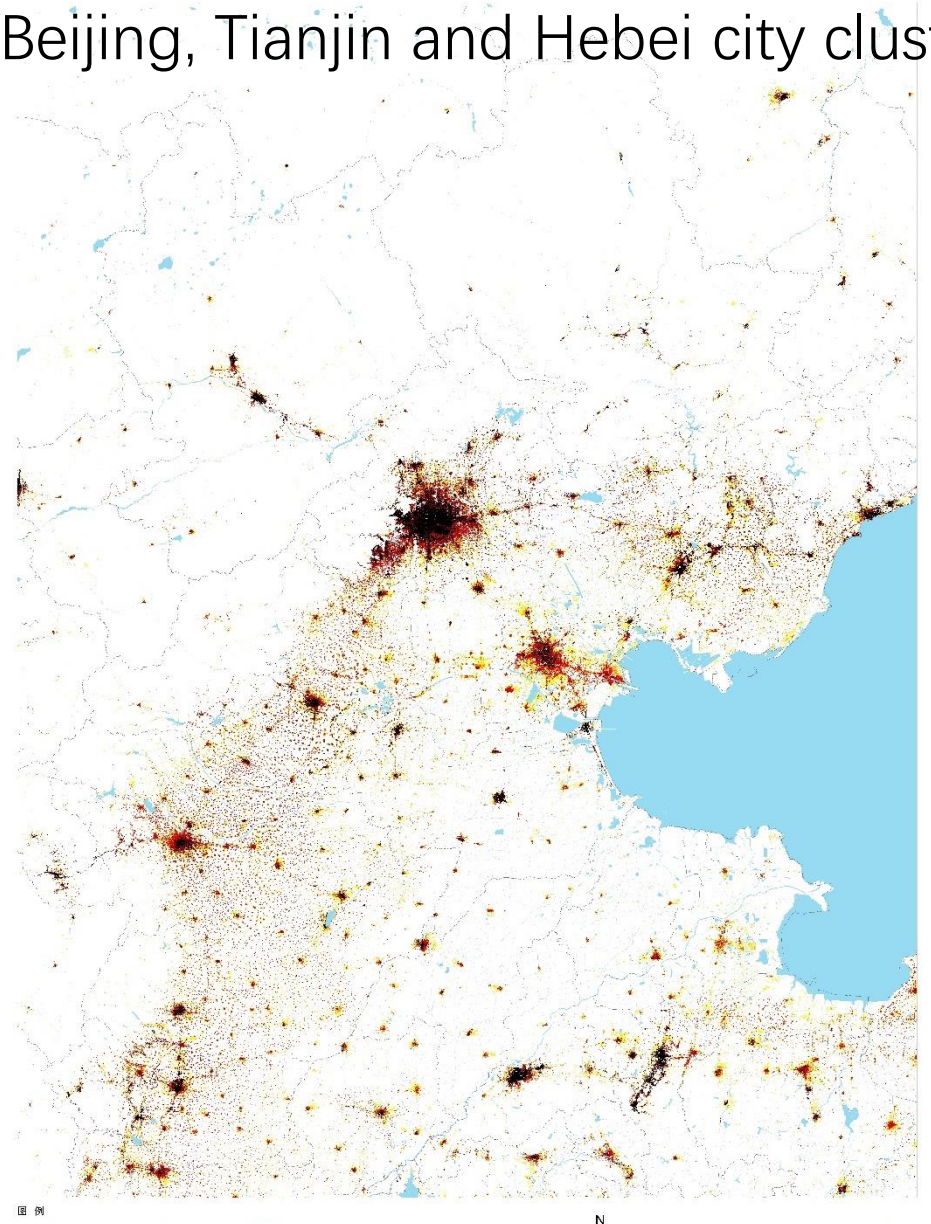
长三角城市群

Yangtze River Delta city cluster



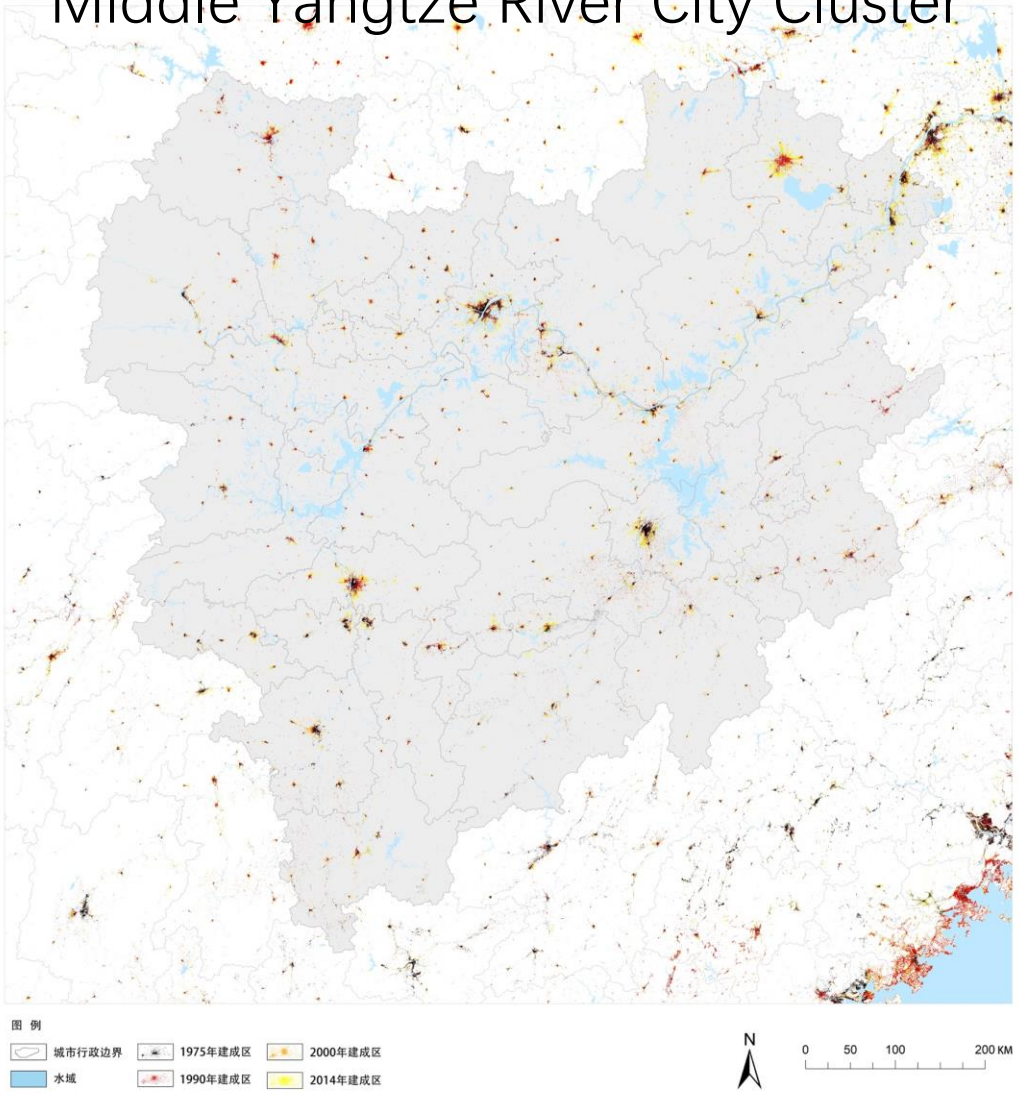
京津冀城市群

Beijing, Tianjin and Hebei city cluster



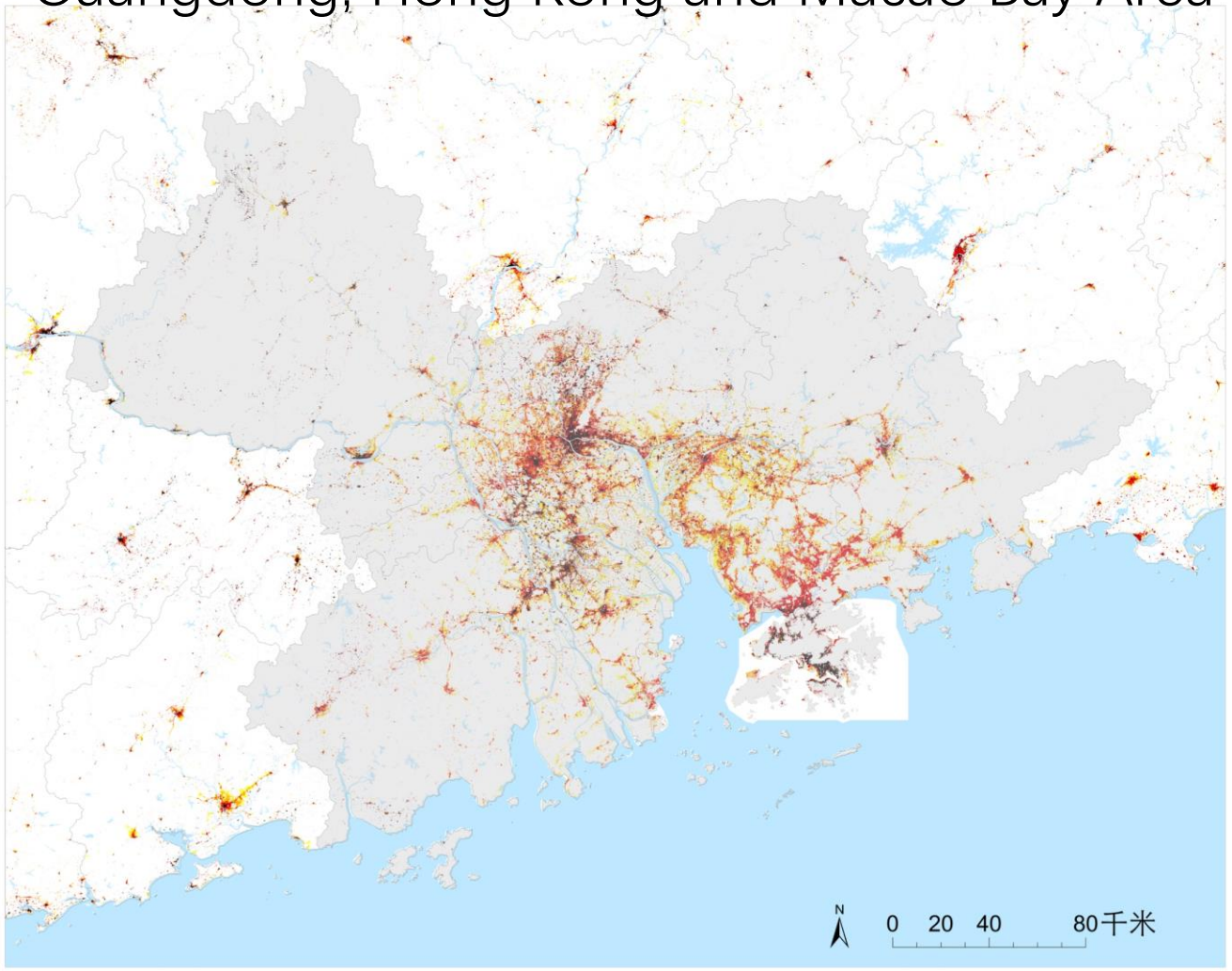
长江中游城市群

Middle Yangtze River City Cluster

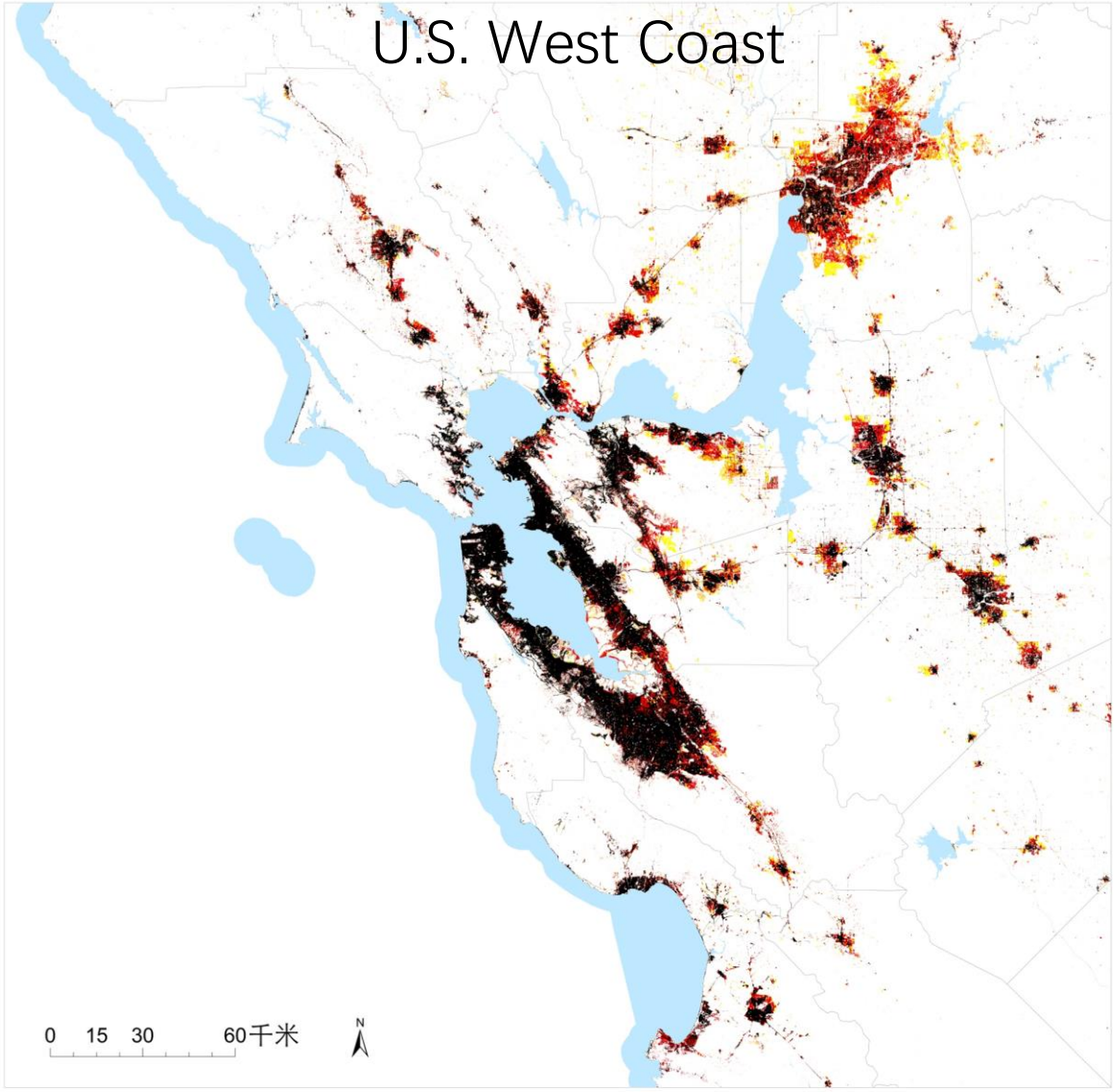


粤港澳湾区

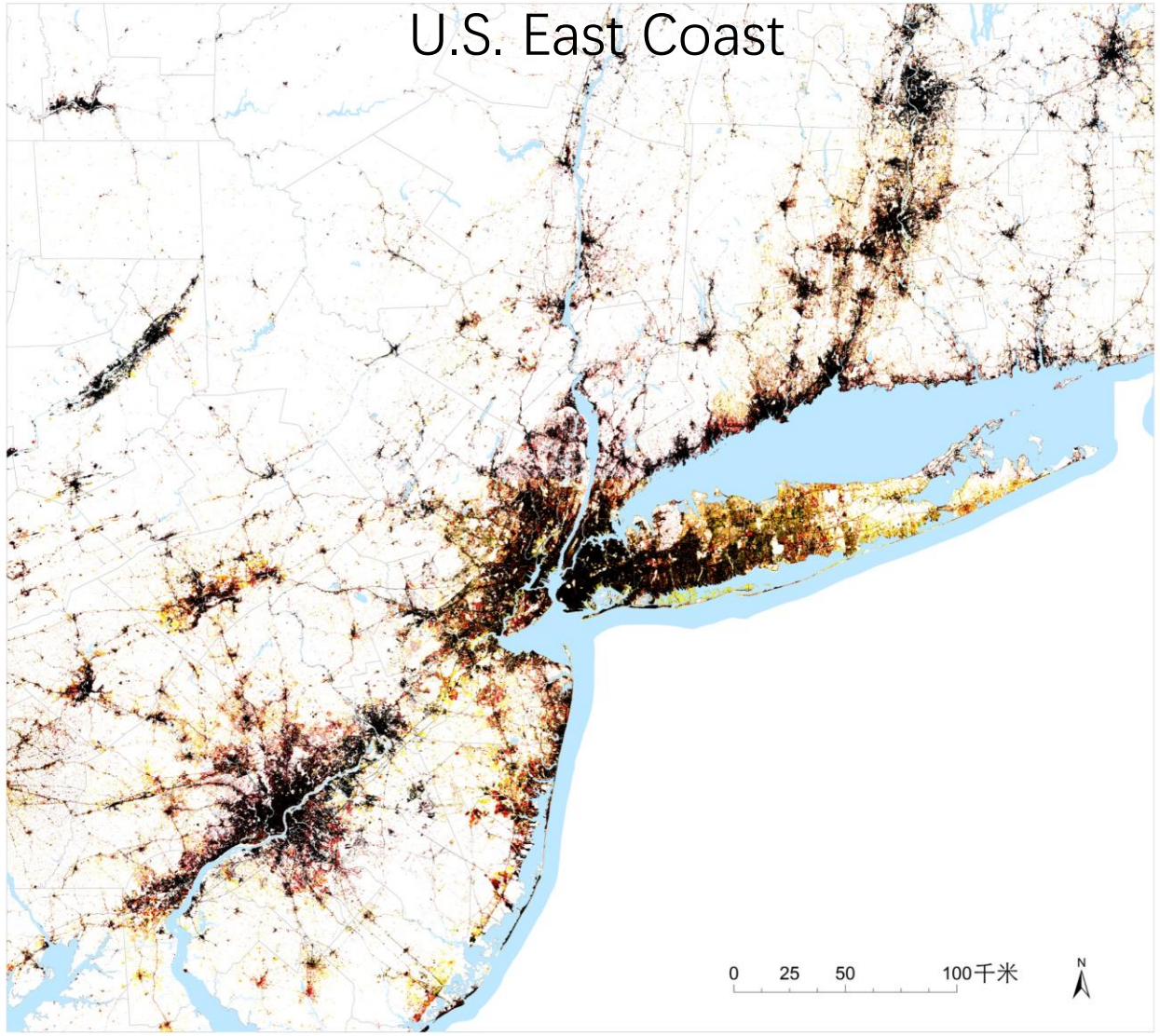
Guangdong, Hong Kong and Macao Bay Area



美国西海岸

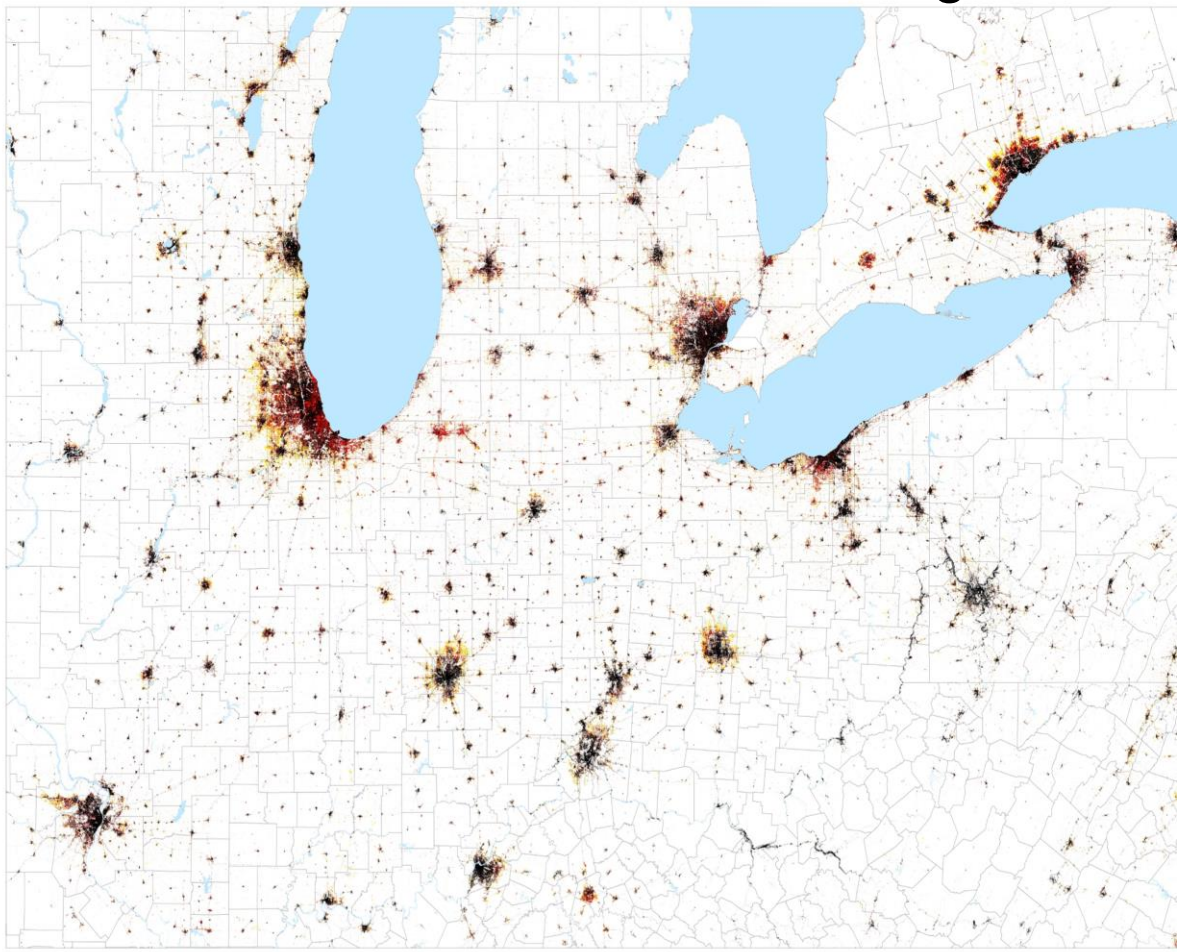


美国东海岸



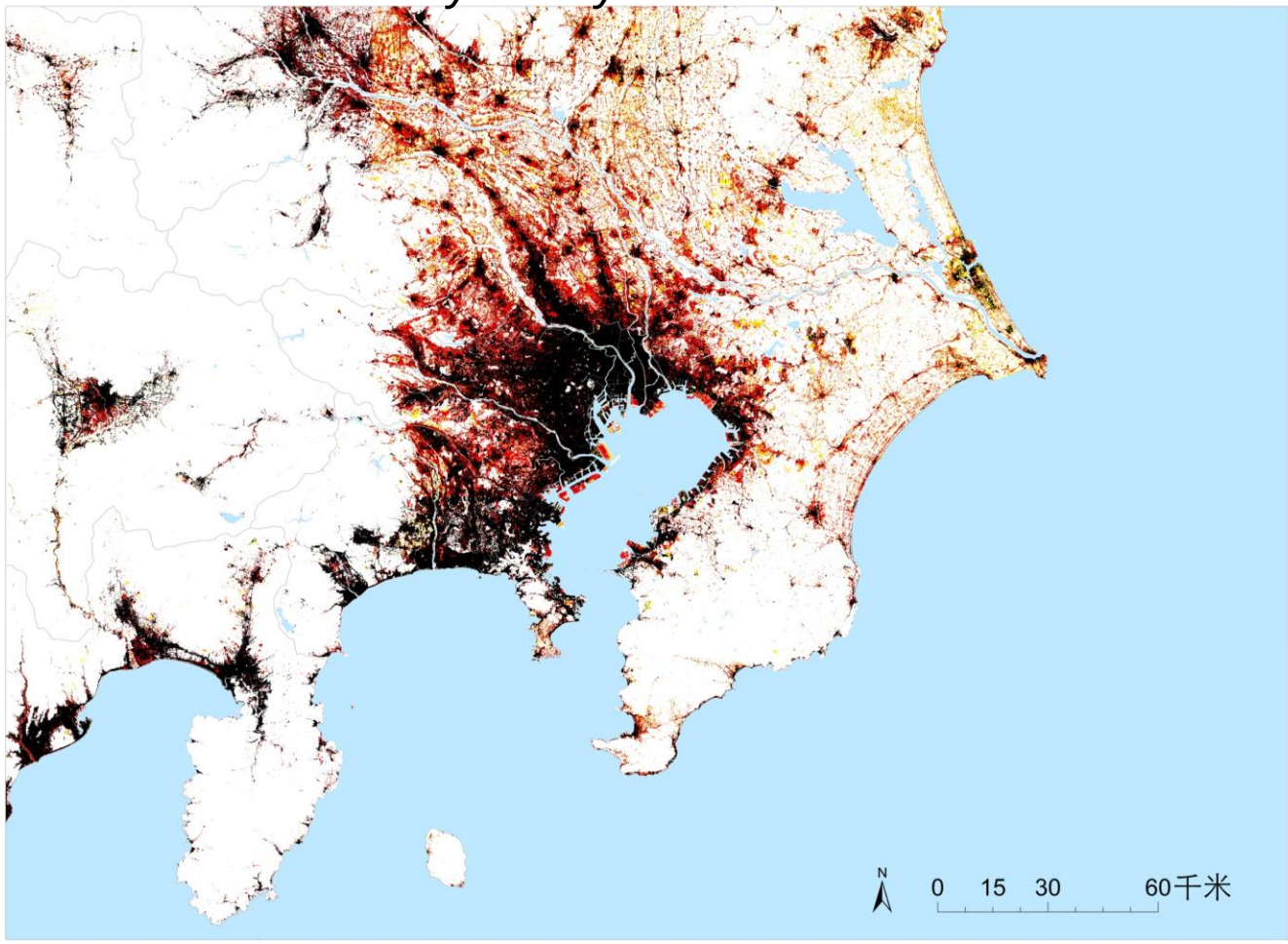
五大湖

U.S. The Great Lakes region



东京湾

Tokyo Bay Area



Thank you very much for your attention!

Otthein Herzog
herzog@tzi.de