CPGIS Educational Webinars on Spatiotemporal Study of Urban Dynamics (4)

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Journal of Computational Urban Science

"Monitoring urban land dynamics – from local to global scale"

Dr. Peng Gong, Geography and Earth Sciences, University of Hong Kong
Chair: Cuizhen Wang, University of South Carolina

Abstract

- Over the past three decades, a lot of efforts have been made to map and monitor urban land changes using remotely sensed data. Most studies concentrated on a single city or a cluster of cities. Global mapping and monitoring of cities are recent phenomena.
- Share our experience on mapping urban land from local to global scales.
- Present some possible future perspectives.

Urban land use / land cover mapping – spectral, spatial, texture, contextual methods

ELSEVIER

Remote Sensing of Environment

Volume 30, Issue 1, October 1989, Pages 33-42

Performance analyses of probabilistic relaxation methods for land-cover classification ☆

Peng Gong *, Philip J. Howarth *

LAND COVER TO LAND-USE CONVERSION - A KNOWLEDGE-BASED APPROACH

作者: GONG, P; HOWARTH, PJ

会议: 50TH ANNUAL MEETING OF THE AMERICAN CONGRESS ON SURVEYING AND MAPPING / 56TH ANNUAL MEETING OF THE AMERICAN SOC FOR PHOTOGRAMMETRY AND REMOTE SENSING 会议地点: DENVER, CO 会议日期: MAR 18-23, 1990

会议赞助商: AMER SOC PHOTOGRAMMETRY & REMOTE SENSING

TECHNICAL PAPERS : 1990 ACSM-ASPRS ANNUAL CONVENTION, VOL 4: IMAGE PROCESSING / REMOTE SENSING 页: 447-456 出版年: 1990

THE USE OF STRUCTURAL INFORMATION FOR IMPROVING LAND-COVER CLASSIFICATION ACCURACIES AT THE RURAL-URBAN FRINGE

作者: GONG, P; HOWARTH, PJ

PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING 卷: 56 期: 1 页: 67-73 出版年: JAN 1990

FREQUENCY-BASED CONTEXTUAL CLASSIFICATION AND GRAY-LEVEL VECTOR REDUCTION FOR LAND-USE IDENTIFICATION

作者: GONG, P; HOWARTH, PJ

PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING 卷: 58 期: 4 页: 423-437 出版年: APR 1992

A COMPARISON OF SPATIAL FEATURE-EXTRACTION ALGORITHMS FOR LAND-USE CLASSIFICATION WITH SPOT HRV DATA

作者: GONG, P; MARCEAU, DJ; HOWARTH, PJ

REMOTE SENSING OF ENVIRONMENT 卷: 40 期: 2 页: 137-151 出版年: MAY 1992

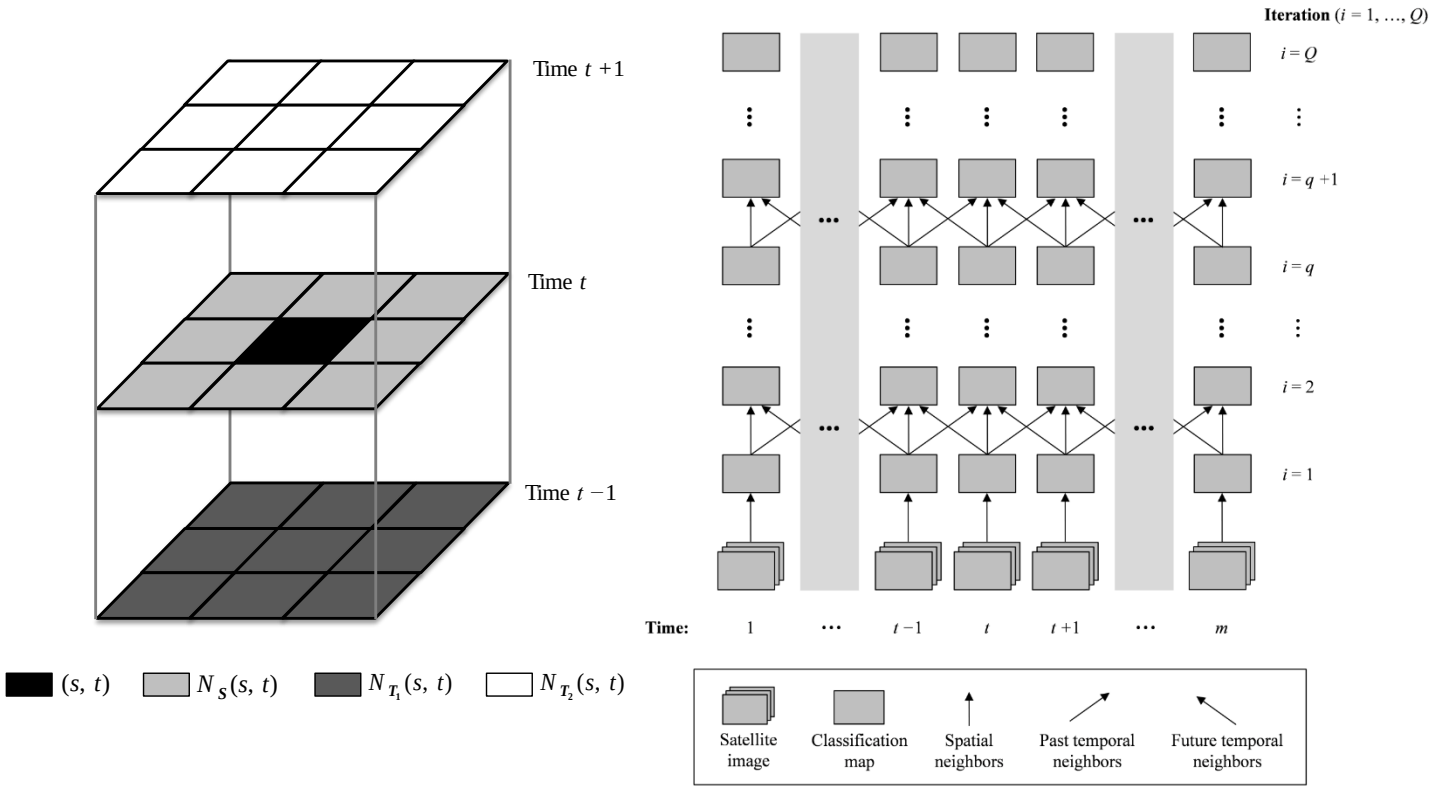
LAND-USE CLASSIFICATION OF SPOT HRV DATA USING A COVER-FREQUENCY METHOD

作者: GONG, P; HOWARTH, PJ

INTERNATIONAL JOURNAL OF REMOTE SENSING 卷: 13 期: 8 页: 1459-1471 出版年: MAY 20 1992

Spatial-temporal consistency check and probability adjustment

Improved the temporal continuity



Li et al., 2015, RSE

Remote Sensing of Environment 222 (2019) 183–194

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Hierarchical mapping of annual global land cover 2001 to present: The MODIS Collection 6 Land Cover product

Damien Sulla-Menashe[a,*], Josh M. Gray[b], S. Parker Abercrombie[c], Mark A. Friedl[a]

[a] Department of Earth and Environment, Boston University, 685 Commonwealth Avenue, Boston 02215, MA, United States of America
[b] Center for Geospatial Analytics, North Carolina State University, 2800 Faucette Drive, Campus Box 7106, Raleigh 27695, NC, United States of America
[c] Operations Laboratory, NASA Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena 91109, CA, United States of America

ARTICLE INFO ABSTRACT

波士顿大学地球环境系系主任

A key weakness in previous MLCT collections was the frequency of interannual variability in class labels arising from classifier uncertainty (Friedl et al., 2010), which, as we describe previously, is largely related to challenges in land cover mapping at the coarse spatial resolution of MODIS. In C6, we mitigated (but did not resolve) this issue by post-processing annual classification results using hidden Markov models (Abercrombie and Friedl, 2016). Using information from the entire time series at each pixel, the hidden Markov model helps to distinguish actual state changes (i.e., land cover change) from stochastic variability in classification results arising from uncertainty in classification predictions (Hermosilla et al., 2018). The result, as we describe in Section 3.3, is a substantial decrease in the number and frequency of spurious land cover label changes, which increases the quality of the resulting maps, especially for land cover classes that are defined as mixtures. In this context, it is important to understand that the main benefit of the HMM post-processing implemented in C6 is to reduce spurious land cover changes. It does not, unfortunately, resolve fundamental issues surrounding uncertainty in land cover mapped from coarse spatial resolution instruments such as MODIS. By definition, land cover change is a local process. Hence, [illegible] instruments such as [illegible] legacy of existing global land cover data sets.

Acknowledgments

This work was funded by NASA from award number NNX14AJ35G. Many people assisted in the collection and reviewing of training sites over the past 10 years and we give special thanks to Adam Sibley, J. Meghan Salmon, Xiaoman Huang, and Doug Bolton. Academic collaborators who were key contributors in other aspects of development include Dany Plouffe, Navin Ramankutty, Annemarie Schneider, Carly Mertes, and Olga Krankina. We also gratefully acknowledge the NASA MODAPS team, who supported operational implementation of the C6 code base, including Sanjeeb Bhoi, Gang Ye, Kurt Hoffman, Jihad Ashkar, and Sadashiva Devadiga. At Boston University we were assisted by the Scientific Computing and Visualization group, particular thanks goes to Katia Oleinik and Keith Ma. The authors gratefully acknowledge the constructive contributions from three anonymous reviewers.

Appendix A. Supplementary data

[illegible] at https://

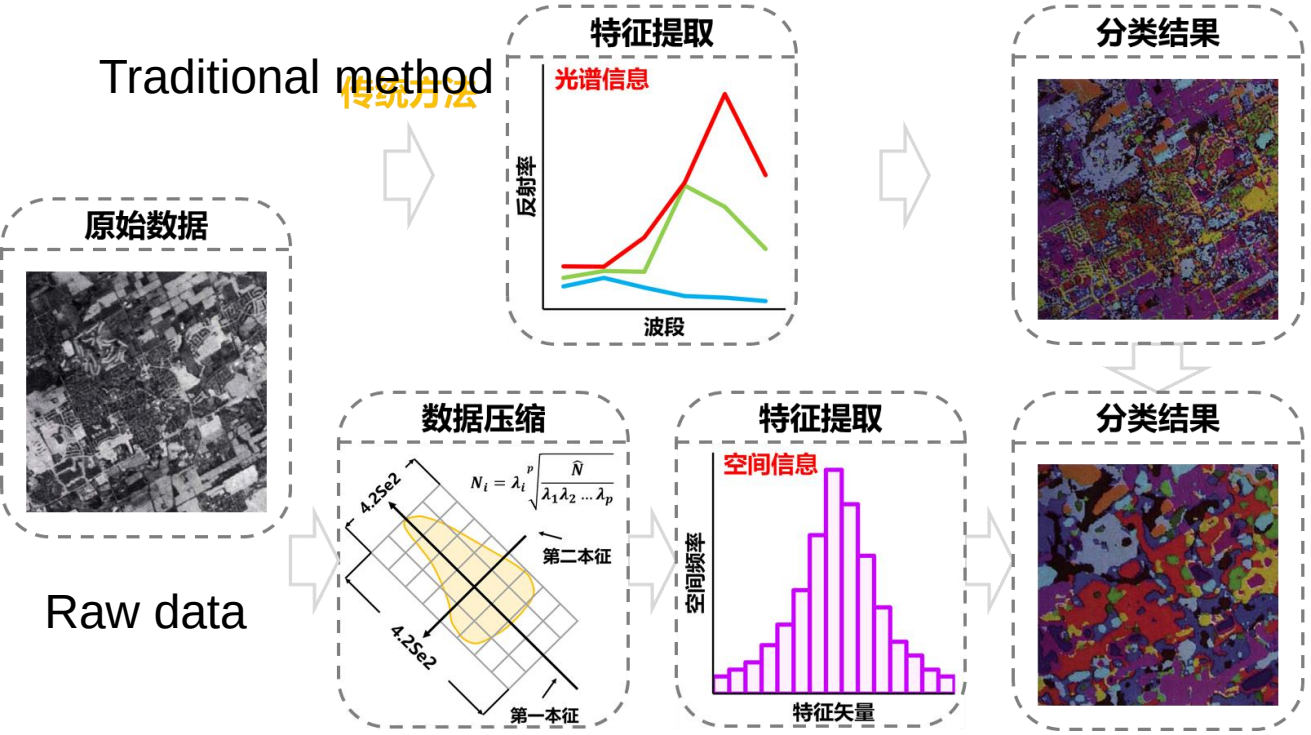
Gong and Howarth 1989
to Liu et al 2006
to Cai and Liu 2013

Land-use classification based on eigen-space transformation – Gray level vector reduction method

Fast and accurate

Results

Traditional method 传统方法

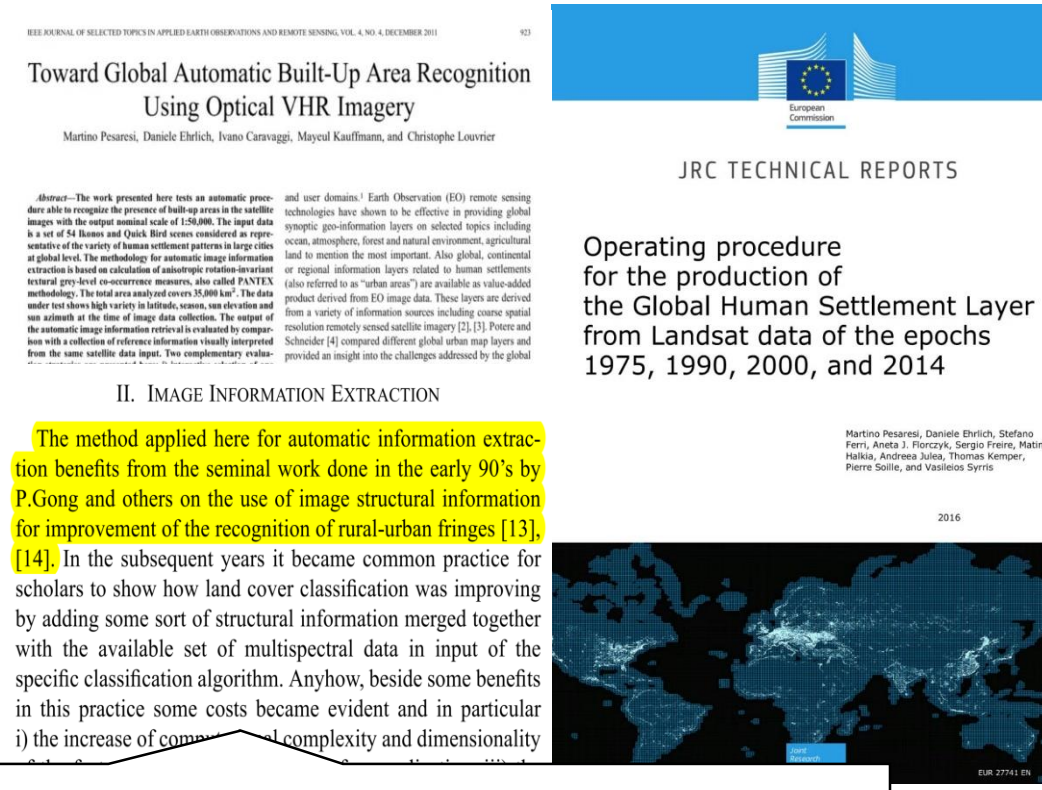


Raw data

Data reduction Feature extraction

Gong and Howarth, 1992, PERS

Accuracy improvement 制图精度提高 15%



IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING, VOL. 4, NO. 4, DECEMBER 2011 923

Toward Global Automatic Built-Up Area Recognition Using Optical VHR Imagery

Martino Pesaresi, Daniele Ehrlich, Ivano Caravaggi, Mayeul Kauffmann, and Christophe Louvrier

Abstract—The work presented here tests an automatic procedure able to recognize the presence of built-up areas in the satellite images with the output nominal scale of 1:50,000. The input data is a set of 54 Ikonos and Quick Bird scenes considered as representative of the variety of human settlement patterns in large cities at global level. The methodology for automatic image information extraction is based on calculation of anisotropic rotation-invariant textural grey-level co-occurrence measures, also called PANTEX methodology. The total area analyzed covers 35,000 km². The data under test shows high variety in latitude, season, sun elevation and sun azimuth at the time of image data collection. The output of the automatic image information retrieval is evaluated by comparison with a collection of reference information visually interpreted from the same satellite data input. Two complementary evalua-

and user domains.[1] Earth Observation (EO) remote sensing technologies have shown to be effective in providing global synoptic geo-information layers on selected topics including ocean, atmosphere, forest and natural environment, agricultural land to mention the most important. Also global, continental or regional information layers related to human settlements (also referred to as "urban areas") are available as value-added product derived from EO image data. These layers are derived from a variety of information sources including coarse spatial resolution remotely sensed satellite imagery [2], [3]. Potere and Schneider [4] compared different global urban map layers and provided an insight into the challenges addressed by the global

II. Image Information Extraction

The method applied here for automatic information extraction benefits from the seminal work done in the early 90's by P.Gong and others on the use of image structural information for improvement of the recognition of rural-urban fringes [13], [14]. In the subsequent years it became common practice for scholars to show how land cover classification was improving by adding some sort of structural information merged together with the available set of multispectral data in input of the specific classification algorithm. Anyhow, beside some benefits in this practice some costs became evident and in particular i) the increase of comput[illegible]l complexity and dimensionality

European Commission

JRC TECHNICAL REPORTS

Operating procedure for the production of the Global Human Settlement Layer from Landsat data of the epochs 1975, 1990, 2000, and 2014

Martino Pesaresi, Daniele Ehrlich, Stefano Ferri, Aneta J. Florczyk, Sergio Freire, Matin Halkia, Andreea Julea, Thomas Kemper, Pierre Soille, and Vasileios Syrris

2016

Joint Research

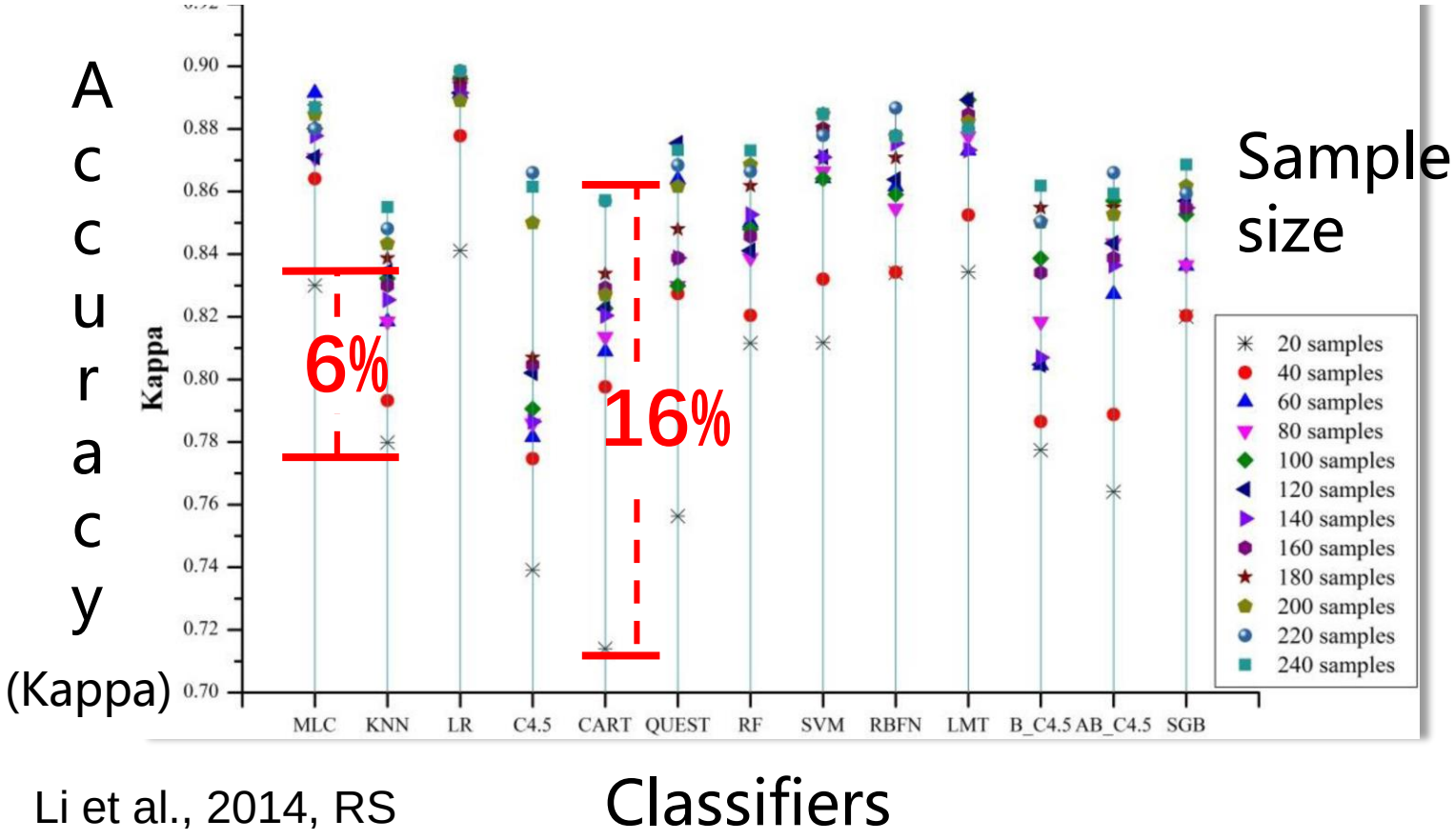
EUR 27741 EN

JRC is still using them for global human settlement monitoring

Comparison of sample size and algorithms

Learnt through a large amount of tests： Sample size is more important than algorithm in large area mapping

Different classifiers vs sample size



Li et al., 2014, RS

INTERNATIONAL JOURNAL OF REMOTE SENSING
2018, VOL. 39, NO. 23, 8387–8427
https://doi.org/10.1080/01431161.2018.1550919

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EDITORIAL

Check for updates

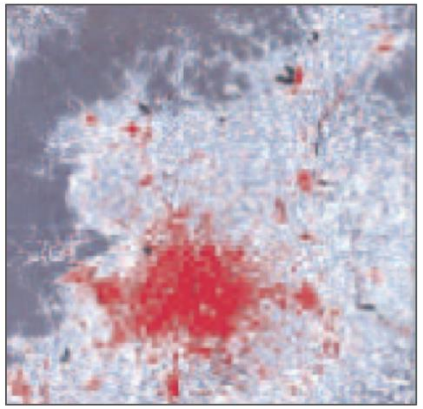
The development of remote sensing in the last 40 years

What Gong et al. did was to make use of the release of the Landsat archive to derive a 30 m resolution Finer Resolution Observation and Monitoring of Global Land Cover (FROM-GLC) database. This involved using 8929 TM or ETM+ scenes from 1984 to 2011 to produce a global land cover map, see Figure 23. The data behind these four products is at 30 m resolution. While differences between the products of the four classification methods used can be detected, it is worth noting that these differences are small, which is consistent with the general view of Li et al. (2014) that it does not matter very much which classification method is used so long as one has good training data.

"Seminal work"
Arthur Cracknell and co-authors

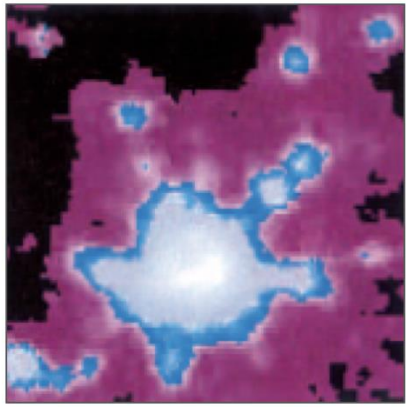
From a single city to all cities in China

Proposed an adjustable threshold method for extraction of urban boundaries of different economic levels



Landsat 影像

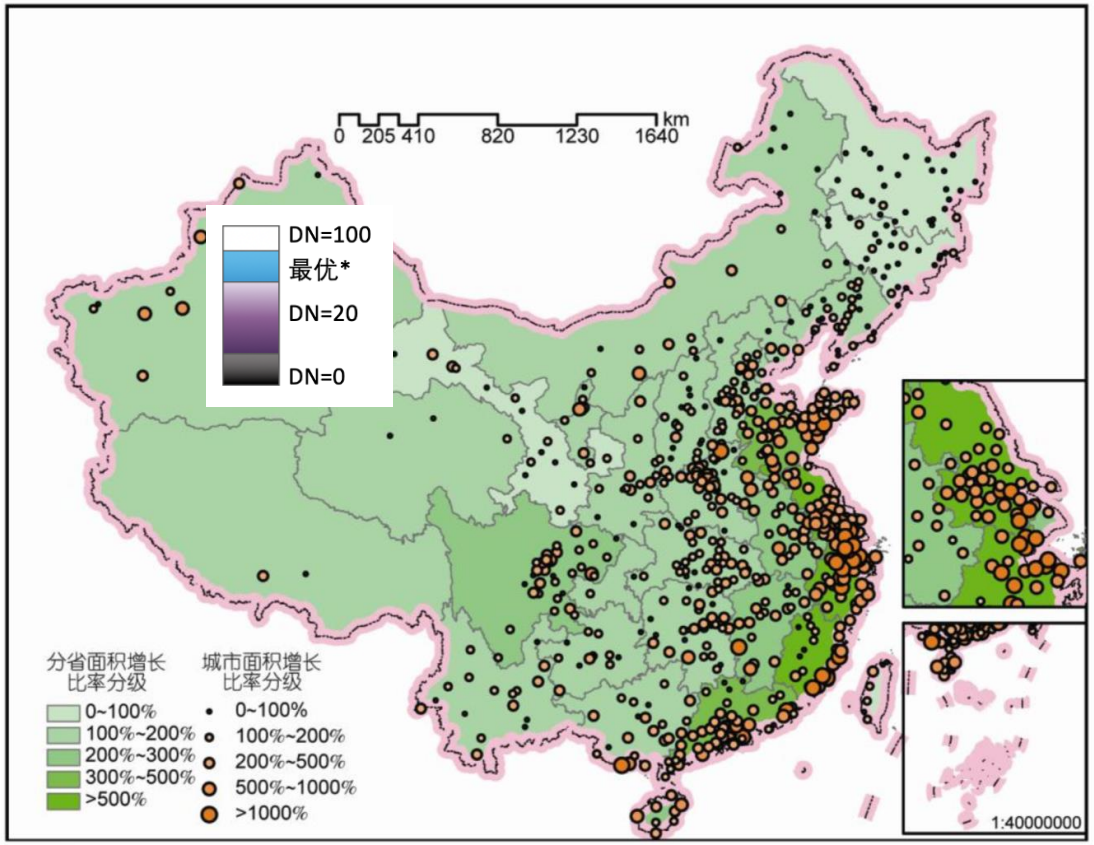
Images



DMSP 夜间灯光

Night light

Henderson, Yeh, Gong, 2003, IJRS



Watershed segmentation algorithm
Wang et al, IJRS, 2010

Wang et al, 2010
Chinese Science Bulletin

A 30-year (1984-2013) record of annual urban dynamics of Beijing City derived from Landsat data

作者: Li, Xuecao; Gong, Peng; Liang, Lu

REMOTE SENSING OF ENVIRONMENT 卷: 166 页: 78-90 出版年: SEP 1 2015

被引频次: 148
(来自 Web of Science 的核心合集)

高被引论文

Mapping Urban Land Use by Using Landsat Images and Open Social Data

作者: Hu, Tengyun; Yang, Jun; Li, Xuecao; 等.

REMOTE SENSING 卷: 8 期: 2 文献号: 151 出版年: FEB 2016

被引频次: 155
(来自 Web of Science 的核心合集)

高被引论文

40-Year (1978-2017) human settlement changes in China reflected by impervious surfaces from satellite remote sensing

作者: Gong, Peng; Li, Xuecao; Zhang, Wei

SCIENCE BULLETIN 卷: 64 期: 11 页: 756-763 出版年: JUN 15 2019

被引频次: 77
(来自 Web of Science 的核心合集)

热点论文

Annual maps of global artificial impervious area (GAIA) between 1985 and 2018

作者: Gong, Peng; Li, Xuecao; Wang, Jie; 等.

REMOTE SENSING OF ENVIRONMENT 卷: 236 文献号: 111510 出版年: JAN 2020

被引频次: 58
(来自 Web of Science 的核心合集)

热点论文

Mapping essential urban land use categories in China (EULUC-China): preliminary results for 2018

作者: Gong, Peng; Chen, Bin; Li, Xuecao; 等.

SCIENCE BULLETIN 卷: 65 期: 3 页: 182-187 出版年: FEB 15 2020

被引频次: 34
(来自 Web of Science 的核心合集)

高被引论文

From 2D to 3D

IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 49, NO. 3, MARCH 2011

ICESat GLAS Data for Urban Environment Monitoring

Peng Gong, Zhan Li, Huabing Huang, Guoqing Sun, *Senior Member, IEEE*, and Lei Wang

Developing a method to estimate building height from Sentinel-1 data

作者: Li, Xuecao; Zhou, Yuyu; Gong, Peng; 等.

REMOTE SENSING OF ENVIRONMENT **卷:** 240 **文献号:** 111705 **出版年:** APR 2020

被引频次: 10
(来自 Web of Science 的核心合集)

使用次数

Reference Data

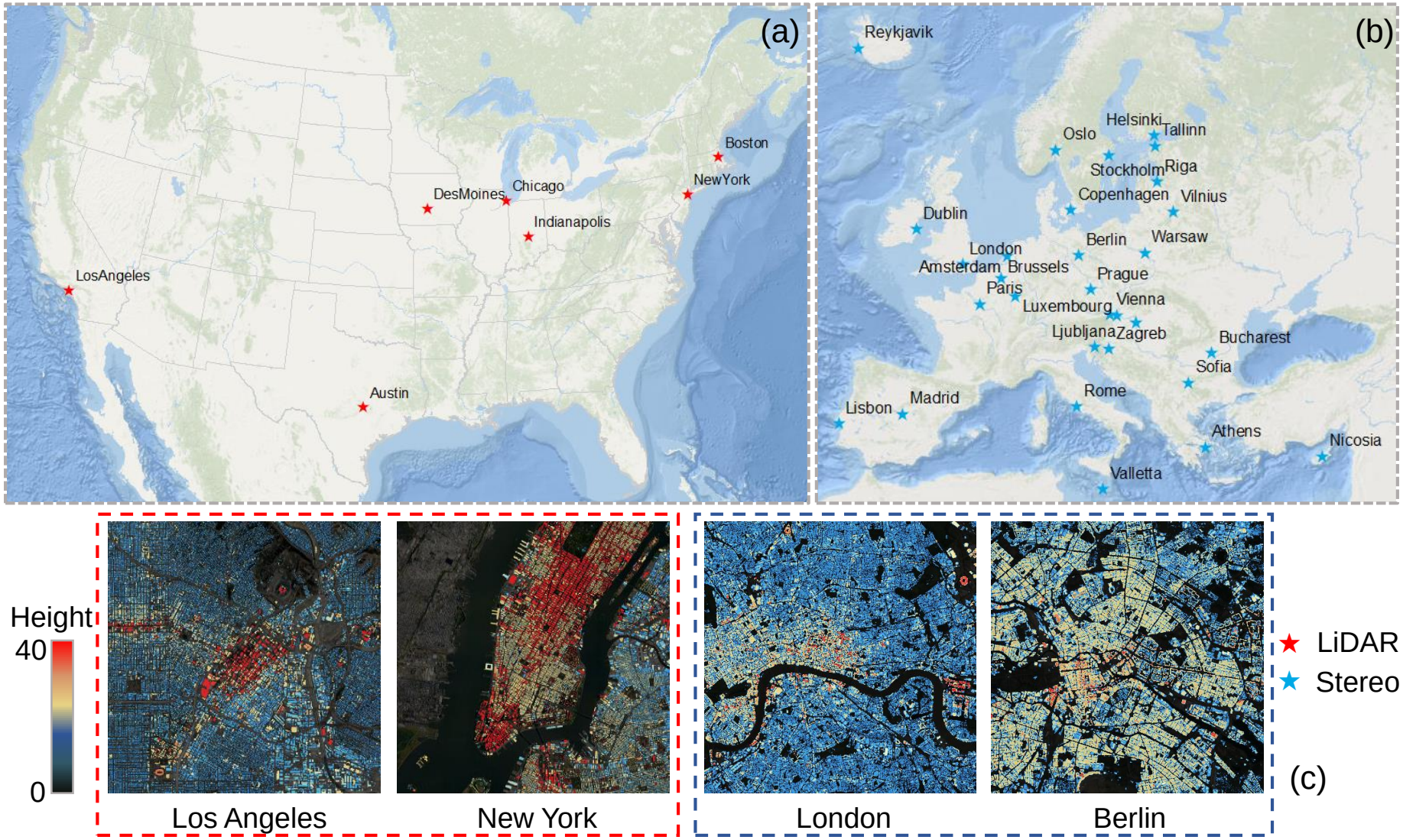
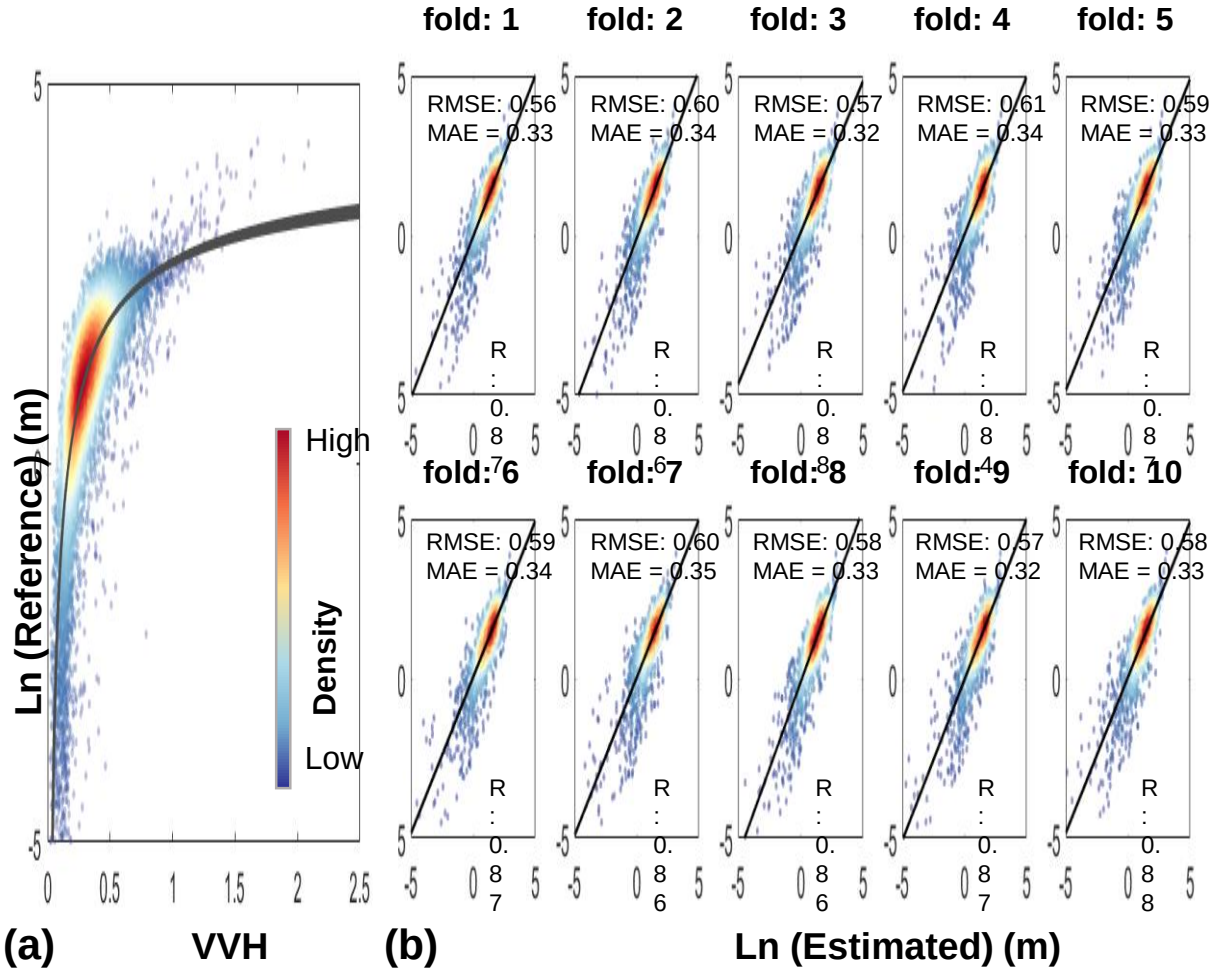
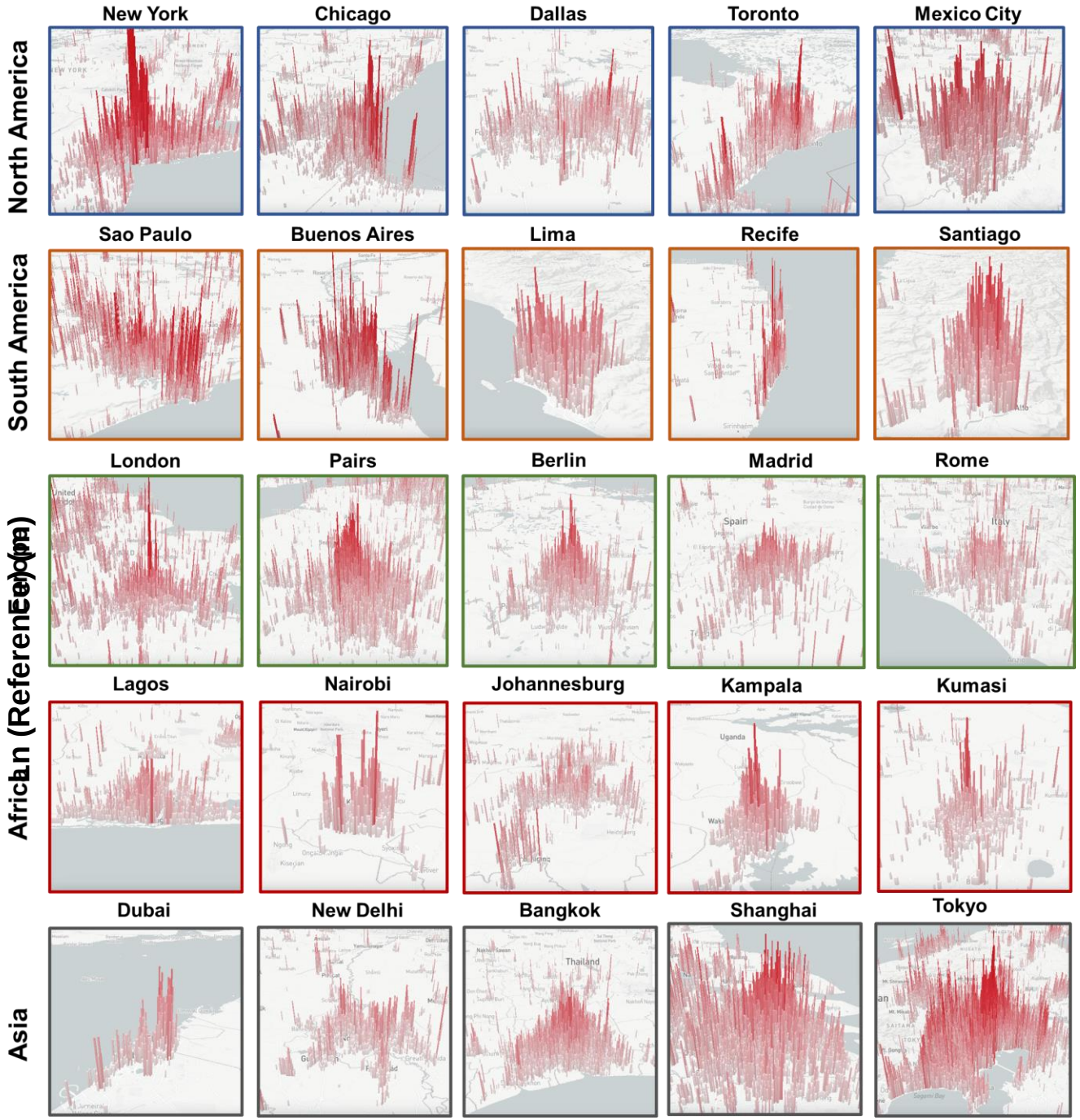


Fig.1 Distribution of selected reference height data in US (a) and Europe (b). Building heights for representative cities in US and Europe (c). Each snapshot in (c) is about 20km x 20 km. Reference data in US and Europe were derived from LiDAR and Stereo images, respectively.

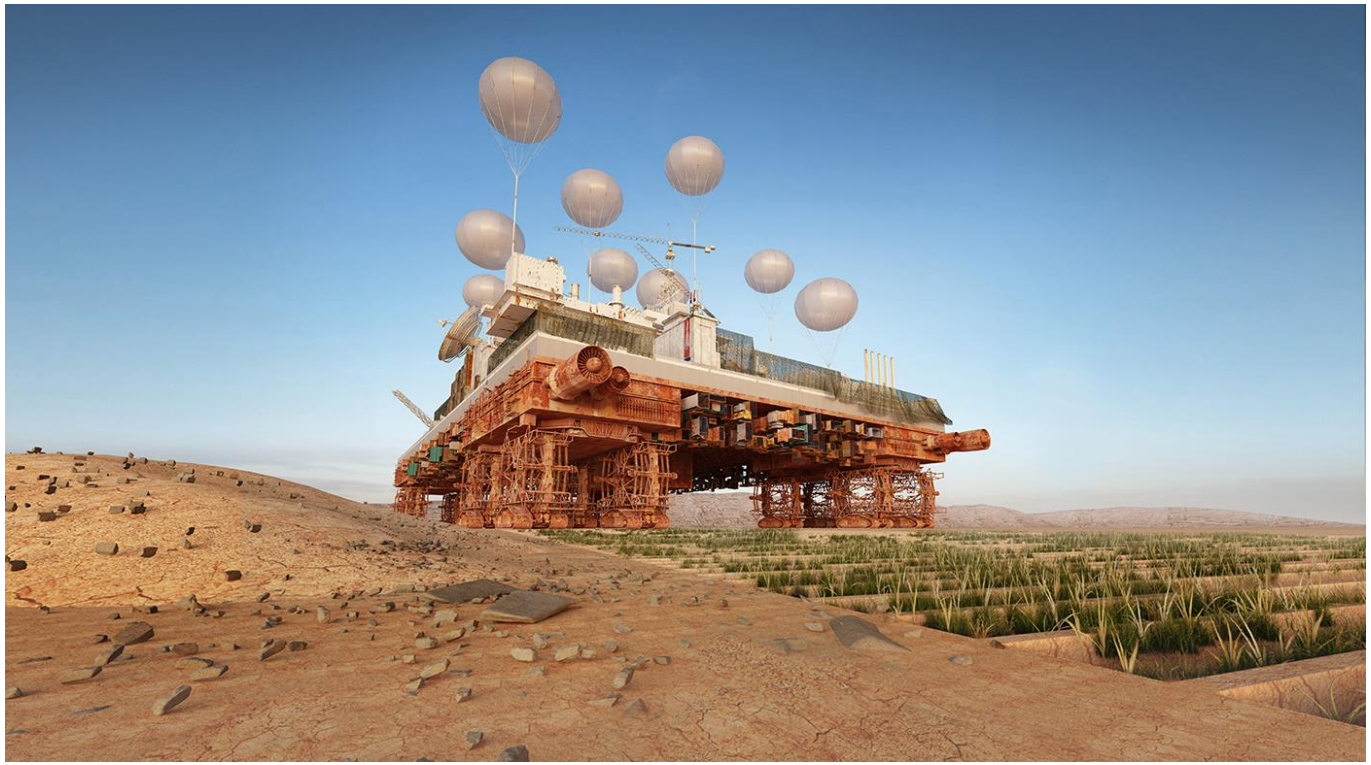
Building height extraction from Sentinel-1 data



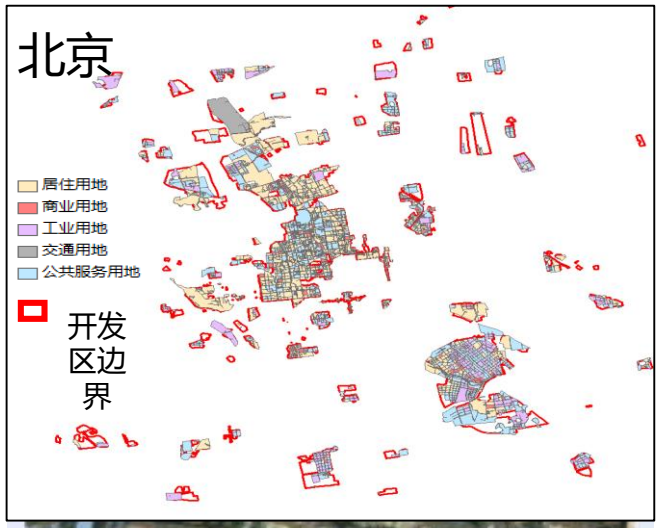


Future cities require more innovative, frequent and flexible mapping and monitoring

Emily Badger



https://www.stephanemalka.com/portfolio/the-green-machine-i-greening-the-desert-i-sahara-2014/



Future perspectives

- Big data makes ground truthing easier – e.g. “building Rome in a day”
- Virtual organization – from bottom up – helps global mapping efforts
- Cloud computing is the trend for large area mapping

Work presented here are joint efforts primarily with

- Xuecao Li – Professor at CAU,
- Tengyun Hu – Engineer in Beijing Planning Institute
- Bin Chen – Assistant Professor at HKU
- Hao Ni – Grad student at Tsinghua