

Satellite monitoring of urbanization in china for sustainable development: Final Results

*Ban, Yifang*¹; *Gong, Peng*²; *Gamba, Paolo*³; *Du, Peijun*⁴

¹Royal Institute of Technology - KTH; ²Tsinghua University; ³University of Pavia; ⁴Nanjing University

China, the most populous country on earth, has experienced rapid urbanization due to the unprecedented combination of economic and population growth since the early 1980s. Two decades ago, fewer than 20% of China's people lived in urban areas; today it is approximately 50%; and by 2030, another 400 million people will move to urban areas. Urbanization and the impact of human settlements are two of the main causes of global environmental degradation. Therefore, monitoring urbanization and their impact on the environment is of critical importance for urban planning & sustainable development in China.

Most of the efforts in China for urbanization monitoring are based on optical remote sensing. Due to frequent cloud cover, smog, haze and sand storms, however, optical data may not be available during critical monitoring cycle. With its all-weather capability, synthetic aperture radar (SAR) is an attractive data source for monitoring urbanization. The overall objective of this research is to investigate spaceborne SAR data, optical data and fusion of SAR and optical data for monitoring urbanization in China, and assess the impact of urbanization on the environment for sustainable urban development. The specific objectives are to

- develop effective methodologies to extract urban land-cover information from spaceborne SAR data;
- develop effective change detection methods for urbanization monitoring using ENVISAT ASAR and ERS SAR data;
- investigate the fusion of C-, X- and L-band SAR data, and fusion of SAR and optical data such as HJ-1 MS and HSI, and Beijing-1 MSI data for urban land-cover mapping and change detection;
- determine which satellite data at which resolution/scale at which season are suitable for identifying which urban land covers and monitoring what types of changes;
- assess the impacts of these changes on the environment for sustainable urban development.

The main results for the project are highlighted below:

- the development of the KTH-Segmentation, the segmentation algorithm based on edge-aware region growing and merging, and the comparison of Berkeley Image Segmentation algorithm with Marpu Segmentation algorithm;
- the evaluation and development of change detection algorithms including Kittler-Illingworth minimum-error thresholding algorithm, PCA-NLM based method and Markov Random Field;
- improved urban land cover mapping using fusion of ENVISAT ASAR and HJ-1 data;
- comparative results on various classifiers and Beijing-1, CBERS-02B and HJ-1 data;
- completed a mapping of the urban expansion from 1990, 2000 to 2010 using manual interpretation of Landsat TM/ETM+ data for all cities of China;
- the spatial relationship between land use/land cover and land surface temperature were analyzed;
- the environmental impact of urban land cover changes on the eco-system services are discussed.

Dragon project id

04 URBANISATION (ID. 5317)

服务可持续发展的中国城市化卫星监测：研究报告

班艺舫¹；宫鹏²；Gamba, Paolo³；杜培军⁴

1 瑞典皇家理工学院；2 清华大学；3 意大利帕维亚大学；4 南京大学

中国作为地球上人口最稠密的国家，自上个世纪80年代早期开始，由于经济和人口的空前增长，导致了城市化进程的快速推进。二十多年前，只有不到20%的中国人口居住在城市；而现在，这个数字将接近于50%；到2030年，将新增4亿人口移居至城市。城市化和人类居住地影响是导致全球环境退化的两大主要因素。因此，有效监测城市化过程和其对于环境的影响将对中国的城市规划和可持续发展起到至关重要的作用。

对于城市化监测，迄今为止在中国所做的工作和努力大多基于光学遥感。但是，由于频繁的云层覆盖，雾，霾和沙尘暴，光学影像数据在监测过程中经常不能有效使用。合成孔径雷达（SAR）具有全天候观测的能力，可作为城市化监测中一种良好的数据源。本研究的主要目标是探究星载SAR数据、光学数据和两者的融合数据在中国城市化监测中的作用，并且评估城市化过程对于城市可持续发展进程中环境的影响。具体的研究目标包括：

- (1)构建从星载SAR数据提取城市土地覆盖信息的有效方法；
- (2)构建使用ENVISAT ASAR和ERS SAR数据进行城市化监测的有效变化检测方法；
- (3) 探究C-、X-和L-波段SAR数据融合，雷达和光学数据融合（如HJ-1 MS和HIS），和Beijing-1 MSI数据在城市土地覆盖制图和变化检测中作用；
- (4)判定何种卫星数据，在何种分辨率/尺度下，在哪个季节中适用于识别何种城市土地覆盖和监测何种类别变化；评价这些环境变化对于城市可持续发展的作用。

项目主要成果包括：

- (1)提出和构建了KTH分割算法，该算法基于边缘引导的区域增长和合并算法，并与伯克利图像分割算法和Marpu分割算法进行了比较；
- (2)评价和构建变化检测算法包括Kittler-Illingworth最小错误率阈值算法，基于PCA-NLM方法和马尔科夫随机场等；
- (3)通过融合ENVISAT ASAT和HJ-1数据提高了城市土地覆盖制图效果；
- (4)比较不同数据Beijing-1、CBERS-02B和HJ-1数据分类结果；
- (5)通过人工解译Landsat TM/ETM+数据完成了中国城市从1990年、2000年至2010年城市扩展的制图；
- (6)分析了土地利用/土地覆盖和地表温度的空间关联；
- (7)探讨了城市土地覆盖变化对于生态系统服务的环境影响。

龙计划ID 04 URBANISATION (ID.5317)