Contribution of fused Sentinel-1A SAR and Sentinel-2A MSI Data to the City Biodiversity Index (CBI)

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INTRODUCTION

The objective of this study is to evaluate the potential use and synergetic effects of ESA Sentinel-1A C-band SAR and Sentinel-2A MSI data for urban land cover mapping and their contribution to the City Biodiversity Index (CBI). The suitability of Sentinel-1A SAR in Interferometric Wide Swath mode and Sentinel-2A MSI data is evaluated in a classification of an urban area over Beijing, P. R. China. Based on the outcome from fused, segmented and SVM-classified data, five of 24 indicators that make up the City Biodiversity Index (CBI) are derived as proportion of natural areas in the city, connectivity measures, regulation of quantity of water, climate regulation, recreation and education.

STUDY AREA AND DATA

Beijing as capital of the P. R. of China was chosen as study area. Beijing is located at the northern edge of the North China Plain and is surrounded by Hebei Province at 39°55'N and 116°23'E. As China's currently second largest city in terms of population after Shanghai, urban biodiversity plays an important role for many urban residents and visitors. The urban core is characterized through high density built-up areas in form of the traditional Hutong areas and modern, high-rise complexes with commercial and residential function. Low density built-up areas exist as well in form of newly built aggregations of low-rise single-family homes interspersed with green spaces and in form of public spaces and parks with buildings, footpaths, lawns, trees and water bodies. There are agricultural areas to be found in the urban fringe that are however gradually replaced by artificial structures. The study area has been limited to Beijing's fourth ring road and covers about 300 km^2.

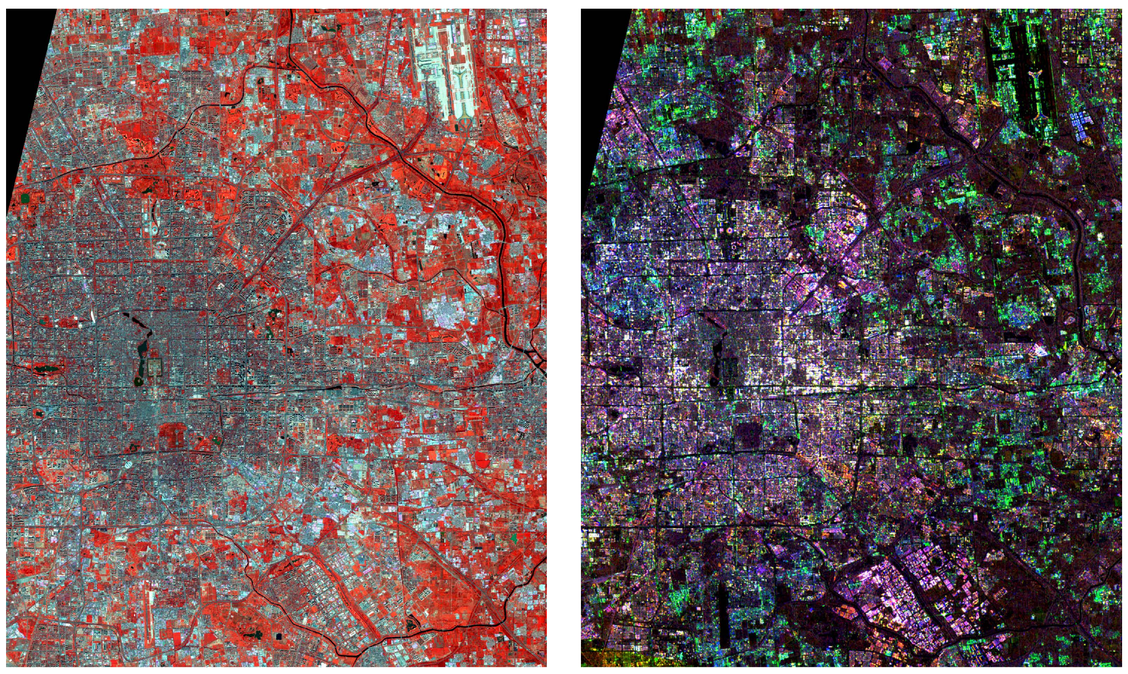

Figure 1. False-colour-composite of the Sentinel-2A scene from September 2015 (left) and Sentinel-1A 5x5 adaptive Lee speckle filtered intensity data from September 2015 (VH-VV-VH) (right)

Indicator 1: Proportion of natural areas in the city	7.5% = 2 points
Indicator 2: Connectivity measures	64.9 ha = 0 points
Indicator 3: Regulation of quantity of water	7.5 % = 0 points
Indicator 12: Climate regulation	3.0 % = 0 points
Indicator 13: Recreation and Education	785ha/8.1 mio persons = 0 points

A Sentinel-2 level 1c product dating from 2015-09-13 was acquired and used in combination with two Sentinel-1A C-band SAR Level-1 GRD products. Both are in dual polarisation (VH+VV) IW mode, one from an ascending (2015-07-30), the other from a descending (2015-06-06) node. The Level-1 GRD product consists of focussed detected, multi-looked SAR data projected to an Earth ellipsoid. The ellipsoid is corrected using the terrain height specified in the product general annotation.

METHODOLOGY

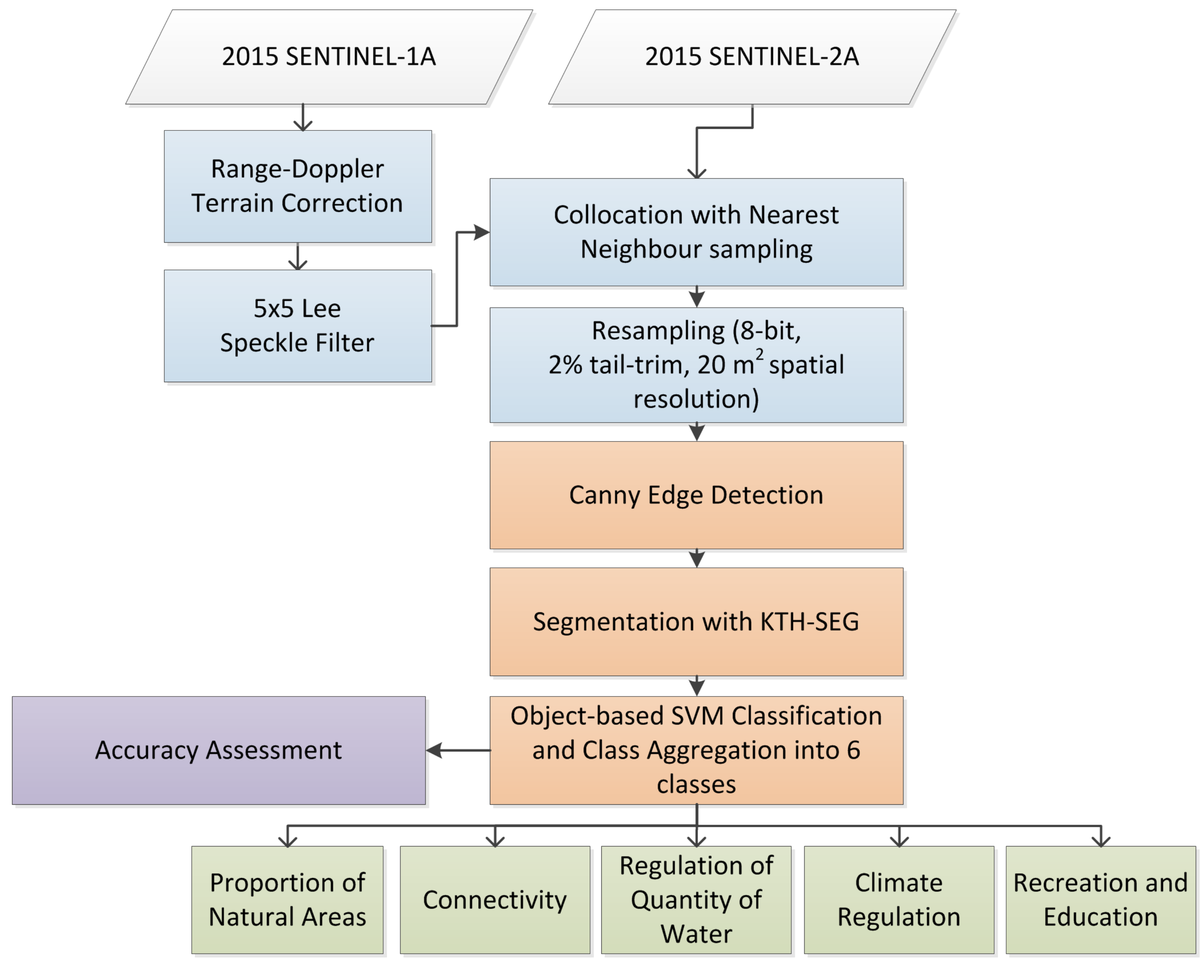

Figure 2. Methodology Flowchart

RESULTS AND DISCUSSION

The classification into urban and natural classes resulted in an overall accuracy of 90.79% with a Kappa coefficient of 0.89 indicating the suitability of the chosen classification method and underlying data. Largest confusions occurred between high density and low density built-up areas as well as between built-up classes and roads.

Class	Urban Green Spaces	Forest	Water	LDB	HDB	Roads	UA
Urban Green Spaces	**92.7**	1.9	0.0	0.1	0.1	3.1	**94.7**
Forest	0.2	**91**	0.0	1.6	1.6	1.5	**94.9**
Water	0.0	0	**100.0**	0.0	0.0	0.0	**100**
LDB	0.0	1.6	0.0	**88.1**	10.4	0.0	**88.1**
HDB	0.0	0	0.0	10.5	**89.5**	0.0	**89.5**
Roads	4.2	0	0.0	2.6	9.7	**83.5**	**83.5**
PA	**95.4**	**96.3**	**100**	**85.7**	**80.1**	**94.9**	-

The resulting land cover map was related to 5 CBI indicators and their scores ranging from 0 to 4 were calculated according to the Singapore Index User Manual (2014):

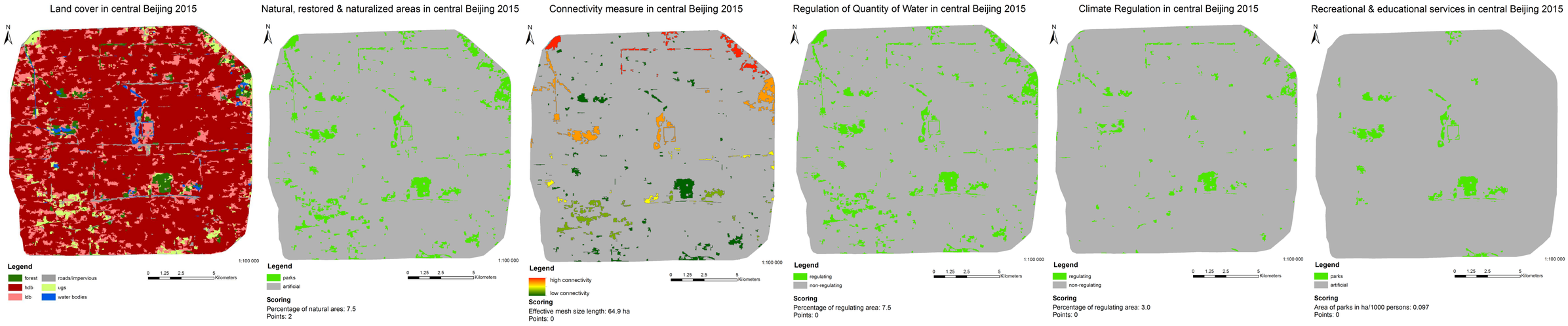

Figure 3. Classification result and the five CBI indicators

CONCLUSIONS

- The combined use of Sentinel-1 SAR and Sentinel-2 MSI data has proven effective in urban land cover classification and in contribution to the CBI through the determination of five indicators.
- Beijing's aggregated CBI score for the five indicators is 2 out of 20, the percentage of natural areas in the city being the only contributor to biodiversity in Beijing.
- The use of high-resolution data could contribute in detection smaller urban green spaces and integration of topological and shape features in the classification could reduce the present class confusions, especially for the road class.

MAJOR REFERENCE

Singapore Index User Manual, 2014.

ACKNOWLEDGEMENT

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