Assessment of Polarimetric and Spatial Features for Built-up Mapping using ALOS PALSAR Polarimetric SAR Data

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Introduction

- PolSAR provide information that can be used to interpret the complex scattering mechanisms between the radar signal and the natural media.
- However, due to the SAR imaging mechanism and complexity of ground surface, built-up mapping using PolSAR image still remains challenged.

challenge

- The objective of this research is to assess the performance of polarimetric and spatial features extracted from PolSAR data for built-up mapping using SVM and RF classifiers, respectively.
- Scattering entropy, scattering angle, and anisotropy computed from the Cloude decomposition are used to represent the polarimetric features, and the texture parameters extracted by the GLCM represents spatial features.

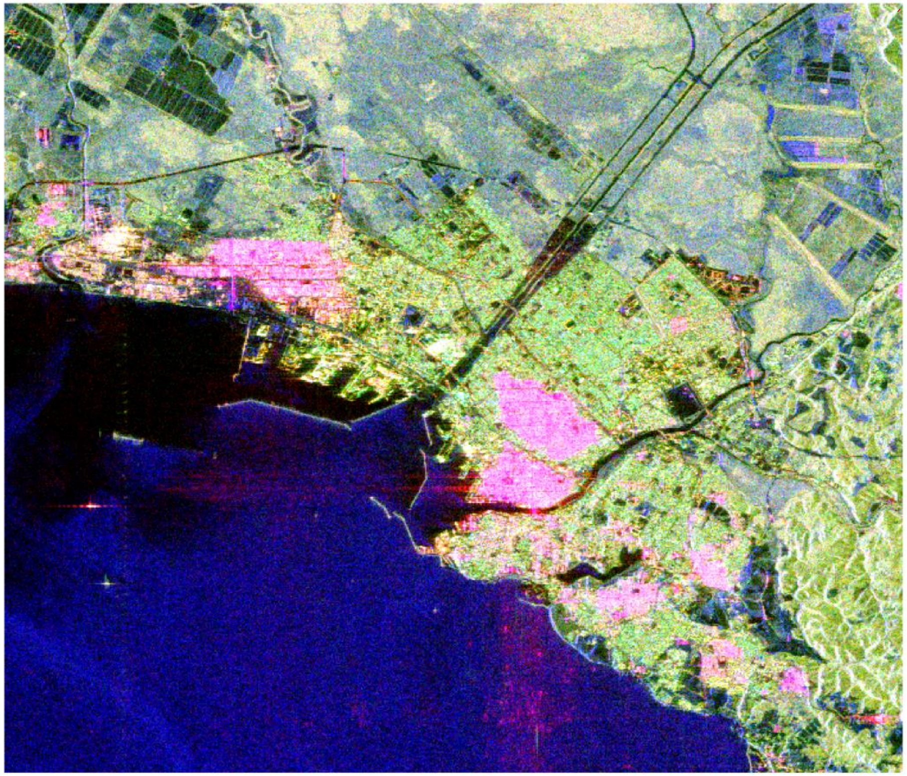
objective

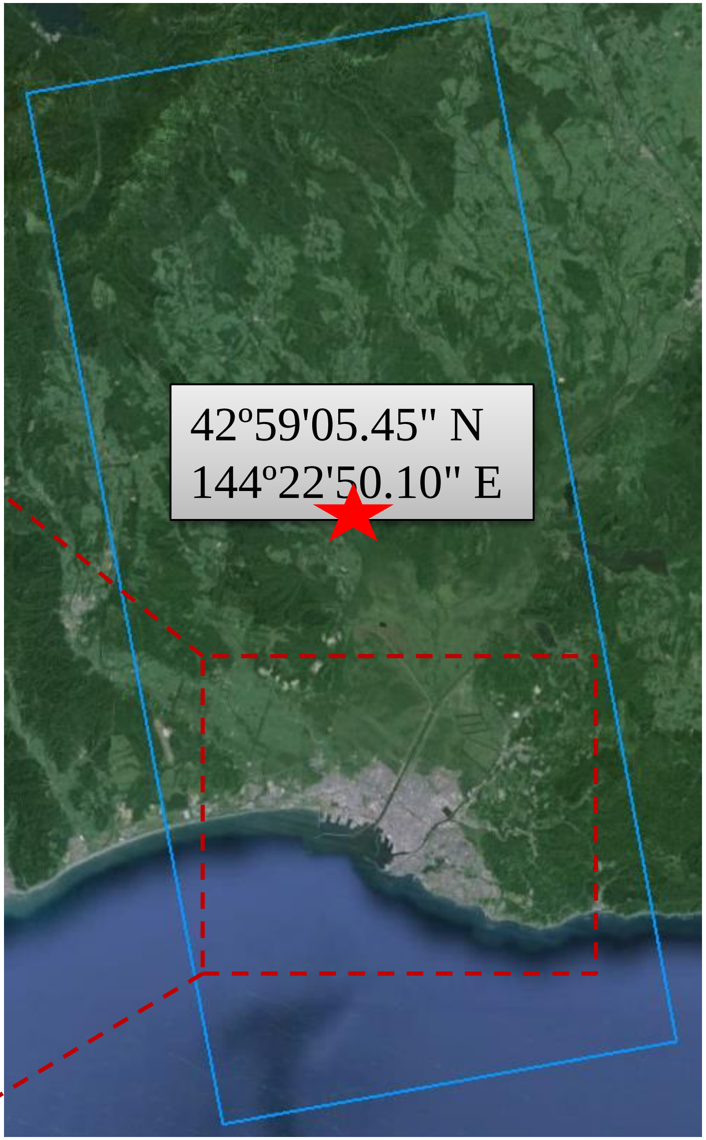
Study Area and SAR Data

Study Area

Land cover: water, farmland with different crop types, forest, built-up, bridge, major road and street, and bare soil.

Pauli composite image





Study Area and SAR Data

■ *SAR Data*

Preprocessing:

multilooking,

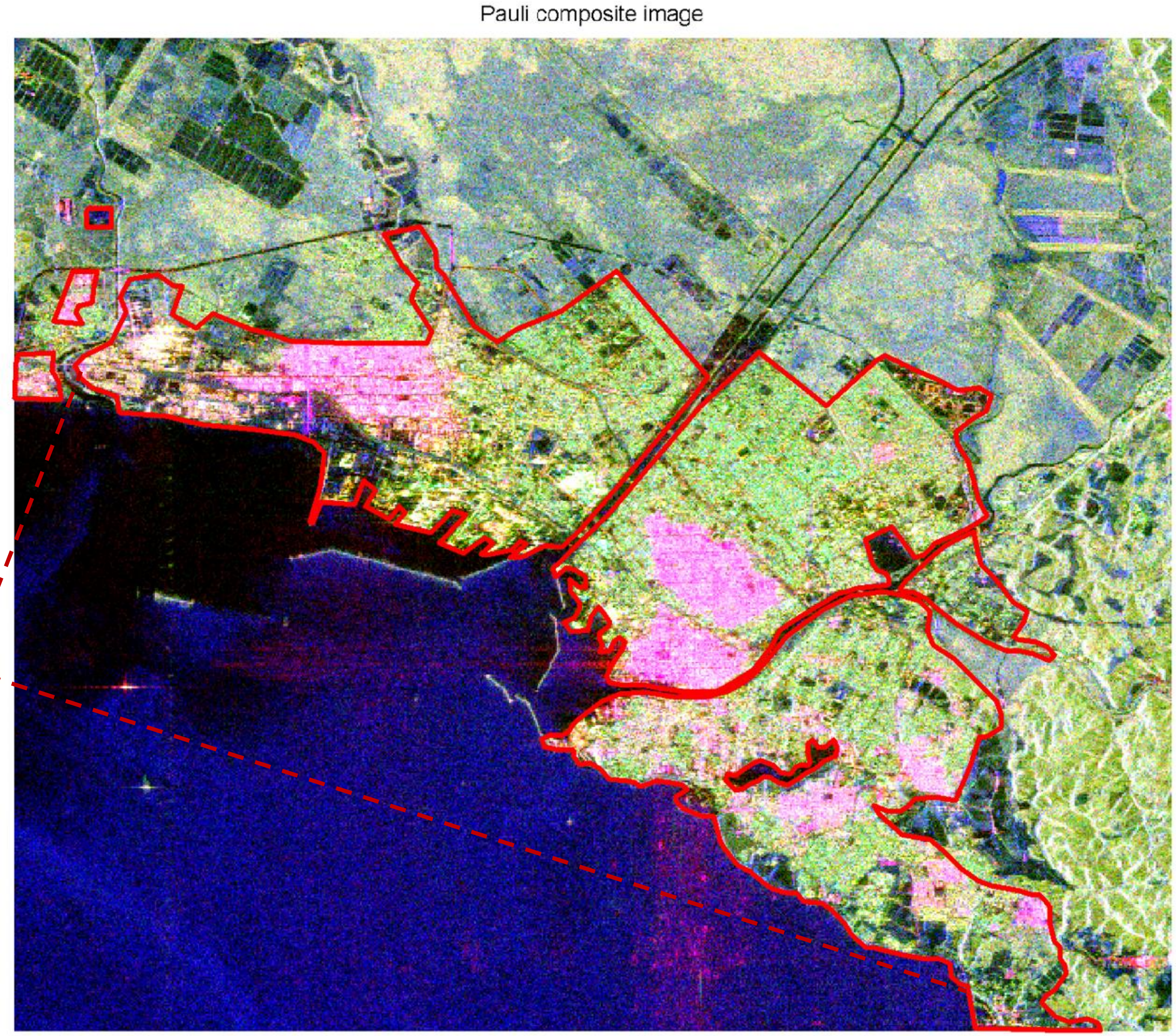
enhanced Lee filter

Cloude decomposition

Texture computation

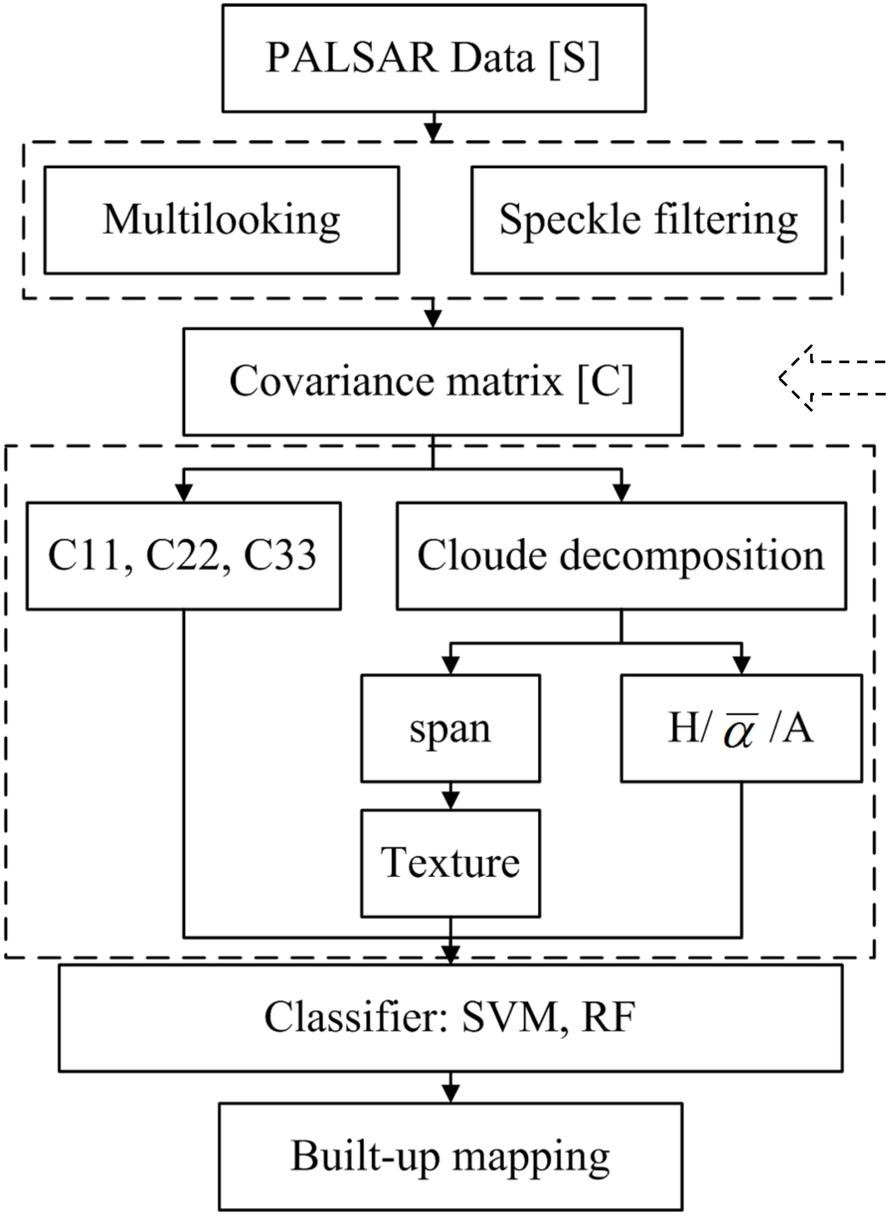
It is based on PolSARPro

built-up areas for reference



Satellite	L-band ALOS PALSAR
Date	April 4, 2009
Mode	HH, HV, VH, VV
Pixel spacing	9.37m×3.56m
Center incidence	23.83º
Pass	Ascending
Image size	18432×1248 pixels

Classification Methods



Framework

- PALSAR data preprocessing
- Cloude decomposition parameters
- Texture parameters extraction
- Feature parameters combination
- Classifier selection
- Built-up mapping

Classification Methods

Cloude decomposition parameters extraction

$$[S]=\begin{bmatrix} S_{HH} & S_{HV} \\ S_{VH} & S_{VV} \end{bmatrix}$$

$$[C]=\sum_{i=1}^{3}\lambda_i[C_i]=\lambda_1 e_1 e_1^* + \lambda_2 e_2 e_2^* + \lambda_3 e_3 e_3^*$$

$$H=\sum_{i=1}^{3}-P_i\log_3 P_i, P_i=\frac{\lambda_i}{\sum\lambda_i}$$

$$\bar{\alpha}=\sum_{i=1}^{3}P_i\alpha_i$$

$$[C]=\begin{bmatrix} S_{HH}S_{HH}^* & \sqrt{2}S_{HH}S_{HV}^* & S_{HH}S_{VV}^* \\ \sqrt{2}S_{HV}S_{HH}^* & 2S_{HV}S_{HV}^* & \sqrt{2}S_{HV}S_{VV}^* \\ S_{VV}S_{HH}^* & \sqrt{2}S_{VV}S_{HV}^* & S_{VV}S_{VV}^* \end{bmatrix}$$

$$A=\frac{\lambda_2-\lambda_3}{\lambda_2+\lambda_3}$$

$$span=\lambda_1+\lambda_2+\lambda_3$$

Scattering matrix—>Coherency matrix—>Cloude decomposition parameters

Texture parameters extraction

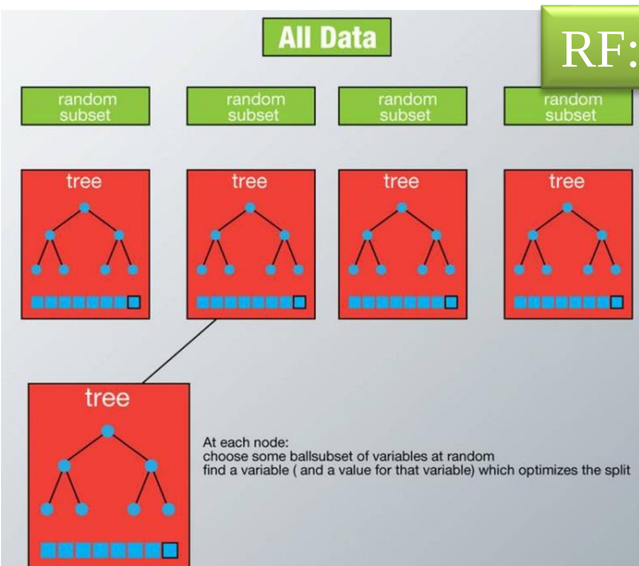
a) eight texture variables (GLCM) : mean, variance, homogeneity, contrast, dissimilarity, entropy, second moment, and correlation
b) Parameter setting: 3×3 pixels window size, 1×1 co-occurrence shift, 64 greyscale quantization levels
c) span is used for textural feature parameters extraction

Classification Methods

Feature parameters combination

Features combination	Features numbers	Input feature parameters for SVM and RF
F1	3	HH, HV, and VV intensity
F2	11	HH, HV, and VV intensity; span texture
F3	6	HH, HV, and VV intensity; H/α/A
F4	14	HH, HV, and VV intensity; span texture; H/α/A

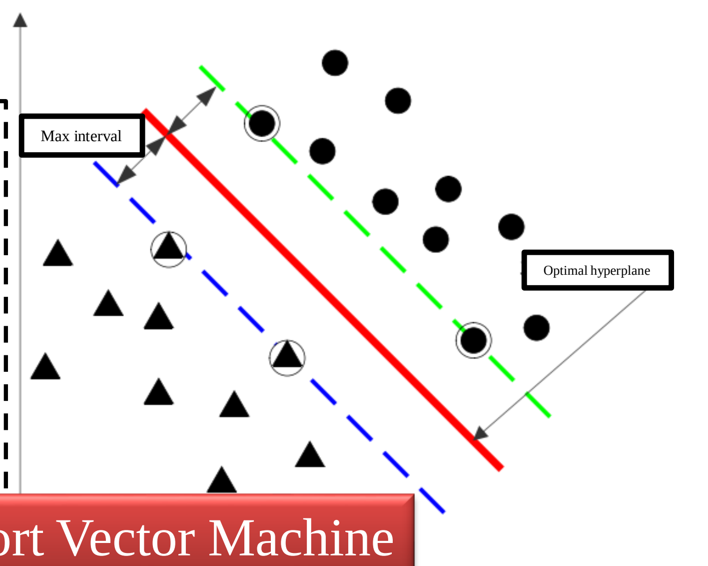
Classifier selection



RF: Random Forest

RF: decision trees is set as 100

SVM: LibSVM is used



SVM: Support Vector Machine

Experiment Results

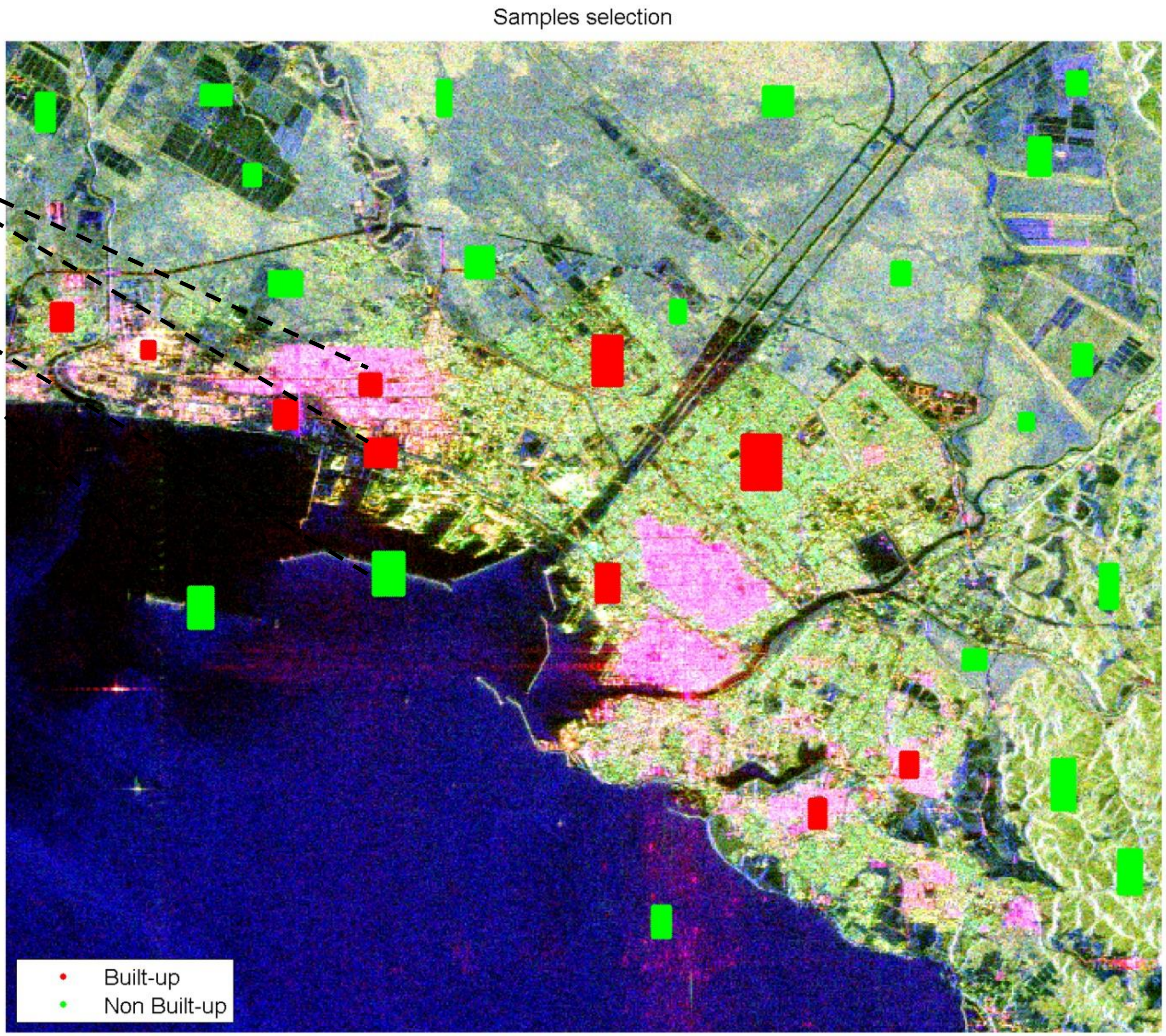
■ *Built-up samples selection*

built-up

non-built-up

built-up
- high density built-up
- low density built-up

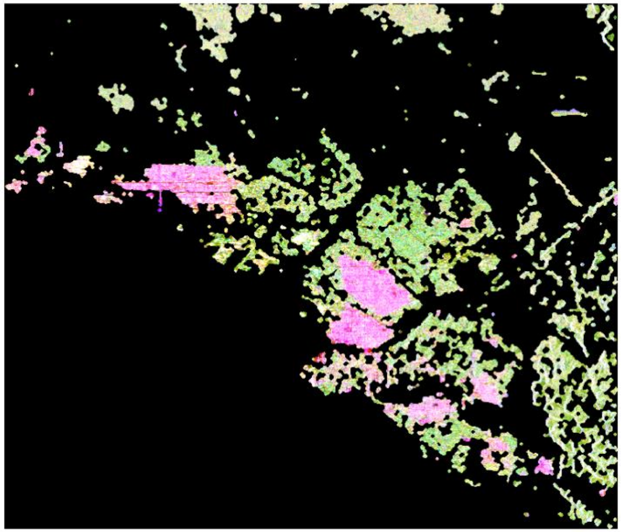
non-built-up
- Water
- Farmland
- bare soil
- Forest
- Road
- ……



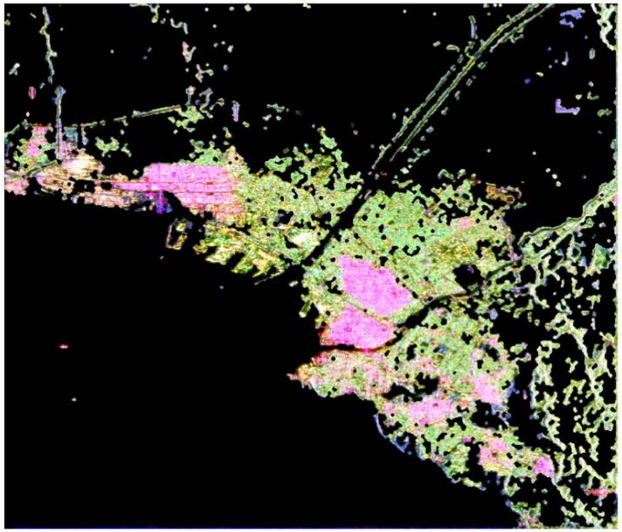
Experiment Results

■ *Built-up samples mapping: SVM*

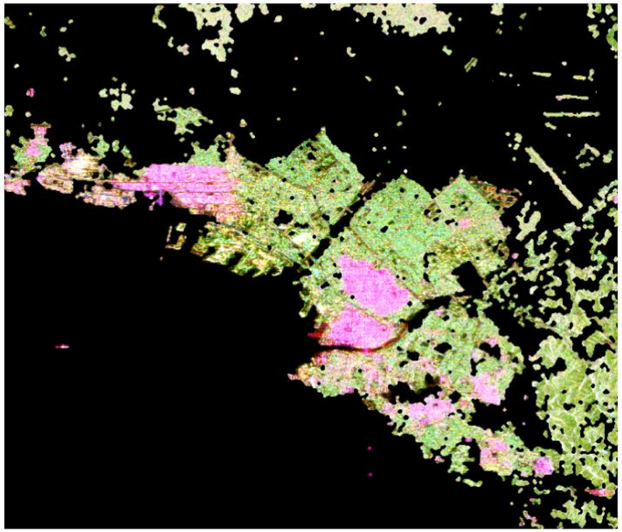
SVM-F1



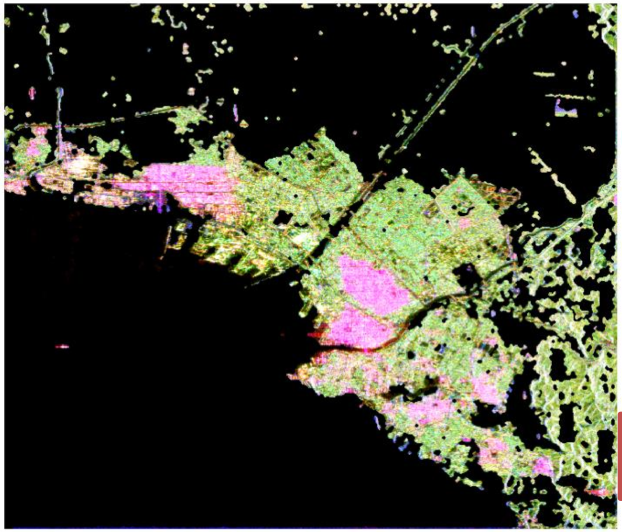
SVM-F2



SVM-F3



SVM-F4



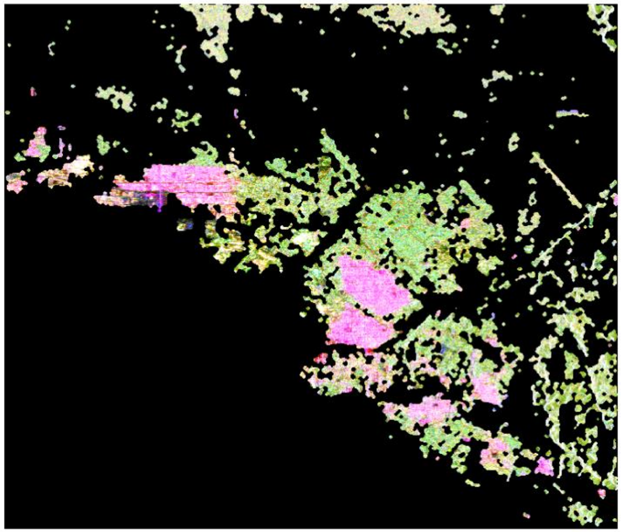
Features combination		B	B->N	N->B	N	Kappa
SVM	F1	0.6384	0.3616	0.0891	0.9109	54.93%
	F2	0.9416	0.0584	0.1165	0.8835	82.51%
	F3	0.9764	0.0236	0.0015	0.9985	97.49%
	F4	0.9935	0.0065	0.0054	0.9946	98.81%

polarimetric and texture parameters contribute to results

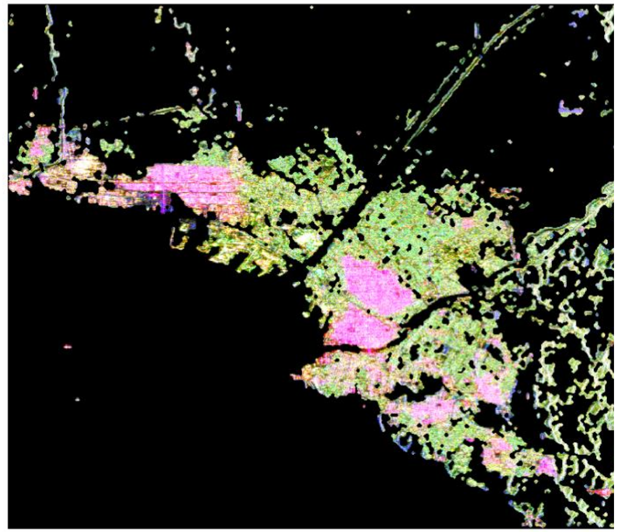
Experiment Results

■ *Built-up samples mapping: RF*

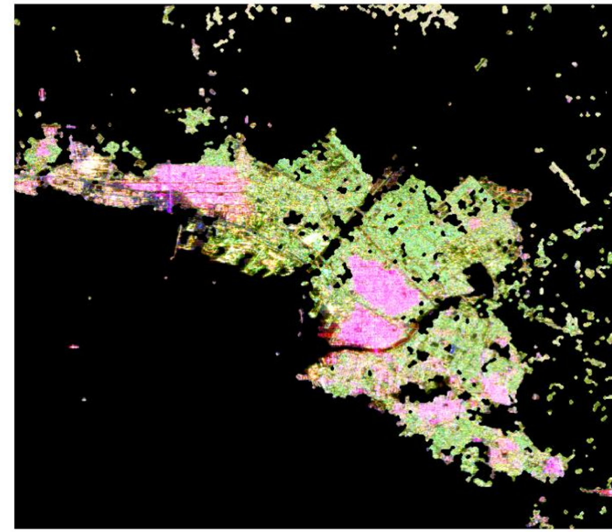
RF-F1



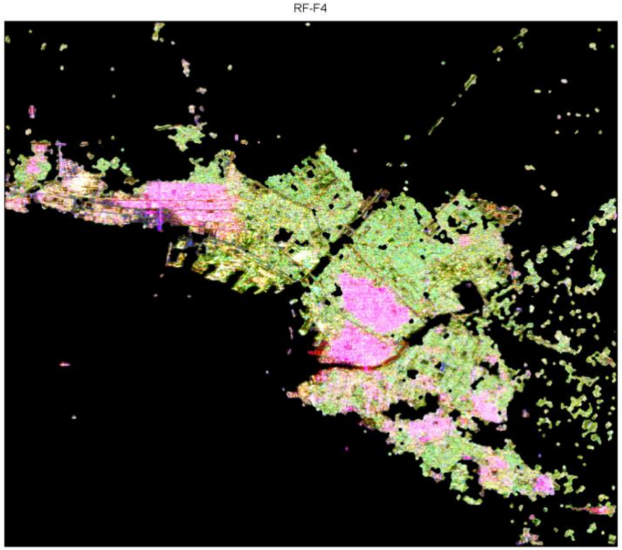
RF-F2



RF-F3



RF-F4



Features combination		B	B->N	N->B	N	Kappa
RF	F1	0.9995	0.0005	0.0002	0.9998	99.93%
	F2	0.9998	0.0002	0.0001	0.9999	99.97%
	F3	0.9994	0.0006	0.0002	0.9998	99.92%
	F4	0.9998	0.0002	0.0001	0.9999	99.97%

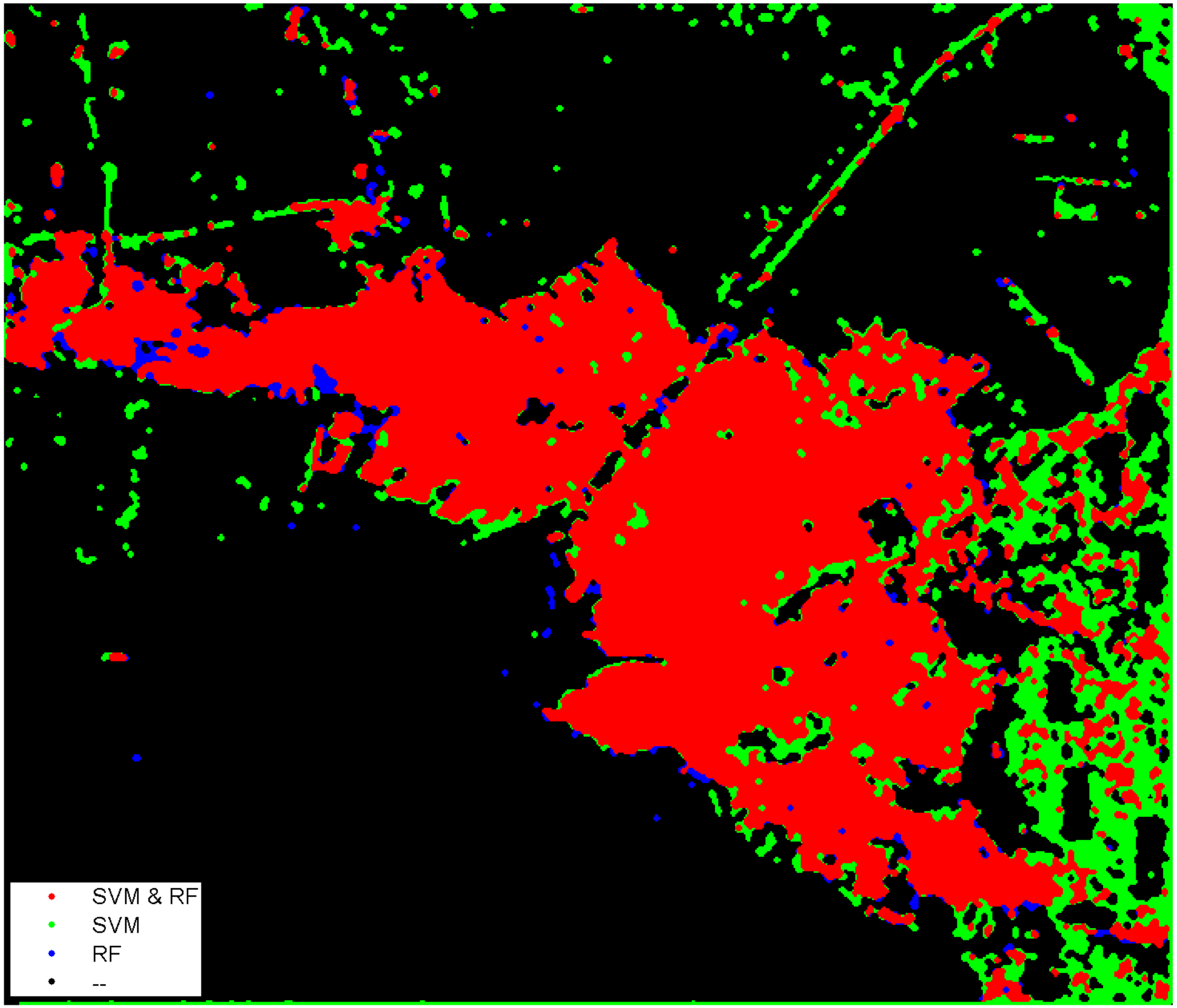
polarimetric and texture parameters contribute to results

Experiment Results

■ *Built-up samples mapping: SVM vs RF*

The majority of the built-ups have been detected by SVM and RF classifier. Part of forest areas have been classified as built-up by SVM. The mapping results not only depend on the feature parameters but also on the classifier.

Difference of built-up mapping between SVM and RF



Difference of built-up mapping between SVM and RF classifier

Concluding Remarks

- Assessing the polarimetric and spatial feature parameters for built-up mapping
- Comparatively investigating the performance SVM and RF classifiers.

- Both polarimetric and spatial feature parameters are effective for built-up mapping.
- SVM and RF are adequate built-up mapping using ALOS PALSAR data.
- Further work will be focused on the separation of built-up and forest by considering other polarimetric and spatial feature parameters and improving the performance of classifier.

Thanks for Your Attention