CE◉SpaceTech

DLR

Enhanced Classification of Land Cover through Joint Analysis of Sentinel- 1 and Sentinel- 2 Data

Anca POPESCU [(1)]   Daniela FAUR [(1)]   Corina VADUVA [(1)]   Mihai DATCU [(1, 2)]

[(1)] ETTI-EAII-CEOSPACETECH, University POLITEHNICA Bucharest, 060042, Romania
[(2)] German Aerospace Center DLR Oberpfaffenhofen, D-82234 Wessling, Germany
apopescu@ceospacetech.pub.ro

ABSTRACT

The new European missions Sentinel 1 and Sentinel 2 bring added value to the Earth Observation market for land applications by providing timely high quality products with complementary information. The efficient and effective exploitation of the vast amounts of data already delivered by Sentinel 1, combined with the data delivered by Sentinel 2 is mandatory in order to get improved capabilities for the understanding and modelling of land cover classes dynamic and synergy. In this context, this paper discusses a potential methodology for Sentinel 1 and Sentinel 2 joint analysis and highlights the benefits brought by the increased information yielded by putting together these two kinds of data. To this end, the proposed approach follows the next steps: data pre-processing and registration, data representation and combined feature extraction, data classification and interpretation. The results are emphasized on urban and agricultural areas of high heterogeneity.

INTRODUCTION

The current study aims to asses the degree of comprehension achieved by joint processing of Sentinel-1 and Sentinel-2 data. The data fusion is performed at feature level and the comparative assessment is achieved relative to the common single sensor approaches. Resulting products are single and joint sensor(s) land cover maps of the same scene with high complexity (urban area, water, forest, agriculture).

Benefiting from the availability of the Sentinel missions data, the feature level fusion strategy comes to extend the spatial and temporal coverage and to support various remote sensing applications.

For areas which are prone to risk such as Romanian County Vrancea (i.e seismic risk) it is important that pre- and post-event data be readily available. Therefore joint and/or complementary usage of optical and SAR data is desired. Examples include multitemporal/ multisensor feature level based data fusions for forest mapping based on ALOS PALSAR and Landsat data [1], building recognition in dense areas by InSAR and optical aerial imagery [2], and land cover classification based on ALOS PALSAR and ALOS AVNIR-2 data products [3].

Fig. 1 World View – SNAP City of Buzau and its surroundings, Romania

Fig.2 S-2, desceding orbit, 25.08.2015, natural colors

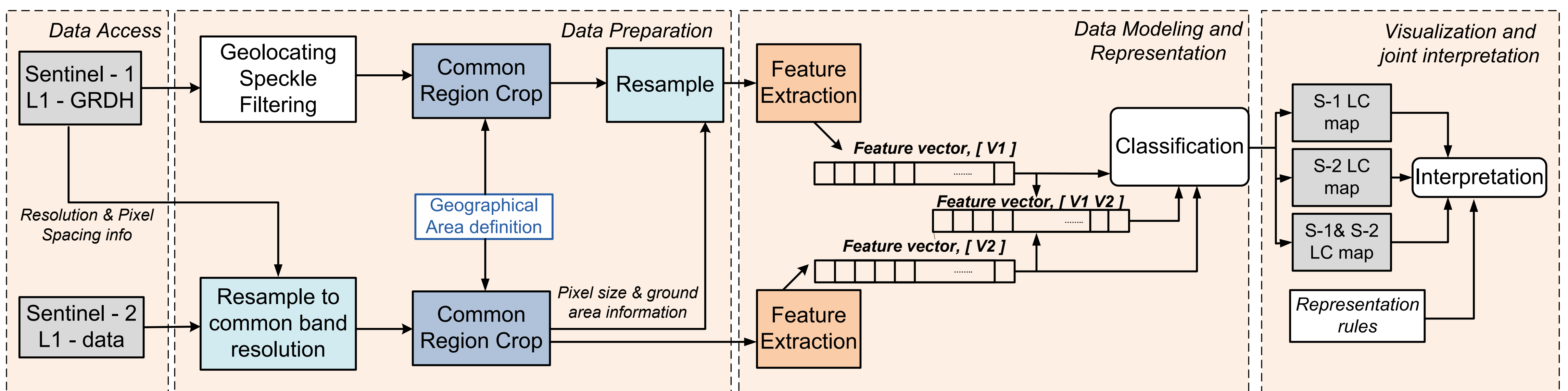Fig.3 S-1, GRDH, 22.08.2015, VH Polarization, rescaled

Fig. 4 Methodology

PROPOSED APPROACH

DATA PRE-PROCESSING

To allow for joint processing and interpretation of S-1 and S-2 data the following pre-processing steps were performed:

- First, both polarizations (VH, VV) of the Sentinel-1 GRD product were geolocated to eliminate the geographical ambiguity caused by the Side Looking SAR in ascending mode.

- Next, the bands of the S-2 product were brought to the same resolution (10m). This procedure accounted for the fact that the S-1 product has 20x22m with pixel spacing 10x10m.

- The SAR image bands (VH and VV) were de-speckled using an iterative probabilistic approach.

- Next, the area of interest was selected and both datasets were cropped to the same area of interest surrounding the city of Focsani.

- Finally, to ensure that the same ground sampling grid is employed in both datasets the SAR data was resampled to reach the same number of pixels as the optical data.

DATA MODELING, RESULTS AND INTERPRETATION

Feature extraction

The techniques applied to extract features depend on the characteristics of the data sources. SAR feature extraction was performed over both polarizations, at pixel level. There are three categories of computed features: i) Radiometric descriptors based on Information Theoretical Measures, ii) Texture descriptors based on local homogeneity, and iii) Spectral descriptors based on time-frequency representations of the data [4]. The optical features were represented by the pixel intensities at the different wavelengths, to exploit the multispectral capabilities of S-2. For classification purposes, each band was normalized independently, accounting for the maximum attainable pixel value.

Feature level based data fusion

The features extracted from the two datasets are sequentially concatenated into a feature vector to be further used in classification. The first 20 elements of the vector represent SAR extracted feature while the last thirteen values are the Sentinel 2 data bands. Advantages and limitations: Data fusion at feature level enables usage of data-specific primitive feature extraction algorithms. This allows for a better characterization of individual datasets and to jointly exploit the extracted information. At the same time, concatenation may cause over fitting for small size training samples. This is not an issue however for EO archives. Other difficulties in discovering of highly non-linear relationships that exist between low-level features across different modalities may be encountered, as there can be redundancies and dependencies between features extracted from different datasets which may be correlated. This limitation can also be dealt with by usage of dimensionality reduction techniques.

Classification The Sentinel 1- Sentinel 2 joint feature vector represents the visual word used for input to Latent Dirichlet Allocation (LDA) modeling [5]. Two parameters need to be chosen for the interactive classification: the number of topics W, the number of words q, and the size of the document n.
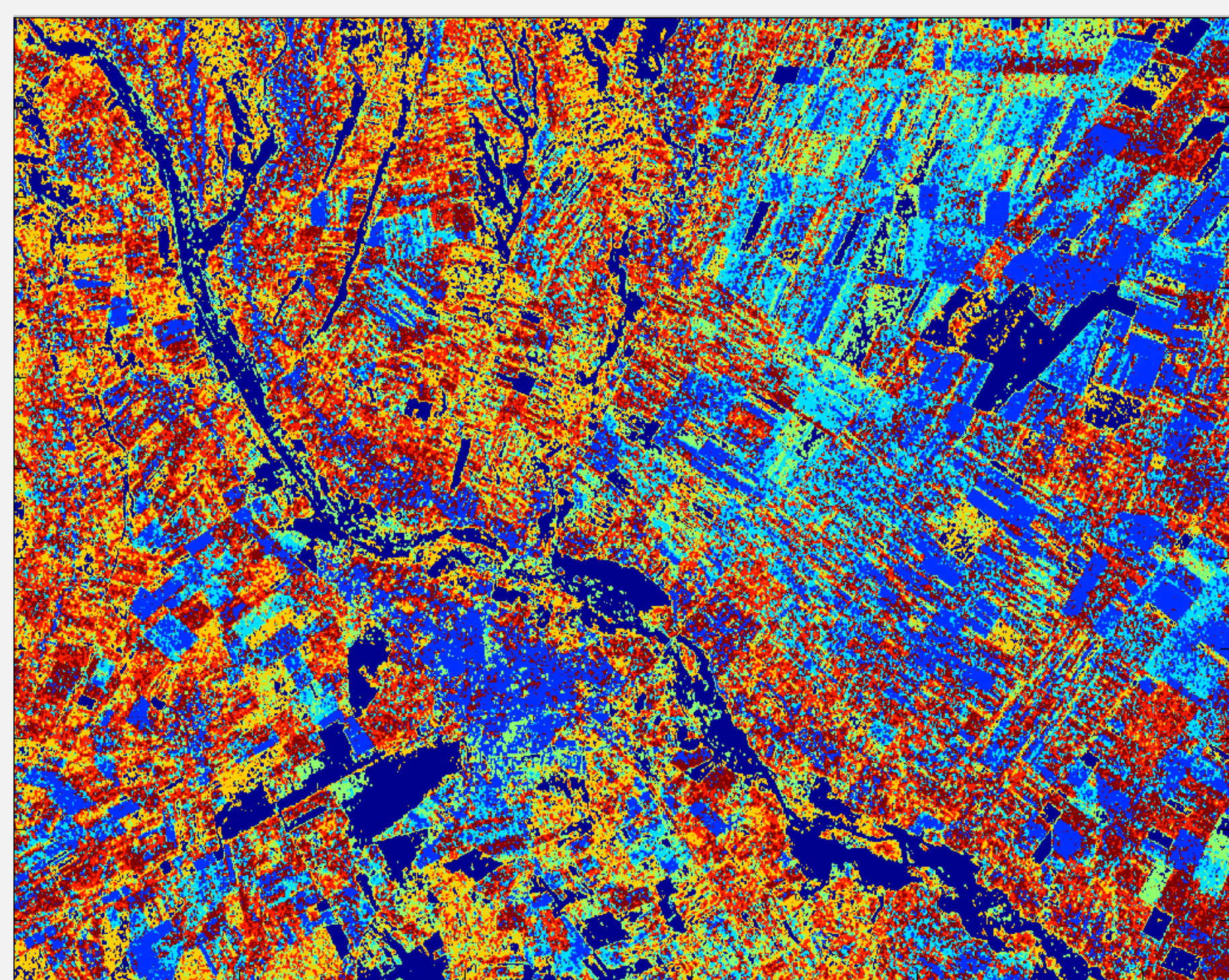
Fig. 5 Landcover map obtained throughout processing Sentinel 1 data feature space using LDA algorithm for classification. n=10, W=5, Q=100
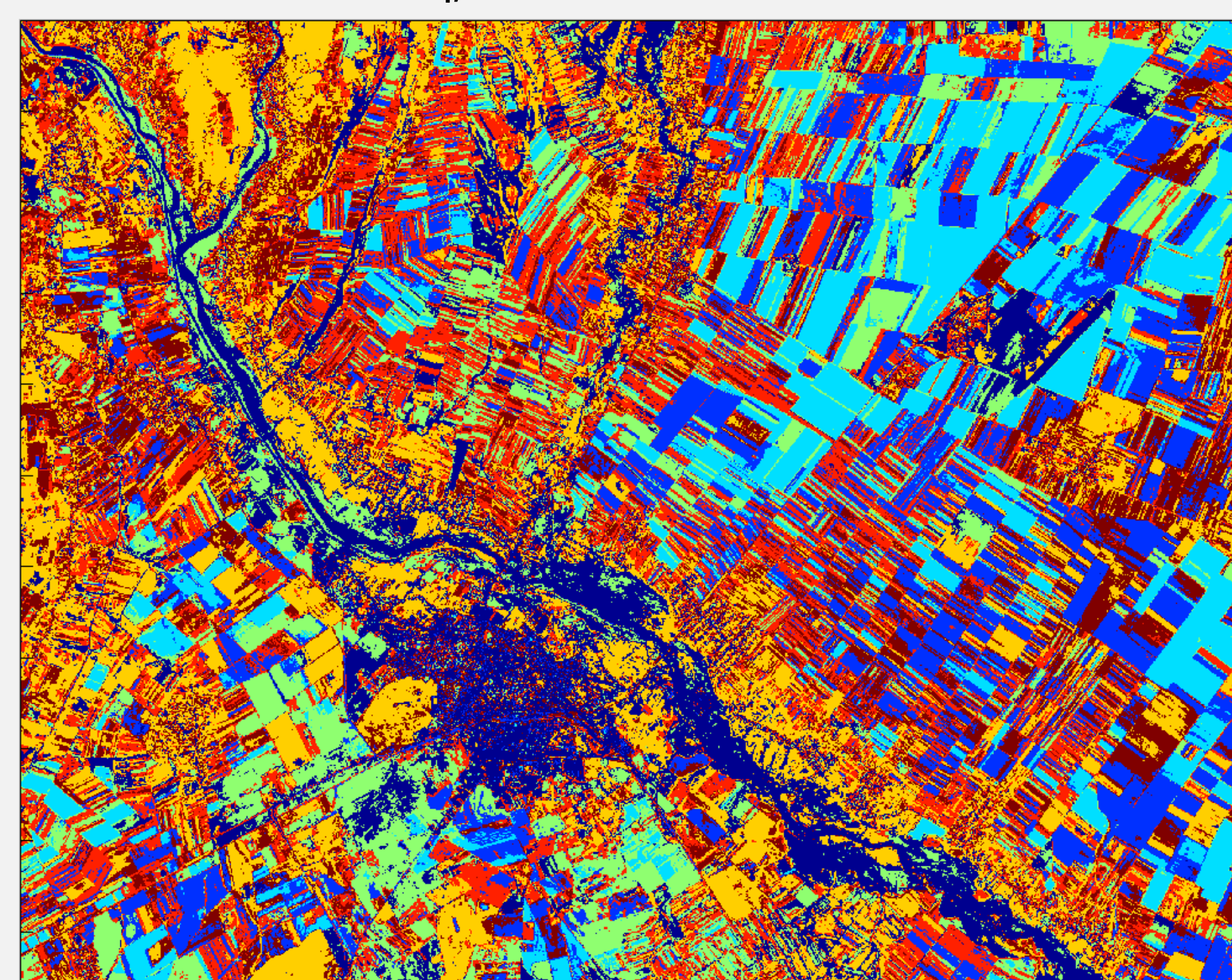
Fig. 6 Landcover map obtained throughout processing Sentinel 2 data feature space using LDA algorithm for classification. n=10, W=5, Q=100
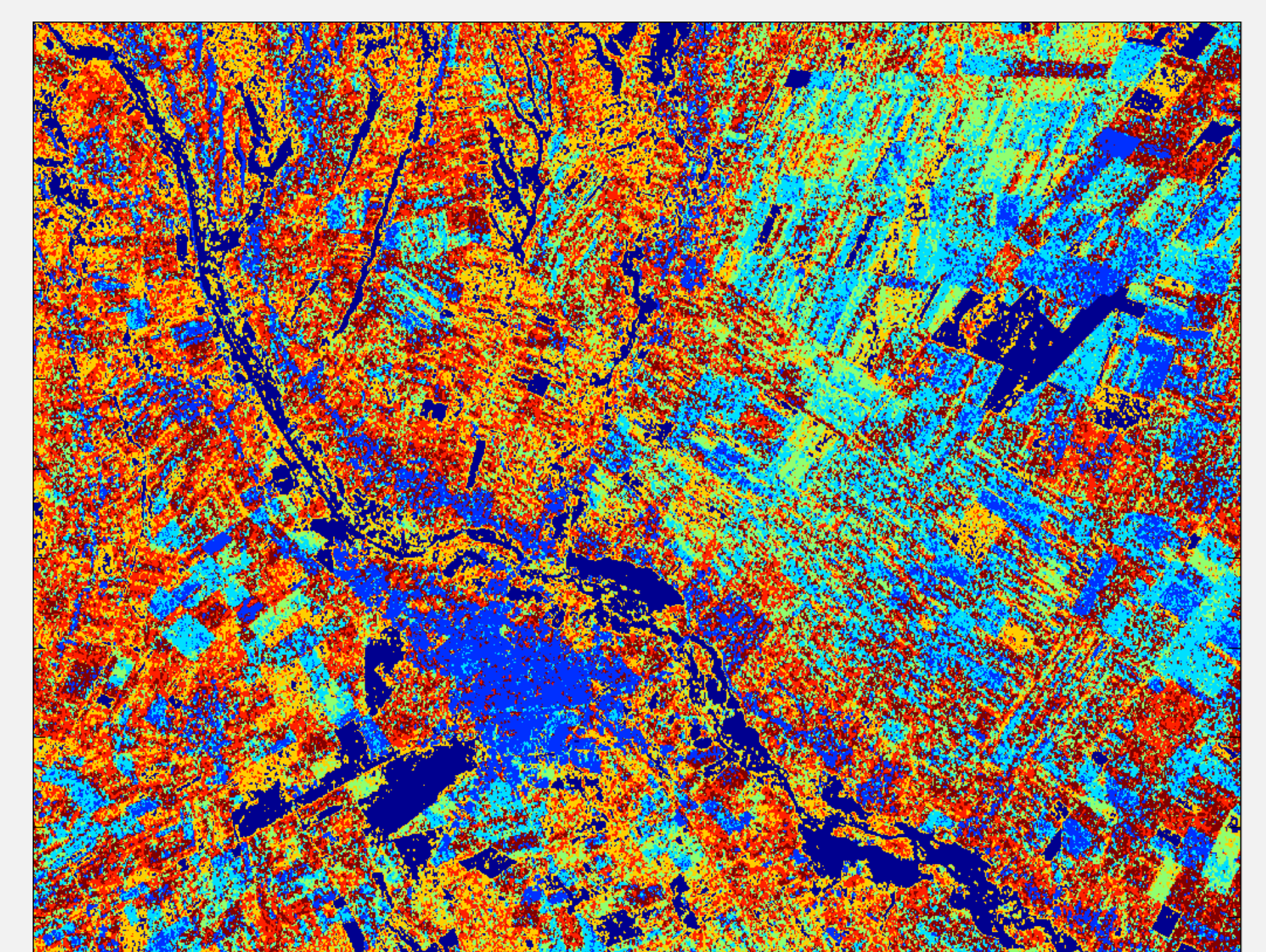
Fig. 7. LDA_S1 & S2_ n=10, W=5, Q=100

CONCLUSIONS

The proposed method aims to achieve a better understanding of the scene's characteristics by joint exploitation of S-1 and S-1 data. Comparative assessments of Landcover maps obtained through classification of single sensor feature spaces and joint feature space reveals that better discrimination can be achieved for a number of classes, including urban areas and water bodies.

REFERENCES

[1]. J. Reiche, C. M. Souza, D. H. Hoekman, J. Verbesselt, H. Persaud and M. Herold, "Feature Level Fusion of Multi-Temporal ALOS PALSAR and Landsat Data for Mapping and Monitoring of Tropical Deforestation and Forest Degradation," in IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 6, no. 5, pp. 2159-2173, Oct. 2013.

[2] J. D. Wegner, A. Thiele, U. Soergel – Fusion of optical and InSAR features for building recognition in urban ares – in Stilla U, Rottensteiner F, Paparoditis N (Eds) -CMRT09. IAPRS, Vol. XXXVIII, Part 3/W4 Paris, France, 3-4 September, 2009

[3] K. Chureesampant, J. Susaki – Multitemporal SAR and optical data fusion with texture measures for landcover classification based on the Bayesian theory , http://www.isprs-sc.org/newsletter_files/vol5no4/multi_temporal_sar_and_optical_data.pdf

[4] R. G. Baraniuk, P. Flandrin, A. J.E.M. Janssen, O. J.J. Michel "Measuring Time-Frequency Information Content using the Rényi Entropies", IEEE Transactions on Information Theory, vol 47, no 4, May 2001, pp 1391-1409

[5] D.M. Blei, A.Y. Ng, M.I. Jordan, ―Latent Dirichlet Allocation‖, Journal of Machine Learning Research 3, March 2003, pp. 993-1022.