# **Development of Copernicus and EO Based Products as Input** to Urban Regeneration Policies in Europe

### de Martino M.<sup>1</sup>, Serpico S.B.<sup>1</sup>, Sannier C.<sup>2</sup>, Soukup T.<sup>3</sup>, Desclée B.<sup>2</sup>, Jupova K.<sup>3</sup>, Krylov V.<sup>1</sup>, and Moser G.<sup>1</sup>

<sup>1</sup> University of Genoa (I), Dept. Electrical, Electronic, Telecom. Eng. and Naval Architecture (DITEN), sebastiano.serpico@unige.it <sup>2</sup> Systèmes d'Information à Référence Spatiale (SIRS) (F), christophe.sannier@sirs-fr.com <sup>3</sup> GISAT S.R.O., Czech Republic, tomas.soukup@gisat.cz





## Introduction

Urban sprawl is a Europe-wide serious problem, not only due to total area taken, but also because of its spatial distribution patterns (leading often to landscape fragmentation) and the composition of land taken (mostly agriculture and natural areas are converted to artificial landuse zones). Land is a finite resource and therefore urban planners need to select land for further development wisely applying the concept of *land recycling*. There is a need for *user-oriented services* facilitating the identification of suitable sites for redevelopment. To achieve this goal, the European Urban Atlas, the High Resolution Layer of Imperviousness degree together with other related global **Copernicus data sets** provide unique information for developing EO based information services. The aim of such services is to provide detailed information to policy makers and practitioners on potential land to be (re)developed within existing urban areas. This work focuses on the recent results obtained from the exploitation of these data sets, and especially from EO image analysis, within the "URBan land recycling Information services for Sustainable cities" (URBIS) project funded by the European Union as a part of the 2007-2013 Competitiveness and Innovation Framework Program (Grant Agreement n°621125). Within **URBIS**, a **service** for exploiting the aforementioned data sets to create and temporally update an inventory of *potential development areas (PDAs)* on the European territory is defined and experimentally validated on three pilot sites.

# Larger Urban Zone

The analysis is performed on European cities with agglomerations of over 100.000 inhabitants, which are covered by the *Copernicus Urban Atlas*. Three pilot sites are the focus of the study:

- City of Osnabruck (Germany);
- Moravian-Silesian Region (Czech Republic);
- The Greater Amiens (France).



Classification map						
building	roads	low veg	bare	tall veg	water	
95380	5968	2872	128	2241	34	0.8946
888	34072	3231	370	3774	5	0.8047
0	38	225729	0	1078	0	0.9951
1672	925	6021	161440	14901	0	0.8728
1205	5505	7094	1854	187095	0	0.9228
2296	2572	12627	0	9145	97629	0.7856
0.9403	0.6942	0.8764	0.9856	0.8573	0.9996	
0.9026	0.8793	0.8782				
Overall	Average	Карра				
	building 95380 888 0 1672 1205 2296 0.9403 0.9026 Overall	buildingroads95380596888834072038167292512055505229625720.94030.69420.90260.8793OverallAverage	Classification   building roads low veg   95380 5968 2872   888 34072 3231   0 38 225729   1672 925 6021   1205 5505 7094   2296 2572 12627   0.9403 0.6942 0.8764   0.9026 0.8793 0.8782   Overall Average Kappa	Classification   building roads low veg bare   95380 5968 2872 128   888 34072 3231 370   0 38 225729 0   1672 925 6021 161440   1205 5505 7094 1854   2296 2572 12627 0   0.9403 0.6942 0.8764 0.9856   0.9026 0.8793 0.8782    Overall Average Kappa	Classificati-mapbuildingroadslow vegbaretall veg95380596828721282241888340723231370377403822572901078167292560211614401490112055505709418541870952296257212627091450.94030.69420.87640.98560.85730.90260.87930.8782VerageKappa	Classification mapbuildingroadslow vegbaretall vegwater9538059682872128224134888340723231370377450382257290107801672925602116144014901012055505709418541870950229625721262709145976290.94030.69420.87640.98560.85730.99960.90260.87930.8782VerallAverageKappa

#### Amiens (F), 2012 – Land Cover map (above) and Imperviousness map (below) by SPOT5 data@2.5 m

Non-impervious
25% impervious
50% impervious
75% impervious
100% impervious



## Methodology

We employ the following *pixel and region-based classification* and multi-temporal image analysis techniques:

• Region-based random field models

Standard and multi-scale region-based Markov Random Fields

The results are produced on **SPOT-5 HRG** satellite images at **2.5 m.**, Urban Atlas maps, and ancillary data, in reference years 2012 and 2006 (not exhibited here). The **accuracy** is around 90%.



Classification map						Producer accurac	
Test samples	building	roads	low veg	bare	tall veg	water	
building	117285	962	127	5431	185	0	0.9459
roads	4177	39420	144	109	129	51	0.8953
low veg	0	107	295250	3959	1935	0	0.9801
bare soil	3482	1024	196	328715	115	0	0.9856
tall veg	920	6184	1676	1939	418257	0	0.975
water	186	116	536	29	117	339736	0.9971
User Accuracy	0.9305	0.8245	0.991	0.9663	0.9941	0.9998	•

(MRF) to integrate multi-source imagery and features.

### • Pixel-wise classification methods

Random Forest (RF), an efficient and flexible tools to perform classification based on multiple spatial, spectral, and textural image features.

### Domain adaptation and transfer learning

Graph-based techniques to minimize training requirements by transforming image data without training samples to match image data that are endowed with training samples and were collected under different acquisition conditions.

### **Employed Features**

The intended analysis relies on the use of the following urbansensitive features:

- Morphology and structural features to extract geometrical patterns;
- Texture description via (semi-)variograms and Grey Level Cooccurrence Matrix (GLCM) like contrast, dissimilarity and entropy features, for surface classification based on statistical contextual dependence properties;

	Producer accuracy						
Test samples	building	roads	low veg	bare	tall veg	water	
building	95410	2482	279	703	7238	0	0.8991
roads	0	14196	139	0	0	0	0.9903
low veg	0	487	194784	78	3727	0	0.9784
bare soil	31	158	11007	115426	1799	0	0.8988
tall veg	4317	146	4676	1402	290199	0	0.9649
water	37	0	9	0	34	19355	0.9959

0.9785 0.9632 0.9728 Overall Average Kappa

Ostrava (CZ), 2012 – Land Cover map (above) and Imperviousness map (below) by SPOT5 data@2.5 m

the multispectral data. **JRBIS** Partners

 Vegetation and water indices for the identification of vegetation and water classes based on reflectance properties of



Osnabruck (D), 2012 – Land Cover map (above) and Imperviousness map (below) by SPOT5 data@2.5 m



🄊 gisat		Universität Osnabrück	CHERENE ALTER		Agence de développement et d'urbanisme du Grand Amiénois
SAT	SIRS	UOS	UNIGE	STADT+	ADUGA
AT S.R.O.	SYSTÈMES D'INFORMATION À RÉFÉRENCE SPATIALE (SIRS)	UNIVERSITAET OSNABRUECK	UNIVERSITA DEGLI STUDI DI GENOVA	DR. FERBER, UWE UND	AGENCE DE
ha, CZECH REPUBLIC	SAS Lille, FRANCE Mr. Christophe Sannier	Osnabrueck, GERMANY Mr. Martin Kada	Genoa ITALY	PROJEKTGRUPPE STADT +	D'URBANISME DU GRAND AMIENOIS ASSOCIATION
Tomáš Soukup			Mr. Sebastiano Serpico	ENTWICKLUNGS	
				Leipzig, GERMANY	Amiens, FRANCE
				Mr. Uwe Ferber	Mr. Jérôme Grange

