



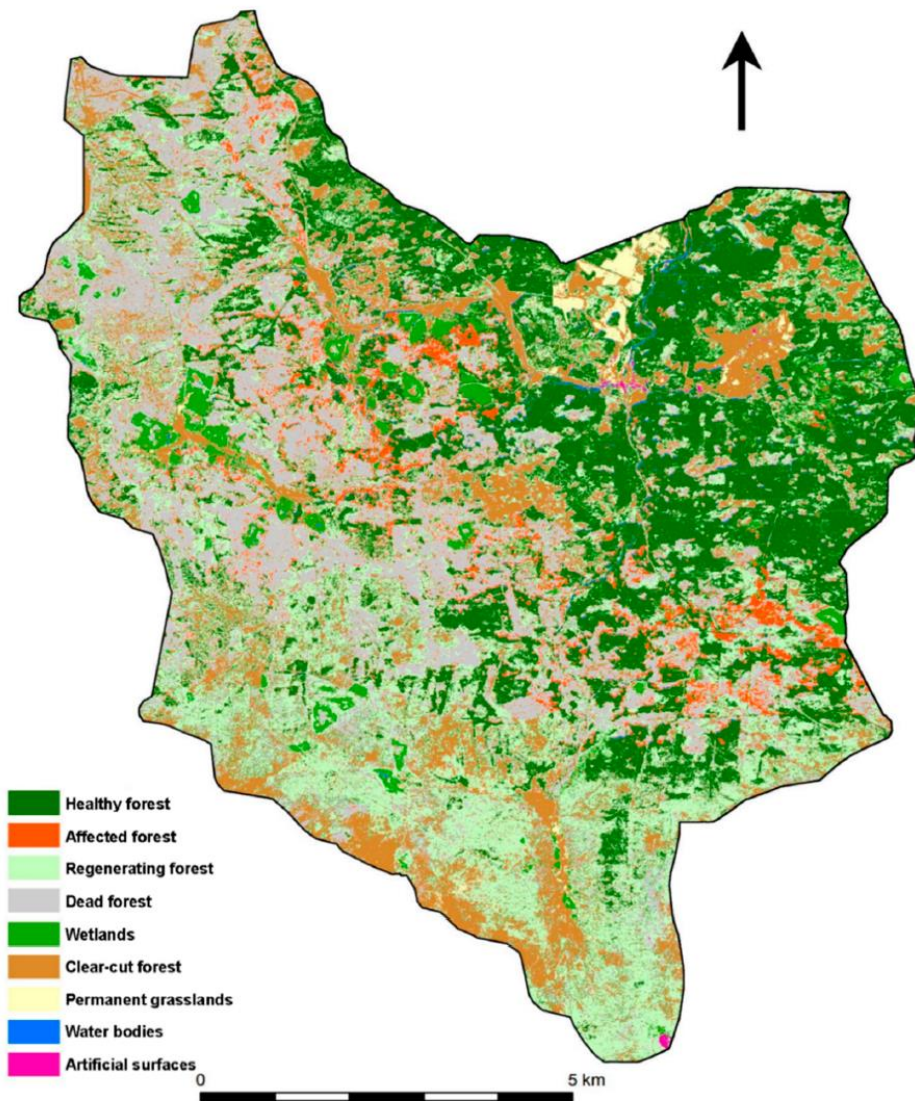
CHARLES UNIVERSITY
Faculty of Science
Department of Applied Geoinformatics and Cartography

A comparison of WV2 and L-8 classification of bark beetle outbreaks using a SVM and a NNs in the Sumava mountains

Seminar: Bark Beetle Damage in the SCERIN domain



Přemysl Štych, Josef Laštovička, Daniel Paluba and Barbora Jeřábková
EO4Landscape Research Team, Prague 2021



Article

A Comparison of WorldView-2 and Landsat 8 Images for the Classification of Forests Affected by Bark Beetle Outbreaks Using a Support Vector Machine and a Neural Network: A Case Study in the Sumava Mountains

Premysl Stych *, Barbora Jerabkova, Josef Lastovicka, Martin Riedl and Daniel Paluba

Department of Applied Geoinformatics and Cartography, Faculty of Science, Charles University, Albertov 6, 128 43 Prague 2, Czech Republic

* Correspondence: stych@natur.cuni.cz

Received: 15 June 2019; Accepted: 2 September 2019; Published: 11 September 2019

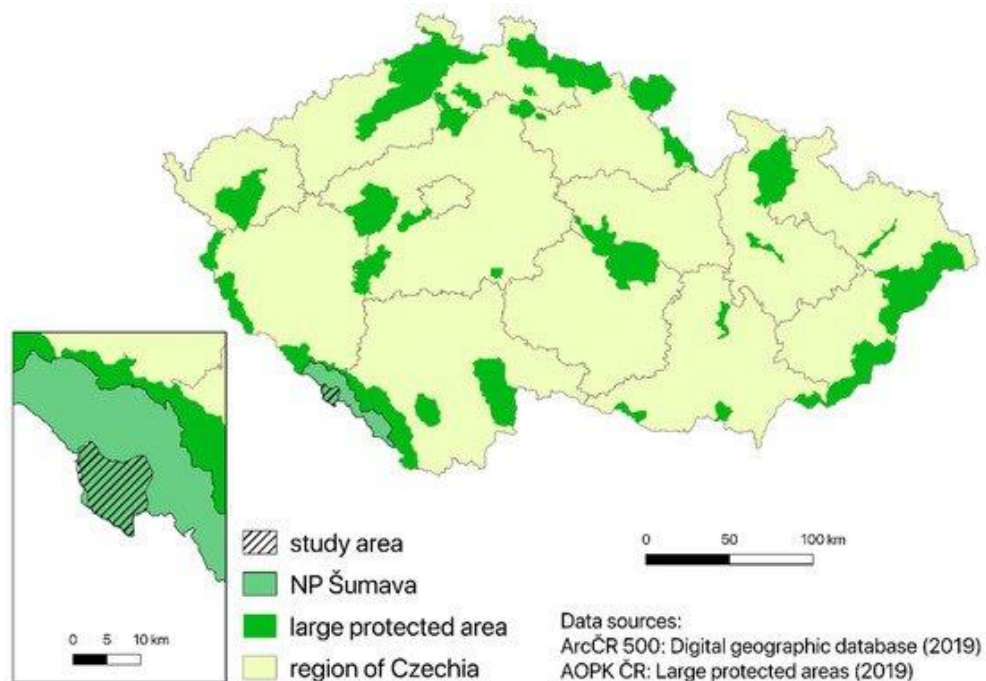


Abstract: The objective of this paper is to assess WorldView-2 (WV2) and Landsat OLI (L8) images in the detection of bark beetle outbreaks in the Sumava National Park. WV2 and L8 images were used for the classification of forests infected by bark beetle outbreaks using a Support Vector Machine (SVM) and a Neural Network (NN). After evaluating all the available results, the SVM can be considered the best method used in this study. This classifier achieved the highest overall accuracy and Kappa index for both classified images. In the cases of WV2 and L8, total overall accuracies of 86% and 71% and Kappa indices of 0.84 and 0.66 were achieved with SVM, respectively. The NN algorithm using WV2 also produced very promising results, with over 80% overall accuracy and a Kappa index of 0.79. The methods used in this study may be inspirational for testing other types of satellite data (e.g., Sentinel-2) or other classification algorithms such as the Random Forest Classifier.

Keywords: neural network; support vector machine; Landsat 8; WorldView-2; Czechia; forest disturbances

Introduction

- Disturbances in forest ecosystems in Central Europe
- Šumava National Park, year 2015
- Bark beetle calamities (*Ips typographus*)



Aims and Research questions

To assess WorldView-2 (WV2) and Landsat OLI (L8) images in the detection of bark beetle outbreaks in the Sumava National Park.

What is the impact of the spatial resolution of high and very high spatial resolution data on the accuracy of forest ecosystem classification?

What is the overall accuracy of the SVM and NN classifiers?

Input parameters, training areas, and other important parameters (e.g., number of iterations and background layers) have been tested

To interpret the results of the classification and define the positives and weaknesses of the used data and classification methods.

Data used – autumn 2015

Landsat 8

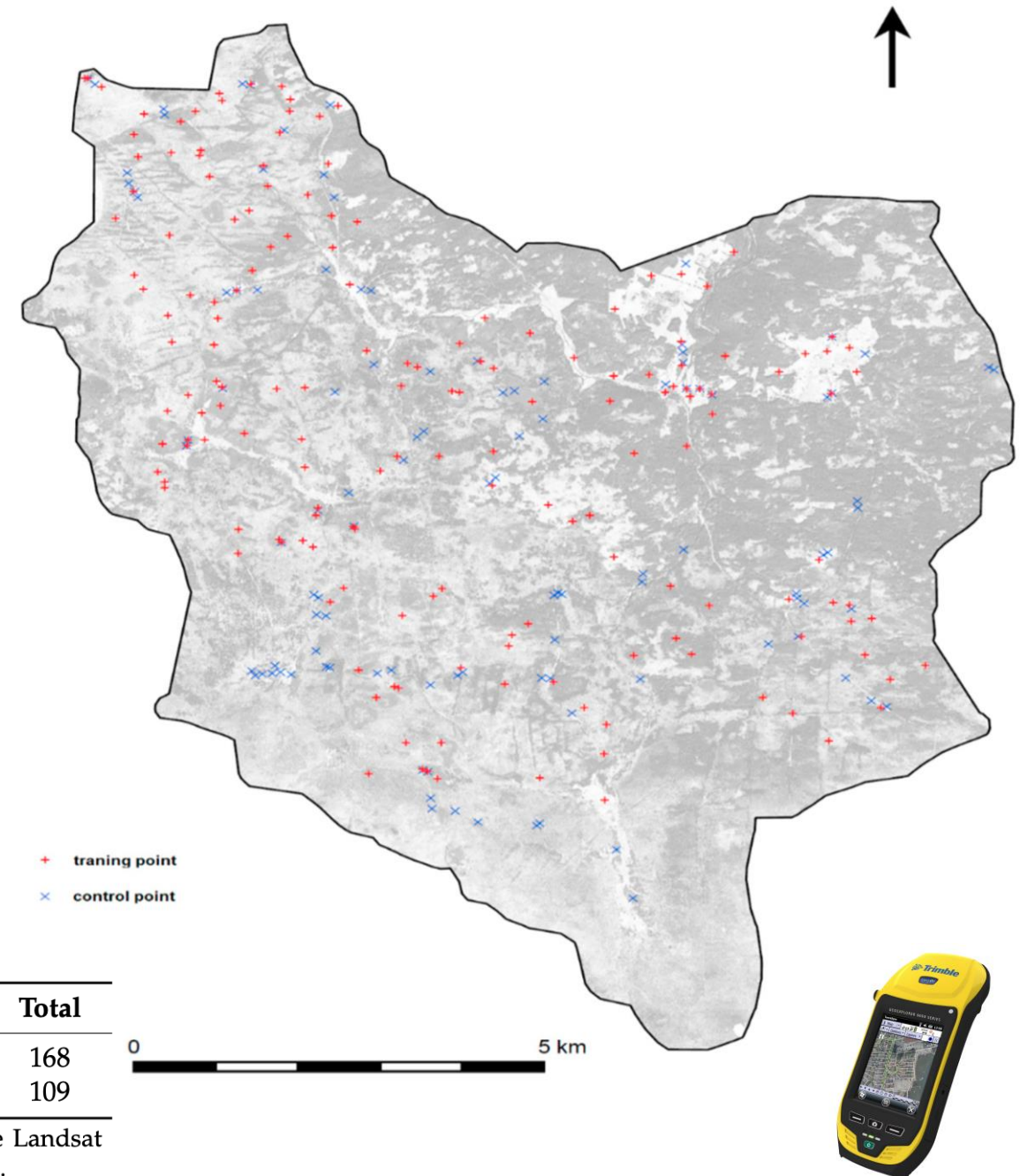
Band	Name of Band	Range from (μm)	Range to (μm)
1	COASTAL	0.43	0.45
2	BLUE	0.45	0.51
3	GREEN	0.52	0.6
4	RED	0.63	0.68
5	NIR	0.85	0.89
6	SWIR 1	1.56	1.66
7	SWIR 2	2.1	2.3

WorldView-2

Band	Name of Band	Range from (μm)	Range to (μm)
1	COASTAL	0.40	0.45
2	BLUE	0.45	0.51
3	GREEN	0.51	0.58
4	YELLOW	0.59	0.63
5	RED	0.63	0.69
6	RED EDGE	0.71	0.75
7	NIR 1	0.77	0.90
8	NIR 2	0.86	1.04

Methodology

- Free available data Landsat 8 and commercial data WorldView-2
- Ortho-rectification of WorldView-2 was performed in the ENVI software with DMR 5G (0,3 m)
- In-Situ measurement with GPS: Trimble Geoexplorer 6000 Geo XT GPS with an accuracy of ± 0.5 m
- Supervised classifications: Support Vector Machine and Neural Network classifications



Class	A1	A2	A3	A4	B	C1	C2	E	F	Total
Number of Training Points	25	24	20	27	16	23	11	11	11	168
Number of Control Points	20	16	12	17	10	15	6	7	6	109

Note: The points of water bodies (Category E) were excluded from the accuracy assessment of the Landsat classification because the water bodies were not classified by Landsat (low spatial resolution of Landsat).

Legend

- Healthy Forest (Class A1)
- Affected Forest (Class A2)
- Regenerating Forest (Class A3)
- Dead Forest (Class A4)
- Wetlands (Class B)
- Clear-Cut Forest (Class C1)
- Permanent Grasslands (Class C2)
- Water Bodies (Class E)
- Artificial Surfaces (Class F)



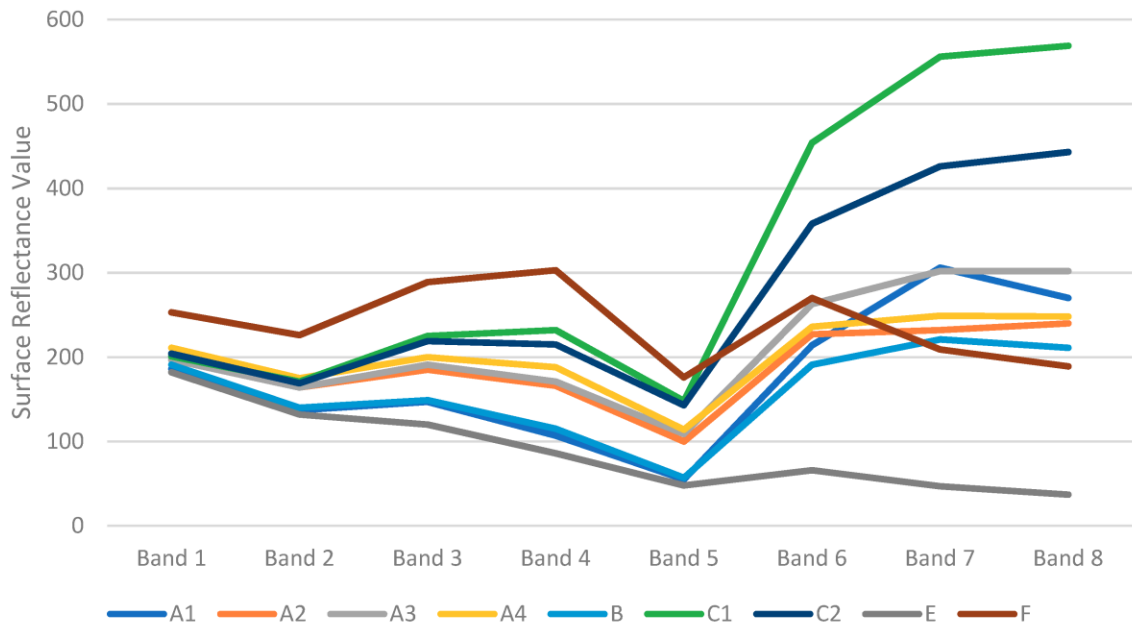
Figure A2. Aerial photo and photo of class A2.



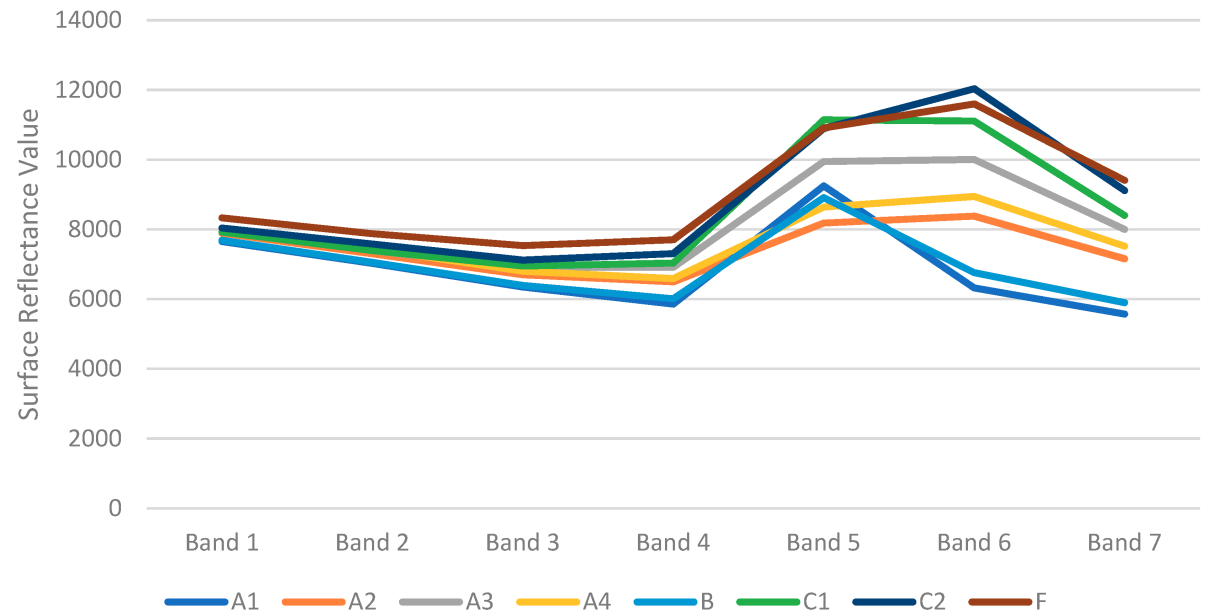
Figure A3. Aerial photo and photo of class A3.

Spectral curves for WorldView-2 and Landsat 8

WorldView-2



Landsat 8



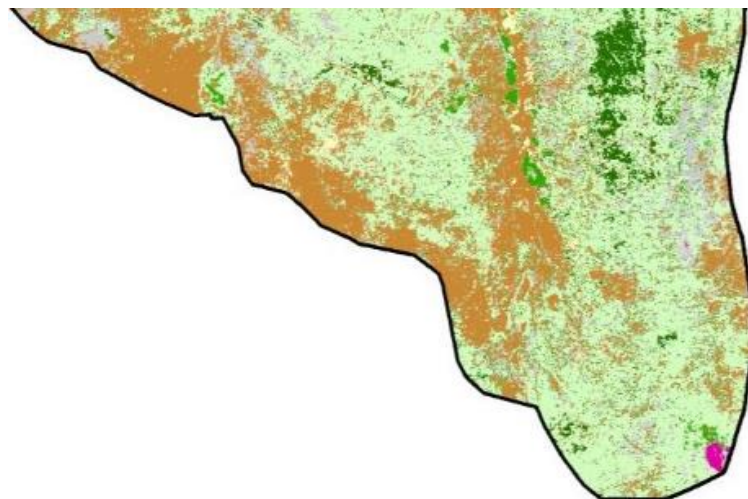
Results

- Data WorldView-2 higher overall accuracy
- For SVM and NN was with WorldView-2 data achieved overall accuracy higher than 80 %
- Landsat 8 data achieved for both classifiers overall accuracy higher than 69 %
- SVM achieved higher accuracy than NN

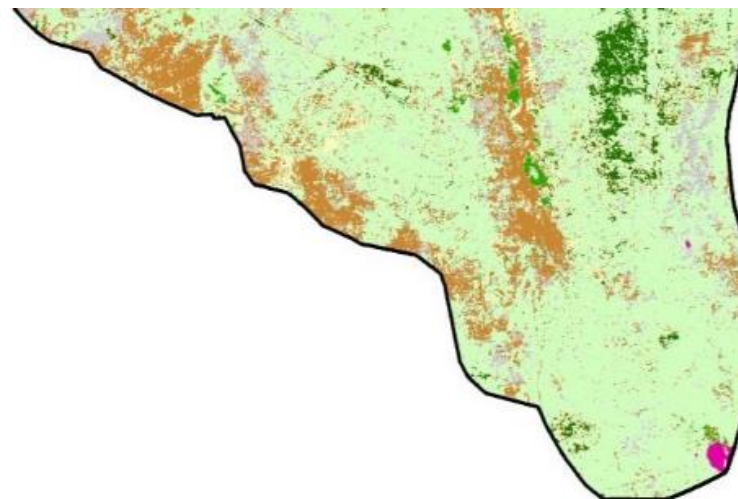
Table 6. Overall accuracy and Kappa index classification of SVMs.

SVM		Parameters			WorldView-2		Landsat 8	
Combination	Kernel Function	Gamma Parameter	Penalty Parameter	Polyonomy	Overall Accuracy (%)	Kappa Index	Overall Accuracy (%)	Kappa Index
1	RBF	10	50	-	76.15	0.73	68.63	0.64
2	RBF	Default 1	90	-	84.40	0.82	69.61	0.65
3	RBF	Default 1	100	-	84.40	0.82	70.59	0.66
4	polynomial	Default 1	90	6	84.40	0.82	70.59	0.66
5	polynomial	Default 1	100	6	86.24	0.84	70.59	0.66

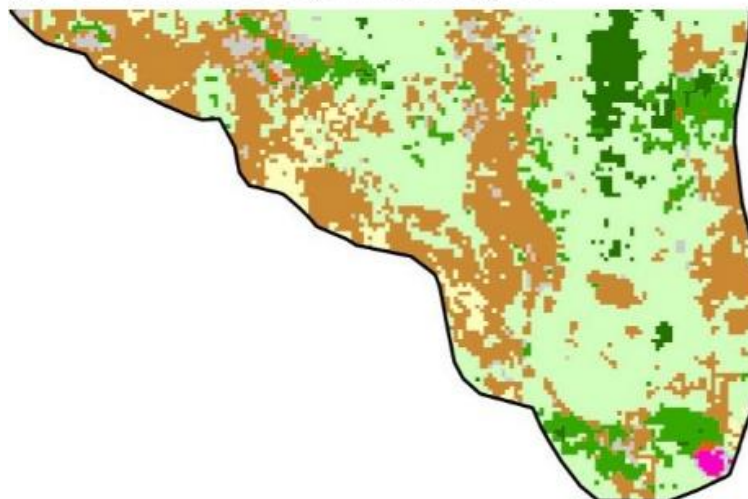
¹ Default Value—Landsat 8, $\gamma = 0.143$, WorldView-2, $\gamma = 0.125$.



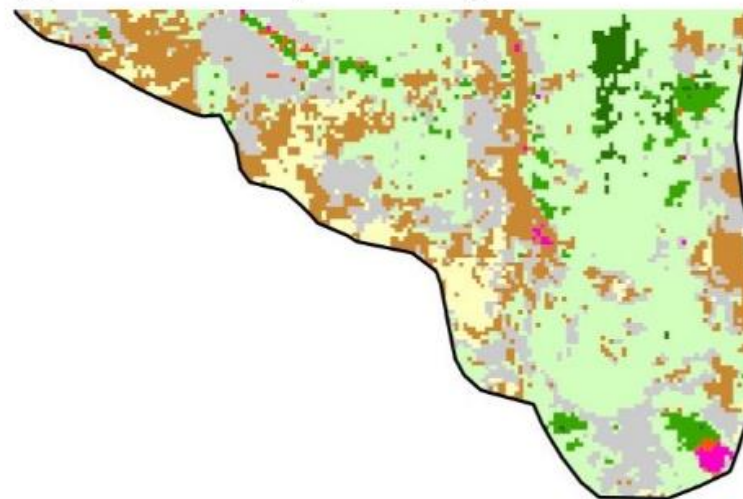
(a) Classification SVM, WorldView-2, 2016



(b) Classification NN, WorldView-2, 2016



(c) Classification SVM, Landsat 8, 2016



(d) Classification NN, Landsat 8, 2016



Conclusions

- a problematic classification was assumed for the classes of the affected (A2), dead (A4) and regenerating forest (A3).
- most precisely, these categories were distinguished by the SMV classification based on WV2
- WV2 is useful in small-scale case studies due to the better spatial resolution with a suitable spectral resolution (visible, red edge and NIR bands)
- Landsat data are suitable for larger-scale case studies/regions within a long-term period.



Thank you for your attention. Time for your questions.

Přemysl Štych
stych@natur.cuni.cz