DEUTSCHES GEOFORSCHUNGSZENTRUM
Department 1 Geodesy and Remote Sensing
Section 1.4: Remote Sensing
GFZ Potsdam - Telegrafenberg - D-14473 Potsdam – Germany

Dr. Sabine Chabrillat
Tel.: +49-(0)331-288-1108 ; Fax: +49-(0)331-288-1192
chabri@gfz-potsdam.de

Charles University in Prague
Faculty of Science
Department of doctoral studies
Prof. RNDr. Bohuslav Gas, Dean of the Faculty
Albertov 6, 128 43 Prague 2, Czech Republic

REPORT ON THE EVALUATION OF THE PH.D. THESIS OF MGR. VERONICKA KOPACKOVA ON THE THEME « HYPERSPECTRAL REMOTE SENSING FOR ENVIRONMENTAL MAPPING AND MONITORING »

The Doctoral Thesis of Mgr. Veronika Kopackova is part of the recent efforts in the Czech republic and at international level focusing on the use of airborne hyperspectal imaging to support environmental mapping and monitoring programs, through a case study on the Sokolov lignite mine, NW Bohemia, a region affected by long-term extensive mining. While it is already demonstrated that hyperspectral imagery is able to some extent to locally map mine tailings and acidic mine drainage in open areas in certain environments, such studies are still limited in spatial extent, and environmental monitoring capabilities are still to be demonstrated. Furthermore, the potential of the technique for multitemporal regional environmental mapping studying vegetation stress linked with mining environment, and relationships between soil and foliar chemistries was never tested. In this context, the work of Mgr. Kopackova shows its high significance especially in the frame of an application on the issue of mapping and monitoring of open-pits soil and neighboorhing forest health which is very finalized.

The doctoral thesis of Mgr. Kopackova presents itself as a typescript of 182 pages including appendix. The thesis is mainly composed of 7 chapters. First an introduction presents the background of the study. Then the following chapters present the application of hyperspectral remote sensing for acid mine drainage mapping and related issues (chapters 2-3), and for monitoring of vegetation stress on surrounding forests (chapters 4-6). Chapters 2-6 consist of separate chapters with separated abstract and reference list, each being associated with one peer-review publication. Two publications are printed (chapters 2, 4), three are in review. Please note that the PhD candidate appears as second author of the publication associated with Chapter 4.

Chapter 1 presents an excellent introduction chapter to the thesis that i can recommand as teaching/education purposes. It demonstrates the background knowledge of the candidate in mineral identification for acid mine drainage mapping and in vegetation stress identification. Chapters 2 and 3 show successfull approaches toward mapping of hazardous low pH material based on ASTER

satellite imagery linked with field spectroscopy data (Chapter 2), and toward surface quantitative pH mapping based on HyMap imagery (Chapter 3). For these applications of acid mine drainage mapping, despite many challenges in the remote sensing data (BRDF effects) and due to variable environmental surface conditions (mixing in the field-of-view of different elements), state-of-the art methods in hyperspectral imagery were successively considered combined with multi-variable statistical mapping. The results with an R_v^2 ~0.,76 in particular in chapter 3 are very impressive as very few works have been able to perform surface pH mapping based on remote sensing data. It shows the high skills of Mgr. Kopackova for the analyses of complex data and interpretation of reflectance spectra linked with geochemical modeling. Further, it allowed the assessment of surface pH in Sokolov open-pit mining areas and demonstrates the potential of imaging spectroscopy for acid mine drainage monitoring if the geochemical model can be transfered.

Chapter 4-6 represent a different thematic domain of study based on the same airborne data set. Chapter 4 shows the development of an innovative methodological approach in hyperspectral remote sensing to assess Norway Spruce forest health status, tested for 2009 data set. Here, one can regret that the detailed contribution of the PhD candidate in this chapter is not clearly stated, preventing the evaluation of the work performed. The approach developed allowed the mapping of vegetation stress through 5 relatives class of health status. Chapter 5 presents the externsion of this work to multi-temporal hyperspectral data set, where similar health classes are used. Then change analyses are performed linked with geochemical and biological ground work to study the evolution of health status from summer 2009 to summer 2010. The mapping and validation results obtained show change maps obtained for Norway Spruce health in four locations around the area of Sokolov mine with temporally and spatially coherent variability. The resulting maps based on the innovative and solid approach are very finalized and are quite impressive. The interpretation of the maps is based on careful analyses of environmental changes and on ground validation chemistry data. Chapter 6 represents the final step of the thesis, where innovative analyses are performed studying relationships between foliar and soil chemistries in points location. To the knowledge of the reviewer, this has never been attempted in other studies. This chapter, although more difficult to follow as it is very descriptive with very few summary graphs for all data, brings the whole thesis further as we reach another step of analyses and interpretation. The methodology here is based on correlation matrix and factor analyses linking soil with foliar chemistry. Although results at this level are necessarily still speculative, the maps and results presented in chapters 5-6 are original and force the admiration. It shows that the work performed is of high quality, leading to a high quantity of new information that will need to be validated.

Here i would like to address a positive criticism regarding the format of the thesis. In general through the chapter presentation, the reader is a little bit confused as a clear presentation of the hyperspectral data set and corrections (e.g. illumination effects) is missing. No reflectance image of the non-corrected imagery is shown, no spectral calibration/validation graphs. Also, in the vegetation study, not one single reflectance image spectrum is shown, neither e.g. the spectra in the 4

sampling locations. As a result, the reviewer cannot evaluate the quality of the remote sensing data and spectral changes in the Norway Spruce through the area.

In conclusion, Mgr. Kopackova performed a very high quality work contributing significantly to the advancement of the use of hyperspectral remote sensing and spectroscopy data for environmental monitoring. In particular, the resulting pH surface mapping and vegetation stress changes maps are original work, and the very rigourous approach followed demonstrate the mastery of the candidate for the tools studied. The impressive number of international publications submitted has to be underlined, since it is seldom achieved within the course of a doctoral thesis. For this, I recommand highly the thesis of Mgr. Kopackova as appropriate for defense. The work is of excellent quality and reaches highly the level sufficient to be presented for the award of the degree of Doctor of Philosophy from the Charles University.

Madrid, 16.09.2013

Sabine Chabrillat
Senior Researcher