SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Physical Geography

has the honour to invite you to the public defence of the PhD thesis of

Long LI

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Mapping and characterizing spectral evolution of lava flows with remote sensing: From field spectroscopy to satellite imagery

Promotor:

Prof. dr. Matthieu KERVYN

The defence will take place on

Tuesday, October 18, 2016 at 16:00

in Auditorium D.2.01 at the Campus Etterbeek of the Vrije Universiteit Brussel, Pleinlaan 2 - 1050 Elsene, and will be followed by a reception.

Members of the jury:

Prof. Dr. P. HUYBRECHTS (VUB, chairman)
Prof. Dr. N. KOEDAM (VUB, secretary)
Prof. Dr. C. SOLANA (UK, co- promotor)
Prof. Dr. F. CANTERS (VUB, co-promotor)
Prof. Dr. J. C-W CHAN (VUB)
Dr. P. TREFOIS (RMCA)
Prof. Dr. B. SOMERS (KUL)

Curriculum vitae

Long LI (born in Changsha, PR China) in September 1986, obtained his BSc in Geographical Information System and MSc in Physical Geography from China University of Mining and Technology and started his PhD at VUB in September 2012.

During his four year PhD study, Long has (co)authored 4 peer-review publications and a conference paper, and presented his research work at multiple national and international conferences (EGU2014, IUGG2015 etc.) by oral talks and posters.

He also supervised two master student theses.

Abstract of the PhD research

As important volcanic products, lava flows represent a persistent geohazard to human activities and to the environment. A strong interest therefore exists in mapping and characterizing historical lava flows, which has benefited considerably from recent advances in Earth observation techniques. The thesis aims at understanding the spectral evolution of lava surfaces in contrasted environmental conditions and at developing strategies for dating and mapping lava flows with remote sensing techniques from using satellite images to field spectroscopy.

Spectral reflectance measurements of lava surfaces on Tenerife Island (Spain), obtained through field spectroscopy, show that oxidation and lichen growth are two major processes affecting the spectral reflectance of lava flows in a semi-arid environment. Two spectral indices are accordingly proposed and applied to satellite imagery to quantify oxidation degree and lichen coverage, respectively. In tropical climates, vegetation grows fast and impacts lava spectra as well. Through linear spectral mixture analysis, one vegetation endmember and three lava endmembers, corresponding to old-, intermediate- and young-aged lava, are extracted from lava flows of Nyamuragira volcano (DRC). It is demonstrated that the spectral unmixing technique is capable of characterizing volcanic fields, of discriminating between different types of lava surfaces and also of enabling a timeline for vegetation recovery.

Based on the understanding that vegetation recovery is jointly governed by multiple factors, including time, topographic and climatic conditions, statistical models for dating lava flows are constructed for three African volcanoes: Nyamuragira, Mt Cameroon (Cameroon) and Karthala (the Comoros). The site-specific models prove to be robust and can serve as a tool for age prediction of undated lava flows. In addition to dating lava flows, remote sensing is also effective in mapping lava flows. From moderate spatial resolution satellite imagery, both pixel-based and object-based random forest classification is used for automated mapping and classification of lava flows. The object-based classification results in homogenous and continuous lava flow maps, in good agreement with the physical characteristics of lava flows.

In conclusion, the thesis contributes to an improved understanding of lava flows from a remote sensing point of view. It not only demonstrates how remote sensing techniques can be applied to date and map lava flows in the context of hazard management and mitigation, but also provides insights into the spatial pattern of vegetation recovery in volcanic regions.