Mapping a century of forest cover change and treeline dynamics in the north Ethiopian Highlands – the Lib Amba case

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North Ethiopian high altitude forests play an important role in the hydrology of the surrounding valleys and are critical in terms of biodiversity. Their composition and extension is potentially responsive to the risen average temperatures of the past century. We reconstructed the extent of the upper Erica Arborea L. tree limit since the 1930s in the north Ethiopian highlands: Lib Amba of the Abune Yosef Mt. range (12°04’N, 39°22’E, 3952 m a.s.l.) and the Ferrah Amba Mt. (12°52’N, 39°30’E, 3939 m a.s.l.). The present upper and physiognomic treeline limits were recorded by high resolution satellite imagery and field data (February, 2012). Historical treelines were studied from aerial photographs (1965-1982) and historical terrestrial photography (1907-1916). Automatic classification of the forest cover from orthorectified aerial photographs (1965 and 1982) and Bing Map images (Global Data, 2013) enabled a raster based change trajectory of the forest cover since 1965. Historical terrestrial photography (1917) is qualitatively analyzed to detect changes from the early twentieth century. Preliminary results indicate a severe decrease of the forest cover extent from 1917 to 1965, caused by recent land occupation and agricultural expansion of mountain regions. Subsequently between 1965 and present the forest density increased in small isolated patches and strongly degraded outside of these managed forest patches. We found evidence that the elevation of the Erica Arborea L. treeline increased slightly, which has to be understood against the important land use changes on the mountains and potentially by regional temperature rise.

Key words: Treeline dynamics, LCC, orthophotographs, North Ethiopian Highlands
Worldwide, urban growth or the consumption of land by built-up areas has become an issue of growing concern because of the related environmental impacts. Also in Flanders, the seemingly uncontrolled expansion of the urban fabric attracts the attention of policymakers and the academic world. The degree of imperviousness or soil sealing is a helpful indicator to estimate the spatial distribution and intensity of the observed urban development.

Impervious surfaces have become an important topic in research related to urban growth. Much work is done on the mapping of impervious surface cover by means of remote sensing imagery, and on estimating its environmental impact. However, only few publications focus on explaining the spatial pattern of impervious surface cover and on predicting its future evolution, given anticipated changes in land-use. This research aimed at developing spatial distribution models to explain and simulate impervious surface cover within different land use types in a highly urbanized and fragmented area in Flanders, including the Brussels-Capital Region.

The spatial variables defined for developing the models include the distance to various features of the transport infrastructure as well as the local density of a range of specific land-use types. These land-use-based variables allow relating the current land-use pattern with impervious surface cover distribution. As such, the models can be linked with a land-use change model to simulate the future impervious surface cover distribution from predicted land-use changes. Information on the actual land use, as well as future land-use simulations were made available by VITO and were produced with the RuimteModel Vlaanderen, a cellular automata-based model able to predict land use change for alternative development scenarios.

Impervious surface distribution models were defined for residential/commercial/agrarian development and for industrial development. First, a correlation analysis was done to explore the explanatory potential of the spatial variables and to define the optimal spatial scale for modeling the relationship between impervious surface proportions and the spatial variables. Next, global regression models (GRM) and regression tree models (RTM) were calibrated, and subsequently applied and validated on the land-use modeling resolution of 100m. By benchmarking the performance of the spatial distribution models against more elementary models, the added value of the models developed was assessed.

For residential/commercial/agrarian development areas, the best performing global regression model and regression tree model show a similar mean absolute error (MAE) of about 16 %, yet the regression tree model performs slightly better in reproducing the observed spatial variation of impervious surface proportions. The best performing models include, in order of significance, the local urban or residential land-use density, the distance to navigable waterways, the weighted distance to regional and local roads and the weighted distance to centers of development as explanatory variables.

For industrial areas, the best performing regression model also shows a mean absolute error of about 16 %, yet the model does not perform better than the more elementary models used in the benchmark, given the defined set of spatial explanatory variables.

The research conducted demonstrates the potential of spatially explaining and, hence, forecasting the distribution of impervious surface cover in Flanders based on the local density of land uses and on the distance to important features in the landscape. Future research should will focus on improving and refining the distribution models proposed and on application of the models to Flanders as a whole.
On the optimal delineation of urban agglomerations: 
a fractal solution and its application to the 18 Belgian cities

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Abstract
In this paper we extract the morphological boundaries of urban agglomerations and characterize 
boundary shapes using eight fractal and non-fractal spatial indexes. Analyses are first performed 
on six archetypal theoretical cities, and then on Belgium’s 18 largest towns. The results show 
that: (1) the relationship between the shape of the urban boundary (fractal dimension, dendricity, 
and compactness) and the built morphology within the urban agglomeration (fractal dimension, 
proportion of buildings close to the urban boundary) is not straightforward; (2) each city is a 
unique combination of the morphological characteristics considered here; (3) due to their 
different morphological characteristics, the planning potential of Flemish and Walloon cities 
seems to be very different.
SpatioData: une plateforme pour la gestion de l'histoire du bâtiment

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Résumé

Les travaux de rénovation sur un bâtiment existant sont souvent problématiques, l'emplacement des câbles n'est pas connu, on ne sait pas ce qu'il y a derrière le mur, on ne sait pas quel disjoncteur faire sauter pour couper l'électricité d'une certaine pièce. Ces informations relatives au bâtiment sont souvent lacunaires, perdues ou indisponibles au moment du travail. Pourtant toutes ces informations ont été disponibles au moment de la construction ou de la rénovation du bâtiment. Le projet SpatioData propose une solution pour encoder ces informations au moment de leur production avant qu'elles ne soient perdues. Il s'agit en fait de la constitution de l'histoire du bâtiment.

SpatioData se présente sous la forme d'une plate-forme Web, accessible en temps réel à partir d'une station de travail, d'un Smartphone ou d'une tablette. Il permet d'accéder à un modèle partagé du bâtiment et d'obtenir ou de fournir des données le concernant. Le projet a commencé en février 2011 et se terminera en janvier 2014. Ce projet est interdisciplinaire et regroupe des spécialistes de la construction, des architectes, des programmeurs, des spécialistes des bases de données, des géomaticiens et des ergonomes.

Les utilisateurs envisagés pour ce système sont très variés, il s'agit, par exemple, du gestionnaire de bâtiment, des techniciens (plombiers, électricien, menuisier, etc.), ou des propriétaires de maisons individuelles.

Face à cette diversité, développer une application unique est complexe. Nous avons choisi l'option de baser le système sur un serveur central et sur des applications clientes accédant au serveur. La force du système réside dans sa base de données commune à l'ensemble des intervenants du bâtiment. La particularité du système est, contrairement aux solutions existantes, de permettre d'encoder des données incomplètes, contradictoires et ambigües, voire fausses par moment. Les informations que peut accueillir le système sont variées : plans, croquis, photographies, textes, fichiers informatiques…

Le client principal constitue un socle de base pour l'interface utilisateur. Sa particularité est qu'il ne nécessite pas la saisie de longs formulaires fastidieux. Nous avons travaillé tout particulièrement à l'ergonomie et à la rapidité de la saisie de l'information. Le client principal est extensible par plug-ins de façon à répondre à un métier et à ses besoins spécifiques. En restant proche de l'utilisateur, la solution SpatioData ne nécessite pas l'apprentissage d'un logiciel complexe. L'intervenant encode facilement et rapidement ses informations et il accède aux informations pratiques ou techniques dont il a besoin.

SpatioData repose sur un modèle de données flexible, permettant une structuration spatiale, temporelle et sémantique souple des objets. Cette approche interdisciplinaire pose des questions fondamentales de représentation de l'information à grande échelle pour lesquelles l’apport de géographes géomaticiens est essentiel.
Capabilities of remotely sensed indexes to map and date lava flows of Nyamuragira using Landsat imagery

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Category: 5 Earth surface processes / geomorphology

To assess hazards of volcanic eruptions, it is essential to have a volcanological map indicating the extent and source location of historical and pre-historical lava flows. To date, a large number of volcanological maps have been created for active volcanoes, many of which should be updated because some lava flows were not precisely pinpointed or not mapped at all due to previously limited techniques or because new lava flows have been formed. For remote and inaccessible volcanoes like Nyamuragira, in D.R.Congo, remote sensing techniques are indispensable. Previous studies mapped lava flows based on visual interpretation of optical imagery or radar data or both of them. A good knowledge of eruptive frequency of volcanoes is important to prevent potential volcanic hazards but so far, dating lava flows using satellite imagery is less studied. This study aims at developing more simple and transferable techniques to map and date lava flows using remotely sensed indexes derived from easily accessed Landsat imagery of Nyamuragira.

Nyamuragira is a 3058 m high active shield volcano located in D.R.Congo. Data used for this study include 20 lava flows mapped and vectorized by Smets et al. (2010) for later accuracy validation and a Landsat ETM+ image acquired on January 31, 2003. The four remotely sensed indexes used here are commonly-used vegetation indexes (NDVI, normalized difference vegetation index, and SRVI, simple ratio vegetation index) and new rock indexes (NDRI, normalized difference rock index, and SRRI, simple ratio rock index) which are proposed in this study for the first time. Equations for rock indexes are similar to that for vegetation indexes but use bands 7 and 5 in place of bands 4 and 3. An appropriate threshold is identified for each index in order for the imagery of the four indexes to be classified into lava and non-lava surfaces.

Results show that the four remotely sensed indexes are effective in distinguishing vegetation and lava flows. The overall classification accuracy is greater than 93%. For each lava flow, SRRI has the best performance of detecting lava flows, particularly old lava flows erupted during the period from 1980 to 2002. Furthermore, linear relationship is found between the eruption year of lava flows and the four indexes. NDVI has the strongest linear relationship with the eruption year ($R^2 = 0.90$), followed by SRVI and NDRI (both of their $R^2 = 0.85$) and SRRI ($R^2 = 0.78$). Because of correlation among these indexes, multiple linear regression analysis fails to combine them together. Using only NDVI alone can relatively date lava flows but may not be able to calculate exact age of lava flows precisely. Consequently, in order to be able to obtain the age of lava flows as accurate as possible, more spectra-controlling factors should be found out and investigated in future work.
Past and future glacier retreat in the Swiss Alps:  
a modelling study on the Morteratsch glacier

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We use a glacier flow model for Vadret da Morteratsch (Engadin, Switzerland) to better understand its strong retreat since the end of the Little Ice Age (LIA) and to study its further disintegration under future warming. The 3-D higher-order glacier flow model is implemented on a 25 m horizontal resolution and the sliding and rate factors are tuned to measured surface velocities. The model is coupled to a 2-D energy balance model, which takes into account a parameterization of the surface energy fluxes, the shading effect of surrounding mountains and changes in snow thickness, which affect the albedo.

The observed frontal retreat since 1864 is reconstructed by forcing the mass balance model with monthly temperature and precipitation data from nearby meteorological stations. The modelled glacier evolution is validated by comparing it with past extents known from topographic maps and volume changes derived from DEM differencing.

Based on the Swiss Climate Change Scenarios CH2011, the future evolution of the glacier is simulated. Results indicate that due to its slow response, the present glacier geometry is severely out of equilibrium with today’s climate. Even without additional warming a strong retreat and mass loss are projected in the coming century and the Morteratsch glacier disconnects from its main tributary, Vadret Pers. Assuming a warming of more than 3°C by 2100, only isolated ice patches remain at high elevation. These are largely stagnant and precede the almost total demise of the glacier complex if those climate conditions were sustained beyond that period.