

GIS day 2012

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Poster Abstracts

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GIS Applications to Estimate the Demographic and Political Characteristics of Proposed Quebec Ridings.

Malcom Araos-Egan and Dr. Benjamin Forest

On July 17, 2012, the Federal Electoral Boundaries Commission for Quebec released its proposal for new Federal Election Districts (ridings). In its report, the commission included a description of the boundaries of the 78 ridings. In our analysis, we use GIS to impute the demographic and political characteristics of the proposed ridings using, respectively, 2006 Census data and the results of the 2011 Federal Election. Both Census and election data were assigned to the proposed districts using spatial allocation by centroid. We obtained Census data at the dissemination area (DA) level, and election results at the poll division (PD) level. Both DAs and PDs are small spatial and demographic units compared to ridings, which allowed us to aggregate data associated with DAs and PDs into the proposed districts. In the end, our analysis allows us to estimate the socio-demographic and political composition of the proposed ridings.

Global Data Development of Waterfall Features

Joseph Ariwi, Günther Grill and Dr. Bernhard Lehner
Waterfalls and cascades are ubiquitous topological features that naturally fragment river courses and stream networks. River fragmentation, both manmade and natural, cause well documented effects on the flora and fauna of river regions at varying scales. Despite their large effect on river ecology and hydrology, there is presently no existing waterfall database at the global scale. Therefore, the development of a waterfall dataset would open countless avenues for scientists, environmental modelers and other data users. User generated content (UGC) and other non-academic data can be a valuable contribution to data development efforts, provided that validation and data quality controls are performed. Data of this nature will work to improve the quality and depth of existing data. Proposing the inclusion of UGC, the goal of this project is to create a high quality global waterfall database product for integration with existing hydrological network datasets.

Can we build constructive spaces with 160 characters?

Ana Brandusescu and Dr Renee Sieber

Current research regarding mobile technology and location focuses on private and public aspects of space, particularly the effects of location on mobile

phone use. The anytime, anywhere allure of mobile phones has lead the devices to become integral to individuals' lives. Mobile phones in combination with social networking sites go beyond traditional approaches to data generation. Providing real-time information relating to place offers constructive insights for context, replacing information recall. The new data collection method is user friendly, with sharing and spontaneity as core factors. The research will assess whether the collection of virtual messages will determine common trends in perceptions of neighbourhood places among community members, via the Crowmap based *Espaces Lachine* website. Do Lachine residents care about comments regarding places in their neighbourhood? Is the location of their messages significant? Will the spatial representation of messages display different geographic and temporal distributions?

Semi-automatic Classification of the Tortuguero Conservation Area in Costa Rica using Geographic Information Systems.

Natalie Cornish, Dr Pablo Arroyo and Dr Margaret Kalacska

The objective of this project was to develop a new, semi-automated classification workflow for analyzing land use and land cover, as part of an ongoing deforestation/afforestation monitoring research effort for Costa Rica. Classifications were produced using 50 cm spatial resolution, orthorectified, colour aerial photographs of the Tortuguero Conservation Area (ACTO) in Costa Rica. ArcGIS and eCognition provided the tools necessary for preprocessing and classification of the acquired data. The resulting classification is intended to provide a baseline for future research assessing the quality of national forest cover assessments. Ultimately, this research aims to contribute to our insight on how to better monitor deforestation and conduct more effective forest cover change assessments.

Light use efficiency modeling in three Boreal ecosystems

Julie de Gea, Frank Ferber, and Dr. Margaret Kalacska

Understanding vegetation phenology through remote sensing is an important aspect of environmental studies. Advancements in technology have provided finer resolution data in remote

sensing data, allowing for the scaling of ground measurements to ecosystems. Phenological changes in vegetation obtained from remotely sensed data, however, are poorly understood. Measurements are either not temporal or involve short time frames of data collection, creating a gap in knowledge for understanding this relationship. In this study, we plan to analyze the spectral response over the growing season from three major boreal ecosystems (black spruce forest, burned jack pine forest, and a peatland) in the Eastmain-1 reservoir, Quebec in order to: **1.** understand the relationship between reflectance and vegetation light-use efficiency at various temporal scales and under various conditions, **2.** outline optimal time windows for imagery collection aimed at landscape-level estimations of light-use efficiency, **3.** help data users in improving carbon estimation models.

The influence of home neighbourhood characteristics on daily step counts in adults with type 2 diabetes mellitus

Samantha Hajna, Dr. Kaberi Dasgupta and Dr Nancy Ross

Rates of physical inactivity in Canada are alarmingly high. To facilitate population-level increases in physical activity, understanding the role of urban designs on physical activity behaviour is important. My research aims to quantify the unique impact that urban designs play in the walking behaviour of adults with type 2 diabetes (DM2), a population that is highly inactive. To accomplish this, I am conducting three studies each of which will explore a different aspect of the environment-walking relationship. The first will assess the relationship in a nationally representative sample of adults with DM2, the second will assess the role of season as an effect modifier, and the third will assess how increased precision of outcome measurement alters the observed relationships. Together, these studies will increase our understanding of the role of urban designs on walking and improve our capacity to facilitate increases in walking in adults with DM2.

Fragmentation of migratory fish habitat due to future hydropower development in the Mekong River Basin: Which dam is worst?

Günther Grill, and Dr. Bernhard Lehner
Compared to terrestrial connectivity, relatively little research has been carried out to advance freshwater connectivity assessments, especially not over larger scales. We present new hydrographic data and GIS-

based network tools to calculate connectivity indicators at the network scale. In a case study in the Mekong Basin we used presence-only data to create a simple species habitat model for 102 long-distance migratory fish based on minimum spanning trees within a graph-theoretical framework. We created an index to estimate the impact of 83 planned dams in the Mekong Basin. The index allows to assess each dam individually and to estimate the relative impact of its construction on individual and groups of species. We found that most long-distance migratory fish are potentially threatened by dam construction on the mainstem of the Mekong Basin, whereas dams built on smaller tributaries generally have little impact on network connectivity for fish migrants. We hope that our results encourages discussion amongst ecologists about new and better ways to include species presence data into freshwater connectivity models. Such models could then form part of large scale environmental impact assessment framework in order to improve conservation of freshwater species and to better inform decision makers about possible effects of dams in biologically sensitive areas.

Spatial analysis of sleeping sickness burden in Uganda.

Finola Hackett and Dr. Lea Berang-Ford
We mapped the burden of human African trypanosomiasis (HAT), also known as sleeping sickness, in Uganda, which had not previously been evaluated at the sub-country scale. Disability-adjusted life-year (DALY) totals for HAT were estimated based on modelled age and mortality distributions, mapped using Geographic Information Systems (GIS) software, and summarised by parish and district. The results showed that HAT burden in Uganda is greatly affected by the level of under-reporting and varies significantly across parishes. Furthermore, while the national total burden of HAT is low relative to other conditions, certain districts in Uganda are particularly severely affected by HAT. These results contribute to a more targeted approach to identifying and addressing the burden of HAT as a neglected tropical disease.

A Study of the Effects of Cadaveric Decomposition on Hyperspectral Signatures of Soil and Vegetation.

Carrie Herzog, Dr. Tim Moore, and Dr. Margaret Kalacskas

A greenhouse experiment was conducted with soybean and wheat plants under different fertilizer treatments and a cadaver proxy (pork liver) to test if spectral signatures from plants grown on soil with pork liver are spectrally different from those grown with different fertilizers (manure, blood meal or bone meal) and soil. The premise is that through decomposition, the pork liver will release nutrients and elements into the soil matrix affecting the spectral signature of the soil and vegetation. This research aims to test if different fertilizer treatments such as manure, blood meal and bone meal can be differentiated from grave spectral signatures and to determine if spectral signatures of vegetation in contact with graves are different from non grave sites. Preliminary results have shown that differences between reference soil and grave soils can be found around the 475-525nm range and from the 700-950 nm.

Forest Change Analysis in the Sino-Vietnamese Uplands using Historical Aerial Photographs - From the Colonial Period to Current Day.

Gabriela Ifimov, Dr. Pablo Arroyo, and Dr. Margaret Kalacska

Using aerial photographs from 1954 and 1993 taken over the district of Sa Pa, Lào Cai province, in Northern Vietnam, the aims of this project are twofold: first, to determine a standardized methodology to extract total forest cover from historical air photos. Second, to determine land cover change (forest and non-forest) in this remote region. Using an object based classification scheme, forest cover based on the texture and intensity of the greyscale photos was extracted. The results of the analysis show a 13.7% decrease in forest cover. The quality of the historical air photos limits the number of classes extracted from the imagery but nonetheless allows for abroad comparison of trends in land cover change.

The hyperspectral determination of Sphagnum spp. water content in a bog.

Mark Lalonde, Dr. Margaret Kalacska, and Dr. Tim Moore

Sphagnum spp. water content is an important ecosystem engineer in bogs, owing to the strong water holding capacities of *Sphagnum* spp., the dominance of *Sphagnum* spp. in bogs and the importance of water in regulating photosynthesis. Spectral vegetation indices (SVIs) derived from hyperspectral data are useful tools that allow for efficient modeling of *Sphagnum* spp. water content

at large scales. Nonetheless, the effectiveness of SVIs in this context has rarely been tested. This study tests whether linear models relating an SVI to *Sphagnum* spp. water content can be applied to CASI/SASI airborne hyperspectral images taken over Mer Bleue Bog, near Ottawa, Ontario, Canada. Results indicate that the Water Band Index (WBI) was the most effective in estimating *Sphagnum* spp. water content out of all the SVIs ($R^2 = 0.89$, $P = 0.00$). The application of the WBI to the area identified as being *Sphagnum* spp.-rich results in a map of *Sphagnum* spp. water content on that day.

Development and evaluation of a global river reach classification at high spatial resolution.

Camille O. Dallaire, and Dr. Bernhard Lehner

The growing pressure on freshwater resources and aquatic ecosystems mandates for advancements in sustainable watershed management; for example, new frameworks of environmental flow requirements are promoted as means of improving ecosystem resilience. These new and advanced methods require manageable freshwater units to be identified preferably accompanied with attributes that allow for stratified grouping or classification. Such units have previously been created on watershed and national scales, but a global classification at a high spatial resolution is not yet available. The Global River Classification (GloRIC) project aims to create such units based on the analysis of geo-physical characteristics of river reaches at the global scale. Part of this project is also to create a multi-scale, holistic and flexible framework for river classification based on the current literature. The final classes for each classification were analyzed for and compared with similar regional classifications and global units such as biomes and large river basins.

Regional-Scale Estimates of Connectivity : a New Circuit-Based Approach Using Tiling

David Pelletier, and Dr. Jeffrey Cardille

Connectivity models based on circuit theory, where each pixel in a map is assigned a resistance value like an electrical circuit, are useful tools that improve the ability of researchers and managers to plan land use. However, these models are resource-hungry and are of limited value when trying to use them to assess connectivity over very large areas. To allow connectivity assessments over large areas, we

developed a method that consists in cutting a large raster map into smaller square areas with ample buffer areas around them, called tiles. Each of these tiles is then processed in Circuitscape in East-West and North-South directions. The buffer area is discarded and the tiles are assembled back together in East-West and North-South directional maps, that are then combined into multidirectional maps. The resulting maps show possible paths for animal movements over very large areas with little to no artifacts at the tiles borders.

Biomass mapping using hyperspectral data in a Boreal forest ecosystem.

Carlomagno Soto, Frank Ferber, Dr. Ian Strachan, Dr. Pablo Arroyo, and Dr. Margaret Kalacska

Many sensors are designed to remotely model ecosystem aboveground biomass from airborne and space-borne platforms. However, specifically studies employing hyperspectral data have shown promising results linking biomass with spectral band ratios and allometric equations. This study will be focused on relating the spectral response of three boreal ecosystems (black spruce, burned Jack pine and peatland) to biophysical variables. The study area is located at the Eastmain reservoir in Northern Quebec, where hyperspectral data was collected with the CASI/SASI sensors. The imagery was collected by the National Research Council Canada's Flight Research Laboratory during the summer of 2011 in a collaborative project with Hydro Quebec. To validate the imagery classification and models a data set of aerial photos captured from a helicopter with a camera (Canon T1i) and a DGPS together with ground-based hemispherical and panoramic photographs will be used.

Hyperspectral remote sensing of individual clandestine graves.

Eva Snirer, and Dr. Margaret Kalacska

Detection of gravesites through hyperspectral remote sensing is a multidisciplinary approach encompassing various disciplines such as physical anthropology, geology, plant physiology and remote sensing. I investigate the use of hyperspectral remote sensing as a technique for the detection of individual gravesites. The key research questions investigated are 1) how does burial depth affect the spectral signature?; 2) how long do these effects persist at detectable levels?; 3) how does spectral

signature change over time?; and 4) what is the chemical basis responsible for these changes?

Essentially the body is treated as being a form of environmental contamination. It is known that a decomposing body alters the surrounding soil environment and that the changes in the soil matrix alter plant chemistry, which in turn are reflected in the plants' signature. Using Airborne hyperspectral data collected at the experimental site, as well as laboratory based soil and vegetation sample spectra in conjunction with chemical analysis of the soil and vegetation, I explore the relationships between the various disciplines and research questions.

An Assessment of Carbon Variability across Costa Rica using Forest Management Data.

Sienna Svob, Dr. Pablo Arroyo, and Dr. Margaret Kalacska

As a reaction to decreasing tropical forest cover and increasing greenhouse gas emissions, many studies and international organizations have emphasized the need to measure and monitor tropical forest carbon stocks. This study addresses the use of natural forest management plan (NFMP) data to estimate above ground carbon stocks across the diverse ecosystems of Costa Rica. In this study, a geodatabase will be designed and developed to store NFMP data collected from five of Costa Rica's conservation areas (CAs). Using the functionality of the geodatabase, the carbon stocks of each NFMP unit will be estimated via allometric equations. In a final step, a Bayesian belief network will be created to model the distribution and variability of above ground carbon stocks across the lowlands of five Costa Rican CAs. This research will provide a unique digitized record of Costa Rican forests and the baseline ground level data needed to monitor national carbon stocks.

Integrating Geospatial Principles with Bayesian Networks for the Analysis of Historical Indian Ocean World Data.

Sienna Svob, Jin Xing, Dr. Margaret Kalacska, and Dr. Gwyn Campbell

This project combines the use of Bayesian Networks and geospatial principles to analyze historical data on the Indian Ocean World. The objective of the project is to model the relationship between climate change (mainly long periods of drought with consequent crop failures and associated disease) and economic change. Of particular interest is the comparison of historical data from three major

periods hypothesized to be times of global economic upturn (200 BCE to 200 CE; 800-1300 CE, and 1800-1900) and times of economic stagnation between these periods. In this study, geospatial principles are used to aggregate and clean the raw data used to train Bayesian Networks. Bayesian Networks are used to model and visualize the complex relationships between migration, exchange, disease and natural disasters. This research shows the utility of using advanced machine learning, statistical tools, and geospatial principles for historical data analysis.

Assessing Coastal Squeeze of Tidal Marshes

Dante Torio, and Dr. Gail Chmura

As sea level rise and land development intensify along the coasts, natural habitats will become more threatened by coastal squeeze. Barriers that protect coastlines from rising sea level prevent or reduce tidal flows while impermeable surfaces prevent wetland from establishing in the adjacent uplands. Coastal squeeze will vary in scale, intensity and time with the contribution of different natural and anthropogenic barriers. Subsequently, it may affect the ecological functions of coastal wetlands. In conserving current and future tidal marshes, it is important to locate and quantify the intensity of coastal squeeze on the landscape. We ask to what degree the current landscape around salt marshes contributes to coastal squeeze as sea level rises? In this study, we investigated how to rank topographic and impervious surface data derived from LiDAR and ASTER imagery using fuzzy logic resulting in an index that can be used to evaluate any tidal wetland.

Determining the effect of socio-ecological factors on forest cover change (1999-2009) in northern upland Vietnam using GWR.

Kate Trinski, and Dr. Thi-Thanh-Hiên

This research aims to explore the extent of forest cover change and its socio-ecological predictors in 5 remote border districts of Lao Cai province, Vietnam. Forest cover in this location is extensive and provides a wide range of resources for ethnic minorities (e.g. honey, cardamom, timber) and hence contributes largely to their livelihood diversification. Old-growth and regrowth forest were calculated using Landsat images from 1999 and 2009. Forest cover change was analyzed using geographically weighed regression with respect to slope, elevation, distance to markets, distance to border and distance to roads. Results indicate that the topographic factors are the most important variables associated to changes in forest cover. Old-growth forest increases with increasing slope while regrowth increases with decreasing elevation. Both relationships vary spatially and to explain such local variation, further research needs to be conducted on local forestry policy and cultural practices of land use.

IHC3: An Integrated Hybrid Cloud Computing Cyberinfrastructure for GIS/RS Research

Jin Xing, and Dr. Renee Sieber

With the advancement of technologies, earth observation data could be obtained with finer spatial and spectral resolution. However, the increasing volume and complexity of those high resolution data presents new challenges in geographic information systems (GIS) and remote sensing (RS) research, especially for the underlying geospatial cyberinfrastructure. Therefore, I propose IHC3—integrated hybrid cloud computing cyberinfrastructure for advanced geospatial cyberinfrastructure research. IHC3 is designed to seamlessly integrate the computing resource of local hardware with public cloud providers, and it can dynamically adjust the boundary of private and public cloud with respect to the variable workload. A set of functionalities to simplify the image data processing, analysis, and visualization in GIS/RS research are also implemented in IHC3.