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CORPORATE OVERVIEW:

Environmental Geosolutions is a full-service geomatics company serving clients in both Canada and the USA. The company has a mandate to develop custom geospatial products and tools for targeted user groups that lead to more applied uses of geospatial data. Environmental Geosolutions was founded by Stephen Boles in 2005 to perform product development and delivery of geomatics services (GIS, remote sensing, web-based mapping, computer modeling), primarily for agro-forestry applications. Boles has been active in the GIS and remote sensing communities for over a decade, authoring numerous peer-reviewed journal articles and speaking at conferences and workshops regarding various applications and products derived from geospatial technology. Boles has been active in the development of geospatial products to address a wide range of issues, including avian influenza risk assessment, greenhouse gas emissions, precision agriculture, and water quality monitoring.

KEY QUALIFICATIONS:

Thematic capabilities

- Development of geospatial tools (based on GIS, remote sensing, and computer models) to assess a multitude of issues facing the agro-forestry sector
- Development of on-line visualization and distribution environments for GIS and remotely-sensed data products
- Expertise in the analysis of geospatial, remote sensing, and related infrastructure at the local, regional and national level
- Developing successful technology transfer procedures for geospatial information
- Proficiency in renewable and non-renewable resource and environmental monitoring within the framework of sustainable development

Technical capabilities

- Consultation and database development for agro-forestry applications involving the use of geospatial and model-based tools
- Remote sensing analysis methods and field work planning and support for several sensing systems (radar, hyperspectral, and multi-spectral, airborne)
- Public speaker and author related to the use of remote sensing and geospatial information

NATIONAL AND INTERNATIONAL PROFESSIONAL COMMITMENTS:

- Member of several professional organizations including American Society for Photogrammetry and Remote Sensing (ASPRS) and American Geophysical Union (AGU)
- Has reviewed papers for all of the major English language journals in the field (Remote Sensing of Environment, International Journal of Remote Sensing, PERS)

COUNTRIES OF WORK EXPERIENCE:

North America: Canada, United States of America.

Eurasia and Pacific: China, Vietnam, Russia

Latin America and the Caribbean: Brazil

EDUCATION:

1998 M.Sc. School of Agriculture and Land Resource Management, University of Alaska Fairbanks. Thesis involved the development of real-time forest fire detection models from satellite imagery for Alaska's boreal forest.

1996 B.S. (Honours) Department of Geography, University of Waterloo, Ontario. Senior research project used satellite imagery to locate granular resources in the diamond-producing areas of Canada's NWT.

EMPLOYMENT HISTORY:

2006 – present, Environmental Geosolutions

President and Chief Scientist of Environmental Geosolutions, founded to promote and provide scientifically sound geospatial technologies and integrated spatial information services for enhanced sustainability in the agro-forestry sector. Some examples of specific expertise provided:

- Geospatial analyses using GIS and remote sensing tools (both optical and radar data)
- Development of web-based GIS environments for the dissemination of geospatial datasets
- Generation of airborne-derived precision agriculture products
- Development of computer model tools to address various environmental issues related to nutrient cycling in agro-ecosystems (e.g. water quality, air quality, greenhouse gases)

Environmental Geosolutions Client and Project List:

Ontario Ministry of Agriculture, Food, and Rural Affairs – funded under the Nutrient Management Joint Research Program, Environmental Geosolutions will be performing a comprehensive assessment of the Nitrogen-Index tool, which is used to guide manure applications in Ontario during the high-risk fall season.

Indian and Northern Affairs Canada – Environmental Geosolutions is contributing to the development of on-line mapping tools addressing granular resources in the area of the Mackenzie Valley pipeline

Agriculture and Agri-Food Canada – Environmental Geosolutions is constructing the national spatial databases (climate, soils, census) required to feed a computer model that will generate greenhouse gas emission estimates from the Canadian agriculture sector

Agricorp – Environmental Geosolutions and an associate company (Kim Geomatics) have been contracted to provide a conceptual plan for Agricorp (Ontario's crop insurance agency) to adopt geospatial tools in its business operations

Ontario Centres of Excellence – Environmental Geosolutions is part of a consortium (headed by the University of Guelph) that is developing precision agriculture tools from remote sensing and weather datasets to serve the grape growers and wineries of the Niagara region

Food and Agriculture Organization (UN): Environmental Geosolutions is participating in the remote sensing component of an effort (led by the University of New Hampshire) to generate a geospatial risk assessment system for avian influenza in Asia

California Energy Commission: Environmental Geosolutions led the GIS component of this project (led by Applied Geosolutions, LLC) to estimate the irrigation water demands for California agriculture

1999-2006. Research Scientist, Complex Systems Research Center, University of New Hampshire

Research focused on the use of visible, infra-red, and microwave remote sensing data with geographical information systems for monitoring and modeling land cover and land use change, and agricultural land use at the site to regional scales. Central to these research activities was the development of spatially explicit databases on land cover, land use, and other biophysical attributes and socio-economic census data for biogeochemical modeling. Other duties involved the mentoring and guidance of graduate students from the department.

As professional staff member conducted the following professional assignments.

- 1999-2000. Conducted land use and land cover change analysis in the Pearl River delta around Hong Kong.
- 1999 – 2001. Developed Landsat-based land cover classifications for several intense rice growing regions in southern and central China, in a comparison of satellite- and census-derived rice area estimates.
- 1999 – 2001. Developed forest cover change maps for sites in Rondonia, Brazil as part of NASA's Large-scale Biosphere Atmosphere (LBA) project.
- 2001 – 2002. Generated a land cover map of Temperate East Asia from unsupervised classification of VEGETATION images.
- 2001 – 2005. Using multi-temporal full-season MODIS and VEGETATION time series, developed algorithms to automatically detect areas of rice growth and phenological characteristics of the crop.
- 2003 – 2005. Created comprehensive GIS datasets (soil characteristics, crop type, climate) of the rice-producing countries in Asia to use as input to a nutrient cycling model.
- 2003 – 2006. Modification of original DNDC nutrient cycling model to a watershed-based water quality assessment tool, to use in quantification of nutrient leaching potential to the surface and ground water from a variety of crop management and climate scenarios. This tool has since been

used in water quality planning in several protected US Estuarine Research Reserves (California, Ohio, Delaware).

- 2005 – 2006. Created comprehensive GIS datasets (soil characteristics, crop type, climate) of the boreal forest region of Europe and Asia to use as input to a nutrient cycling model that will assess the carbon sink/source potential of the forest in the future.

PRINCIPAL PUBLICATIONS

Refereed Papers

1. Salas, W.A., **Boles, S.**, Li, C., Babu, J., Xiao, X., Frohking, S., and Green, P., (2007), Mapping and modeling of greenhouse gas emissions from rice paddies with satellite radar observations and the DNDC biogeochemical model. *Aquatic Conservation: Marine and Freshwater Ecosystems*. In Press.
2. Gilbert, M., Xiao, X., Chaitaweesub, P., Kalpravidh, W., Premasathira, S., **Boles, S.**, and Slingenbergh, J., (2007), Avian influenza, domestic ducks and rice agriculture in Thailand. *Agriculture Ecosystems and Environment*. doi:10.1016/j.agee.2006.09.001.
3. Xiao, X., **Boles, S.**, Frohking, S., Li, C., Babu, J., Salas, W., Moore, B., (2006). Mapping paddy rice agriculture in south and southeast Asia using multi-temporal MODIS images. *Remote Sensing of Environment*. 100: 95-113.
4. Li, C., Frohking, S., Xiao, X., Moore, B., **Boles, S.**, Qiu, J., Huang, Y., Salas, W. and Sass, R., (2005), Modeling impacts of farming management alternatives on CO₂, CH₄ and N₂O emissions: A case study for water management of rice agriculture of China, *Global Biogeochemical Cycles*, 19:doi:10.1029/2004GB002341.
5. Xiao, X., **Boles, S.**, Liu, J., Zhang, D., Frohking, S., Li, C., Salas, W., and Moore, B., (2005), Mapping paddy rice Agriculture in southern China using multi-temporal MODIS images. *Remote Sensing of Environment*, 95: 480-492.
6. Xiao, X., Zhang, Q., Saleska, S., Hutrya, L., De Camargo, P., Wofsy, S., Frohking, S., **Boles, S.**, Keller, M., and Moore, B., (2005), Satellite-based modeling of gross primary production in a seasonally moist tropical evergreen forest, *Remote Sensing of Environment*. 94:105-122.
7. **Boles, S.H.**, Xiao, X., Liu, J., Zhang, Q., Munkhtuya, S., Chen, S., and Ojima, D., (2004), Land cover characterization of Temperate East Asia using multi-temporal VEGETATION sensor data, *Remote Sensing of Environment*, 90, 477-489.
8. Xiao, X., Zhang, Q., **Boles, S.**, Rawlins, M., and Moore, B., (2004), Mapping snow cover in the pan-Arctic zone, using multi-year (1998-2001) images from optical VEGETATION sensor, *International Journal of Remote Sensing*, 25:5731-5744.
9. Xiao, X., Braswell, B., Zhang, Q., **Boles, S.**, Frohking, S., and Moore, B., (2003), Sensitivity of vegetation indices to atmospheric aerosols: continental-scale observations in Northern Asia. *Remote Sensing of Environment*, 84: 385-392.
10. Xiao, X., Zhang, Q., Braswell, B., Urbanski, S., **Boles, S.**, Wofsy, S., Moore, B., and D. Ojima, (2004), Modeling gross primary production of temperate deciduous broadleaf forest using satellite images and climate data, *Remote Sensing of Environment*. 91:256-270.
11. Xiao, X., Liu, J., Zhuang, D., Frohking, S., **Boles, S.**, Xu, B., Liu, M., Salas, W., Moore, B., and Li, C., (2003), Uncertainties in estimates of cropland area in China: a comparison between an AVHRR-derived dataset and a Landsat TM-derived dataset, *Global and Planetary Change*. 37:297-306.
12. Qiu, J., Tang, H., Frohking, S., **Boles, S.**, Li, C., Xiao, X., Liu, J., Zhuang, Y., and X. Qin, (2003), Mapping single-, double-, and triple-crop agriculture in China at 0.5° x 0.5° by combining county-scale census data with a remote sensing-derived land cover map, *Geocarto International*. 18:3-13.
13. Salas, W., **Boles, S.H.**, Frohking, S., Xiao, X., and Li, C., (2003), The perimeter/area ratio as an index of misregistration bias in land cover change estimates, *International Journal of Remote Sensing*. 24(5):1165-1170.
14. Li, C., Qiu, J., Frohking, S., Xiao, X., Salas, W., Moore, B., **Boles, S.**, Huang, Y., and Sass, R., (2002), Reduced methane emissions from large-scale changes in water management of China's rice paddies during 1980-2000, *Geophysical Research Letters*, 29(20): no. 1972.
15. Frohking, S., Qiu, J., **Boles, S.**, Xiao, X., Liu, J., Li, C., and Qin, X., (2002), Combining remote sensing and ground census data to develop new maps of the distribution of rice agriculture in China. *Global Biogeochemical Cycles*, 16(4): no. 1091.

16. Xiao, X., **Boles, S.**, Frohking, S., Salas, W., Moore, B., Li, C., He, L. and R. Zhao, (2002) Observation of flooding and rice transplanting of paddy rice fields at the site to landscape scales in China using VEGETATION sensor data. *International Journal of Remote Sensing* 23:3009-3022.
17. Xiao, X., **Boles, S.**, Frohking, S., Salas, W., Moore, B., Li, C., He, L., and R. Zhao, (2002), Landscape-scale characterization of cropland in China using Vegetation and Landsat TM images. *International Journal of Remote Sensing*. 23:3579-3594.
18. Xiao, X., Moore, B., Qin, X., Shen, Z., and **Boles, S.**, (2002), Large-scale observations of alpine snow and ice cover in Asia: using multi-temporal VEGETATION sensor data, *International Journal of Remote Sensing*. 23:2213-2228.
19. Xiao, X., He, L., Li, C., Salas, W., Moore, B., Zhao, R., Frohking, S., and **Boles, S.**, (2002), Quantitative relationships between field-measured leaf area index of paddy rice fields and VEGETATION sensor derived vegetation index data, *International Journal of Remote Sensing*. 23(18):3595-3604.
20. Xiao, X., **Boles, S.**, Liu, J., Zhuang, D., and Liu, M. (2002), Characterization of forest types in northeastern China using multi-temporal SPOT-4 VEGETATION sensor data, *Remote Sensing of Environment*. 82:335-348.
21. **Boles, S.H.** and Verbyla, D.L., (2000), Comparison of three AVHRR-based fire detection algorithms for interior Alaska. *Remote Sensing of Environment*. 72:1-16.
22. Verbyla, D.L., and **Boles, S.H.**, (2000), Bias in land cover change estimates due to misregistration. *International Journal of Remote Sensing*. 21: 3553-3560.
23. **Boles, S.H.** and Verbyla, D.L., (1999), Effect of scan angle on AVHRR fire detection accuracy in interior Alaska. *International Journal of Remote Sensing*. 20:3437-3443.

Conference Presentations

1. Li, C., Salas, W., and **Boles, S.H.** “Manure-DNDC: A process model-based tool for full carbon and nitrogen emission accounting from animal feeding operations (AFOs)”. Presented at: *Integrated Solutions to Manure Management III*, London, Ontario. March 2006.
2. Li, C., Salas, W., and **Boles, S.H.** “[Developing a watershed nutrient management tool \(WNM-DNDC\) for reducing nutrient loading in coastal watersheds](#)”. Presented at: *Estuarine Research Federation 2005*, Norfolk, Virginia. October 2005.
3. Xiao, X., **Boles, S.H.**, Liu, J., Zhuang, D., Li, C., Frohking, S., and Moore, B. “Mapping paddy rice agriculture in southern China using multi-temporal MODIS images”. Presented at: *American Geophysical Union 2004 Joint Assembly*. Montreal, Quebec. May 2004.
4. **Boles, S.H.**, Salas, W., Xiao, X., Liu, J., Zhang, Q., Frohking, S., Li, C., “Monitoring and Mapping Rice Agriculture in China using Optical and Radar Data”. Presented at: *ASPRS 2003 Annual Meeting*. Anchorage, Alaska. May 2003.
5. Xiao, X., **Boles, S.H.**, Liu, J., Zhuang, D., and Liu, M., “Characterization of forest types in Northeastern China using multi-temporal SPOT-4 VEGETATION sensor data”. Presented at: *IGARSS 2002 Annual Meeting*. Toronto, Ontario. June 2002.
6. Xiao, X., **Boles, S.H.**, Liu, J., Frohking, S., Salas, W., Li, C., and Moore, B. “Sub-pixel Mapping of Croplands in China: Using Multi-temporal VEGETATION Sensor Data and Spectral Mixture Analysis”. Presented at: *American Geophysical Union 2001 Spring Meeting*. Boston, Massachusetts. May 2001.