University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Doctor of Philosophy

of

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"Spatial and Temporal Analysis of Water Siltation Caused by Artisanal Small-scale Gold Mining in the Tapajós Water Basin, Brazilian Amazon: An Optics and Remote Sensing Approach"

Department of Geography

Wednesday, July 8, 2015
10:00 A.M.
David Turpin Building
Room A144

Supervisory Committee:
Dr. Maycira Costa, Department of Geography, University of Victoria (Supervisor)
Dr. Fred Wrona, Department of Geography, UVic (Member)
Dr. Kevin Telmer, School of Earth and Ocean Sciences, UVic (Outside Member)

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Dr. Jo-Anne Lee, Department of Women's Studies, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

The main goal of this research was to investigate the spatial and temporal impacts of water siltation caused by Artisanal Small-scale Gold Mining (ASGM) on the underwater light field of the Tapajós River and its main tributaries (Jamanxim, Novo, Tocantinzinho, and Crepori rivers). In order to accomplish this, two fieldwork research trips were undertaken to collect data associated with water quality and radiometric data. This data provided information to quantify the underwater light field in water affected by a gradient of mining tailings intensity, clustered into five major classes ranging from 0 to 120 mg/L of total suspended solids (TSS) (Chapter 3). In general, with increased TSS from mining operations such as in the Crepori, Tocantinzinho, and Novo rivers, the scattering process prevails over absorption coefficient and, at sub-surface, scalar irradiance is reduced, resulting in a shallower euphotic zone where green and red wavelengths dominate. The effects of light reduction on the phytoplankton community was not clearly observed, which may be attributed to a low number of samples for proper comparison between impacted and non-impacted tributaries and/or to general low phytoplankton productivity in all upstream tributaries.

In Chapter 4, aiming to extend the information derived from Chapter 3 over a 40- year period (1973-2012), the TSS concentration along the Tapajós River and its main tributaries was quantified based on *in situ* data and historical Landsat-MSS/TM/OLI data.

Measurements of radiometric data were used to calibrate satellite atmospheric correction and establish an empirical relationship with TSS. The regression estimates TSS with high confidence from surface reflectance (ρsurf(red)) up to 25%, which corresponds to approximately 110 mg.L-1. The combination of the atmospheric correction and the robust reflectance-based TSS model allowed estimation of TSS in the Tapajós River from the historical Landsat database (40 years). In Chapter 5, the role of the temporal changes of ASGM area in the water siltation over the last 40 years was investigated in four sub-basins: the Crepori, Novo, and Tocantins sub-basins (mined); and the Jamanxim sub-basin (non-mined), considering the landscape characteristics such as soil type and proximity to drainage system. ASGM areas were mapped for five annual dates (1973, 1984, 1993, 2001, and 2012) based on Landsat satellite images. Results showed that ASGM increased from 15.4 km2 in 1973, to 166.3 and 261.7 km2 in 1993 and 2012, respectively. The effects of ASGM areas on water siltation depends on several factors regarding ASGM activities, such as the type of mining, type of gold deposits, and intensity of gold mining, represented by number of miners and gold production.