

## **HICO Data User's Proposal**

### **Hyperspectral remote sensing of water quality in hydroelectric reservoirs in Sao Paulo State (Brazil)**

#### **Principal Investigator**

Enner Herenio de Alcântara

Sao Paulo State University - UNESP

Rua Roberto Simonsen, 305, Centro Educacional

Presidente Prudente, Sao Paulo State, Brazil

Postal code: 19060-900

<http://scholar.google.com.br/citations?user=PzwzeeMAAAAJ&hl=pt-BR>

#### **Co-Investigators**

Claudio Clemente Faria Barbosa

National Institute for Space Research - INPE

Maria de Lourdes Bueno Trindade Galo, Ph.D

Sao Paulo State University - UNESP

E-mail: mlourdes@fct.unesp.br

Nilton Nobuhiro Imai, Ph.D

Sao Paulo State University - UNESP

E-mail: nnimai@fct.unesp.br

Fernanda Watanabe, Ph.D Candidate

Sao Paulo State University - UNESP

E-mail: fernandasyw@gmail.com

Luiz Henrique Rotta, Ph.D Candidate

Sao Paulo State University - UNESP

E-mail: luizhrotta@yahoo.com.br

Thanan Pequeno, Ph.D Candidate

Sao Paulo State University - UNESP

E-mail: twalesza@hotmail.com

Enner Alcântara, Remote Sensing Ph.D

19/08/2013

# **Hyperspectral remote sensing of water quality in hydroelectric reservoirs in Sao Paulo State (Brazil)**

## **Abstract**

Reservoirs, or man-made lakes, are usually built to store water for water supply, for flood control, or power generation. The hydroelectric sector is responsible for 97% of Brazil's energy generation and is considered the largest hydroelectric park in the world. The management of the sustainable use of water resources depends crucially on the information about water quality and how it changes over time. The hyperspectral remote sensing in combination with in situ data collection can be a powerful tool to study the water quality in large aquatic systems. There is a cascade of reservoirs passing through the Tietê River (Sao Paulo State) with different water biogeochemistry. Besides, this differences is unknown if we consider the water quality distribution in the space. The objective of this project is to use HICO images to study the optical active components in selected hydroelectric reservoirs in Sao Paulo State, Brazil.

## ***Statement of work***

This research is part of three thesis that will be developed in two hydroelectric reservoirs, Nova Avanhandava e Barra Bonita, using the HICO images. This analysis will be integrated with in situ measurements for estimating Total Suspended Solids (TSS), Chlorophyll-*a* (Chl-*a*) and Submerged Aquatic Vegetation mapping. In situ measurements of inherent optical properties (absorption, scattering and attenuation coefficients) and apparent (upward radiance, downward irradiance ( $E_d$ ), remote sensing reflectance ( $R_{rs}$ ) and diffuse attenuation coefficient ( $K_d$ ) will be collected also.

## **Background**

The Remote Sensing and Geoprocessing Group for Environmental Modeling and Analysis of the Sao Paulo State University, Department of Cartography, has developed and applied methods to study inland waters, such as submerged aquatic vegetation (Watanabe et al. 2013), suspended solids, water surface temperature (Alcântara et al. 2010), heat flux exchange (Curtarelli et al. 2013) and chlorophyll-*a* mapping (Ferreira et al 2013; Ogashawara et al. 2013) through the use of satellite imagery and field spectroscopy. During the last year, the group has approved two projects to study two hydroelectric reservoirs in Sao Paulo State, specifically to parameterize a bio-optical model to estimate the chlorophyll-*a* concentration.

## **Study Site**

The study site are the Nova Avanhandava and Barra Bonita reservoirs, located in Sao Paulo State (Brazil, see Figure 1). Barra Bonita reservoir is the first of a series of six large reservoirs in the Tietê River São Paulo state, primarily constructed for hydroelectricity production. The reservoir is located in the Middle Tietê River Basin in the central region of São Paulo state (22° 36' 25,76" S; 48° 21' 57,64" W). The reservoir started its operation in 1963 and from that period several changes in its watershed occurred as a consequence of agricultural and industrial development and increase of population. Nova Avanhandava Reservoir (21° 10' 49,19" S; 50° 07' 10,90" W) is the fifth of Tietê cascade. Its dam is at an elevation of 358m and has a surface area of 210 km<sup>2</sup>, total water volume of 2,720 x 10<sup>6</sup> m<sup>3</sup>, mean discharge rate of 688m<sup>3</sup>s<sup>-1</sup>, maximum depth of 30m and water permanence time of 46 days.

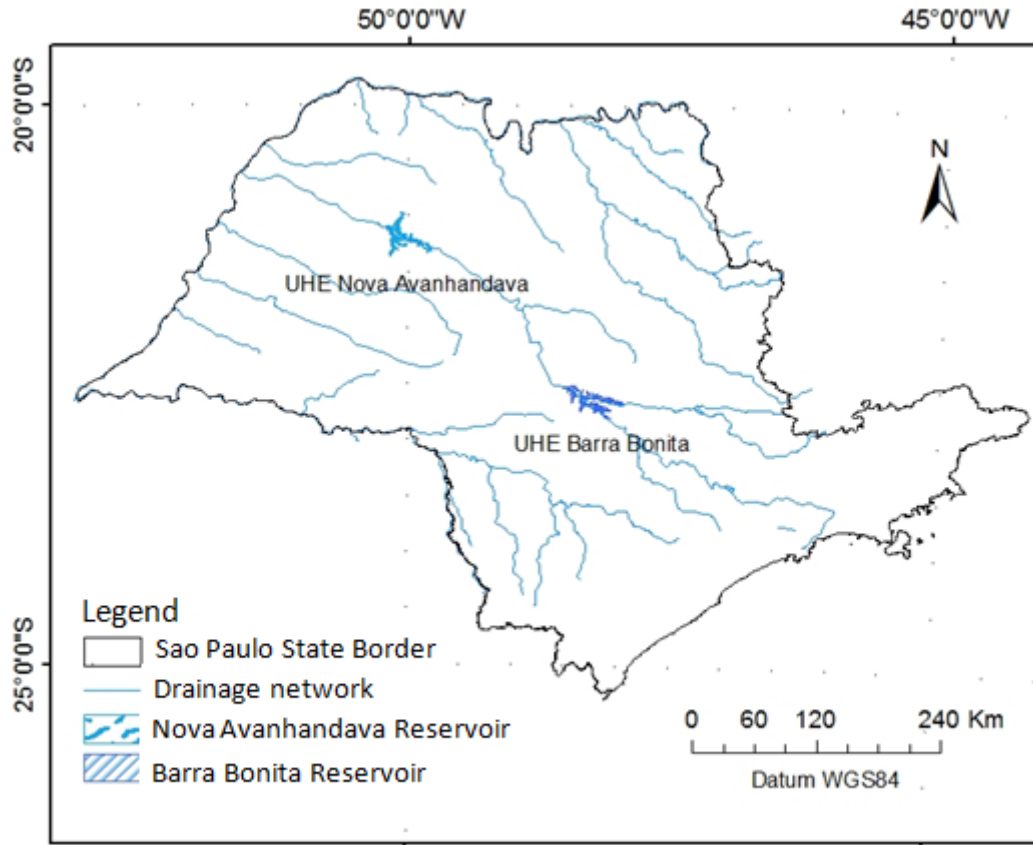


Figure 1: Location of Nova Avanhandava and Barra Bonita reservoirs in Sao Paulo State (Brazil).

***Biographical sketch and available facilities***

Enner Alcântara will lead this study in collaboration with Dr. Claudio Clemente Faria Barbosa, Dr. Maria de Lourdes Bueno Trindade Galo, Dr. Nilton Nobuhiro Imai, and the Ph.D Candidates Fernanda Watanabe, Luiz Henrique Rotta and Thanan Pequeno. Dr. Enner Alcântara is a Professor in Sao Paulo State University (UNESP) at Presidente Prudente (Sao Paulo State, Brazil).

***Available facilities***

The group has started to get some of the most required equipments such as hyperspectral radiometer to measure radiance and irradiance (RAMSES - Trios), field spectrophotometers to measure attenuation and absorption coefficients (ACS-Wetlabs) and backscatter coefficient (ECO BB9 -Wetlabs). Meanwhile we have used the equipments from National Institute for Space Research (Dr. Claudio Barbosa).

***Output and deliverables***

- 1) Using the HICO imagery as input to the parameterized bio-optical models;
- 2) Yearly participation in HICO Data Team Meetings to present our ongoing results.

## **References**

Alcântara, E.H.; Stech, J.L.; Lorenzetti, J.A.; Bonnet, M-P.; Casamitjana, X.; Assireu, A.T.; Assireu, A.T.; Novo, E.M.L.M. Remote sensing of water surface temperature and heat flux over a tropical hydroelectric reservoir. **Remote Sensing of Environment**, p. 1-15, 2010.

Curtarelli, M.P.; Alcântara, E.; Rennó, C.D.; Stech, J.L. Effects of cold fronts on MODIS-derived sensible and latent heat fluxes in Itumbiara Reservoir (Central Brazil). **Advances in Space Research**, In Press, Available Online, 2013.

Ferreira, M.S.; Galo, M.L.B.T. Chlorophyll-a spatial inference using artificial neural network from multispectral images and in situ measurements. **Annals of the Brazilian Academy of Sciences**, v. 85, p. 519-532, 2013.

Ogashawara, I.; Alcântara, E.; Silva, P.B.A.; Barbosa, C.; Stech, J. Spatial Interpolation of Two-Wavelengths Bio-Optical Models to Estimate the Concentration of Chlorophyll-a in A Tropical Aquatic System. **Environment and Pollution**, v. 2, p. 52-66, 2013.

Watanabe, F ; Imai, N ; Alcântara, E. ; Rotta, L ; Utsumi, A . Signal Classification of Submerged Aquatic Vegetation Based on the Hemispherical-Conical Reflectance Factor Spectrum Shape in the Yellow and Red Regions. **Remote Sensing**, v. 5, p. 1856-1874, 2013.