COMPARISON OF IMAGE RESTORATION METHODS APLIED TO INLAND AQUATIC SYSTEMS IMAGES AQUIRED BY HR CBERS 2B SENSOR

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1. INTRODUCTION

Historically, the study of inland aquatic ecosystems has been carried out synoptically, with satellite images of medium spatial resolution. However, small scale water bodies, lakes or rivers, require improvements in the images that could contribute to increase the amount of captured information. Fine spatial resolution could increase information extraction of water body features in regions with high spatial variability and land use mapping next to the water body, which could be more accurate with better spatial resolutions. However, the finer the spatial resolution is, the more expensive are the images.

Programs like CBERS (China Brasil Earth Resources Satellite) which distribute high resolutions images with no costs, is an attempt to overcome these cost limitations. However, CBERS satellites are subjected to limitations in their sensor components, which cause blurring and noisy effects in the acquired images. These defects can, however, be overcome by restoration methods[7].

This work compares four deconvolution methods, named the Wiener filter [2], Modified Richardson-Lucy (RL)[5,8,9], Modified Inverse Filter (MIF)[6] and a Row Action Projection filter (RAP)[3], applied to a scene covering the Ibitinga reservoir, located at São Paulo state – Brazil. This site was chosen due to historical occurrences of phytoplankton blooms and by the intense changes in land use in the last decade due to sugar cane plantation. Tests were firstly conducted with PRISM – ALOS-2 (Panchromatic Remote-sensing Instrument for Stereo Mapping - Advanced Land Observing Satellite 2). Intentionally blurred and noisy PRISM images were used in order to compare methods performance. Secondly, the best deconvolution method defined by the tests was applied to a High Resolution (HR) CBERS-2B panchromatic image, acquired over the same area.

2. METHODOLOGY

In order to go further with the application of deconvolution methods mentioned above, a test image from ALOS 2-PRISM, taken at 2008-11-04, with a processing level L1B2-G and covering the area to be studied, was used. PRISM image was intentionally chosen due to its spatial resolution, which has identical nominal spatial resolution as HR CBERS-2B.

The first step consisted in convolving the original PRISM image with HR CBERS-2B Gaussian Point Spread function (PSF)[1] and add noise quantities that fits HR CBERS-2B signal to noise ration [4], creating a “simulated HR CBERS-2B image”. Since HR CBERS-2B signal to noise ratio have a high value, we add more artificial noise, with a Gaussian distribution, to the “simulated HR CBERS 2B image”, creating a “noisy HR CBERS 2B image”, in order to test restoration methods robustness. The original PRISM image, the “simulated HR CBERS 2B” image and the “noisy HR CBERS 2B” image are shown on figure (1).A clip of each image is also shown.

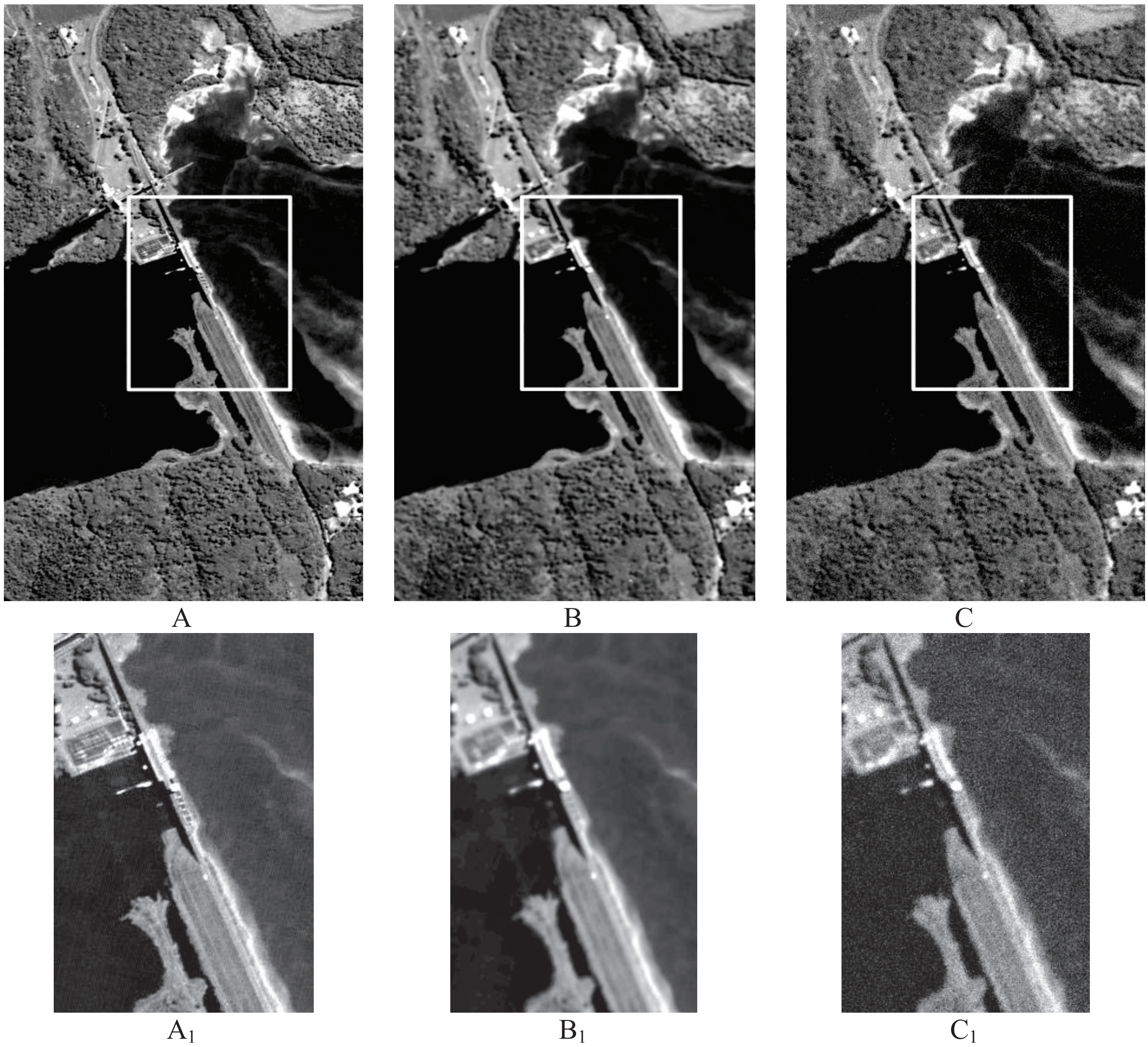
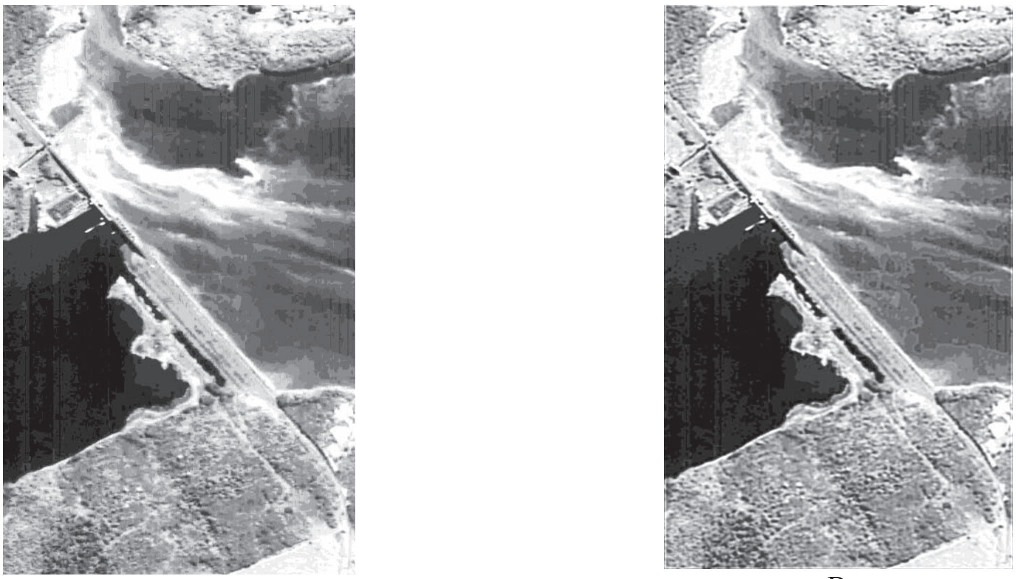


Figure 1
A - Original PRISM – ALOS-2 Image, B - Simulated HR CBERS 2B Image C- Noisy HR CBERS 2B Image
$A_{1,}$ $B_{1,}$ C_1 – Respective A,B,C clips

As restoration methods have specific input parameters in the second step, an algorithm was applied to find the best parameters for each restoration filter. The algorithm uses four different metrics, namely the Improved Signal-to-Noise ratio (ISNR), the Mean Square Error (MSE), the Mean absolute Error (MAE) and the Universal Image Quality Index (UIQI) [10] as a criterion to find the restoration result that better fits the simulated HR CBERS 2B and noisy HR CBERS 2B image to the original PRISM image. The parameters that have been optimized are the number of iterations, for RL and RAP methods and the constant K for the Wiener filter [2]. As MIF inputs are only PSF's parameters, none were tested for MIF. After the best parameters have been obtained all restoration methods were compared using visual inspection and metrics mentioned above. The best restoration method was finally applied to HR CBERS 2B original image.

3. RESULTS AND CONCLUSIONS

This work intended to analyze and compare 4 deconvolution methods for inland aquatic systems. Visual interpretation and metrics shown that for simulated HR CBERS 2B image and for noisy HR CBERS 2B image, Richardson-Lucy (RL) filter outperforms the three other methods. Since the RL filter has shown the best performance we have applied it to recover a HR CBERS-2B original image, with no geometrical correction acquired on 2008-08-22. It can be noted some increase in details at both land and water surface. A problem appears, when image has artefacts, which seems to be amplified by the restoration process as can be observed on figure 2 show the original HR CBERS-2B and a RL deconvoluted image.



A B

Figure 2: A: Original HR – CBERS2B Image
B:RL Restored HR – CBERS2B Image

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