Textural classification of R99SAR data as an aid to flood mapping in Coari City, Western Amazon region, Brazil

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The objectives of this project are:

- To carry out the radiometric calibration of the R99SAR images for future polarimetric classification;

- To adjust R99SAR data to the MAPSAR Mission requirements;

- To assess the use of the Unsupervised Semivariogram Textural Classifier (USTC) algorithm applied to the high resolution data of R99SAR obtained in L-band and HH, HV and VV polarizations in the Coari floodplain region;

- To identify sensitive environments on a local scale directly from the high flood season data based on textural signatures in each multi-polarized L-band image mosaic.
ACQUISITION PLAN OF R99SAR DATA OVER COARI REGION

- DATE ACQUISITION:
  - 01/June/2006
  (High flood season)

- 16 DESCENDING STRIPS

- BAND ACQUISITIONS
  - L Band - Quad-pol
  - X band – Single look

- INCIDENCE ANGLE
  (for each strip)
  - 39.57° (near range)
  - 70.99° (far range)

- SWATH WIDTH: 20 km

- GROUND RESOLUTION:
  5 m.
Radar signal interaction with different habitats

- Diffuse Backscatter
- Doble Bounce
- Predominantly Forward Scattering
- Specular Reflection

SAR DATA

USTC CLASSIFICATION
R99SAR L-band MOSAIC – SIPAM

- Multi-polarized images used: R(HH) G(HV) B(VV)

- Acquisition date:
  01 JUNE 2005
  (high flood)

- Incidence angle used interval of each strip:
  - 39.57° Near range
  - 45.00° Far Range

- This corresponds to an average of 4 km of each strip used to compose the mosaic;

- Resolution resampled to 10 meters;
R99SAR L-band MOSAIC – SIPAM

- SAMPLE 01
11X11 PIXELS OF FLOODED VEGETATION OR LOW BIOMASS ABOVE WATER
R99SAR L-band MOSAIC – SIPAM

- SAMPLE 02
11X11 PIXELS OF WATER – COARI LAKE
R99SAR L-band MOSAIC – SIPAM

- SAMPLE 03
11X11 PIXELS OF UPLAND FOREST
R99SAR L-band MOSAIC – SIPAM

- SAMPLE 04
11x11 PIXELS OF FLOODED FOREST WITH HIGH BIOMASS ABOVE WATER
HH Polarization

<table>
<thead>
<tr>
<th>CLASS (HH)</th>
<th>WATER</th>
<th>FLOODED VEGETATION</th>
<th>UPLAND FOREST</th>
<th>FLOODED FOREST</th>
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<tbody>
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Lag Distance (h) (pixels)
R99SAR L-band MOSAIC SIPAM
HH Polarization
HV Polarization

<table>
<thead>
<tr>
<th>CLASS (HV)</th>
<th>WATER</th>
<th>FLOODED VEGETATION</th>
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<td>0</td>
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<tr>
<td>FLOODED VEGETATION</td>
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<tr>
<td>UPLAND FOREST</td>
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<tr>
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<td>98.3</td>
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</table>

The graph shows the variation of pixel classification with distance, indicating the percentage of pixels in different classes over lag distance.
R99SAR L-band MOSAIC SIPAM
HV Polarization
### VV Polarization

<table>
<thead>
<tr>
<th>CLASS (VV)</th>
<th>WATER</th>
<th>FLOODED VEGETATION</th>
<th>UPLAND FOREST</th>
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<tbody>
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<tr>
<td>FLOODED FOREST</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

### Graph

- **FLOODED VEGETATION**
- **UPLAND FOREST**
- **FLOODED FOREST**
- **WATER**

**Lag Distance (h) (pixels):**

0 1 2 3 4 5 6 7 8 9 10
R99SAR L-band MOSAIC SIPAM
VV Polarization
R99SAR L-band MOSAIC SIPAM
HH+HV USTC

<table>
<thead>
<tr>
<th>L-BAND POLARIZATION</th>
<th>MEAN</th>
<th>STANDARD DEVIATION</th>
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<tbody>
<tr>
<td>HH</td>
<td>120.8349</td>
<td>78.1614</td>
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<tr>
<td>HV</td>
<td>101.1349</td>
<td>57.5408</td>
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<tr>
<td>VV</td>
<td>128.3939</td>
<td>83.2249</td>
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(A) COVARIANCE MATRIX

<table>
<thead>
<tr>
<th></th>
<th>HH</th>
<th>HV</th>
<th>VV</th>
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</thead>
<tbody>
<tr>
<td>HH</td>
<td>6109.21</td>
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</tr>
<tr>
<td>HV</td>
<td>4257.20</td>
<td>3310.94</td>
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</tr>
<tr>
<td>VV</td>
<td>6275.12</td>
<td>4583.54</td>
<td>6926.38</td>
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</tbody>
</table>

Element of Covariance Matrix

\[ q_{ij} = \frac{\nu_{ij}}{\sqrt{\nu_{ii} \times \nu_{jj}}} \]

Element of Correlation Matrix

Variances of the \(i\)th and \(j\)th bands of data

(B) CORRELATION MATRIX

<table>
<thead>
<tr>
<th></th>
<th>HH</th>
<th>HV</th>
<th>VV</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH</td>
<td>1.0000</td>
<td></td>
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</tr>
<tr>
<td>HV</td>
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<tr>
<td>VV</td>
<td>0.9646</td>
<td>0.9571</td>
<td>1.0000</td>
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### R99SAR L-band MOSAIC SIPAM

**HH+HV USTC**

<table>
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<tr>
<th>CLASS (HH+HV)</th>
<th>% PIXELS</th>
<th>WATER</th>
<th>FLOODED VEGETATION</th>
<th>UPLAND FOREST</th>
<th>FLOODED FOREST</th>
</tr>
</thead>
<tbody>
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<td>FLOODED VEGETATION</td>
<td></td>
<td>0</td>
<td>98.3</td>
<td>1.7</td>
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<td>UPLAND FOREST</td>
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Conclusions

- R99SAR data were processed in order to generate co-registered, uncalibrated multipolarization image mosaics (LHH, LHV, LVV).

- Sample sites of arbitrary size (11 by 11 pixels) were then chosen for selected surface cover types (flooded vegetation, water, upland forest and flooded forest) at each polarization configuration.

- Calculated semivariograms presented distinct signatures, thus justifying the use of the USTC classifier.
Conclusions

• The observation of confusion matrixes for LHH, LHV and LVV USTC classification demonstrated that the LHH configuration yielded the best results for the individual mosaics.

• The least correlated mosaics (LHH and LHV) were jointly processed. The resulting confusion matrix presented better results if compared with the ones corresponding to the individual mosaics.

• Information derived from R99SAR data is easy to interpret and constitutes a powerful high resolution representation of areas with high oil sensitivity in the Amazon rain forest.