# Use of ENVISAT ASAR APP for agriculture applications
# Rice monitoring in the Mekong Delta

## Landtraining 2007

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<u>Goal:</u> to process and analyse an ASAR APP time series in order to retrieve information relevant to paddy rice monitoring. The study takes place in the Mekong river delta, in southern Vietnam.

**<u>Area of interest :</u>**
Top right lat = 10.85° N
Top right lon = 105.4 °E
Bottom left lat = 10.65°N
Bottom left lon = 105.6°E

**<u>Available data:</u>**
ENVISAT ASAR APP
Pixel size: 12.5m
IS2: incidence angle around 23°.
Polarisation 1: VV
Polarisation 2: HH
Ascending pass
6 dates in 2007: January 13th, February 17th, March 24th, April 28th, June 2nd, July 7th.

File names:
```
ASA_APP_1PNIPA20070113_150241_000000152054_00369_25473_2009.N1
ASA_APP_1PNIPA20070217_150241_000000152055_00369_25974_4618.N1
ASA_APP_1PNDPA20070324_150239_000000152056_00369_26475_0748.N1
ASA_APP_1PNIPA20070428_150242_000000152057_00369_26976_1150.N1
ASA_APP_1PNPDE20070602_150243_000000162058_00369_27477_4000.N1
ASA_APP_1PNPDE20070707_150244_000000162059_00369_27978_5549.N1
```

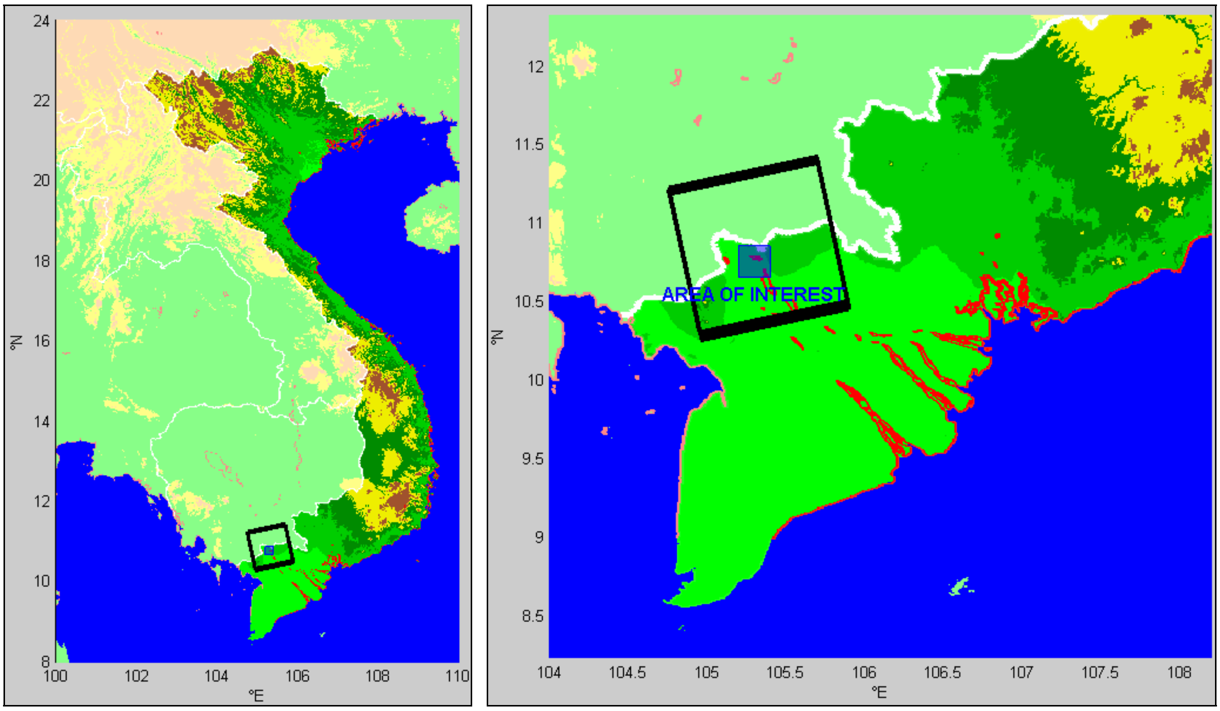


*Figure 1. Localisation of the area under test (blue) and the ASAR APP data frames (black)*

**Rice calendar at the region of interest:**
2 or 3 crops of rice per year (according to occurrence of flood).
2 crop cycles covered by the available ASAR data.

Transplant 1: from end November to end of December
Harvest 1: from mid-February to end of March
Transplant 2: from end of March to mid-April
Harvest 2: from end of June to end of July

## Part I – Processing of ASAR APP data using BEST v.4.0.5

BEST will be used to generate backscattering images, to co-register them and to export them to the BIL format. This processing chain comprises 6 steps:

1. HEADER ANALYSIS
2. FULL RESOLUTION EXTRACTION
3. AMPLITUDE TO POWER CONVERSION
4. BACKSCATTERING IMAGE GENERATION
5. CO-REGISTRATION
6. EXPORT TO BIL

The text below describes how to do the processing for all 6 APP images (12 data bands).

Because of time constraints, you should only do the processing for 2 of these images (4 data bands): preferably January 13th and April 28th.

Preliminary step: cut and past the all the .N1 files from directory "C:\ESA\Day4\Forest-Agriculture Practical\0 - N1" to directory "C:\ESA\Day4\Forest-Agriculture Practical", which will be your working directory.

After launching ENVI and before starting the processing, change the working directory: **Help > Change Working Directory** and choose C:\ESA\Day4\Forest-Agriculture Practical.

**1. Data Import and Quick Look > Header Analysis**
a. Select the input media type: Hard Disk
b. Select the first input product:
ASA_APP_1PNDPA20070324_150239_000000152056_00369_26475_0748.N1
c. Select the alternating polarisation dataset: 1
d. Give names to the output files: 20070324_1.txt and 20070324_1.HAN and click "OK"
e. Select the alternating polarisation dataset: 2
f. Give names to the output files: 20070324_2.txt and 20070324_2.HAN and click "OK"
g. Repeat steps c. to f. for the five other input products.

**2. Data Import and Quick Look > Full resolution extraction**
a. Select the input media type: Hard Disk
b. Select "Y" in the "AOI spec." field, then select "Top Right and Bottom Left in LatLon" and type the corresponding coordinates of the area of interest given above.
c. Select the first input product:
ASA_APP_1PNDPA20070324_150239_000000152056_00369_26475_0748.N1
d. Select the first header analysis file corresponding to this input product:
20070324_1.HAN
e. Give a name to the output file: 20070324_1.XT? and click "OK"
f. Select the second header analysis file corresponding to this input product:
20070324_2.HAN
g. Give a name to the output file: 20070324_2.XT? and click "OK"
h. Repeat steps d. to g. for the five other input products.

**3. Data Conversion > Amplitude to Power**
a. Select the first .XTs input image: 20070113_1.XTs
b. Give a name to the output image: 20070113_1.APf and click "OK"
c. Repeat these steps for the eleven other .XTs images.

**4. Calibration > ENVISAT > Backscattering Image Calibration**
a. Select the first .APf input image: 20070113_1.APf
b. Give a name to the output image: 20070113_1.BSf
c. Select "Linear" for the Output Image Scale

d. Tick the “External Calibration Constant” box, type the value of this constant: 470977.3125 for polarisation 1 (VV) and 423642.9375 for polarisation 2 (HH), and click “OK”.
e. Repeat these steps for the eleven other .APf images.

Note: The calibration constants can be found in the .txt files generated during the Header Analysis. In this text file, search for the words “absolute_calib_k” and “absolute_calib_k2” corresponding to polarisation datasets 1 and 2 respectively. If no calibration constant is specified by the user, BEST will use the values contained in auxiliary files that may not be up to date.

**5. Co-registration > Co-registration**
a. Select the master image: `20070113_1.BSf`
b. Select “Custom” in the “Parameters” field, then type “25” for Row and Column in the “GCPs number” field, and click “OK”
c. Select the first slave image to co-register to the master image: `20070113_2.BSf` and click “OK”
d. Unselect this slave image
e. Repeat steps c and d for the 10 other slave images

**6. Data Export > Export to BIL**
a. Select the first .CRf input image: `20070113_1.CRf`
d. Give names to the output files: `20070324_1.txt` and `20070324_1.BIL` and click “OK
c. Repeat these steps for the eleven other .CRf images.

Once you have done this for the 2 selected APP, you can copy the BIL files corresponding to the other images from the “6 – BIL“ directory to the working directory and skip to Part II.

## Part II – Multitemporal filtering

Before analysing the backscatter images, the speckle noise must be reduced.
A multitemporal filter is available as an executable file: `multitemp-filter.exe`.
Use the batch file `filtering.bat` to launch the filtering of the 12 .BIL images.

When the filtering is finished, you can use ERDAS Imagine to do a visual comparison of one filtered image and the corresponding unfiltered image, given in the Imagine format (.img), as described below:

**1. Launch ERDAS Imagine and change the working directory:**
Session > Preferences
Set the “Default Data Directory” and “Default Output Directory” fields to your working directory (`C:\ESA\Day4\Forest-Agriculture Practical`), click “User save” and “Close”.

**2. Use the Viewer to open these files: `20070113_1_filter_10log.img` and `20070113_1_nofilter_10log.img`.**
These images have been put to dB scale for a better visualisation: $\sigma°_{dB}$=10*log10($\sigma°$).

Notice how the speckle is reduced and spatial resolution preserved.

## Part III – Data analysis

### 1. Colour composite and analysis

With ERDAS Imagine, do a colour composite with the following bands, as described below:
Red: HH on April 28th
Blue: VV on April 28th
Green: HH on April 28th

For that purpose, stacked images are provided: `stack_HH_dB` and `stack_VV_dB`.

a. Import data to Imagine format
Click Import and set the following fields:

Type: Generic Binary
Media: File
Input file: `stack_HH_dB`
Output file: `stack_HH_dB.img`

Data format: BSQ
Data type: IEEE 32 Bit Float
# Rows: 2097
# Columns: 2081
# Bands: 6

Do the same for `stack_VV_dB`.

b. Use the viewer to open `stack_HH_dB.img`
c. Raster > Band Combinations and select Band 4 in `stack_hh_dB.img` for the Red and Blue channels, and Band 4 in `stack_vv_dB.img` for the Green channel.

This colour composite is pictured in Figure 2.

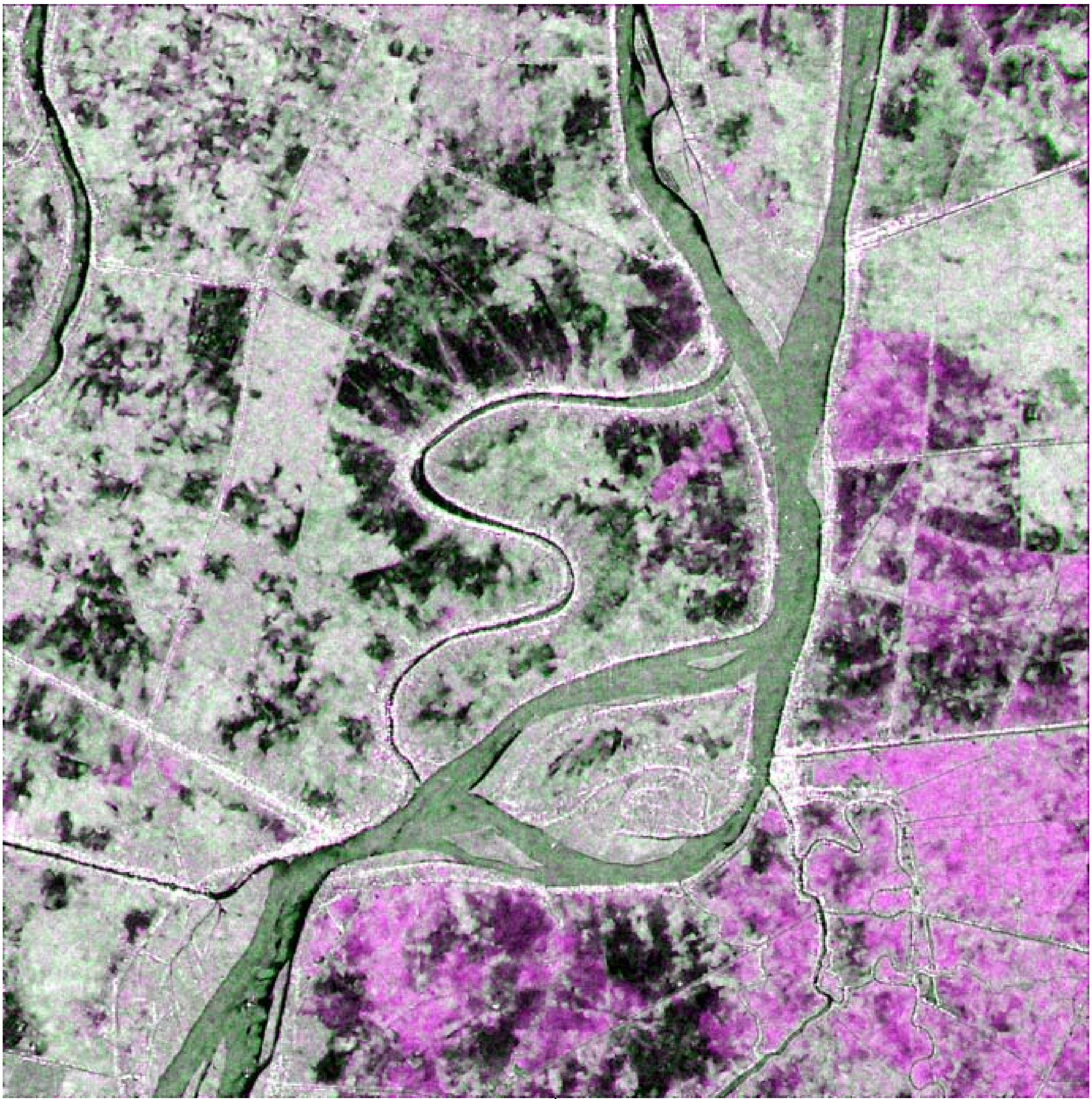

*Figure 2. APP image of April 28$^{th}$ (HH in magenta, VV in green)*

To interpret the colour composite in Figure 2, use the NDVI profiles provided by SPOT VGT in Figure 3, corresponding to two one-square-km pixels located in this area of interest: the profiles show 3 peaks of rice crops from August 2004 to July 2005, and a shift in calendar from 1 block to the next.

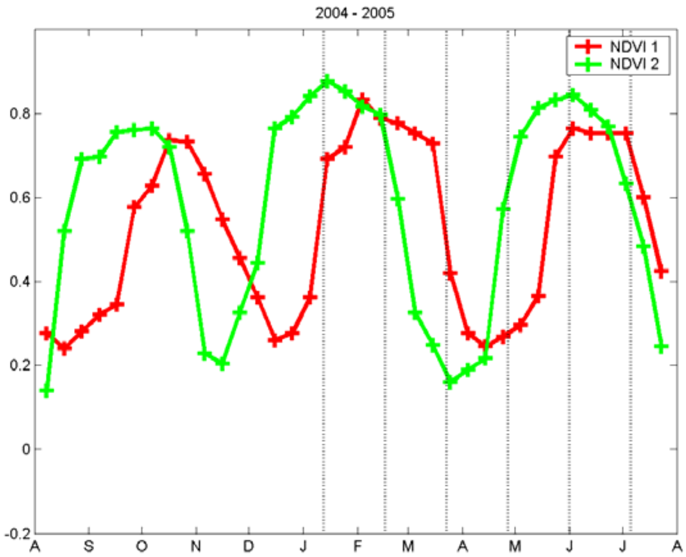


*Figure 3. Two NDVI profiles showing the shift in the agricultural calendar within the area of interest. A vertical black line is drawn at the acquisition date of every APP image in the dataset.*

**2. Polarisation ratio computation and rice maps production**

a. Compute the polarisation ratio HH/VV. As the images are already converted to dB, you need to compute the difference between tht two stacked images.
Use the “Interpreter > Utilities > Operators” tool to produce the `stack_ratio_dB.img` image `(stack_hh_dB.img - stack_vv_dB.img).`
b. Use the “Modeler > Model Maker” tool to create a `stack_rice_map_dB.img` by thresholding the `stack_ratio_dB.img` so as to keep pixels greater than 3dB.

Figure 4 pictures the created rice maps for each date.

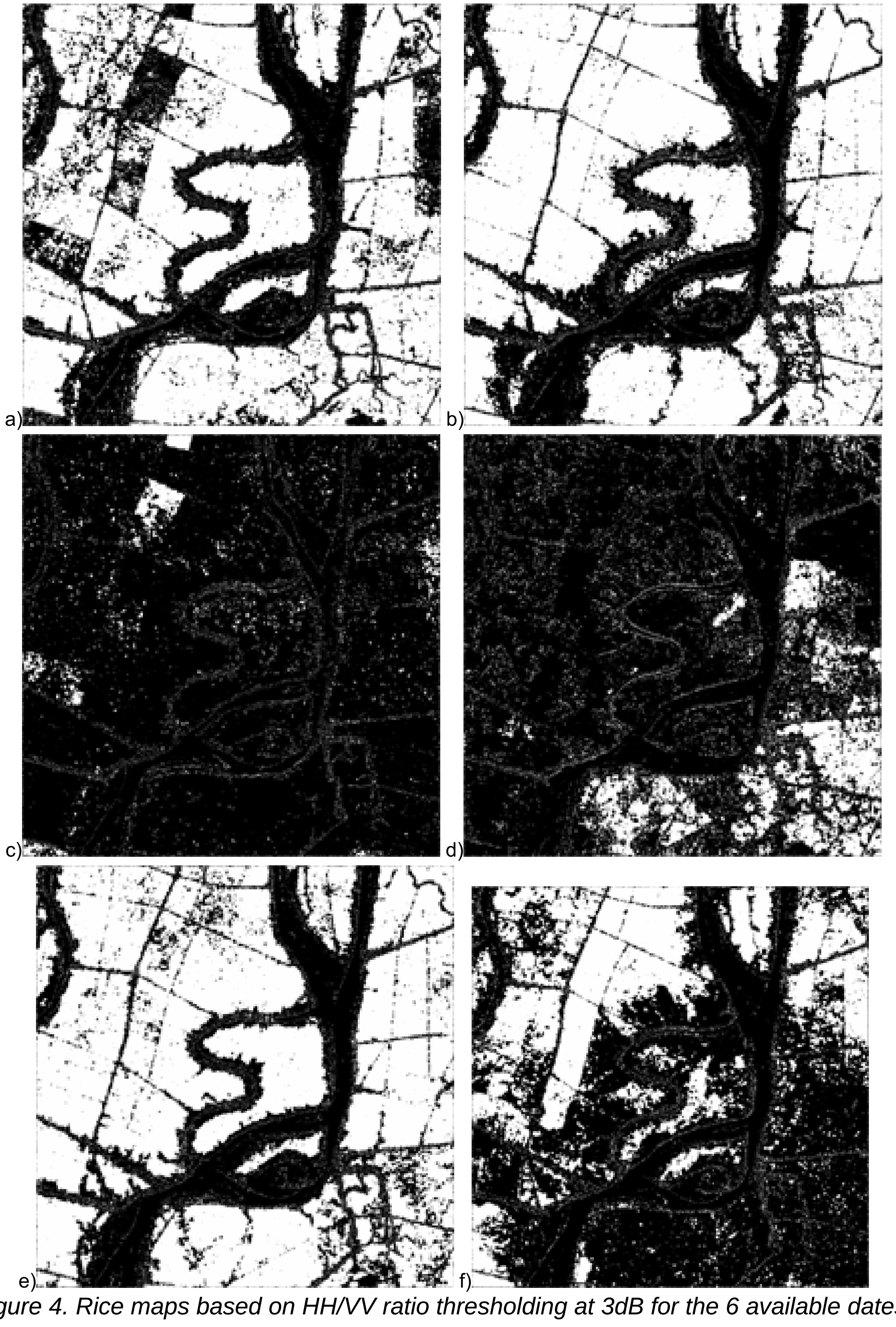


*Figure 4. Rice maps based on HH/VV ratio thresholding at 3dB for the 6 available dates.*