

### A Vegetation Classification of the Opunohu Valley (Moorea Island, French Polynesia) based on a Relative Canopy-Height Class Set Using AirSAR and MASTER Data

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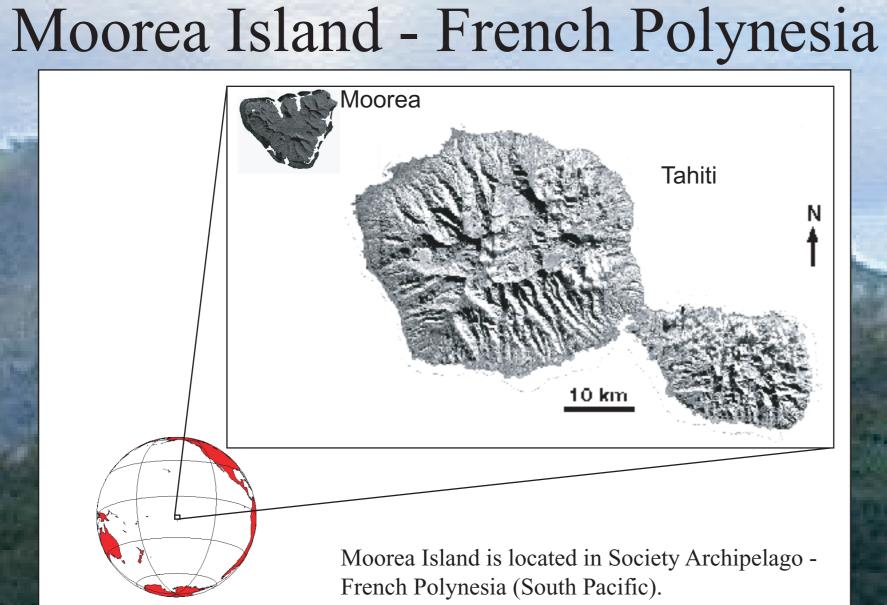


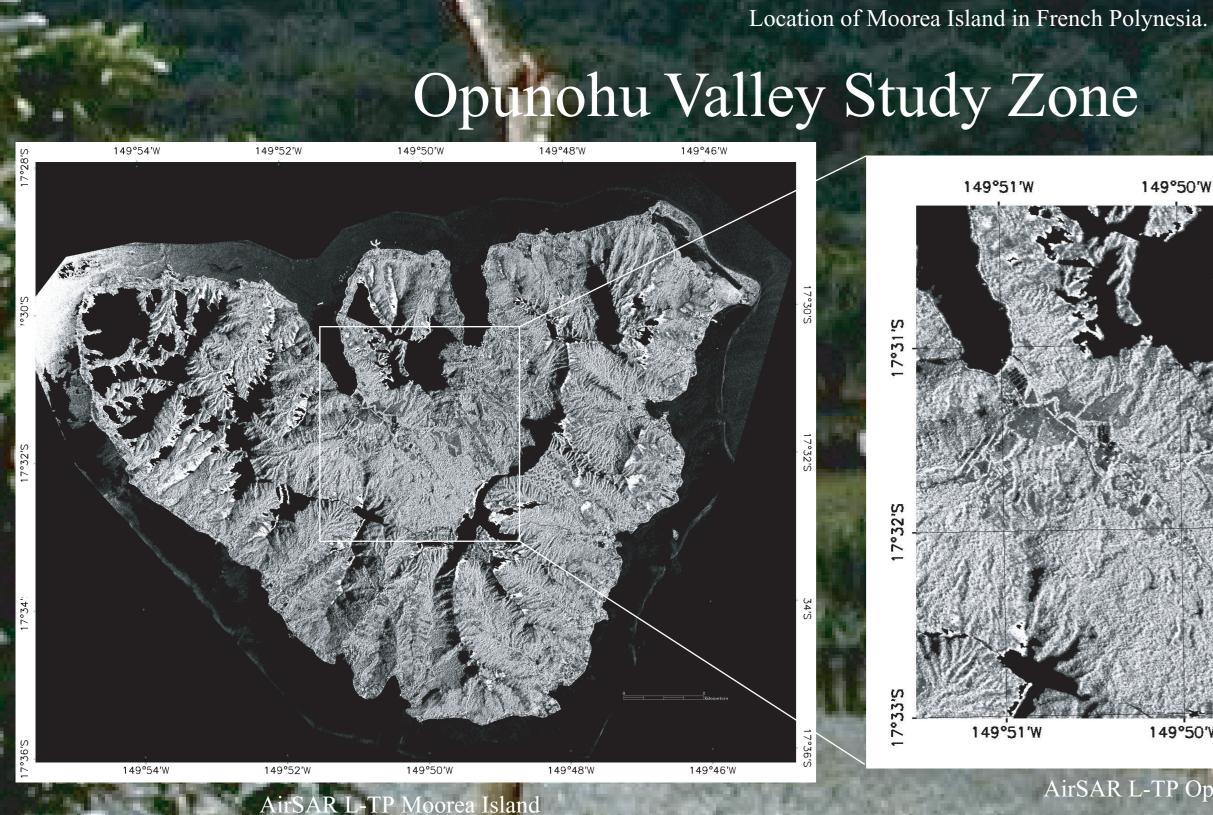


This poster addresses the vegetation mapping and land use of Opunohu Valley (Moorea Island - French Polynesia) using JPL-AirSAR and MASTER (MODIS/ASTER simulator) images acquired during the PACRIM2 mission (Aug. 2000).

These sensors are different but can be considered as complementary since MASTER is a 20 meters ground resolution multispectral imaging scanner with 50 channels distributed in the visible-shortwave nfrared, mid infrared and thermal infrared, and AirSAR is a C-band (TOPSAR) and L-band (POLSAR), 5meters ground resolution radar sensor.

Our main application field deals with the complex and fragile vegetation cover of south pacific volcanic islands. We presently focus on Opunohu Valley because of its highly representative diversity of vegetation and land cover (found in other polynesian volcanic islands), including different types of forests, coconut fields, grass fields, fern lands, urban zones, agricultural areas, etc ... Moreover this area is particularly interesting because of its flat topography reducing the slope effect on the radar backskattering signal.





<ul> <li>The JPL-NASA PACRIM2 mission over French Polynesia (August 2000), gives a complete data set from MODIS/ASTER and AirSAR sensors.</li> <li>MODIS/ASTER (MASTER): multispectral imaging scanner <ul> <li>50 channels distributed in the visible-shortwave infrared, mid infrared and thermal infrared (<i>only 32 bands usable in Moorea Data Set</i>)</li> <li>20m ground resolution (<i>after geometric correction</i>)</li> </ul> </li> <li>JPL-AirSAR: XTI1 mode <ul> <li>C-band single-baseline interferometry in VV polarization (TOPSAR)</li> <li>L-band Polarimetry (POLSAR)</li> <li>P-band Polarimetry (<i>unvailable for Moorea Island Data Set</i>)</li> <li>40MHz Bandwidth thus the pixel size is 5m ground-range resolution.</li> </ul> </li> <li>TOPSAR C-band (5.6cm) POLSAR L-band (25cm) <ul> <li>VV polarization</li> <li>Correlation</li> <li>VV polarization</li> <li>Incidence angle</li> <li>HV polarization</li> <li>DEM</li> <li>Total Power</li> </ul> </li> </ul>	PACR	M II M	ssion Da	ata	
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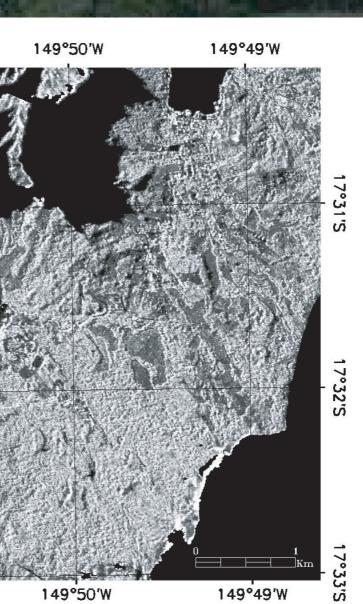


A set of aerial photographs (courtesy of French Polynesia Territory) from October 16th, 2002 completes the Data Set available for this study.

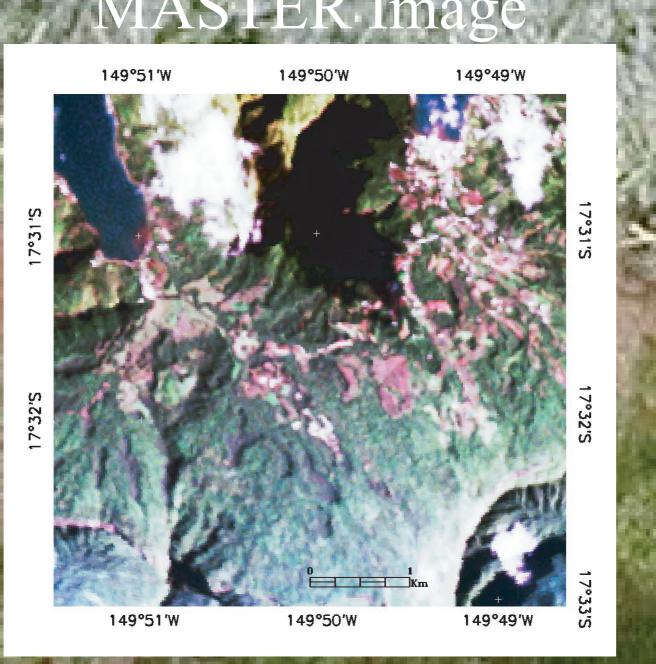
149°51'W

# A Vegetation Classification of the Opunohu Valley (Moorea Island - French Polyne Based on a Relative Canopy-Height Class Set Using AirSAR and MASTER Dat



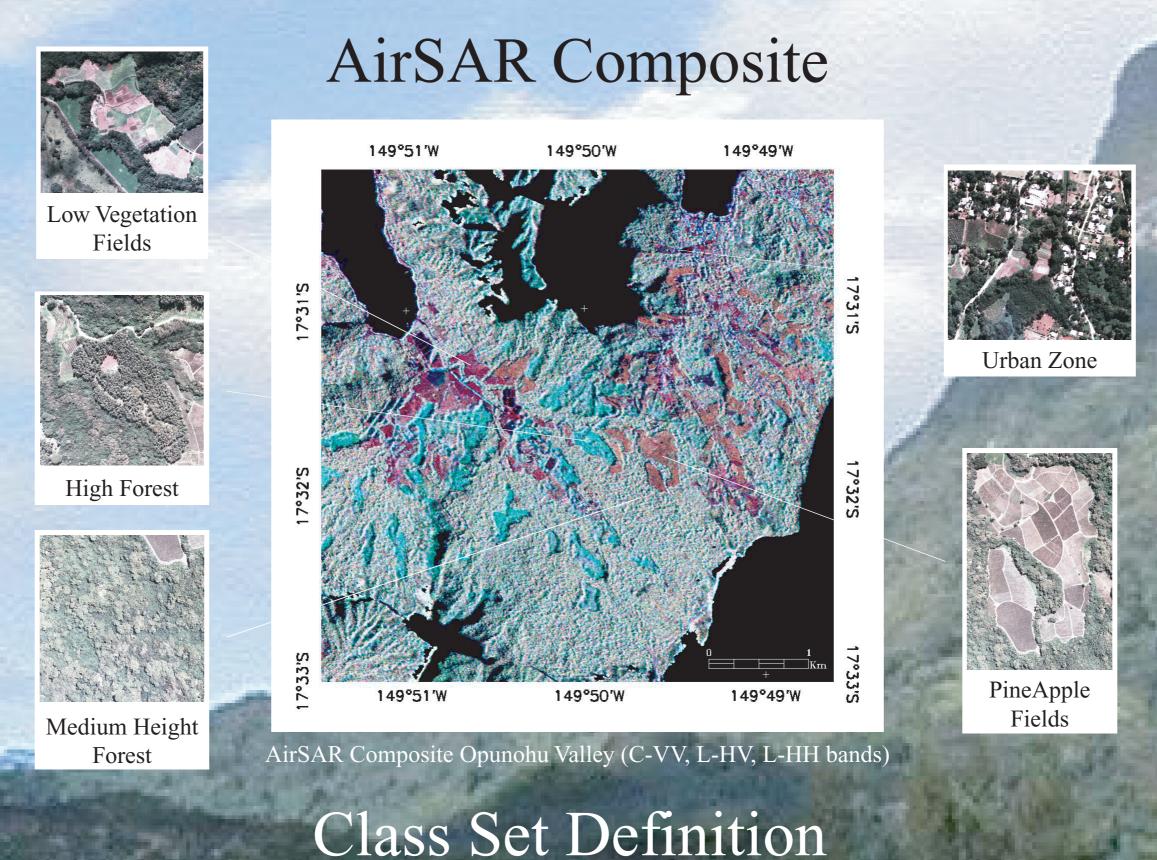


irSAR L-TP Opunohu Valley



MASTER Image of Opunohu Valley (5,3,2 bands)





A 4 classes set has first been defined on a relative vegetation density since radar backscattering signal can be representative of the volume of vegetation and its crown complexity.

• Medium density vegetation • Low density vegetation • No vegetation High density vegetation

A RGB composite (respectively C-VV, L-HV, L-HH bands used as Red, Green, and Blue) has been processed to visually dicriminate the above classes. An histogram equalization contrast stretch must be applied to normalize the mean power of the various bands (*C-band (TOPSAR) or L-band (POLSAR)*) and polarizations (*VV, HV or HH*). The colors in the resulting RGB composite image reflects the above class properties, i.e. a low vegetation field will be represented in red, dark green will represent a high density of vegetation, etc... A 5 class set is defined visually from this RGB Composite (the no-backscatterring area are excluded by masking):

High Forest	Pinus,
Medium Forest	Purau,
Pineapple Field	
Low Vegetation	Low gr
Urban Zone	Local h

This simple class set is based on the relative-height of the vegetation except for the Urban Zone and the Pineapple Field classes.

Ground Truth missions helped defining precisely the components of each class: -The High Forest class includes essentially the Pinus Caribeae and Falcata (Paraserianthes Falcataria) culminating way above the Medium Forest, which is the main type of forest in volcanic islands including "Purau" (Hibiscus Tiliaceus), Bamboo, Fern lands, Mango Trees and etc...

-The Pineapple Fields class discriminates from the height-related Low Vegetation class, the other crop area seems to be classified in Medium Forest or Low Vegetation depending on their quantity of vegetation. -The Urban Zone is a collection of heteroclit objects, local houses, garden, roads, trees, etc...

-High Forest class should include the "Mape" (Tahitian Chestnuts, inocarpus fagiferus) forest but this trees grow in river beds and the canopy doesn't culminate the medium forest and therefore is classified as Medium Forest, moreover, the "Aito" (Casuarina Equisetifolia) trees should be classified in medium forest class (because of its canopy height) but its relative height is important compared to the surrounding Low Vegetation so it's mostly classified as High Forest.

The Region of Interests are then defined using aerial photographs, each clearly identified zone is delineated for the Supervised Algorithm learning process.

## Geometric correction

AirSAR Data are already corrected by NASA JPL-office, but MASTER data need a geometric correction to match the AirSAR images geometry, after this process the pixel size is 20 meters. Georeferencement, Mosaic and Masks

Both images were georeferenced using an IGN Map in order to have a common ground reference, a mosaic step was then processed for the AirSAR Data (two scenes). The AirSAR mask was based on the radar shadows while the MASTER image mask includes the clouds and shadows area. A common mask including both AirSAR and MASTER masks helps compare the classification results. **Filtering and Region Of Interest Separability** 

A speckle reduction was processed on AirSAR Data, Several ENVI(R) filtering techniques were tested using ENVI(R) ROI Separability Index (Jeffries-Matusitaas) as a comparison criteria for Speckle filters. The Lee filtering (preserves image sharpness and detail while suppressing noise) with 10x10 pixels window shows best results on our AirSAR image and ROI definition.

Low Vegetation	Pineapple Field	1.2
High Forest	Medium Forest	1.7
Medium Forest	Urban Zone	1.8
High Forest	Urban Zone	1.9
Low Vegetation	Urban Zone	1.9
Pineapple Field	Urban Zone	1.9
Medium Forest	Pineapple Field	1.9
Low Vegetation	Medium Forest	1.9
Low Vegetation	High Forest	1.9
High Forest	Pineapple Field	1.9

### Classification

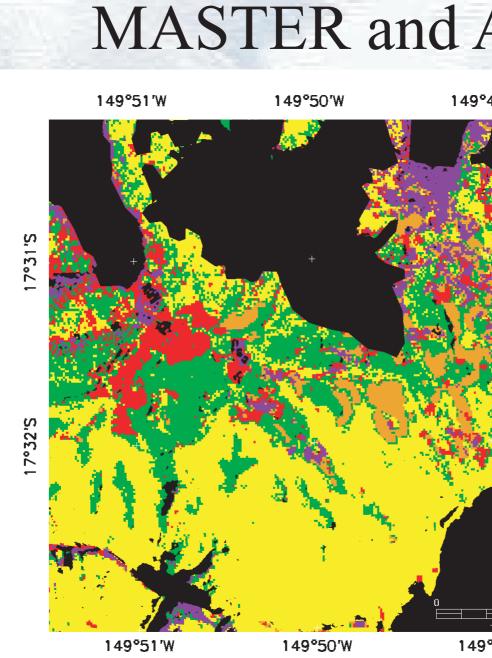
A standard Maximum-Likehood Supervised classification algorithm was processed on the filtered data. We performed this algorithm on the C-VV, L-HH, L-HV, L-VV bands. MASTER image was classified, using the same M-L algorithm and the same learning ROI on the 32 bands (18 bands were corrupted *during the acquisition*)

Falcata, etc.. , Bamboo, Mango Tree, etc…

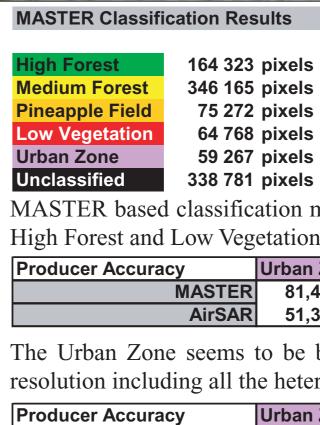
rass fields, etc.. houses, garden, roads, trees, etc...

25635474 .75250398 .86430262 .90294545 90301543 91280686 .98632083 .98817265 99698506 99796923

The Jeffries-Matusitaas Separability Index range from 0 to 2.0 and indicates how the ROI pairs statistically separate.



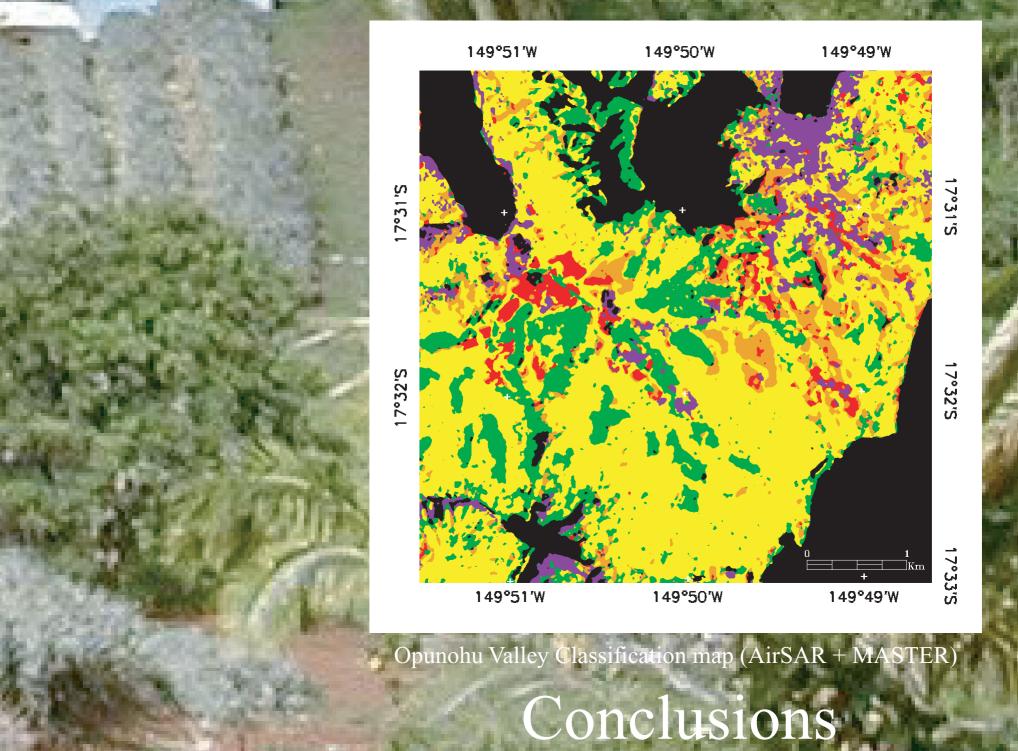
Classification map of Opunol



AirSAR 20m 6 A majority analysis shows that homogeneity of its classified an compared to the original 5 meters image. Producer Accuracy AirSAR/MASTER 81,44 AirSAR/MASTER Maj 83,62

AirSAR Maj 5

A fusion step has been processed to keep the MASTER estimated Urban Zone class and estimate the vegetation classes using the AirSAR 5 meters ground resolution, the overall accuracy of the resulting classification map is increased.



A simple relative canopy height class set has been defined using the AirSAR signal backskattering properties. A particular Pineapple Field class proved to discriminate from the height-related Low Vegetation class (Pineapple is an important economic ressource in Moorea Island). Two classification maps were produced from MASTER and AirSAR images based on this class set including an Urban Zone which proved to be better classified on MASTER image while the vegetation based classes (Pineapple Field, Low Vegetation, High and Medium Forest) can be well classified from the AirSAR images. A fusion between MASTER and AirSAR images has been processed using MASTER for classifying the Urban Zone and AirSAR for the Vegetation classes, this MASTER + AirSAR classification fusion improves the results (considering the overall accuracy).

This class set made from and for the AirSAR Data could be improved by adding the Polsar P-band (lacking from the Moorea data set) and the use of the related DEM could add some interesting informations on the High Islands Vegetation.

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9°49′W	149°5	51'W 1	49°50′W	149°49′W	
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TER Data) ISSIFICAT		alysis	ounohu Valley ( Diff.	AirSAR Data)	
els (33,01%) Mec els (7,18%) Pine els (6,18%) Low els (5,65%) Urb els (32,31%) Unc	dium Forest427eapple Field79Vegetation40an Zone38classified339	148 pixels       (4         965 pixels       (         903 pixels       (         722 pixels       (         734 pixels       (	1,64%)       -4,03%         0,74%)       7,72%         7,63%)       0,45%         3,90%)       -2,28%         3,69%)       -1,96%         2,40%)       0,09%	and the second sec	
n map under-estima on classes.	ties the Medium F	orest while ove	er-estimating th		
an Zone Medium For 1,44% 75,21%	70,83%	98,28%	Low Vegetation 80,07%	and and	1
1,33%91,45%ebetter <td>with MASTER b</td> <td><b>86,86%</b> ecause of its 2</td> <td>71,25% 20meters groun</td> <td>d</td> <td></td>	with MASTER b	<b>86,86%</b> ecause of its 2	71,25% 20meters groun	d	
an Zone Medium For	est High Forest P		Low Vegetation	11.4	100
2,11% 95,57% 9,42% 91,42%	•	89,85% 89,85%	74,29% 75,22%	1 and	a le le
at all AirSAR classe area increases. age down to 20m gr	` <b>`</b>				State of

A degradation of AirSAR image down to 20m ground resolution improves the Urban Zone results

Zone	Medium Forest	High Forest	Pineapple Field	Low Vegetation
4%	92,23%	88,96%	86,60%	71,89%
2%	95,71%	90,94%	89,25%	74,23%
d to been the MASTER estimated Links Zone class and estimate				