remote sensing

MDPI

Article

Relating X-band SAR Backscattering to Leaf Area Index of Rice in Different Phenological Phases

Sonia Asilo [1,2,3,*], Andrew Nelson [1], Kees de Bie [1], Andrew Skidmore [1,4], Alice Laborte [3], Aileen Maunahan[3] and Eduardo Jimmy P. Quilang[2]

[1] Faculty of Geo-Information Science and Earth Observation, University of Twente, Enschede 7500 AE, The Netherlands; c.a.j.m.debie@utwente.nl, a.nelson@utwente.nl, a.k.skidmore@utwente.nl
[2] Philippine Rice Research Institute, Science City of Munoz, Nueva Ecija 3119 Philippines; sl.asilo@philrice.gov.ph, e.j.p.quilang@philrice.gov.ph
[3] International Rice Research Institute, Los Banos, Laguna 4031 Philippines; a.g.laborte@irri.org, a.maunahan@irri.org
[4] Macquarie University, Sydney, NSW, 2109, Australia; a.k.skidmore@utwente.nl
* Correspondence: sl.asilo@philrice.gov.ph ; Tel.: +63-44-456-0277

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Supplementary Material

Survey Questionnaire for Biophysical parameter estimation from RS data

Date (m/d/y): _____ Start time: _____ End time:_____
Target ID: _____ Point ID:_____ Municipality: _____
Dist. to target:_____m Direction: _____ Barangay:_____
Accuracy: _____ Expected Yield:_____ Farm size: _____
Photo ID: _____ Yield (2012-2013) WS: _____ DS: _____
Farmer's Name: _____ Crop Cal: WS_____ DS: _____

Part 1. Observation

1. Close up photo ID: front _____ back _____ left _____ right_____
1.1. Land Cover (LC): ☐ Rice ☐ Mixed (Rice and Non-rice) describe area: _____
1.1a. Describe area in detail and estimate the percentage of LC:

Non-rice	% LC w/in 250m	Description of area
1.		
2.		
Rice		

Note: Non-rice pertains to areas such as: built-up, water, forest, orchard and other vegetation that does not have paddies. If this is the case END of SURVEY. If rice, proceed with interview.

1.2. Agri-related structures: ☐ bund ☐ terraces ☐ irrig. canal ☐ dikes ☐ pond
☐ river/stream ☐ pump ☐ tubewell ☐ deep well ☐ others:_____
1.3. Terrain: ☐ flat ☐ undulating ☐ hilly
1.4. Ecosystem: ☐ Irrigated ☐ Rainfed lowland ☐ Rainfed Upland

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Part 2. Field work for TSX ScanSaR acquisition (Observation)

☐ Land preparation (describe field) _____
☐ Crop establishment: Direct seeded: _____ Transplanted: _____
☐ Crop growth stage:
Vegetative: ☐ Emergence ☐ Seedling ☐ Tillering (early, mid, late)
Reproductive: ☐ Panicle initiation ☐ Booting ☐ Heading ☐ Flowering
Ripening: ☐ Milking ☐ Grain filling ☐ Maturity ☐ Harvesting

2.1. Current weather condition: ☐ Rainy ☐ Cloudy ☐ Sunny ☐ Windy Others condition: _____
2.2. Actual condition of farmer's rice field:
_____
2.3. Describe neighboring fields:
_____

Part 3. Farmer's interview

3.1. Farm activities
1. Variety planted: _____
2. Sowing date: _____
3. Land prep plowing: date: _____ harrowing date: _____ leveling date: _____
4. flooding date: _____
5. transplanting date: _____ seedling age (days): _____
6. harvesting date: _____

3.2. Inputs

Application	Fertilizer	Date	Amount	Pesticide/Herbicide	Date	Amount
1						
2						
3						

(A)

3.3. Water in the field

Do you practice intermittent irrigation? Yes: _____ No: _____

If Yes: When do you drain your field? _____

Irrigation	Date	Volume	If No, when do you drain your field?
Water release date			
Irrigation 1			
Irrigation 2			
Irrigation 3			

3.4. Plant damage

Damage	Causes	Area affected	Symptoms: describe what you see in the field
Pests			
Nutrient deficiency			
Natural calamity			

Part 4. Plant parameter measurements:

Parameter	Measurements					
	Rep 1		Rep 2		Rep 3	
Planting distance (inches)	row:	col:	row:	col:	row:	col:
Water depth (inches)						
Plant height (inches)						
Number of tillers per hill						
Lowest Bund height (inches)						

Water quality (describe): _____

4.1. LAI measurements:

Replicate	LAI	Weather condition
1		
2		
3		

4.2. Chlorophyll Measurements:

Replicate	Chlorophyll				
	1	2	3	4	5
Rep 1					
Rep 2					
Rep 3					

4.3 Harvest data by us (destructive sampling – crop cuts) Date of crop cutting: _____

Replicate	Area	Number of hills	Fresh weight biomass	Grain weight	Grain moisture				
1									
2									
3									

4.4. Harvest data from farmers

Actual date of harvesting by farmers _____

How many sacks of rice were harvested from the entire area planted with rice (wet – fresh from field)? _____

How many kilos per sack? _____

(B)

Figure S1. Survey questionnaire for the **d**ata collected during field monitoring (A) and in situ measurements of biophysical parameters (B) for the WS 2013.

Table S1. Initial parameter values used as input to Baret's equation [33] for curve fitting.

Parameters	Values
a*	0.0010
b*	0.0085
T*i**	2146.6
T*s**	3430.0
maximum LAI	7
sowing date (DOY range)	128-192
harvest date (DOY range)	249-337
accumulated T at sowing	873.3
accumulated T at harvest	4383.8

Table S2. Descriptive statistics of interpolated LAI values (derived from in situ LAI) for rice growth stages and phases.

Stages	**Min**		**Max**		**Mean**		**Median**		
	LAI	dB	LAI	dB	LAI	dB	LAI	dB	**n**
Seedling	0.02	-12.84	0.81	-9.02	0.39	-11.41	0.42	-11.61	26
Tillering - Stem elongation	0.41	-11.36	2.33	-6.08	1.25	-8.59	1.16	-8.37	35
Panicle initiation (PI) - Booting	1.97	-10.30	3.89	-5.41	2.75	-8.58	2.63	-8.54	18
Heading - Flowering	2.49	-11.64	4.76	-7.04	3.31	-9.64	3.39	-9.87	32
Milking - Dough stage (grain filling)	1.96	-12.02	4.37	-7.80	3.05	-10.19	2.93	-10.18	27
Maturity	1.29	-10.88	3.38	-8.32	2.20	-9.93	2.49	-10.16	9
Phases									
Vegetative (seedling - stem elongation)	0.02	-12.84	2.33	-6.08	0.89	-9.79	0.83	-9.83	61
Reproductive (PI - flowering)	1.97	-11.64	4.76	-5.41	3.11	-9.26	3.08	-9.39	50
Ripening (milking - maturity)	1.29	-12.02	4.37	-7.80	2.84	-10.12	2.79	-10.17	36

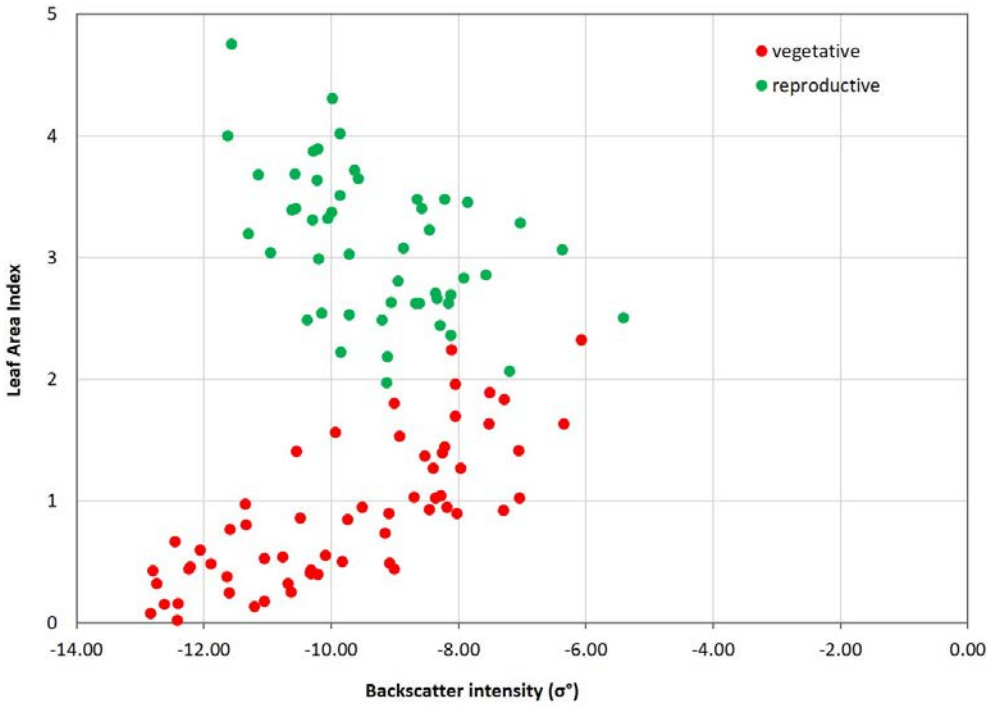

Figure S2. Relationship between TSX ScanSAR X-band backscattering intensity and (estimated) LAI on the same date as SAR image acquisition.