

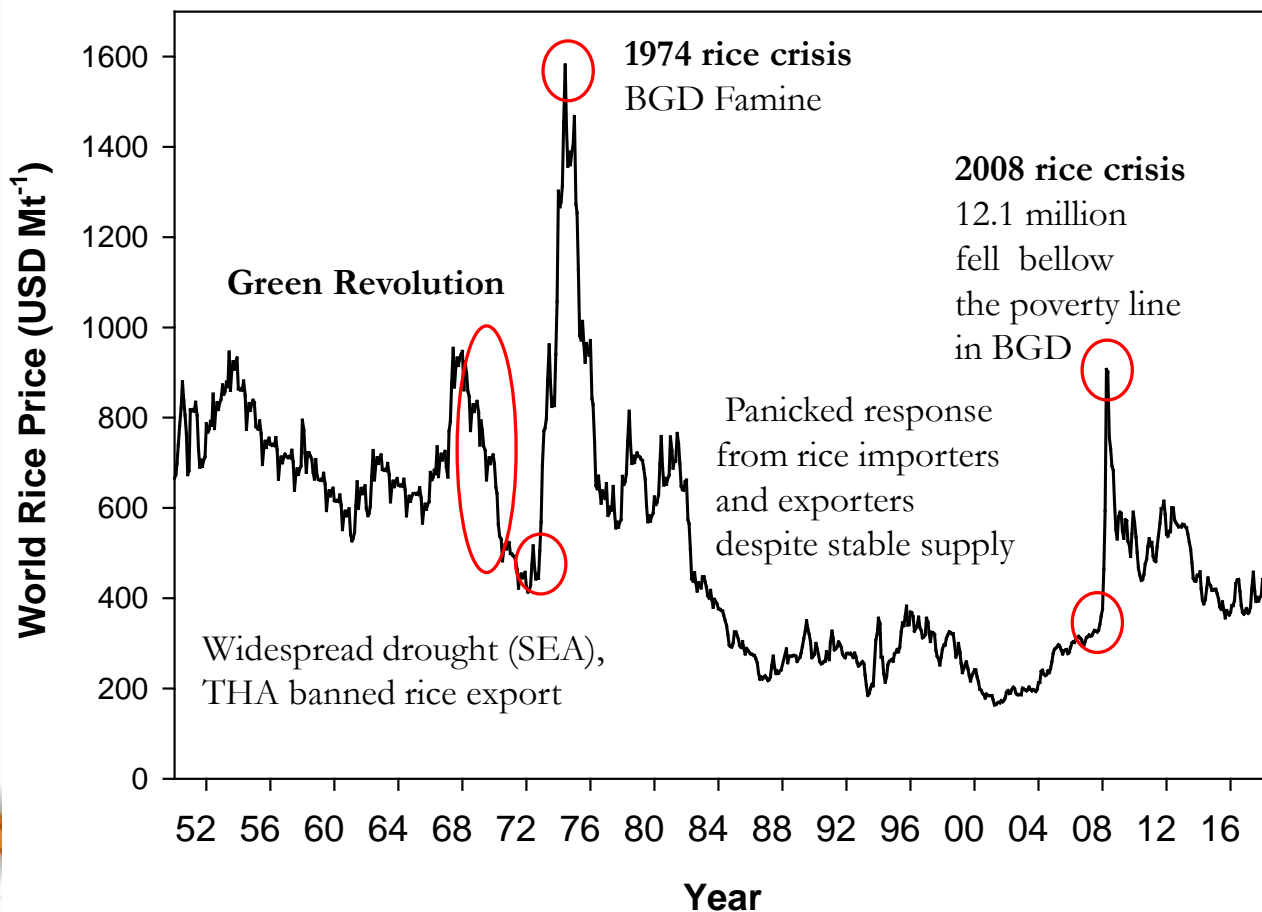
Rice Crop Growth Monitoring and Yield Prediction with Remote-Sensing and ORYZA Crop Growth Model

Tri D. Setiyono

International Rice Research Institute (IRRI), Philippines



The need for timely reliable rice production information



Smallholder farmers, representing 85% of the world's farms, face numerous risks to their agricultural production from pest and disease outbreaks, extreme weather events, and market shocks that threaten their household food and income security



Insurance helps to keep rice farmers in business



Satellite technology can reliably identify losses over large geographies, ensuring farmers receive indemnification more swiftly and enhancing stakeholder trust in crop insurance.

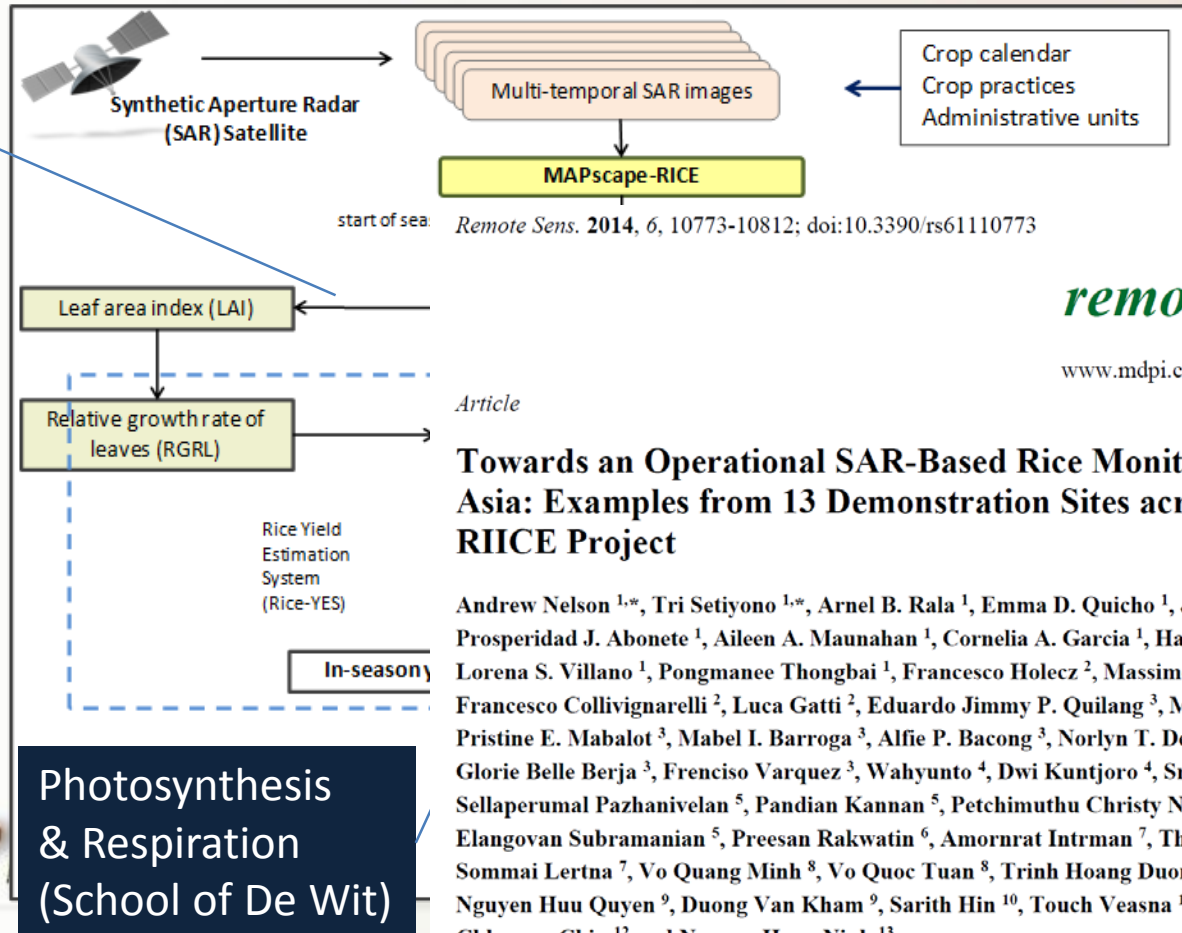
Sentinel-1a

- Launched 3rd/April/2014 by ESA
- Sun-synchronous near-polar orbit, repeat cycle of 12 or 24 days
- C-Band (5.405 GHz)
- Dual polarization: VV+VH
- Free and open access to imagery

Photo: ESA, © ESA/ATG medialab
http://www.esa.int/spaceinimages/Images/2014/01/Sentinel-1_radar_vision

SAR+ORYZA Rice Yield Estimation System

Vegetation
Cloud Model
(Atema &
Ulaby, 1978)



NASA Power

OPEN ACCESS

remote sensing

ISSN 2072-4292

www.mdpi.com/journal/remotesensing

Article

Towards an Operational SAR-Based Rice Monitoring System in Asia: Examples from 13 Demonstration Sites across Asia in the RIICE Project

Andrew Nelson ^{1,*}, Tri Setiyono ^{1,*}, Arnel B. Rala ¹, Emma D. Quicho ¹, Jeny V. Raviz ¹, Prosperidad J. Abonete ¹, Aileen A. Maunahan ¹, Cornelia A. Garcia ¹, Hannah Zarah M. Bhatti ¹, Lorena S. Villano ¹, Pongmanee Thongbai ¹, Francesco Holec ², Massimo Barbieri ², Francesco Collivignarelli ², Luca Gatti ², Eduardo Jimmy P. Quilang ³, Mary Rose O. Mabalay ³, Pristine E. Mabalot ³, Mabel I. Barroga ³, Alfie P. Bacong ³, Norlyn T. Detoito ³, Glorie Belle Berja ³, Frenciso Varquez ³, Wahyunto ⁴, Dwi Kuntjoro ⁴, Sri Retno Murdiyati ⁴, Sellaperumal Pazhanivelan ⁵, Pandian Kannan ⁵, Petchimuthu Christy Nirmala Mary ⁵, Elangovan Subramanian ⁵, Preesan Rakwatin ⁶, Amornrat Intrman ⁷, Thana Setapayak ⁷, Sommai Lertna ⁷, Vo Quang Minh ⁸, Vo Quoc Tuan ⁸, Trinh Hoang Duong ⁹, Nguyen Huu Quyen ⁹, Duong Van Kham ⁹, Sarith Hin ¹⁰, Touch Veasna ¹⁰, Manoj Yadav ¹¹, Chharom Chin ¹² and Nguyen Hong Ninh ¹³

Photosynthesis
& Respiration
(School of De Wit)



For detailed
information on
the IT system
of Rice-YES
please visit
poster by
Romuga et al

Spatial allocation approach of rice yield simulation

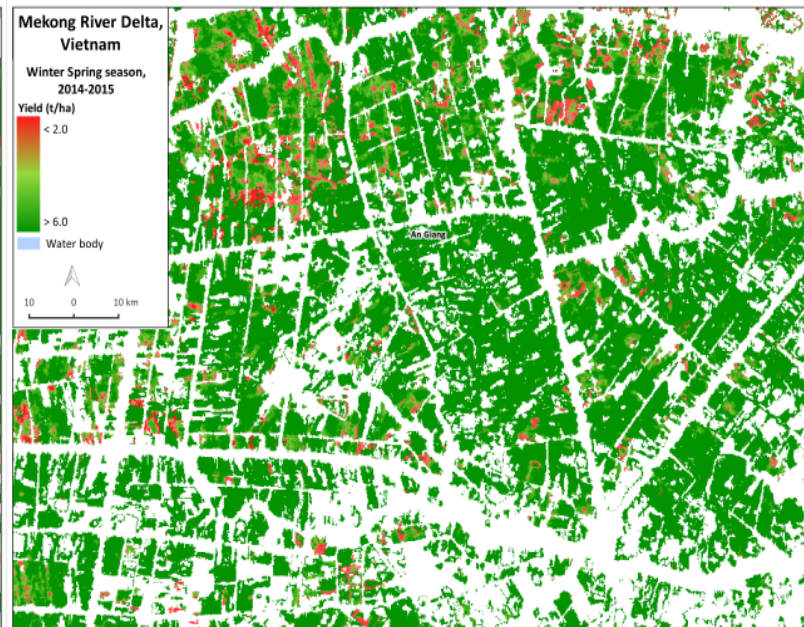
Multi-temporal σ°



150 m resolution
Start of Season (SOS)

30 hr processing time (for entire MRD, VNM)

MAPscape-RICE



20 m resolution

5 hr processing time (for entire MRD, VNM)

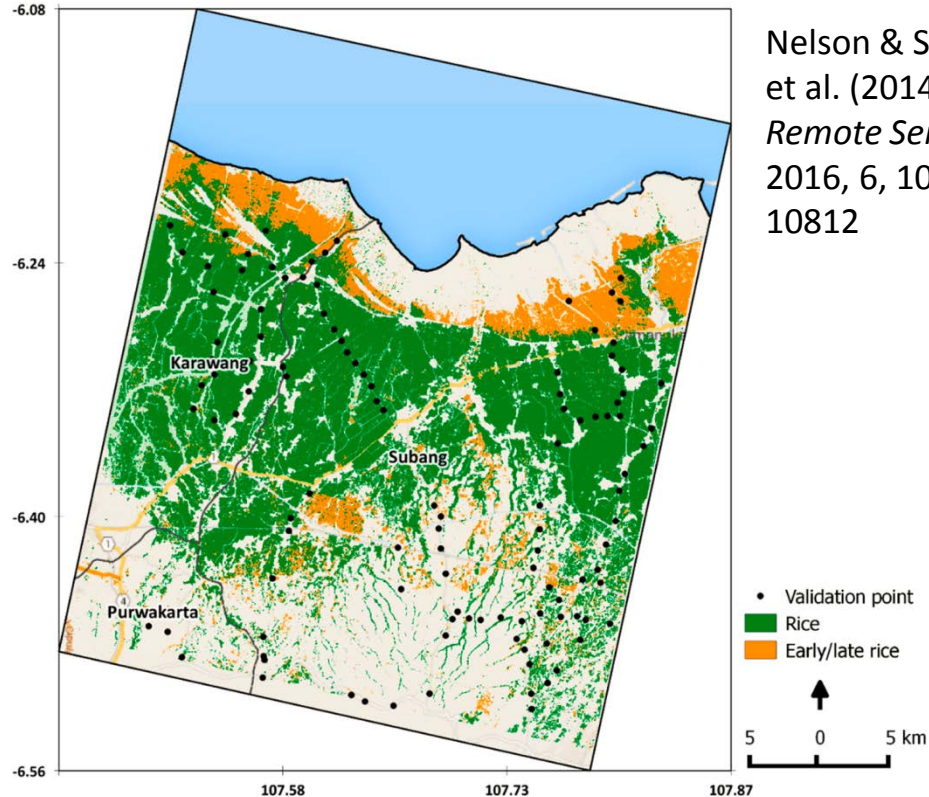


Rice science for a better world

IRRI

SAR-based Rice Area

Subang, Indonesia, Nov '13 – Apr '15



Nelson & Setiyono
 et al. (2014)
Remote Sens
 2016, 6, 10773-
 10812

Rice area map accuracy computation				
		Ground Survey Data		User's Accuracy
		Rice	Non-Rice	
	Map Data	Rice	Non-Rice	
	Rice	91	1	98.9%
	Non-Rice	3	55	94.8%
	Producer's Accuracy	96.8%	98.2%	97.3%

User's Accuracy 96.9%

Producer's Accuracy 97.5%

Overall accuracy 97.3%

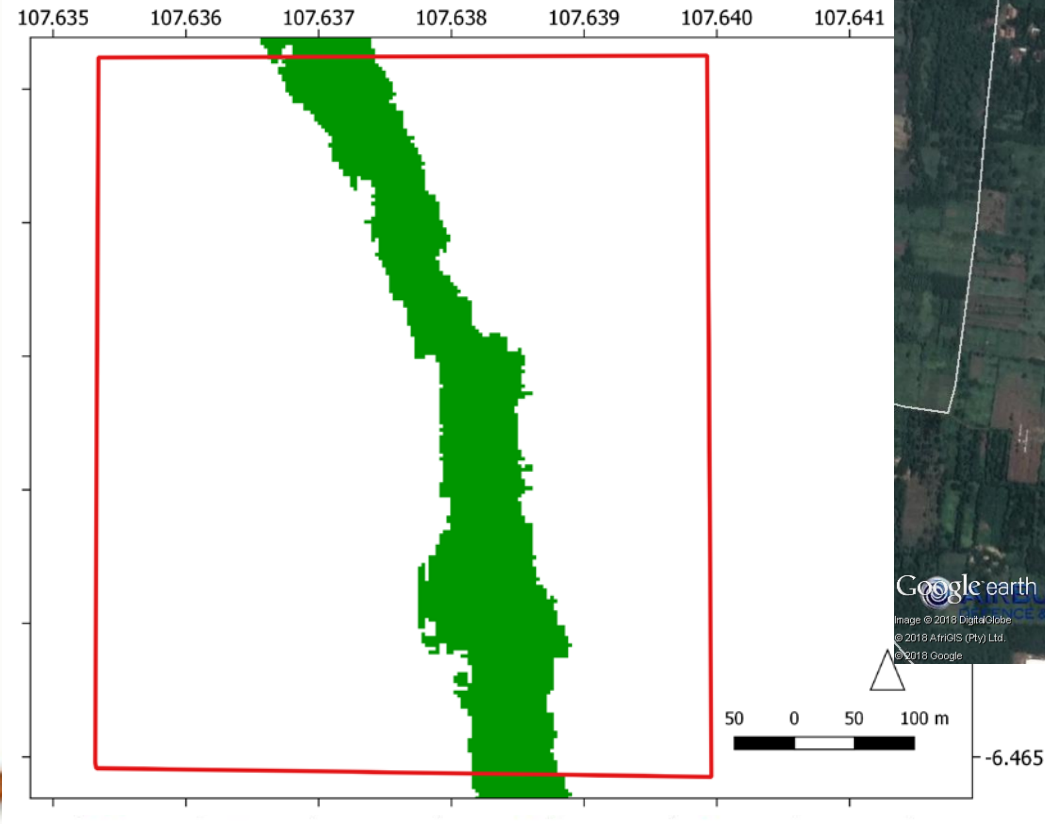
Kappa index 0.95

n = 150

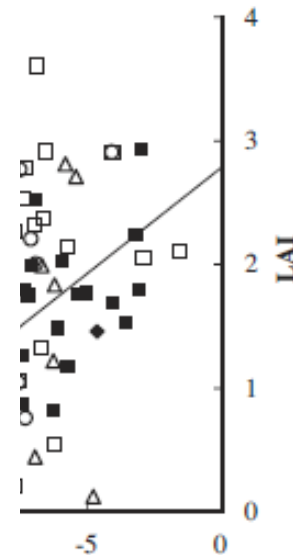
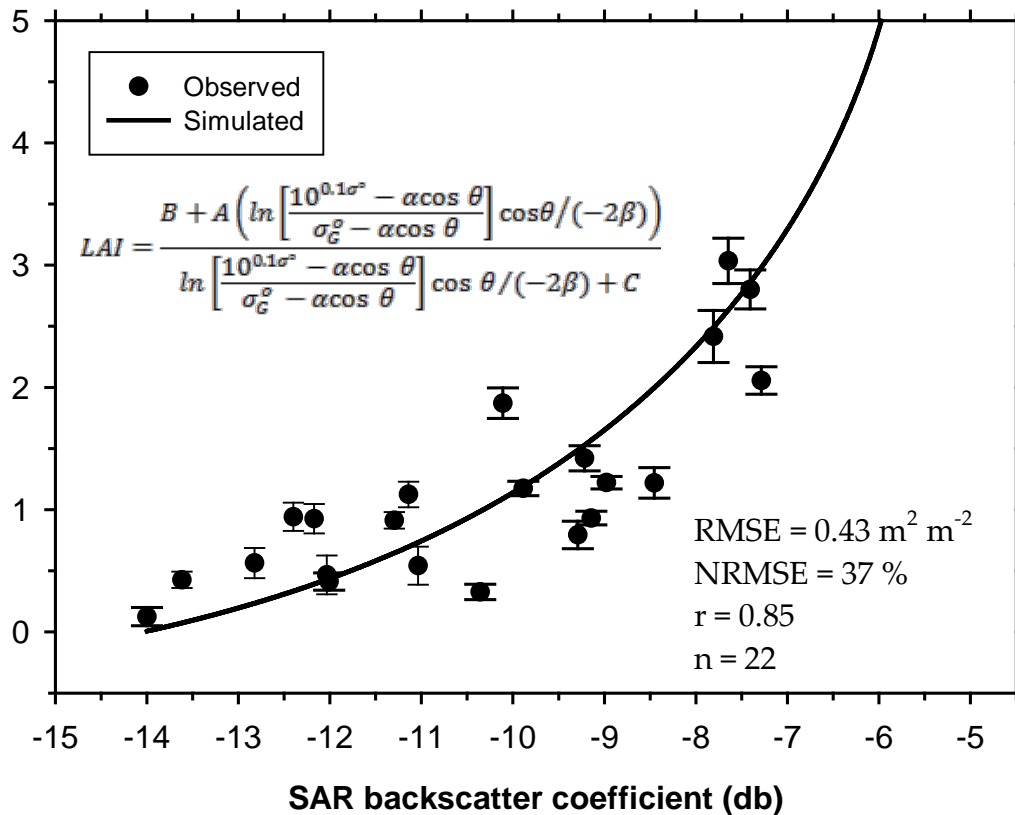
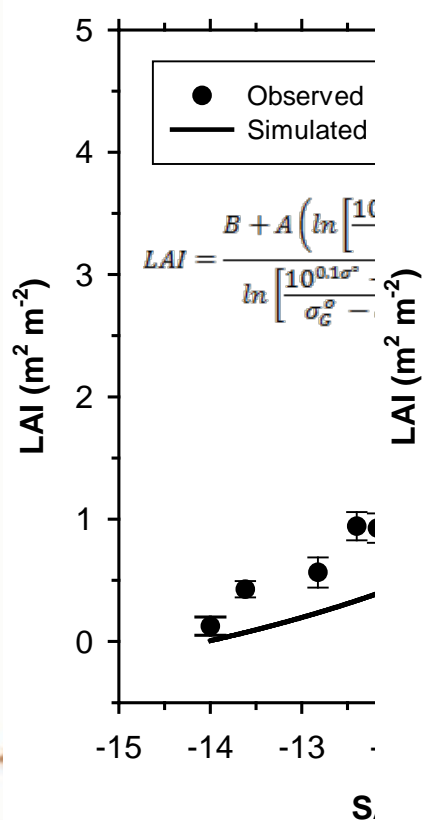
Congalton, R.G. 2001. Accuracy assessment and validation of remotely sense and other spatial information. *Int. J. Wildland Fire* 10: 321–328.

SAR-based Rice Area

Subang, Indonesia, Nov '13 – Apr '15

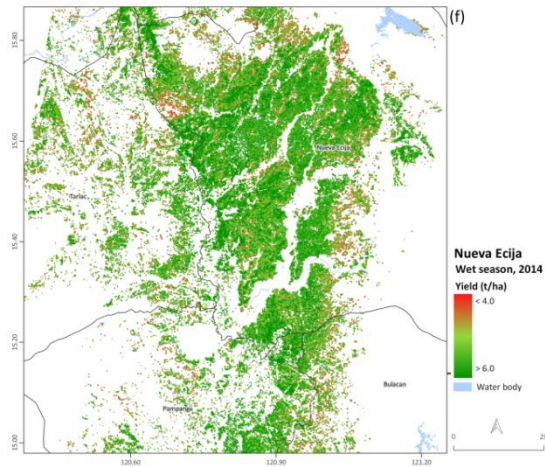
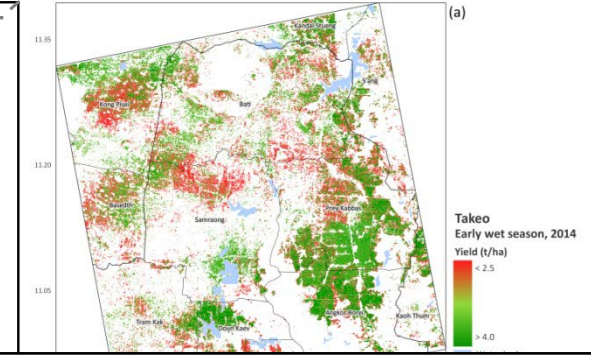
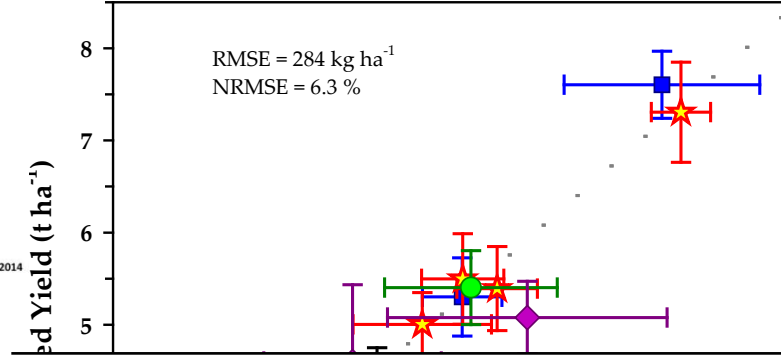
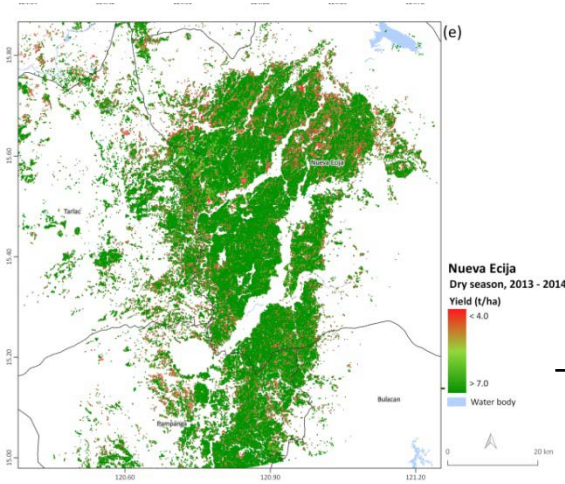


LAI estimation



015.
 176: 119-122

Yield Estimation



Country, sites	Year and season	SAR-based yield estimates, t ha ⁻¹			Official yield/ CCY t ha ⁻¹	RMSE kg ha ⁻¹	NRMSE (%)
		Min.	Mean	Max.			
Cambodia, Takeo	2014 MWS	2.74	3.13	3.51	3.03, 339	242, 634	8.0, 19
Vietnam, Soc Trang	2014 Summer	4.56	5.39	5.77	5.64, 5.45	459, 414	8.1, 7.6
Philippines, Nueva Ecija	2013-14 Dry	6.77	7.60	8.21	7.21, 7.71	980, 1,029	13.6, 13.4
Philippines, Nueva Ecija	2014 Wet	3.96	5.30	5.95	5.31/ 5.77	480, 521	8.9, 8.7

Added value products: MODIS + SAR







remote sensing



Remote Sens. **2018**, *10*, 293; doi:10.3390/rs10020293

Article

Spatial Rice Yield Estimation Based on MODIS and Sentinel-1 SAR Data and ORYZA Crop Growth Model

Tri D. Setiyono ^{1,*}, Emma D. Quicho ¹, Luca Gatti ², Manuel Campos-Taberner ³ , Lorenzo Busetto ⁴ , Francesco Collivignarelli ², Francisco Javier García-Haro ³ , Mirco Boschetti ⁴ , Nasreen Islam Khan ¹ and Francesco Holecz ²

¹ International Rice Research Institute, DAPO Box 7777, Metro Manila 1301, Philippines; e.quicho@irri.org (E.D.Q.); n.khan@irri.org (N.I.K.)

² Sarmap, Cascine di Barico 10, Purasca 6989, Switzerland; lgatti@sarmap.ch (L.G.); fcolli@sarmap.ch (F.C.); fholecz@sarmap.ch (F.H.)

³ Department of Earth Physics and Thermodynamics, Faculty of Physics, Universitat de València, València 46100, Spain; Manuel.Campos@uv.es (M.C.-T.); J.Garcia.Haro@uv.es (F.J.G.-H.)

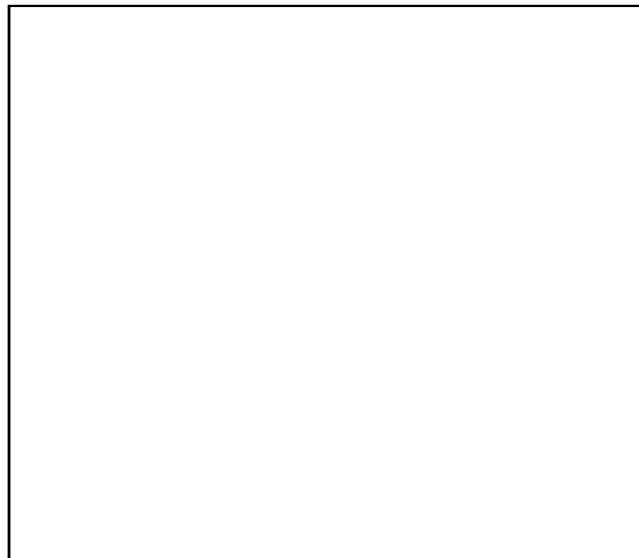
⁴ Institute for Electromagnetic Sensing of the Environment, Italian National Research Council, Via Bassini 15, Milan 20133, Italy; busetto.l@irea.cnr.it (L.B.); boschetti.m@irea.cnr.it (M.B.)

* Correspondence: t.setiyono@irri.org; Tel.: +63-2-580-5600

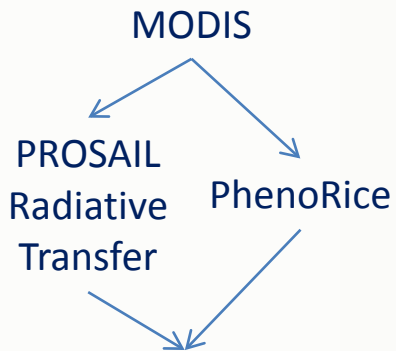
Received: 7 December 2017; Accepted: 23 January 2018; Published: 14 February 2018



Red River Delta, VNM, 2016 Spring & Summer



LAI Estimation



Logistic LAI Model

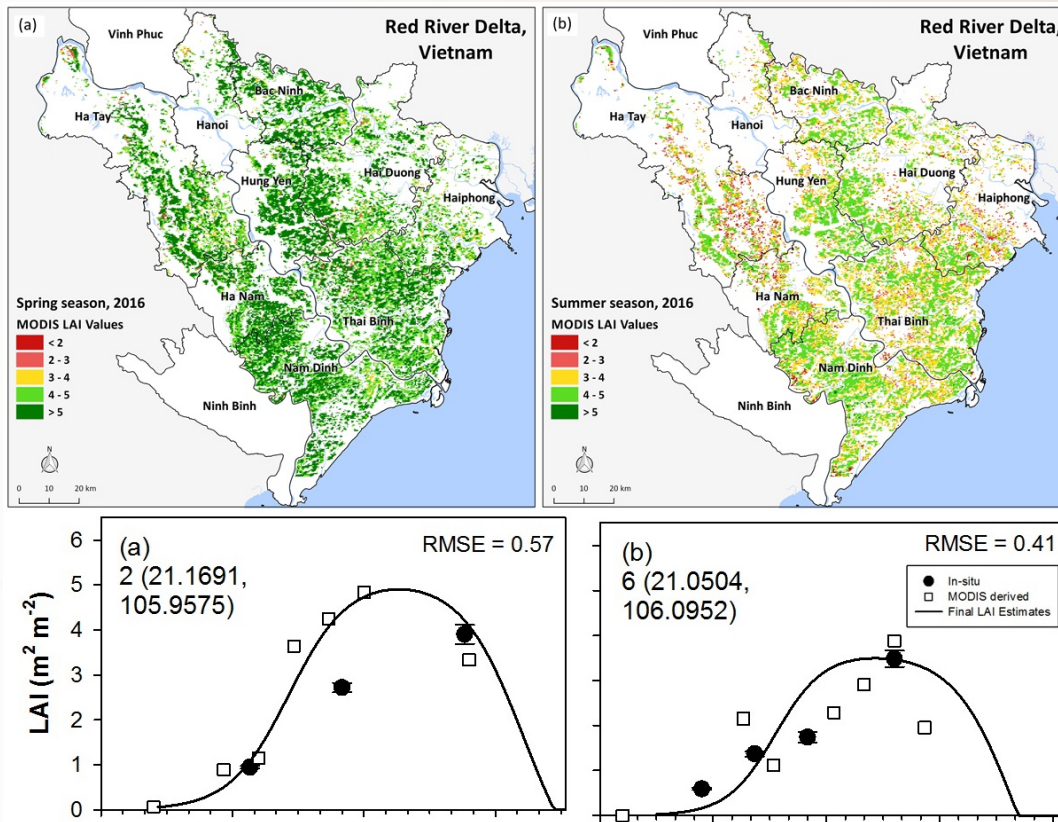
$$LAI_j = \frac{a_j}{1 + b_j \exp(-MPlc_j)}$$

$$LAI = LAI_E - LAI_S$$

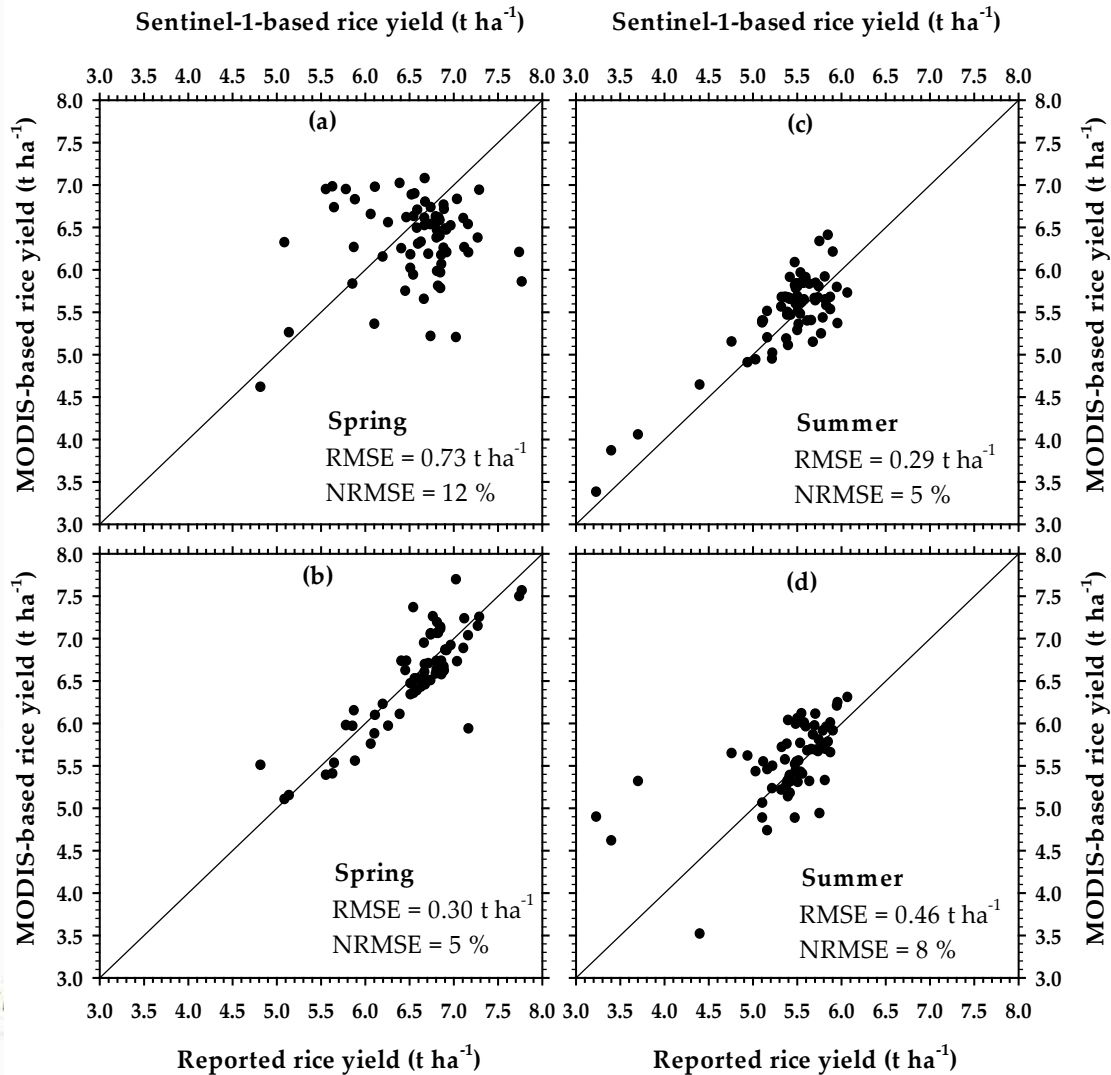
LAI Estimates



Rice science for a better world



Yield Estimation (MODIS)



Application for Crop Insurance: Supporting Pradhan Mantri Fasal Bima Yojana(PMFBY) insurance program in Tamil Nadu, India



Bi-weekly information on crop growth status, derived by SAR-based Rice Monitoring System

Observation on anomaly in rice cultivation helps to guide decision on **Preventive Sowing/ On Account Payment Cover**



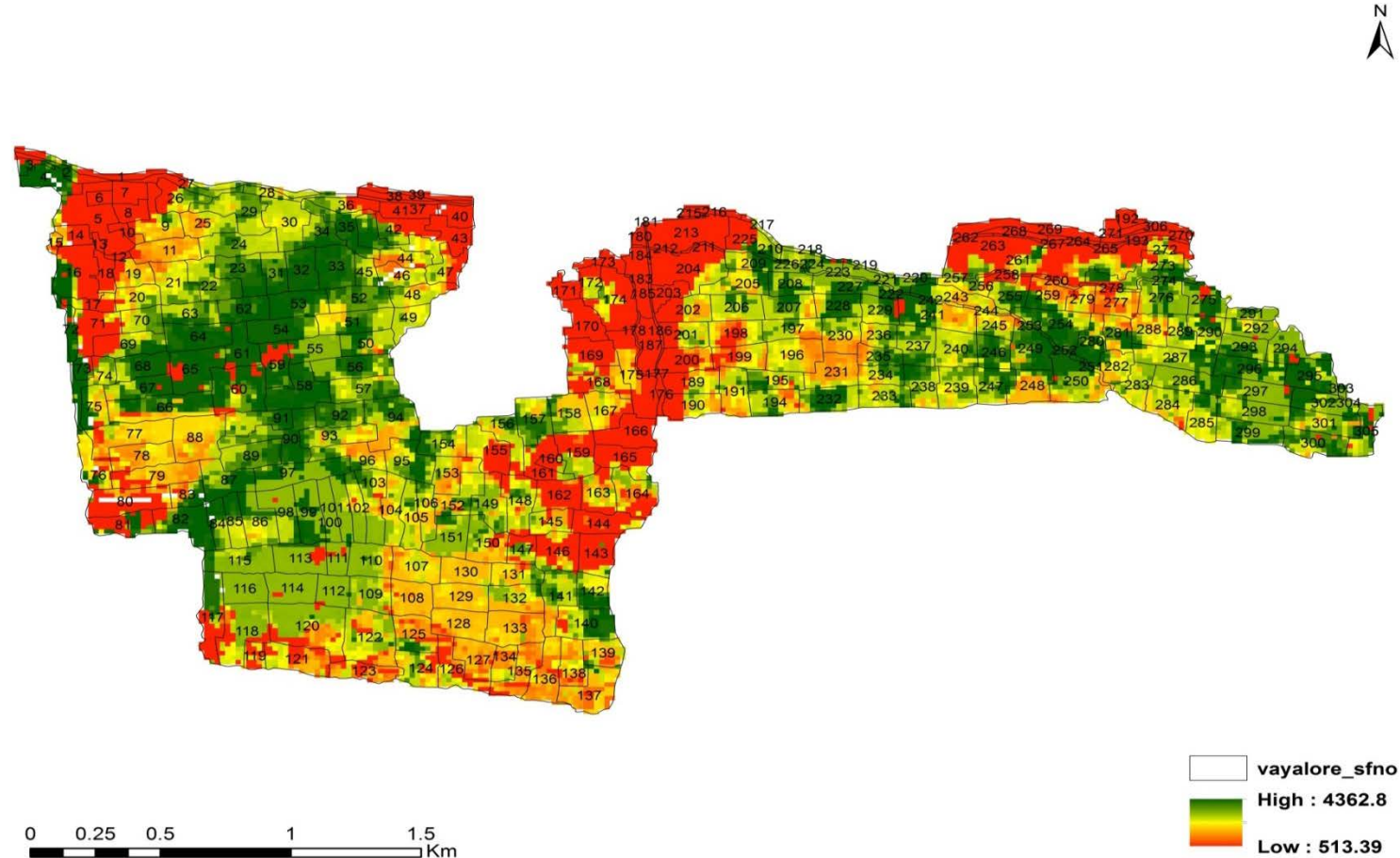
End-of-season yield estimation at village level can guide **Crop Cutting Experiments** (“**Smart sampling**”)



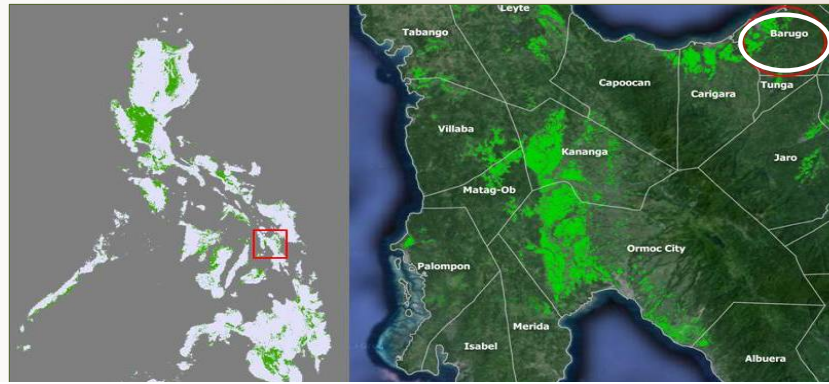
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IRRI

Rice Yield Map of Vayalore Village of Kodavasal Block, Tiruvarur District, Tamil Nadu



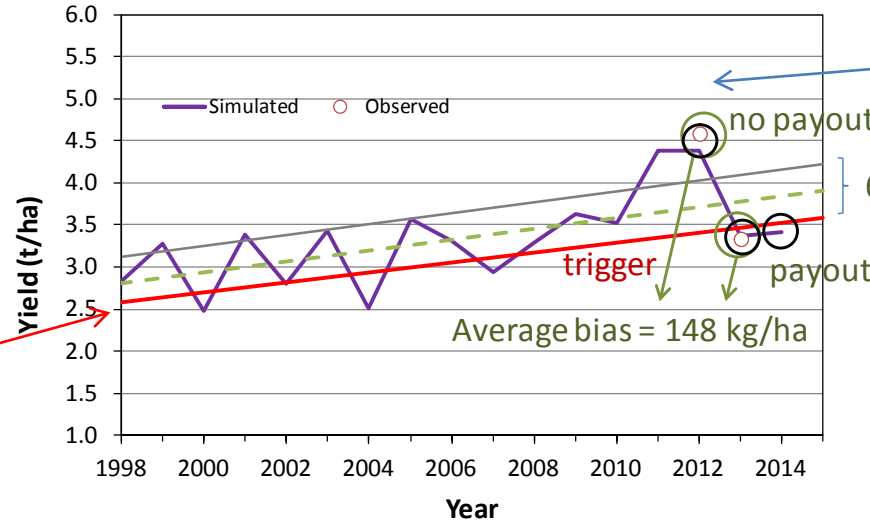
Application for Crop Insurance: Area Yield Index Insurance



MODIS+SAR



Historical
Yield



Rice science for a better world

Conclusion

- SAR-based yield estimation system can provide reliable timely sub-national rice information to support food security policy.
- The innovative spatial allocation approach ensures the efficiency of yield data processing by supporting its potential use in an operational setting.
- MODIS+SAR based yield estimates well suited for reconstructing historical yield data in the context of crop insurance programs.





Thank You!

t.setiyono@irri.org