

## Article

# High-Resolution Mapping of Paddy Rice Extent and Growth Stages across Peninsular Malaysia Using a Fusion of Sentinel-1 and 2 Time Series Data in Google Earth Engine

Fatchurrachman <sup>1</sup>, Rudiyanto <sup>1,\*</sup>, Norhidayah Che Soh <sup>1</sup>, Ramisah Mohd Shah <sup>1</sup>, Sunny Goh Eng Giap <sup>2</sup>, Budi Indra Setiawan <sup>3</sup> and Budiman Minasny <sup>4</sup>

<sup>1</sup> Program of Crop Science, Faculty of Fisheries and Food Science, Universiti Malaysia Terengganu, Kuala Nerus 21030, Terengganu, Malaysia; p4831@pps.umt.edu.my (F.); norhidayah.soh@umt.edu.my (N.C.S.); ramisah@umt.edu.my (R.M.S.)

<sup>2</sup> Program of Environmental Technology, Faculty of Ocean Engineering Technology and Informatics, Universiti Malaysia Terengganu, Kuala Nerus 21030, Terengganu, Malaysia; sunnyg@umt.edu.my

<sup>3</sup> Department of Civil and Environmental Engineering, IPB University, Bogor 16680, Indonesia; budindra@apps.ipb.ac.id

<sup>4</sup> School of Life and Environmental Sciences, Sydney Institute of Agriculture, The University of Sydney, Sydney, NSW 2006, Australia; budiman.minasny@sydney.edu.au

\* Correspondence: rudiyanto@umt.edu.my

## Supplementary Materials

**Citation:** Fatchurrachman; Rudiyanto; Soh, N.C.; Shah, R.M.; Goh, E.G.; Setiawan, B.I.; Minasny, B. High-Resolution Mapping of Paddy Rice Extent and Growth Stages across Peninsular Malaysia Using a Fusion of Sentinel-1 and 2 Time Series Data in Google Earth Engine. *Remote Sens.* **2022**, *14*, 1875. <https://doi.org/10.3390/rs14081875>

Academic Editor: Clement Atzberger

Received: 16 February 2022

Accepted: 11 April 2022

Published: 13 April 2022

**Publisher's Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



**Copyright:** © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

**Table S1.** Growth stages from generalized phenological parameters for rice clusters in rice fields in the Peninsular Malaysia, Malaysia. Table S1 corresponds to Figures 5–7 and Table 4. T = Tillage, V = Vegetative-1, V2 = Vegetative-2, R = reproductive, M = Maturity, F (blank) = Fallow. Orange colour is main season and green colour is off season.

No	Map Unit	Cluster	Code Name	Area (ha)	2019												2020															
					Jan	Feb	Mar	Apr	May	Jun	Jul	Agst	Sep	Oct	Nov	Des	Jan	Feb	Mar	Apr	May	Jun	Jul	Agst	Sep	Oct	Nov	Des				
1	Selangor	1	Sel-1	4,445		T	V	R	M				T	V	R	M			T	V	R	M			T	V	R	M				
2	Selangor	2	Sel-2	2,391	T	V	R	M				T	V	R	M				T	V	R	M			T	V	R	M				
3	Selangor	3	Sel-3	6,053	M			T	V	R	M				T	V	R	M			T	V	R	M			T	V	R			
4	Selangor	4	Sel-4	5,493			T	V	R	M				T	V	R	M			T	V	R	M			T	V	R	M			
5	Perlis	1	Prl-1	21,017	R	M			T	V	R	M			T	V	R	M			T	V	R	M			T	V	V2			
6	Langkawi	1	Lan-1	913	R	M			T	V	R	M			T	V	R	M			T	V	R	M			T	V				
7	Negeri Sembilan	1	Nes-1	179			T	V	R	M	T	V1	V2	R	M			T	V1	V2	R	M			T	V	R	M				
8	Negeri Sembilan	2	Nes-2	124				T	V1	V2	R	M			T	V1	V2	R	M													
9	Negeri Sembilan	4	Nes-3	143				T	V	R	M							T	V1	V2	R	M			T	V	R	M				
10	Johor	1	Joh-1	477	R	M			T	V	R	M				T	V	R	M	T	V1	V2	R	M	T	V	R	M				
11	Johor	2	Joh-2	317				T	V1	V2	R	M						T	V1	V2	R	M			T	V	R	M				
12	Johor	3	Joh-3	288	T	V1	V2	R	M			T	V	R	M				T	V1	V2	R	M			T	V1	V2	R	M		
13	Johor	4	Joh-4	287				T	V	R	M					T	V1	V2	R	M	T	V	R	M								
14	Pahang	1	Pah-1	1,000		T	V1	V2	R	M									T	V	R	M										
15	Pahang	1	Pah-2	1,408	R	M			T	V1	V2	R	M			T	V1	V2	R	M			T	V1	V2	R	M		T	V		
16	Pahang	2	Pah-3	450	T	V1	V2	R	M			T	V	R	M				T	V	R	M			T	V	R	M				
17	Pahang	3	Pah-4	491														T	V	R	M				T	V	R	M				
18	Kedah	1	Ked-1	50,000	R	M				T	V	R	M			T	V	R	M			T	V	R	M			T	V1	V2		
19	Kedah	2	Ked-2	54,782	R	M				T	V	R	M			T	V	R	M			T	V1	V2	R	M			T	V1	V2	
20	Penang	1	Pen-1	1,206			T	V	R	M				T	V	R	M			T	V	R	M			T	V	R	M			
21	Penang	2	Pen-2	9,795	R	M				T	V	R	M				T	V	R	M			T	V	R	M			T	V		
22	Malacca	1	Mal-1	452	R	M			T	V1	V2	R	M			T	V	R	M			T	V1	V2	R	M			T	V1	V2	
23	Malacca	2	Mal-2	382	R	M			T	V	R	M			T	V1	V2	R	M			T	V1	V2	R	M						
24	Malacca	3	Mal-3	226	R	M			T	V1	V2	R	M				T	V	R	M			T	V1	V2	R	M			T	V	
25	Kelantan	1	Kel-1	11,672	T	V	R	M				T	V	R	M				T	V1	V2	R	M			T	V	R	M			
26	Kelantan	2	Kel-2	11,969	T	V1	V2	R	M			T	V1	V2	R	M			T	V1	V2	R	M			T	V1	V2	R	M		
27	Perak	1	Per-1	10,591	M			T	V	R	M				T	V	R	M			T	V1	V2	R	M			T	V	R		
28	Perak	2	Per-2	3,189	M			T	V	R	M				T	V1	V2	R	M			T	V1	V2	R	M	T	V1	V2	R		
29	Perak	3	Per-3	4,528	R	M				T	V	R	M				T	V	R	M			T	V	R	M			T	V		
30	Perak	4	Per-4	14,901		T	V1	V2	R	M				T	V	R	M			T	V	R	M			T	V	R	M			
31	Perak	5	Per-5	5,434	T	V	R	M				T	V1	V2	R	M			T	V1	V2	R	M			T	V1	V2	R	M		
32	Terengganu	1	Ter-1	46				T	V	R	M							T	V	R	M					T	V1	V2	R	M		
33	Terengganu	1	Ter-2	60				T	V	R	M						T	V	R	M			T	V	R	M						
34	Terengganu	2	Ter-3	79	T	V1	V2	R	M		T	V1	V2	R	M				T	V	R	M			T	V1	V2	R	M			
35	Terengganu	4	Ter-4	60				T	V1	V2	R	M					T	V1	V2	R	M			T	V1	V2	R	M				
36	Terengganu	5	Ter-5	30				T	V	R	M					T	V	R	M			T	V1	V2	R	M						

37	Terengganu	6	Ter-6	151		T	V1	V2	R	M					T	V	R	M	
38	Terengganu	1	Ter-7	112		T	V1	V2	R	M									
39	Terengganu	2	Ter-8	90	M	T	V1	V2	R	M		T	V	R	M		T	V	R
40	Terengganu	1	Ter-9	5,457	T	V1	V2	R	M		T	V	R	M		T	V	R	M
Total Rice Field Area in Peninsular Malaysia				230,688															