Supplementary material

Mapping a cloud-free rice growth stages using the integration of PROBA-V and Sentinel-1 and its temporal correlation with sub-district statistics

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Table S1. The cross-correlation between rice growth stages area (vegetative, reproductive, and ripening) and local statistics (rice planting and harvested area).

No	Subdistrict	Area (ha)	Veg - Plant		Veg - Repro		Veg - Ripe		Veg - Harv		Repro - Ripe		Repro - Harv		Ripe - Harv		Plant - Harv	
			Corr.	Lag	Corr.	Lag	Corr.	Lag	Corr.	Lag	Corr.	Lag	Corr.	Lag	Corr.	Lag	Corr.	Lag
									INDRAMAYU									
1	Anjatan	6,419	0.68**	0	0.70**	48	0.74**	90	0.66**	84	0.85**	36	0.75**	48	0.86**	0	0.61**	90
2	Arahan	1,958	0.58**	0	0.68**	48	0.56**	72	0.56**	90	0.77**	36	0.67**	48	0.79**	12	0.66**	90
3	Balongan	1,085	0.58**	0	0.65**	36	0.60**	72	0.59**	84	0.74**	36	0.62**	48	0.75**	12	0.64**	84
4	Bangodua	3,601	0.69**	0	0.74**	48	0.53**	84	0.65**	90	0.54**	36	0.65**	48	0.77**	0	0.57**	90
5	Bongas	3,831	0.62**	0	0.57**	48	0.62**	90	0.55**	90	0.76**	48	0.81**	48	0.85**	0	0.51**	84
6	Cantigi	697	0.69**	0	0.62**	48	0.55**	84	0.52**	90	0.73**	24	0.55**	36	0.68**	12	0.48*	108
7	Cikedung	4,120	0.76**	0	0.82**	48	0.51**	84	0.58**	84	0.5**	36	0.66**	48	0.52**	12	0.71**	84
8	Gabuswetan	6,241	0.63**	0	0.79**	48	0.58**	72	0.64**	84	0.64**	36	0.68**	36	0.58**	0	0.72**	84
9	Gantar	8,059	0.1	0	0.79**	36	0.54**	72	0.67**	84	0.46*	36	0.64**	36	0.68**	12	0.46*	108
10	Haurgeulis	4,403	0.57**	0	0.80**	36	0.51**	72	0.64**	84	0.59**	36	0.75**	36	0.57**	0	0.68**	84
11	Indramayu	1,711	0.55**	0	0.64**	48	0.53**	72	0.51**	90	0.81**	36	0.66**	48	0.72**	12	0.69**	90
12	Jatibarang	2,609	0.52**	0	0.62**	48	0.55**	84	0.55**	90	0.82**	36	0.61**	48	0.78**	24	0.61**	90
13	Juntinyuat	3,697	0.65**	0	0.70**	36	0.56**	72	0.53**	84	0.77**	36	0.73**	36	0.81**	0	0.57**	90
14	Kandanghaur	5,941	0.64**	0	0.49*	48	0.42*	84	0.39*	90	0.82**	36	0.69**	36	0.72**	0	0.47*	90
15	Karangampel	2,066	0.57**	0	0.63**	48	0.51**	84	0.63**	90	0.77**	36	0.62**	48	0.64**	12	0.59**	90
	Kedokan																	
16	Bunder	2,301	0.65**	0	0.67**	48	0.44*	84	0.54**	90	0.68**	36	0.57**	60	0.65**	12	0.45*	84
17	Kertasemaya	2,485	0.35*	0	0.61**	48	0.51**	84	0.56**	90	0.73**	36	0.74**	48	0.72**	12	0.47*	90

18	Krangkeng	4,623	0.47*	0	0.67**	48	0.72**	84	0.64**	108	0.66**	36	0.75**	48	0.72**	12	0.43*	108
19	Kroya	10,064	0.42*	0	0.77**	36	0.50**	72	0.66**	84	0.52**	24	0.67**	36	0.64**	0	0.42*	90
20	Lelea	4,709	0.65**	0	0.80**	48	0.49*	84	0.61**	90	0.55**	36	0.62**	60	0.61**	24	0.49*	108
21	Lohbener	2,479	0.63**	0	0.70**	48	0.65**	84	0.61**	90	0.79**	36	0.68**	48	0.70**	12	0.58**	90
22	Losarang	5,066	0.38*	0	0.69**	36	0.45*	84	0.62**	108	0.60**	36	0.72**	60	0.73**	24	0.35*	108
23	Pasekan	597	0.63**	0	0.65**	48	0.58**	72	0.48*	90	0.74**	24	0.65**	48	0.8**	12	0.54**	90
24	Patrol	2,523	0.6**	0	0.70**	48	0.76**	84	0.65**	84	0.81**	36	0.76**	48	0.77**	12	0.65**	90
25	Sindang	1,381	0.69**	0	0.73**	48	0.57**	84	0.51**	108	0.74**	36	0.65**	48	0.8**	12	0.51**	90
26	Sliyeg	4,607	0.63**	0	0.67**	48	0.56**	84	0.6**	90	0.76**	36	0.75**	48	0.79**	12	0.62**	90
27	Sukagumiwang	2,245	0.51**	0	0.70**	48	0.49*	84	0.48*	108	0.62**	36	0.50**	48	0.64**	12	0.51**	108
28	Sukra	3,351	0.41*	0	0.65**	48	0.66**	84	0.53**	84	0.91**	36	0.77**	48	0.79**	12	0.65**	90
29	Terisi	7,297	0.65**	0	0.84**	36	0.46*	72	0.71**	84	0.46*	36	0.75**	48	0.56**	12	0.73**	84
30	Tukdana	3,692	0.58**	0	0.63**	48	0.60**	84	0.62**	90	0.61**	36	0.65**	48	0.82**	12	0.50**	84
31	Widasari	3,011	0.69**	0	0.78**	48	0.59**	84	0.55**	90	0.60**	36	0.54**	48	0.72**	12	0.56**	90
								KARAWANG										
32	Banyusari	4,332	0.75**	0	0.59**	60	0.69**	84	0.66**	90	0.68**	36	0.82**	60	0.72**	12	0.58**	108
33	Batujaya	4,881	0.56**	0	0.61**	48	0.54**	84	0.48*	84	0.80**	36	0.82**	36	0.81**	0	0.84**	90
34	Ciampel	1,213	0.37**	0	0.21	48	0.02	84	0.14	84	0.55**	24	0.33*	48	0.49*	36	0.29**	84
35	Cibuaya	4,772	0.68**	0	0.58**	48	0.64**	84	0.55**	90	0.84**	36	0.80**	36	0.86**	0	0.79**	90
36	Cikampek	341	0.5**	24	0.42	48	0.42*	84	0.55**	108	0.50**	36	0.59**	36	0.68**	12	0.44*	60
37	Cilamaya Kulon	5,424	0.73**	12	0.65**	60	0.69**	90	0.62**	90	0.75**	36	0.71**	36	0.81**	0	0.78**	90
38	Cilamaya Wetan	5,031	0.73**	12	0.74**	60	0.74**	90	0.64**	90	0.82**	36	0.75**	48	0.80**	0	0.63**	84
39	Cilebar	5,243	0.7**	0	0.63**	48	0.66**	84	0.60**	90	0.84**	36	0.82**	36	0.81**	0	0.80**	90
40	Jatisari	3,968	0.76**	0	0.65**	48	0.47*	84	0.61**	90	0.64**	36	0.70**	60	0.70**	24	0.47*	108
41	Jayakerta	3,393	0.54**	0	0.64**	48	0.67**	84	0.43*	90	0.81**	36	0.59**	48	0.68**	24	0.74**	90
42	Karawang Barat	2,248	0.59**	12	0.50**	60	0.49*	84	0.50**	108	0.66**	24	0.54**	60	0.72**	12	0.63**	90
43	Karawang Timur	1,358	0.59**	0	0.62**	48	0.50**	84	0.45*	90	0.64**	36	0.55**	48	0.67**	12	0.68**	90
44	Klari	2,509	0.29	0	0.36*	48	0.12	84	0.35*	60	0.47*	36	0.14	36	0.20	0	0.25	108
45	Kotabaru	1,416	0.71**	0	0.64**	36	0.44*	84	0.63**	108	0.53**	36	0.59**	36	0.73**	12	0.62**	90

46	Kutawaluya	4,440	0.40*	0	0.59**	48	0.67**	90	0.55**	90	0.72**	48	0.54**	48	0.75**	0	0.65**	90
47	Lemahabang	4,034	0.65**	0	0.56**	60	0.48*	90	0.59**	90	0.59**	36	0.59**	36	0.59**	0	0.61**	90
48	Majalaya	2,417	0.64**	12	0.61**	60	0.52**	84	0.42*	90	0.67**	36	0.61**	36	0.66**	12	0.52**	90
49	Pakisjaya	3,013	0.23	0	0.60**	48	0.57**	84	0.46*	84	0.81**	36	0.75**	48	0.79**	12	0.48*	108
50	Pangkalan	3,025	0.6**	0	0.49**	36	0.45*	72	0.48*	84	0.51**	36	0.59**	36	0.48*	12	0.71**	84
51	Pedes	5,342	0.65**	0	0.66**	48	0.73**	84	0.59**	90	0.80**	36	0.68**	36	0.78**	12	0.8**	90
52	Purwasari	1,768	0.62**	0	0.53**	60	0.53**	84	0.51**	108	0.75**	24	0.73**	60	0.78**	24	0.62**	90
53	Rawamerta	3,516	0.48*	12	0.67**	48	0.59**	72	0.68**	90	0.75**	24	0.66**	48	0.79**	12	0.44*	108
54	Rengasdengklok	2,469	0.19	24	0.38*	60	0.35*	84	0.35*	108	0.65**	36	0.47**	36	0.32*	0	0.27	90
55	Talagasari	4,144	0.74**	12	0.70**	60	0.56**	90	0.63**	108	0.68**	48	0.64**	60	0.61**	12	0.50**	90
56	Tegalwaru	1,968	0.69**	0	0.54**	48	0.48**	84	0.48*	84	0.66**	36	0.61**	36	0.71**	24	0.58**	84
57	Telukjambe Barat	2,625	0.31*	0	0.31*	48	0.06	90	0.15	90	0.44*	36	0.55**	36	0.67**	0	0.62**	84
58	Telukjambe Timur	1,029	0.31*	24	0.17	60	0.03	90	0.26	108	0.76**	36	0.48*	60	0.53**	36	0.47*	84
59	Tempuran	7,215	0.66**	24	0.73**	60	0.70**	90	0.61**	108	0.80**	36	0.67**	48	0.76**	12	0.50**	90
60	Tirtajaya	5,061	0.61**	0	0.62**	48	0.60**	84	0.63**	90	0.78**	24	0.79**	48	0.81**	12	0.79**	90
61	Tirtamulya	3,508	0.72**	0	0.60**	60	0.45**	90	0.63**	108	0.55**	24	0.61**	48	0.65**	24	0.58**	90
							SUBANG											
62	Binong	4,014	0.52**	0	0.61**	48	0.58**	90	0.31*	72	0.8**	48	0.37*	48	0.44*	0	0.59**	84
63	Blanakan	5,234	0.65**	0	0.73**	48	0.77**	84	0.64**	84	0.86**	36	0.66**	24	0.64**	0	0.68**	90
64	Ciasem	8,817	0.54**	0	0.56**	48	0.59**	90	0.51**	84	0.82**	36	0.76**	36	0.82**	0	0.68**	84
65	Ciater	951	0.15	24	0.03	48	-0.01	90	0.14	108	0.47*	12	0.02**	60	-0.10	36	0.74**	84
66	Cibogo	1,990	0.48*	0	0.82**	36	0.60**	72	0.56**	72	0.66**	36	0.54**	36	0.63**	0	0.61**	84
67	Cijambe	2,316	0.39*	24	0.37*	60	0.26	84	0.27	108	0.31*	36	0.36*	60	0.16	36	0.76**	84
68	Cikaum	2,723	0.45*	0	0.63**	36	0.55**	84	0.41*	84	0.76**	36	0.52**	48	0.53**	0	0.67**	84
69	Cipeundeuy	1,933	0.13	24	0.76**	36	0.59**	84	0.20	72	0.70**	36	0.24	48	0.04**	36	0.51**	90
70	Cipunagara	5,974	0.73**	0	0.85**	36	0.56**	72	0.69**	84	0.59**	36	0.74**	48	0.57**	12	0.57**	84
71	Cisalak	1,328	0.20	48	0.23	48	0.31*	90	0.11	60	0.43*	36	0.01	48	-0.07	12	0.66**	90
72	Compreng	5,492	0.21	0	0.69**	48	0.61**	84	0.41*	84	0.81**	36	0.39*	36	0.40*	0	0.69**	90

No	Name	Area	Corr	Lag	Corr	Lag	Corr	Lag	Corr	Lag	Corr	Lag	Corr	Lag	Corr	Lag	Corr	Lag
73	Dawuan	597	0.20	24	0.24	36	0.29	90	0.23	72	0.22	36	0.42*	36	0.20	24	0.74**	90
74	Jalancagak	582	0.39*	24	0.52**	36	0.35*	84	0.41*	108	0.45*	36	0.24	60	0.23	36	0.65**	90
75	Kalijati	2,549	0.57**	12	0.65**	36	0.48*	72	0.29	108	0.59**	36	0.29	48	0.38*	36	0.48*	84
76	Kasomalang	695	0.32*	12	0.48*	48	0.27	90	0.27	90	0.57**	36	0.39*	48	0.18	36	0.77**	84
77	Legonkulon	2,694	0.58**	0	0.46*	60	0.57**	90	0.57**	90	0.73**	36	0.50**	24	0.65**	0	0.87**	90
78	Pabuaran	5,441	0.64**	0	0.70**	36	0.55**	72	0.46*	84	0.61**	36	0.60**	36	0.66**	12	0.66**	90
79	Pagaden	2,691	0.45*	0	0.74**	36	0.61**	84	0.51**	72	0.61**	48	0.58**	36	0.48*	0	0.76**	84
80	Pagaden Barat	3,151	0.48*	0	0.58**	36	0.62**	72	0.55**	72	0.66**	36	0.39*	36	0.52**	0	0.68**	90
81	Pamanukan	2,127	0.54**	0	0.70**	48	0.71**	90	0.72**	84	0.63**	36	0.65**	36	0.72**	0	0.56**	90
82	Patokbeusi	7,066	0.52**	0	0.78**	48	0.43*	84	0.47*	84	0.62**	36	0.60**	36	0.62**	12	0.72**	84
83	Purwadadi	1,418	0.05**	24	0.72**	48	0.46*	84	0.1	60	0.69**	36	0.22	24	0.07**	24	0.60**	90
84	Pusakajaya	4,529	0.74**	0	0.67**	48	0.75**	84	0.67**	90	0.77**	36	0.72**	60	0.74**	12	0.61**	108
85	Pusakanagara	2,399	0.66**	0	0.57**	48	0.57**	84	0.56**	90	0.79**	36	0.68**	36	0.81**	12	0.80**	90
86	Sagalaherang	939	0.17	0	0.20	36	0.20	90	0.13	84	0.45*	12	0.08**	24	0.26	0	0.79**	84
87	Serangpanjang	1,599	0.34*	24	0.49*	36	0.33*	84	0.15	108	0.38*	12	0.16	48	0.11	36	0.76**	90
88	Subang	1,312	-0.01	48	0.78**	36	0.50**	84	0.21	60	0.46*	36	0.03	24	-0.05	24	0.64**	84
89	Sukasari	3,298	0.46*	0	0.71**	60	0.69**	90	0.71**	84	0.72**	36	0.63**	24	0.7**	0	0.7**	90
90	Tambakdahan	5,334	0.52**	0	0.72**	48	0.72**	84	0.66**	84	0.83**	36	0.71**	36	0.73**	0	0.54**	108
91	Tanjungsiang	1,281	0.26	24	0.56**	36	0.53**	84	0.17	108	0.7**	36	0.21	60	0.19	36	0.68**	84
	Total/ Average	309,046	0.52**	5.27	0.61**	46.95	0.52**	83.14	0.50**	89.47	0.66**	34.68	0.57**	44.04	0.60**	12.00	0.61**	90.40

Note : Corr = Correlation, Veg = Vegetative stage area (remote sensing), Repro = Reproductive stage area (remote sensing), Ripe = Ripening stage area (remote sensing), Plant = Paddy planting area (local statistics), Harv = Paddy harvested area (local statistics),, unit in Lag is day (s), ** = $p<0.01$ (highly significant) and * = $p<0.05$ (statistically significant)
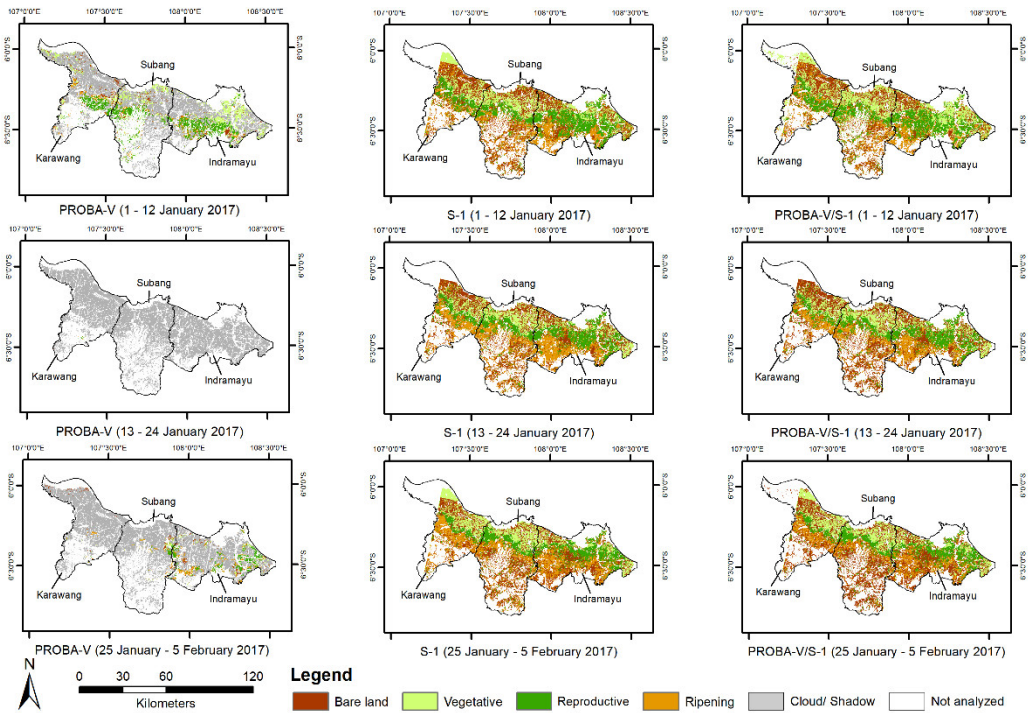
Figure S1. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel-1 on three periods (1 - 12 January 2017, 13 - 24 January 2017, and 25 January - 5 February 2017).
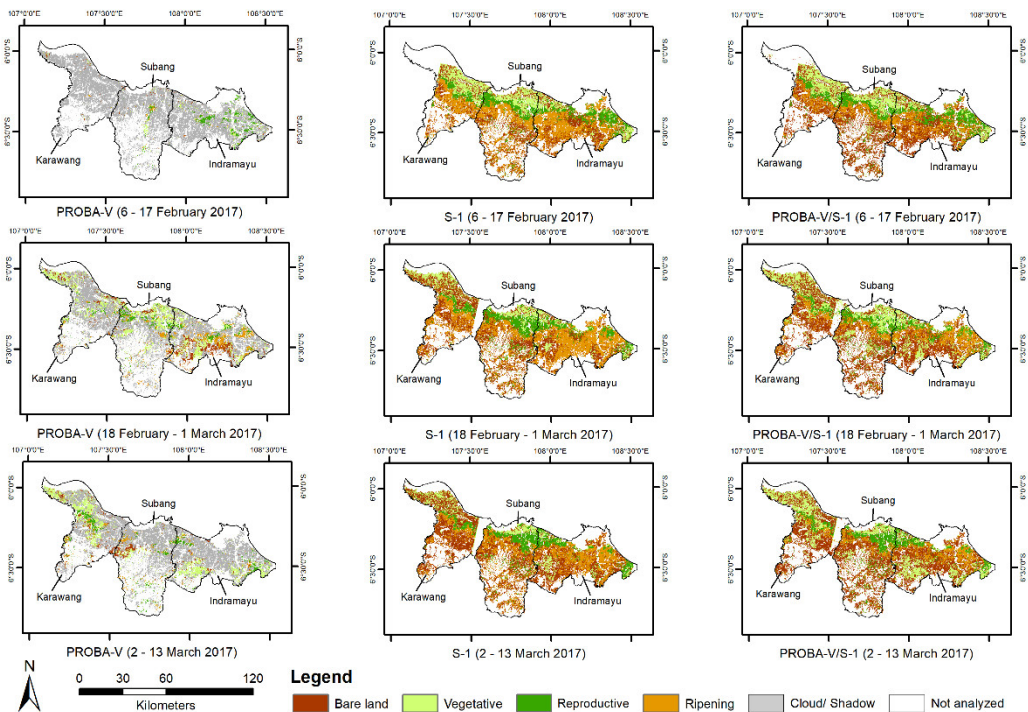

Figure S2. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (6 – 17 February 2017, 18 February – 1 March 2017, and 2 - 13 March 2017).
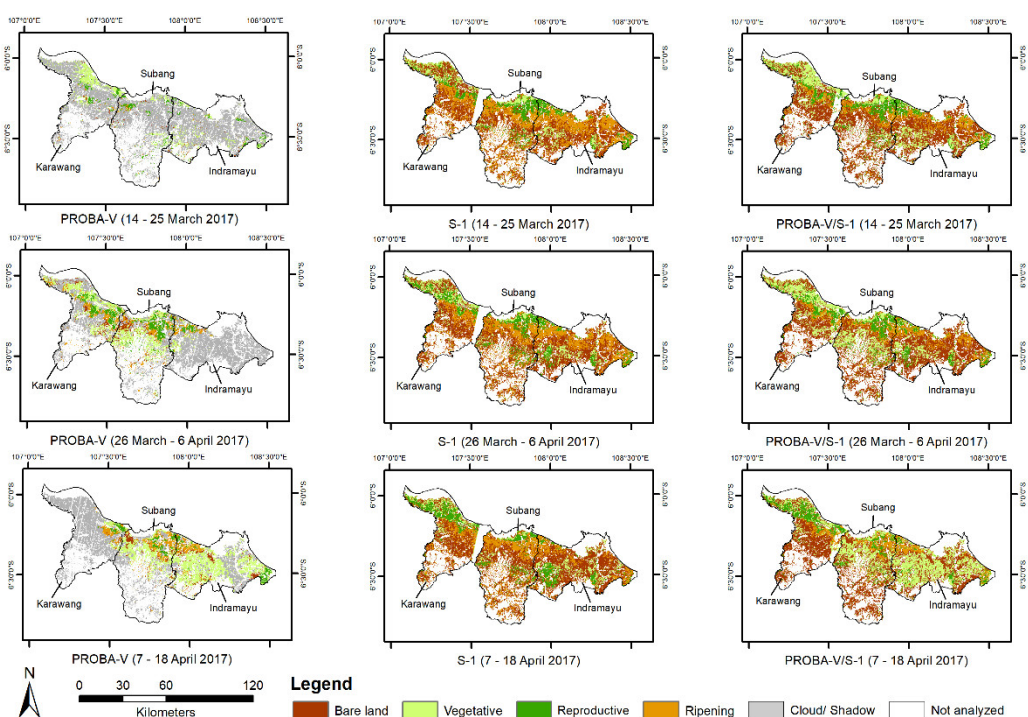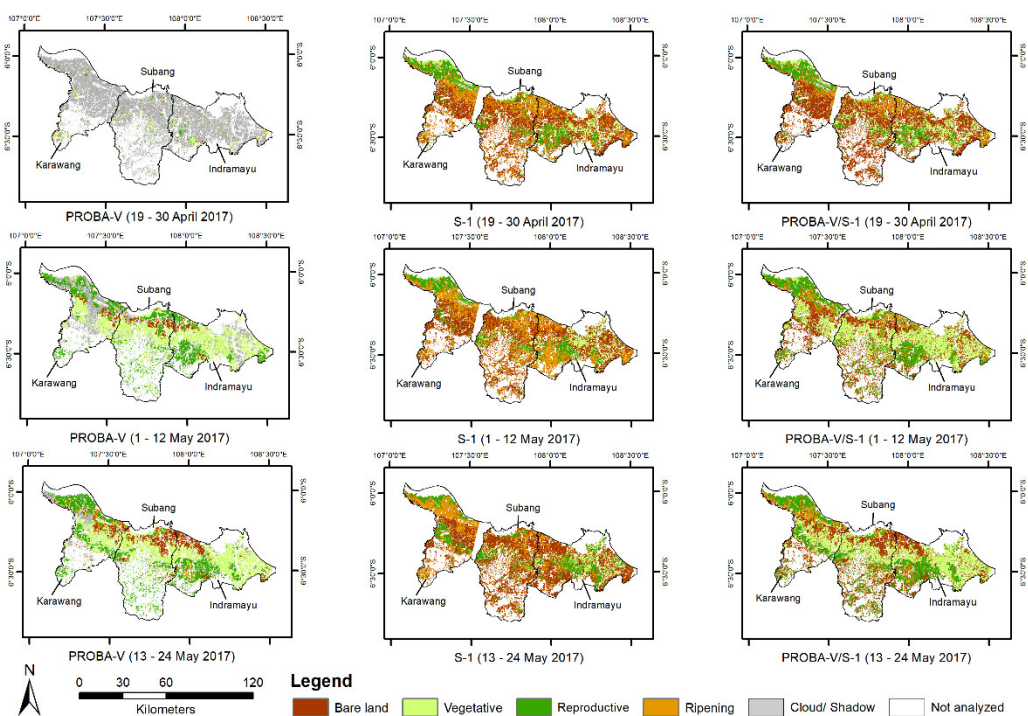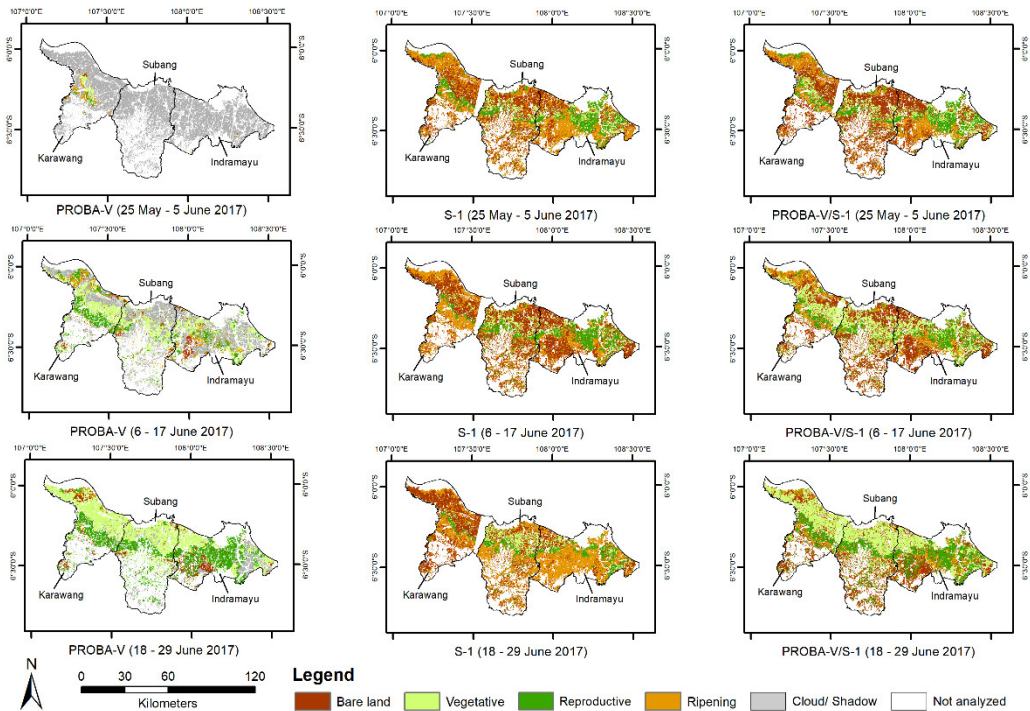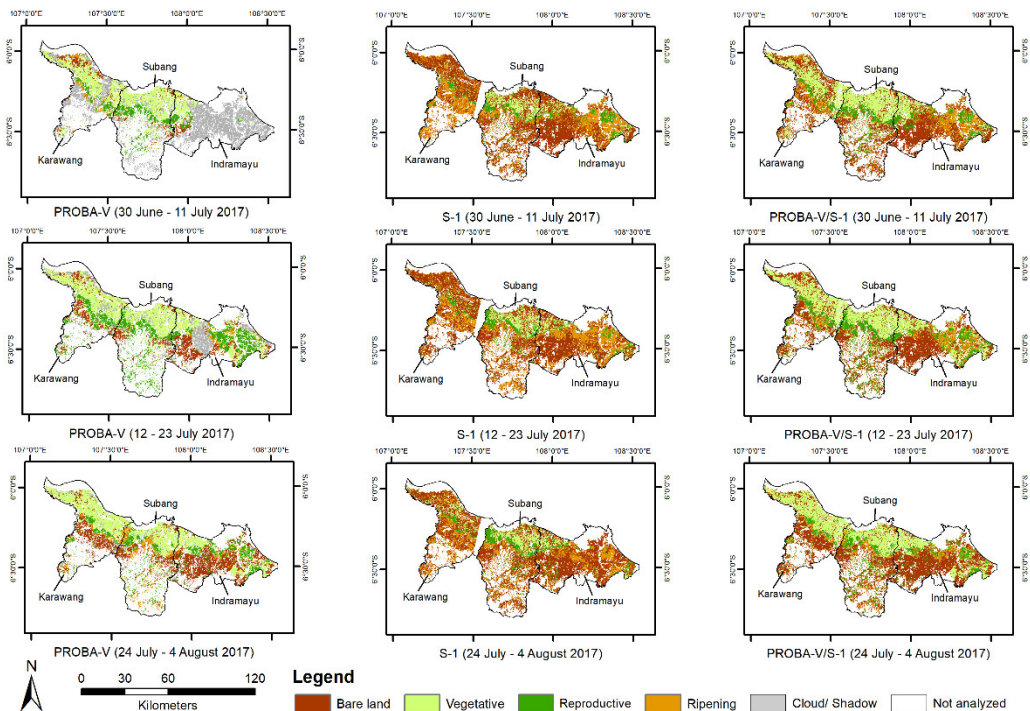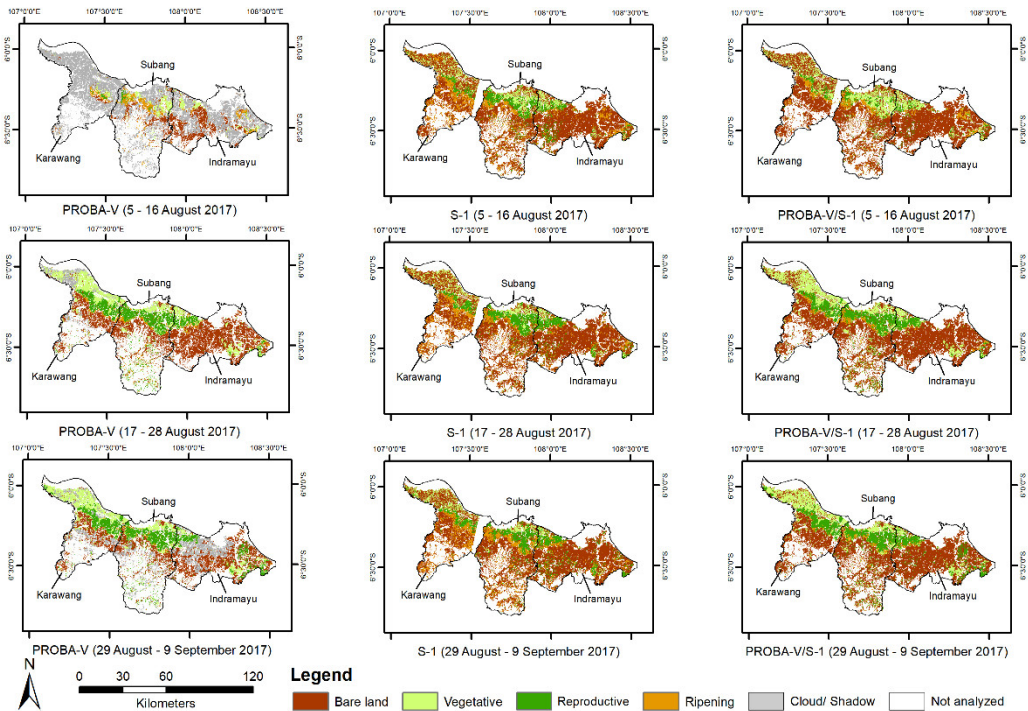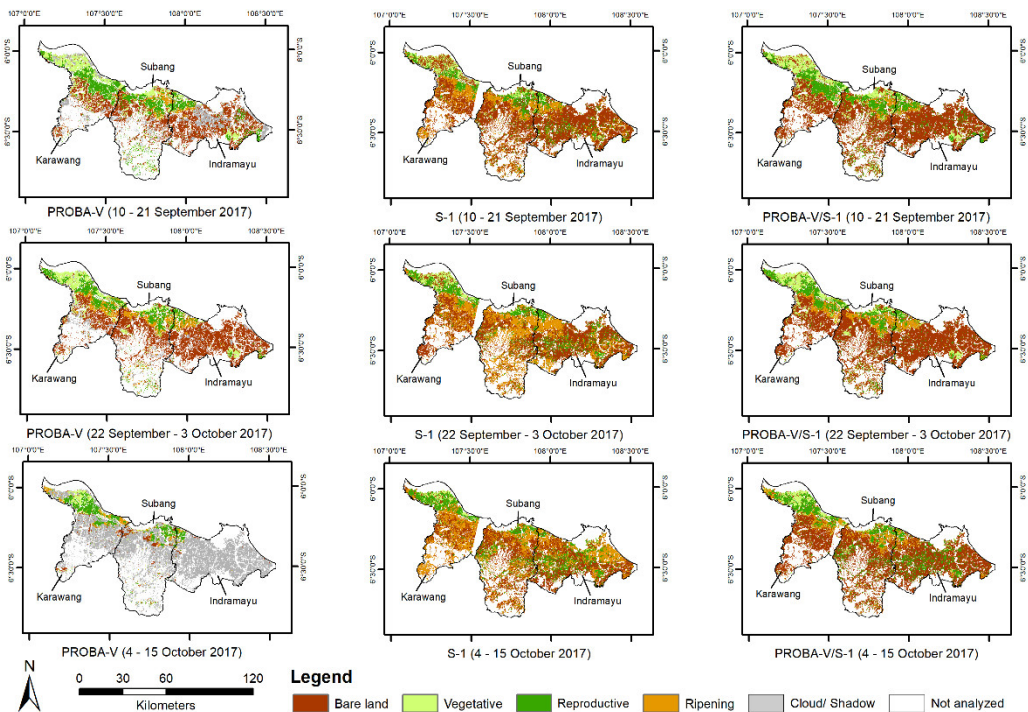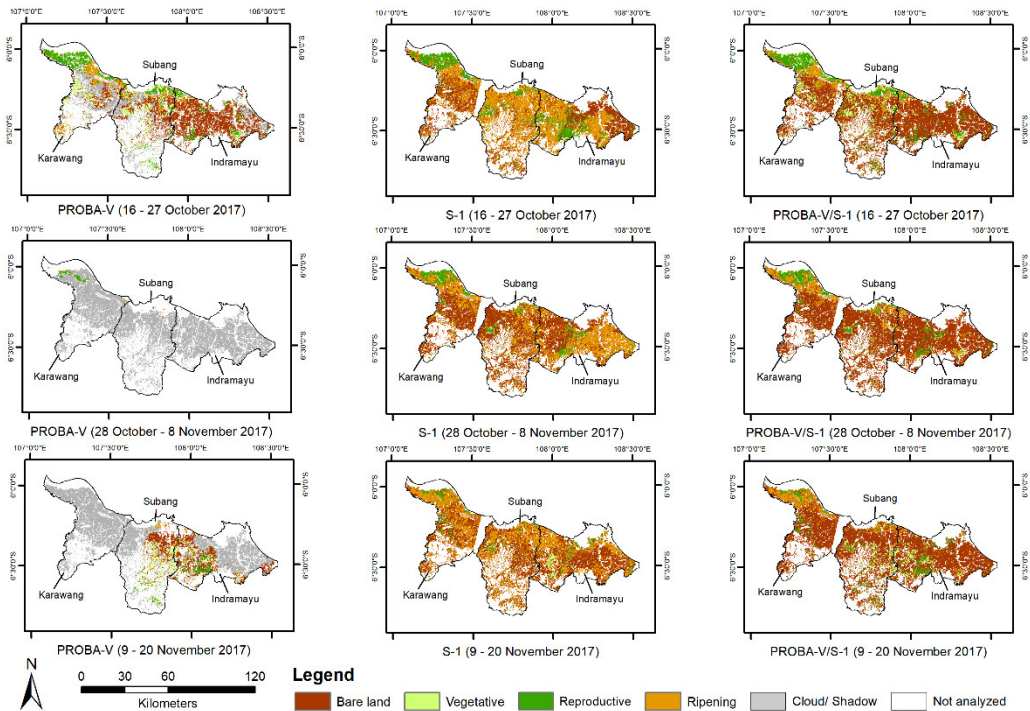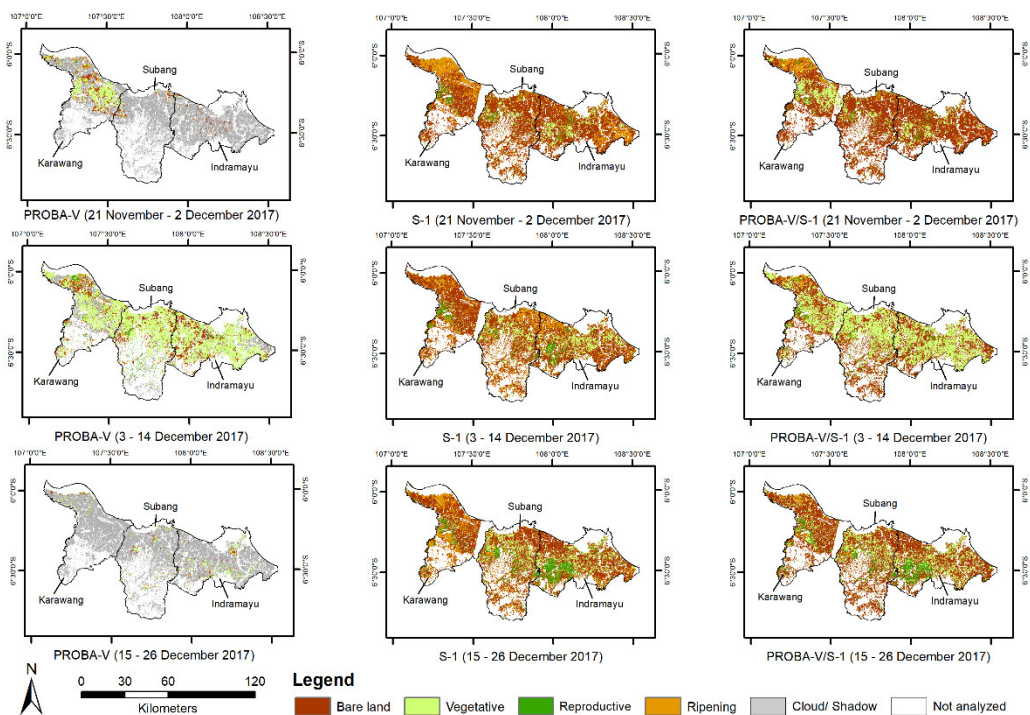
Figure S3. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (14 – 25 March 2017, 26 March – 6 April 2017, and 7 - 18 2017)

Figure S4. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (19 – 30 April 2017, 1 – 12 May 2017, and 13 – 24 May 2017).
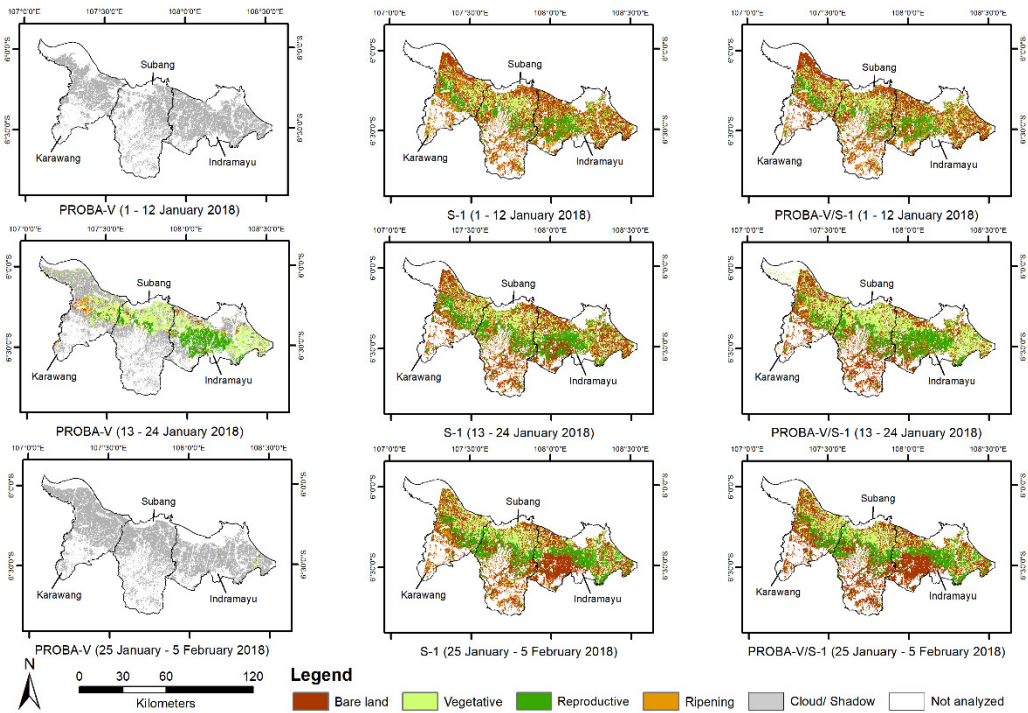
Figure S5. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (25 May - 5 June 2017, 6 - 17 June 2017, and 18 - 29 June 2017).

Figure S6. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (30 June – 11 July 2017, 12 - 23 July 2017, and 24 July – 4 August 2017).
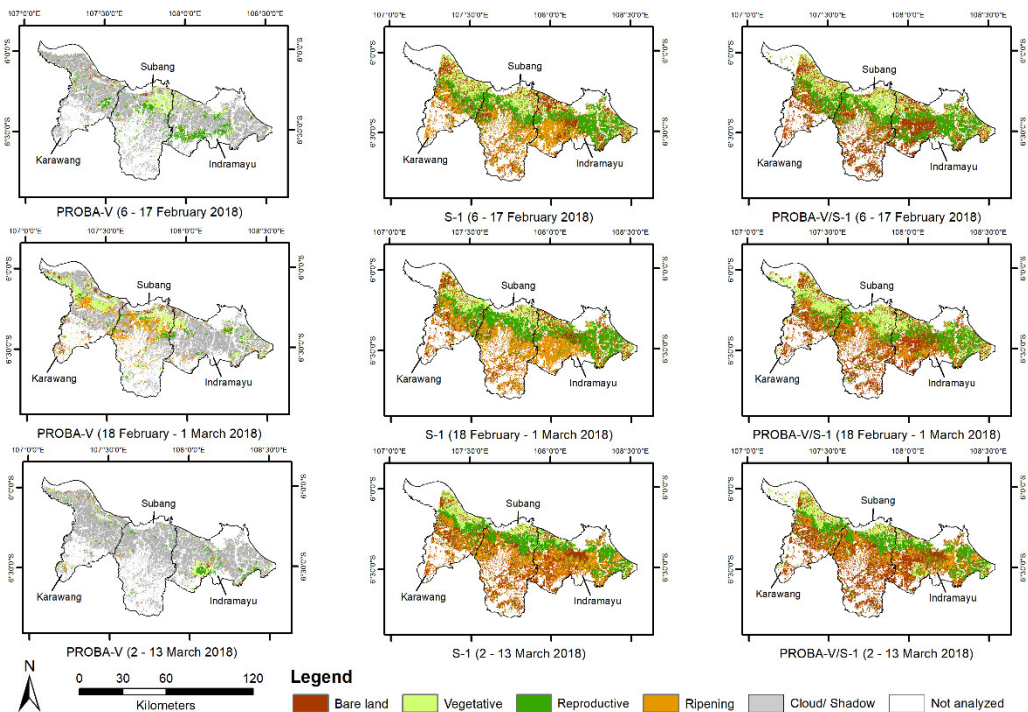
Figure S7. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (5 – 16 August 2017, 17 - 28 August 2017, and 29 August – 9 September 2017).

Figure S8. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel-1 on three periods (10 - 21 September 2017, 22 September – 3 October 2017, and 4 - 15 October 2017)

Figure S9. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and S-1 on three periods (16 – 27 October 2017, 28 October – 8 November 2017, and 9 – 20 November 2017).

Figure S10. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and S-1 on three periods (21 November – 2 December 2017, 3 – 14 December 2017, and 15 – 26 December 2017).

Figure S11. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (1 - 12 January 2018, 13 - 24 January 2018, and 25 January - 5 February 2018).

Figure S12. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (6 – 17 February 2018, 18 February – 1 March 2018, and 2 – 13 March 2018).
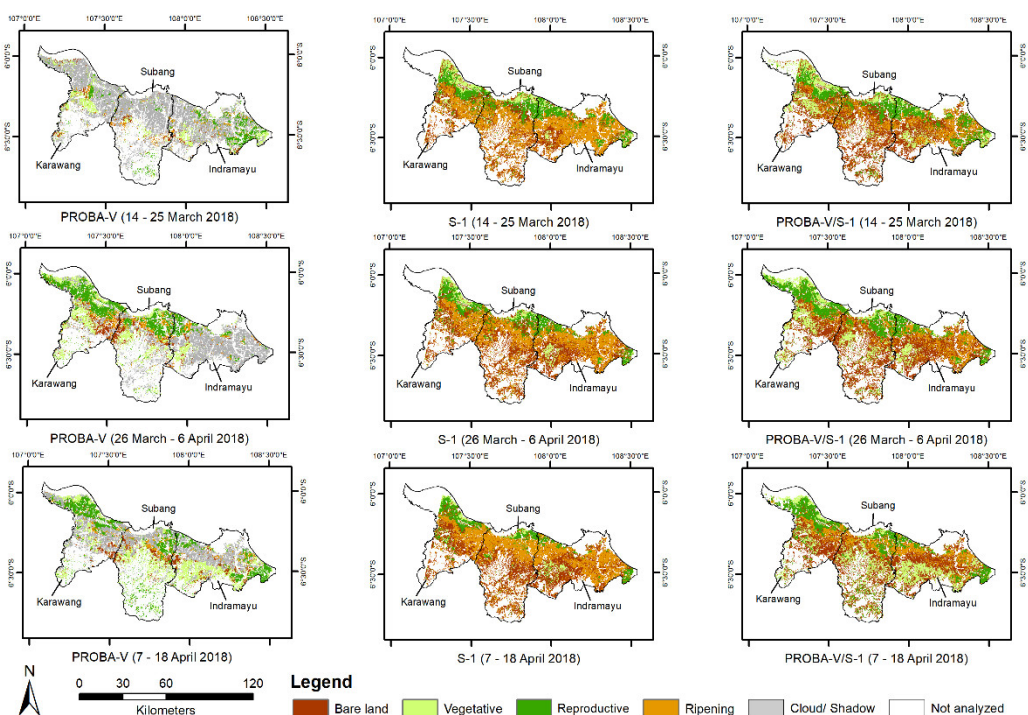
Figure S13. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (14 – 15 March 2018, 16 March – 6 April 2018, and 7 – 18 April 2018)
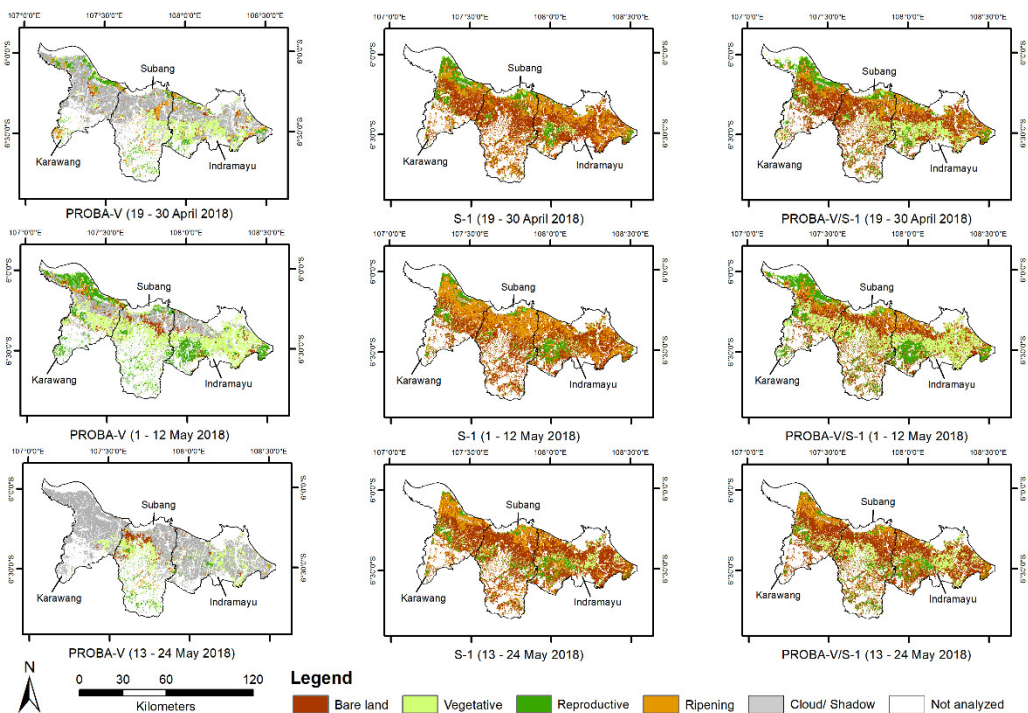

Figure S14. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (19 - 30 April 2018, 1 -12 May 2018, and 13 – 24 May 2018).
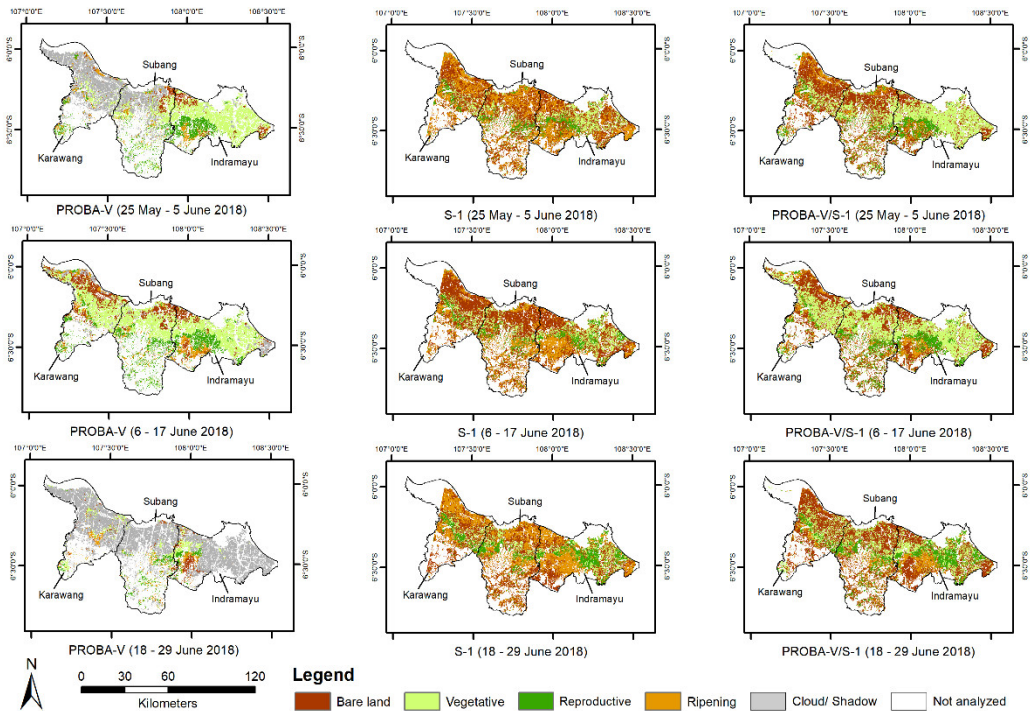
Figure S15. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on three periods (25 May – 5 June 2018, 6 – 17 June 2018, and 18 – 29 June 2018).
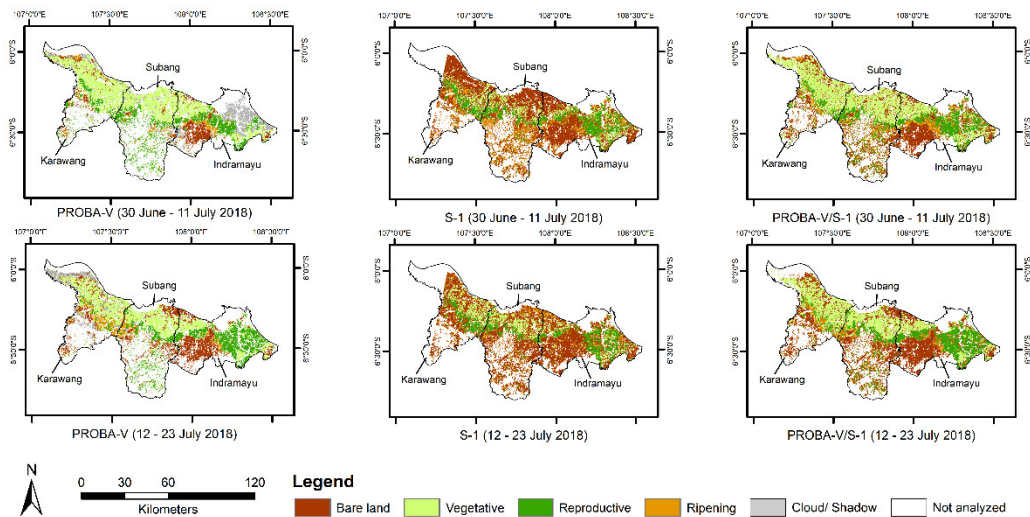

Figure S16. The rice growth stages map from PROBA-V, Sentinel-1, and the integration of PROBA-V and Sentinel -1 on two periods (30 June – 11 July 2018, and 12 – 23 July 2018).