Article

Automatic rice early season mapping based on SNIC and multi-source remote sensing images

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Supplementary Materials

Table S1. OA, UA, PA, Kappa, and F1 scores of rice classification based on SNIC and pixel under SAR+SI data source at different time intervals in the SART3 time stage.

SART3	SNIC					Pixel				
End date	UA	PA	OA	Kappa	F1	UA	PA	OA	Kappa	F1
15-Jun	0.8749	0.5937	0.7322	0.4768	0.7073	0.8074	0.5066	0.6652	0.3489	0.6225
30-Jun	0.9749	0.7232	0.839	0.6834	0.8304	0.8793	0.5986	0.7364	0.4848	0.7123
15-Jul	0.9885	0.7731	0.8714	0.7462	0.8676	0.9246	0.7007	0.8057	0.6174	0.7972
31-Jul	0.9909	0.7933	0.8833	0.7693	0.8811	0.9531	0.7494	0.8433	0.6906	0.8391
15-Aug	0.9975	0.8268	0.9045	0.8106	0.9042	0.9710	0.7948	0.8752	0.7528	0.8741
31-Aug	0.9938	0.8427	0.9114	0.8240	0.9120	0.9723	0.8116	0.8847	0.7712	0.8847
15-Sep	0.9921	0.8525	0.9159	0.8328	0.9170	0.9707	0.8246	0.8908	0.7831	0.8917
30-Sep	0.9901	0.8600	0.9190	0.8388	0.9205	0.9692	0.8305	0.8932	0.7877	0.8945

Table S2. OA, UA, PA, Kappa, and F1 scores of rice classification based on SNIC and pixel under SAR data source at different time intervals in the SART3 time stage.

SART3	SNIC					Pixel				
End date	UA	PA	OA	Kappa	F1	UA	PA	OA	Kappa	F1
15-Jun	0.8543	0.5878	0.7207	0.4537	0.6964	0.7837	0.4894	0.6481	0.3158	0.6026
30-Jun	0.959	0.7212	0.8312	0.6679	0.8233	0.8624	0.5875	0.7241	0.4607	0.6989
15-Jul	0.9739	0.774	0.8655	0.7342	0.8625	0.9108	0.6899	0.7942	0.5947	0.7851
31-Jul	0.9758	0.795	0.8775	0.7575	0.8762	0.9394	0.7429	0.8338	0.6716	0.823
15-Aug	0.9657	0.8317	0.8922	0.7855	0.8937	0.9554	0.7914	0.8661	0.7346	0.8657
31-Aug	0.972	0.8441	0.9018	0.8044	0.9035	0.9562	0.8074	0.8748	0.7515	0.8755
15-Sep	0.9709	0.8615	0.9104	0.8214	0.9129	0.9535	0.8200	0.8800	0.7614	0.8817
30-Sep	0.97	0.8661	0.9124	0.8252	0.9151	0.9496	0.8275	0.8820	0.7650	0.8843

Table S3. Glossary of full-text abbreviations.

Full name	Abbreviation	Full name	Abbreviation
Synthetic aperture radar	SAR	the slope of VH backscattering intensity	VH-slope
land cover types	LCTs	Flooding signal vegetation index	FSVI
Whittaker Smoother	WS	European Space Agency World Cover 10 m 2020 product	ESAWC2020
Google Earth Engine	GEE	Sowing/Transplanting date	ST
Xuan's crop mapping datasets (30 m)	XCP	Transplanting/Mature date	MT
You's crop mapping datasets (10 m)	YCP	non-standard rice time series curve	NSR
overall accuracy	OA	standard rice time series curve	SR
Spectral index	SI	SI weight overlap map	SI-W
Jeffries–Matusita	JM	the cumulative sum of VH backscattering intensity	VH-sum
Normalized difference vegetation index	NDVI	SAR time;start:16-May,end:30-Sep	SART2
Enhanced vegetation index	EVI	SAR time;start:1-Jun,end:30-Sep	SART3
Normalized difference water index	NDWI	Spectral index time	SIT
Modified normalized difference water index	MNDWI	median synthesis of MBWI	MBWI-median
Land surface water index	LSWI	maximum composite value of FSVI at SIT5	FSVI-max-SIT5
Double Logistic function	DL	average composite value of FSVI at SIT5	FSVI-mean-SIT5
Simple Non-Iterative Clustering	SNIC	median composite value of FSVI at SIT5	FSVI-median-SIT5
Savitzky–Golay	SG	weighted overlapped value of FSVI	FSVI-W
Harmonic Analysis of Time Series	HANTS	maximum value synthesis of MNDWI at SIT5	MNDWI-max-SIT5
Multispectral Instrument	MSI	average value synthesis of MNDWI at SIT5	MNDWI-mean-SIT5
Enhanced Theme Imager	ETM+	median synthesis of MNDWI at SIT5	MNDWI-median-SIT5
producer accuracy	PA	weight overlap addition value of MNDWI	MNDWI-W
user accuracy	UA	a hierarchical K-Means binary classification rice automatic identification method based on phenological information feature optimization	PFO-HKMAR
kappa coefficient	KC	Automated Rice Mapping using Synthetic Aperture Radar Flooding Signals	ARM-SARFS
European Space Agency	ESA		

Table S4. Detailed steps of hierarchical K-Means binary classification method.

Step	Detailed methods
Step 1	K=2; select VH-sum and SI-W features and perform K-Means secondary classification. Considering the memory limitations in Google Earth Engine (GEE), 3000 sample points were randomly selected to train the centroids of the two clusters. According to the performance of different land cover types in VH-sum and SI-W features, 3000 sample points were randomly generated on the cultivated land layer of the ESAWC2020 data set.

Step 2	Then, K=2; select the VH-slope feature, and perform K-Means binary classification. Randomly select 3000 sample points to train the centroids of the two clusters. Considering the balance of sample categories, 1500 sample points are randomly generated on the permanent water body layer of the ESAWC2020 data set, and 1500 sample points are randomly generated after masking the permanent water body on the above classification results.