New Workflow of Plastic-Mulched Farmland Mapping using Multi-temporal Sentinel-2 data

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Abstract: Using plastic film mulch on cropland improves crop yield in water-deficient areas, but the use of plastic film on cropland leads to soil pollution. The accurate mapping of plastic-mulched land (PML) is valuable for monitoring the environmental problems caused by the use of plastic film. The drawback of PML mapping is that the detectable period of PML changes among the fields, which causes uncertainty when supervised classification methods are used to identify PML. In this study, a new workflow which merging PML of multiple temporal phases (MTPML) is proposed. For each temporal phase, the "possible PML" is firstly generated, these "temporal possible PML" layers are then combined to generate the "possible PML" layer. Finally, the maximum normalized difference vegetation index (NDVI) of the growing season is used to remove the non-cropland pixels from the "possible PML layer," and then generate PML images. When generating "temporal possible PML layers," three new PML indices (PMLI with near-infrared bands known as PMLI_NIR, PMLI with shortwave infrared bands known as PMLI_SWIR, and Normalized Difference PMLI known as PMLI_ND) are proposed to separate PML from bare land at plastic film cover stage; and the "temporal possible PML layer" are identified by the threshold based method. To estimate the performance of the three PML indices, two other approaches, PMLI threshold and Random Forest (RF) are used to generate "temporal possible PML layer." Finally, PML images generated from the five MTPML approaches are compared with the image time series supervised classification (SUPML) result. Two study regions, Hengshui (HS) and Guyuan (GY), are used in this study. PML identification models are generated using training samples in HS and the models are used for PML mapping in both study regions. The results showed that MTPML workflow outperformed SUPML with 3%–5% higher classification accuracy. The three proposed PML indices had higher separability and importance score for bare land and PML discrimination. Among the five approaches used to generate the "temporal possible PML layer," PMLI_SWIR is the recommended approach because the PMLI_SWIR threshold approach is easy to implement and the accuracy is only slightly lower than the RF approach. It is notable that no training sample was used in GY and the accuracy of the MTPML approach was higher than 85%, which indicated that the rules proposed in this study are suitable for other study regions.

Keywords: plastic-mulched land (PML), Sentinel-2, multi-temporal data, PML indices, threshold rule, Random Forest

Table S1 Number of Sentinel-2 images acquired for each 15-day period for both study regions

	Hengshui	Guyuan
April 1 ~ 15	16	20
April 16~30	16	23
May 1 ~ 15	16	14
May 16~31	14	24
June 1 ~ 15	18	24
June 16~30	18	26
July 1 ~ 15	18	20
July 16~31	18	24
August 1 ~ 15	14	24
August 16~31	18	16
September 1 ~ 15	15	20
September 16~31	18	20
October 1 ~ 15	18	20
October 16~31	18	24
Total	235	299