Spatial Estimation of Methane Emission from Rice Fields using Sentinel-1A SAR Data and MODIS Satellite Data

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Abstract: Rice (*Oryza sativa* L.) is the primary staple food source for more than half of the world's population and has profound influence on the livelihood of farmers. Rice cultivation has been recognized as one of the major anthropogenic source for CH_4 emissions. Synthetic Aperture Radar (SAR) imagery, especially where cloud cover restricts the use of optical imagery. Parameterised classification with multi-temporal features derived from regularly acquired, C-band, VV and VH polarized Sentinel-1A SAR imagery was used for mapping rice area. A fully automated processing chain in MAPscape-Rice software was used to convert the multi-temporal SAR data into terrain-geocoded σ° values, which included strip mosaicking, co-registration of images acquired with the same observation geometry and mode, time-series speckle filtering, terrain geocoding, radiometric calibration and normalization. Further Anisotropic non-linear diffusion (ANLD) filtering was done to smoothen homogeneous targets, while enhancing the difference between neighbouring areas. Multi-Temporal Features viz., max, min, mean, max date, min date and span ratio were extracted from VV and VH polarizations to classify rice pixels. Land surface temperature (LST) is one of the important parameters for studying land surface. Methane emission has been estimated using an empirical model. T factor (temperature related factor) is used to model the change in methanogenic activity as a function of temperature. Experiments have shown that the optimal temperature for the majority of methanogens ranges from 30°C to 40°C. Precise estimation of methane emission from rice fields at regional scale depends on accurate assessment of rice area using Sentinel-1A SAR data and MODIS derived LST T factor were used for spatial estimation of methane emission from six districts of Cauvery Delta Zone and validated with field level estimates. Rice area map was generated using a rule based classifier approach utilizing parameterization with a classification accuracy 88.5 and 91.5 per cent and a kappa score of 0.86 and 0.83 during 2018 respectively. The total classified rice area in Cauvery Delta Zone was 467134 ha during 2018. Days of flooding in rice fields of Cauvery Delta Zone had five classes i.e., 80, 96, 108, 120 and 132 days with an area of 145752, 116540, 93346, 35860 and 75637 ha respectively during 2018. The rate of methane emission based on LST T factor ranged from 35.52 to 45.15 kg/ha/season during 2018 with mean values of 41.44 kg/ha/season. The total methane emission for Cauvery Delta Zone based on LST T factor 20.373 Gg during 2018. The overall agreement between LST based methane emission and field observation was found to be 81.2 to 94.8 per cent. The higher percent of agreement between spatially estimated methane emission and observed values indicated the suitability of SAR and LST T factor based estimation of methane emission for regional or national level GHG monitoring.

Keywords: Rice, Synthetic Aperture Radar (SAR), Sentinel 1A, Land Surface Temperature (LST), Methane emission.