

Supplementary materials for

An approach to high-resolution rice paddy mapping using time-series Sentinel-1 SAR data in the Mun River basin, Thailand

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Supplementary core algorithm code

The relevant codes for rice extraction are shared as follows. All the algorithm codes were written with JavaScript in the Google Earth Engine online Code Editor

1. Determination of the backscattering threshold of permanent water

```
var myReducers = ee.Reducer.mean().combine({
  reducer2: ee.Reducer.stdDev(),
  sharedInputs: true
});

var waterThreshold=sgFitted.map(function(img){

  var meanDictionary = img.reduceRegion({
    reducer: myReducers,
    geometry: p_water,
    scale: 1000,
    maxPixels: 1e12
  });

  var threshold_mean=meanDictionary.get('VH_sg_mean');
  var threshold_std=meanDictionary.get('VH_sg_stdDev');
  threshold_mean=ee.Number(threshold_mean);
  threshold_std=ee.Number(threshold_std);

  var t_up=threshold_mean.add(threshold_std.multiply(1));
  var t_bottom=threshold_mean.subtract(threshold_std.multiply(1));
```

```

var waterimg=img.lt(t_up).and(img.gt(t_bottom)).rename('potentialwater');

return waterimg;
});

```

2. Extraction of potential rice paddies

```

// using pemanent water
var occurrence = water.select('occurrence')
                        .clip(Boundary);
CropExtent=CropExtent.where(occurrence.gte(waterThresholdmyS1_listue),ee.Image(-1));
CropExtent=CropExtent.updateMask(CropExtent.neq(-1));

var mySlpThreshold=2;
var myDEMThreshold=2500;
// using DEM and slope
CropExtent=CropExtent.updateMask(inputDEM.lt(myDEMThreshold))
                        .updateMask(mySlope.lt(mySlpThreshold));
// Map.addLayer(CropExtent,{min:50,max:150},'CropExtent dem',false);

```

3. Extraction of the phenological characteristics of paddy rice

```

var myMaxDate=findMaxDate(sgFitted).rename('peakDate');

function findMaxDate(ImgCol){

  var myS1Max=ImgCol.max();
  var diffS1=ImgCol.map(function(img){
    var mydate=ee.Date(img.get('system:time_start'));
    var DOY=mydate.difference(ee.Date.fromYMD(2017,1,1),'day')//.add(150)
    return img.subtract(myS1Max).rename('VH_diff')
                        .set('DOY',DOY)
                        .set('system:time_start',img.get('system:time_start'));
  })
  var myCloseD=ee.Image.constant(0).clip(myBoundary);

  var closestDate=diffS1.map(function(img){
    var myDate=myCloseD.where(img.select('VH_diff').abs().lte(0.01),img.metadata('DOY'))
    //img.metadata('system:time_start')
    .set('system:time_start',img.get('system:time_start'));
    return myDate.updateMask(myDate.neq(0));//.updateMask(VegInd.max().neq(0))//
  });

  var myMaxDate=closestDate.max();
  return myMaxDate;

}

```

```

var myFirstMinDate=myS1Min.select('constant').max().rename('firstMinDate');

var myS1Min=sgFitted//.sort('system:time_start',false)
  .map(function(img){
    var mydate=ee.Date(img.get('system:time_start'));
    var DOY=mydate.difference(ee.Date.fromYMD(2017,1,1),'day');
    img=img.set('DOY',DOY);
    img=img.addBands(img.metadata('DOY')).clip(myBoundary);
    var myDOY=img.select('DOY');

    var diffDOY=myMaxDate.subtract(myDOY)//.updateMask(myFlag);

    var myRegion=sgFitted.filterDate(ee.Date.fromYMD(2017,6,1),mydate.advance(1,'day'))
      .select('VH_sg');
    var firstMindate=findFirstMinDate(myRegion).updateMask(diffDOY);
    return img.addBands(firstMindate);

  });

function findFirstMinDate(ImgCol){

  var myS1Min=ImgCol.min();
  var diffS1=ImgCol.map(function(img){
    var mydate=ee.Date(img.get('system:time_start'));
    var DOY=mydate.difference(ee.Date.fromYMD(2017,1,1),'day')
    return img.subtract(myS1Min).rename('VH_diff')
      .set('DOY',DOY)
      .set('system:time_start',img.get('system:time_start'));
  })
  var myCloseD=ee.Image.constant(0).clip(myBoundary);

  var closestDate=diffS1.map(function(img){
    var myDate=myCloseD.where(img.select('VH_diff').abs().lte(0.01),img.metadata('DOY'))
    //img.metadata('system:time_start')
      .set('system:time_start',img.get('system:time_start'));
    return myDate.updateMask(myDate.neq(0));//updateMask(VegInd.max().neq(0))//
  });

  var myMinDate=closestDate.min();
  return myMinDate;

}

var Max_firstMin_dateDiff=myMaxDate.subtract(myFirstMinDate);

```

4. Identification of rice paddies

```

var dateDiff_low=50;

```

```
var dateDiff_up=120;
```

```
// using phenological information
```

```
var CropExtent=Max_firstMin_dateDiff.updateMask(Max_firstMin_dateDiff.gte(dateDiff_low))  
                .updateMask(Max_firstMin_dateDiff.lte(dateDiff_up));
```