Sen’s slope VHI Google Earth Engine open-source code

(developed by authors for calculating the mean day and night LST during summer for the study area)

Northeast Italian viticulture affected by heat and vegetation stress. A Satellite-Based Study from 2000 to 2024

Vincenzo Baldan, Eugenio Straffelini, Vincenzo D’Agostino, and Paolo Tarolli (2025)

//follow the same proceeding of the previous script for calculating the VCI, TCI and finally the VHI

var LST = ee.ImageCollection("MODIS/061/MOD11A2").select('LST\_Day\_1km');

var NDVI = ee.ImageCollection("MODIS/061/MOD13Q1").select('NDVI');

var historical\_start = ee.Date("2000-01-01");

var historical\_end = ee.Date("2023-12-31");

var a = 0.5; // Weight for VCI

var NDVI\_hist = NDVI.filterDate(historical\_start, historical\_end);

var LST\_hist = LST.filterDate(historical\_start, historical\_end);

var IminNDVI = NDVI\_hist.reduce(ee.Reducer.min());

var ImaxNDVI = NDVI\_hist.reduce(ee.Reducer.max());

var IminLST = LST\_hist.reduce(ee.Reducer.min());

var ImaxLST = LST\_hist.reduce(ee.Reducer.max());

var NDVI\_summer = NDVI.filter(ee.Filter.calendarRange(2000, 2024, 'year'))

.filter(ee.Filter.calendarRange(6, 8, 'month'));

var LST\_summer = LST.filter(ee.Filter.calendarRange(2000, 2024, 'year'))

.filter(ee.Filter.calendarRange(6, 8, 'month'));

var VCI = NDVI\_summer.map(function(image) {

return image.expression('(Ia - Imin) / (Imax - Imin) \* 100', {

Ia: image,

Imin: IminNDVI,

Imax: ImaxNDVI

}).rename('VCI')

.copyProperties(image, ['system:time\_start']);

});

var TCI = LST\_summer.map(function(image) {

return image.expression('(Imax - Ia) / (Imax - Imin) \* 100', {

Ia: image,

Imin: IminLST,

Imax: ImaxLST

}).rename('TCI')

.copyProperties(image, ['system:time\_start']);

});

var filter = ee.Filter.equals({leftField: 'system:time\_start', rightField: 'system:time\_start'});

var join = ee.Join.inner();

var joined = join.apply(VCI, TCI, filter);

var VHI = ee.ImageCollection(joined.map(function(feature) {

var vci = ee.Image(feature.get('primary'));

var tci = ee.Image(feature.get('secondary'));

return vci.addBands(tci)

.expression('a \* VCI + (1 - a) \* TCI', {

'VCI': vci.select('VCI'),

'TCI': tci.select('TCI'),

'a': a

}).rename('VHI')

.copyProperties(vci, ['system:time\_start']);

}));

print(VHI)

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//filter the collection for only the summer period and clip it with the study area

var coll = VHI.filter(ee.Filter.calendarRange(6, 8, 'month'))

.map(function(image){return image.clip(table)});

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//calculate the Sen’s slope

var afterFilter = ee.Filter.lessThan({

leftField: 'system:time\_start',

rightField: 'system:time\_start'

});

var joined = ee.ImageCollection(ee.Join.saveAll('after').apply({

primary: coll,

secondary: coll,

condition: afterFilter

}));

var slope = function(i, j) {

return ee.Image(j).subtract(i)

.divide(ee.Image(j).date().difference(ee.Image(i).date(), 'days'))

.rename('slope')

.float();

};

var slopes = ee.ImageCollection(joined.map(function(current) {

var afterCollection = ee.ImageCollection.fromImages(current.get('after'));

return afterCollection.map(function(image) {

return ee.Image(slope(current, image));

});

}).flatten());

var sensSlope = slopes.reduce(ee.Reducer.median(), 2);

//clip it with the study area (table) and display the map

var senSlope\_clip = sensSlope.clip(table)

Map.addLayer(senSlope\_clip,'', 'sensSlope');

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//export the results

Export.image.toDrive({

image: senSlope\_clip,

description:'VHI\_senslope\_0024',

region: table.geometry().bounds(),

scale: 250,

maxPixels: 1e13})