Supplementary Material S1: Google Earth Engine Script used in the study.

Link to the online Google Earth Engine Script:

https://code.earthengine.google.com/738ff5813f5df97a1bdd5c7f6ddb0d0b

Script (In Java Script):

```
// FINAL ANALYSIS:
// NDVI and NDVI Change calculated with Cloudless Annual Mean Landsat 8 Surface Reflectance
// DriveFolder: USC_INTERNSHIP_FINAL

//-------------------------------------------------------------------------------
// GEOMETRY INPUT: SUNDARBANS NATIONALPARK SHAPEFILE
//-------------------------------------------------------------------------------

var geometry =
ee.FeatureCollection('users/GwenKarsch/Sundarbans_Nationalpark_Outline_3');
Map.centerObject(geometry);
Map.addLayer(geometry, {color: 'red'}, 'Nationalpark Sundarbans');

//-------------------------------------------------------------------------------
//-------------------------------------------------------------------------------
// LANDSAT 8 ANALYSIS YEARLY NDVI
//-------------------------------------------------------------------------------
//-------------------------------------------------------------------------------

//-------------------------------------------------------------------------------
// 1. REMOVE CLOUD & CLOUD SHADOW
//-------------------------------------------------------------------------------

// Link: https://code.earthengine.google.com/a0910b072edf4e7ccde2d13cdccce1ce

// QA_PIXEL band (CFMask) to mask unwanted pixels.
function maskL8sr(image) {
  // Bit 0 - Fill
  // Bit 1 - Dilated Cloud
  // Bit 2 - Cirrus
  // Bit 3 - Cloud
  // Bit 4 - Cloud Shadow
  var qaMask = image.select('QA_PIXEL').bitwiseAnd(parseInt('11111', 2)).eq(0);
  var saturationMask = image.select('QA_RADSAT').eq(0);

  // Apply the scaling factors to the appropriate bands.
  var opticalBands = image.select('SR_B.').multiply(0.0000275).add(-0.2);
  var thermalBands = image.select('ST_B.*').multiply(0.00341802).add(149.0);

  // Replace the original bands with the scaled ones and apply the masks.
  return image.addBands(opticalBands, null, true)
```

```
    .addBands(thermalBands, null, true)
    .updateMask(qaMask)
    .updateMask(saturationMask);
}

//-------------------------------------------------------------------------------
// 2. RESULTS NDVI
//-------------------------------------------------------------------------------

//----------------------------------------
// 2.1 2014
//----------------------------------------

var collection2014 = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
                  .filterDate('2014-01-01', '2014-12-31')
                  .filterBounds(geometry)
                  .map(maskL8sr);

var composite2014 = collection2014.median();
var clipped_composite2014 = composite2014.clip(geometry);

var clipped_composite2014_nir = clipped_composite2014.select('SR_B5');
var clipped_composite2014_red = clipped_composite2014.select('SR_B4');
var clipped_composite2014_ndvi =
clipped_composite2014_nir.subtract(clipped_composite2014_red).divide(clipped_compo
site2014_nir.add(clipped_composite2014_red)).rename('NDVI');

Map.centerObject(clipped_composite2014_ndvi, 9);

var ndviParams = {min: -1, max: 1, palette: ['blue', 'white', 'green']};

Map.addLayer(clipped_composite2014_ndvi, ndviParams, 'NDVI_2014');

Export.image.toDrive({
  image: clipped_composite2014_ndvi,
  description: 'NDVI_2014',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------------------
// 2.2 2015
//----------------------------------------

var collection2015 = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
                  .filterDate('2015-01-01', '2015-12-31')
                  .filterBounds(geometry)
                  .map(maskL8sr);

var composite2015 = collection2015.median();
var clipped_composite2015 = composite2015.clip(geometry);
```

```
var clipped_composite2015_nir = clipped_composite2015.select('SR_B5');
var clipped_composite2015_red = clipped_composite2015.select('SR_B4');
var clipped_composite2015_ndvi =
clipped_composite2015_nir.subtract(clipped_composite2015_red).divide(clipped_compo
site2015_nir.add(clipped_composite2015_red)).rename('NDVI');

Map.centerObject(clipped_composite2015_ndvi, 9);

var ndviParams = {min: -1, max: 1, palette: ['blue', 'white', 'green']};

Map.addLayer(clipped_composite2015_ndvi, ndviParams, 'NDVI_2015');

Export.image.toDrive({
  image: clipped_composite2015_ndvi,
  description: 'NDVI_2015',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------------------
// 2.3 2016
//----------------------------------------

var collection2016 = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
                  .filterDate('2016-01-01', '2016-12-31')
                  .filterBounds(geometry)
                  .map(maskL8sr);

var composite2016 = collection2016.median();
var clipped_composite2016 = composite2016.clip(geometry);

var clipped_composite2016_nir = clipped_composite2016.select('SR_B5');
var clipped_composite2016_red = clipped_composite2016.select('SR_B4');
var clipped_composite2016_ndvi =
clipped_composite2016_nir.subtract(clipped_composite2016_red).divide(clipped_compo
site2016_nir.add(clipped_composite2016_red)).rename('NDVI');

Map.centerObject(clipped_composite2016_ndvi, 9);

var ndviParams = {min: -1, max: 1, palette: ['blue', 'white', 'green']};

Map.addLayer(clipped_composite2016_ndvi, ndviParams, 'NDVI_2016');

Export.image.toDrive({
  image: clipped_composite2016_ndvi,
  description: 'NDVI_2016',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------------------
```

```
// 2.4 2017
//---------------------------------------

var collection2017 = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
                  .filterDate('2017-01-01', '2017-12-31')
                  .filterBounds(geometry)
                  .map(maskL8sr);

var composite2017 = collection2017.median();
var clipped_composite2017 = composite2017.clip(geometry);

var clipped_composite2017_nir = clipped_composite2017.select('SR_B5');
var clipped_composite2017_red = clipped_composite2017.select('SR_B4');
var clipped_composite2017_ndvi =
clipped_composite2017_nir.subtract(clipped_composite2017_red).divide(clipped_compo
site2017_nir.add(clipped_composite2017_red)).rename('NDVI');

Map.centerObject(clipped_composite2017_ndvi, 9);

var ndviParams = {min: -1, max: 1, palette: ['blue', 'white', 'green']};

Map.addLayer(clipped_composite2017_ndvi, ndviParams, 'NDVI_2017');

Export.image.toDrive({
  image: clipped_composite2017_ndvi,
  description: 'NDVI_2017',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//---------------------------------------
// 2.5 2018
//---------------------------------------

var collection2018 = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
                  .filterDate('2018-01-01', '2018-12-31')
                  .filterBounds(geometry)
                  .map(maskL8sr);

var composite2018 = collection2018.median();
var clipped_composite2018 = composite2018.clip(geometry);

var clipped_composite2018_nir = clipped_composite2018.select('SR_B5');
var clipped_composite2018_red = clipped_composite2018.select('SR_B4');
var clipped_composite2018_ndvi =
clipped_composite2018_nir.subtract(clipped_composite2018_red).divide(clipped_compo
site2018_nir.add(clipped_composite2018_red)).rename('NDVI');

Map.centerObject(clipped_composite2018_ndvi, 9);

var ndviParams = {min: -1, max: 1, palette: ['blue', 'white', 'green']};
```

```
Map.addLayer(clipped_composite2018_ndvi, ndviParams, 'NDVI_2018');

Export.image.toDrive({
  image: clipped_composite2018_ndvi,
  description: 'NDVI_2018',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------------------
// 2.6 2019
//----------------------------------------

var collection2019 = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
                  .filterDate('2019-01-01', '2019-12-31')
                  .filterBounds(geometry)
                  .map(maskL8sr);

var composite2019 = collection2019.median();
var clipped_composite2019 = composite2019.clip(geometry);

var clipped_composite2019_nir = clipped_composite2019.select('SR_B5');
var clipped_composite2019_red = clipped_composite2019.select('SR_B4');
var clipped_composite2019_ndvi =
clipped_composite2019_nir.subtract(clipped_composite2019_red).divide(clipped_compo
site2019_nir.add(clipped_composite2019_red)).rename('NDVI');

Map.centerObject(clipped_composite2019_ndvi, 9);

var ndviParams = {min: -1, max: 1, palette: ['blue', 'white', 'green']};

Map.addLayer(clipped_composite2019_ndvi, ndviParams, 'NDVI_2019');

Export.image.toDrive({
  image: clipped_composite2019_ndvi,
  description: 'NDVI_2019',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------------------
//2.7 2020
//----------------------------------------

var collection2020 = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
                  .filterDate('2020-01-01', '2020-12-31')
                  .filterBounds(geometry)
                  .map(maskL8sr);

var composite2020 = collection2020.median();
var clipped_composite2020 = composite2020.clip(geometry);
```

```
var clipped_composite2020_nir = clipped_composite2020.select('SR_B5');
var clipped_composite2020_red = clipped_composite2020.select('SR_B4');
var clipped_composite2020_ndvi =
clipped_composite2020_nir.subtract(clipped_composite2020_red).divide(clipped_compo
site2020_nir.add(clipped_composite2020_red)).rename('NDVI');

Map.centerObject(clipped_composite2020_ndvi, 9);

var ndviParams = {min: -1, max: 1, palette: ['blue', 'white', 'green']};

Map.addLayer(clipped_composite2020_ndvi, ndviParams, 'NDVI_2020');

Export.image.toDrive({
  image: clipped_composite2020_ndvi,
  description: 'NDVI_2020',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//-------------------------------------------------------------------------------
// 3. NDVI CHANGE DETECTION
//-------------------------------------------------------------------------------

//----------------------------
// 3.1 2019-2020
//----------------------------

var ndviChange2019_2020 =
clipped_composite2019_ndvi.subtract(clipped_composite2020_ndvi);

Map.centerObject(geometry)
Map.addLayer(ndviChange2019_2020, { min:-0.6, max: 0.6, palette:
[ '125000', '2fd000', 'ffffff', 'FF0000', '700000']},
"Changes of NDVI  from 2019 to 2020" );

Export.image.toDrive({
  image: ndviChange2019_2020,
  description: 'NDVI_Change_19_20',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------
// 3.2 2018-2019
//----------------------------

var ndviChange2018_2019 =
clipped_composite2018_ndvi.subtract(clipped_composite2019_ndvi);

Map.centerObject(geometry)
```

```
Map.addLayer(ndviChange2018_2019, { min:-0.6, max: 0.6, palette:
[ '125000', '2fd000', 'ffffff', 'FF0000', '700000']},
"Changes of NDVI  from 2018 to 2019" );

Export.image.toDrive({
  image: ndviChange2018_2019,
  description: 'NDVI_Change_18_19',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------
// 3.3 2017-2018
//----------------------------

var ndviChange2017_2018 =
clipped_composite2017_ndvi.subtract(clipped_composite2018_ndvi);

Map.centerObject(geometry)
Map.addLayer(ndviChange2017_2018, { min:-0.6, max: 0.6, palette:
[ '125000', '2fd000', 'ffffff', 'FF0000', '700000']},
"Changes of NDVI  from 2017 to 2018" );

Export.image.toDrive({
  image: ndviChange2017_2018,
  description: 'NDVI_Change_17_18',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------
// 3.4 2016-2017
//----------------------------

var ndviChange2016_2017 =
clipped_composite2016_ndvi.subtract(clipped_composite2017_ndvi);

Map.centerObject(geometry)
Map.addLayer(ndviChange2016_2017, { min:-0.6, max: 0.6, palette:
[ '125000', '2fd000', 'ffffff', 'FF0000', '700000']},
"Changes of NDVI  from 2016 to 2017" );

Export.image.toDrive({
  image: ndviChange2016_2017,
  description: 'NDVI_Change_16_17',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------
```

```
// 3.5 2015-2016
//----------------------------

var ndviChange2015_2016 =
clipped_composite2016_ndvi.subtract(clipped_composite2015_ndvi);

Map.centerObject(geometry)
Map.addLayer(ndviChange2015_2016, { min:-0.6, max: 0.6, palette:
[ '125000', '2fd000', 'ffffff', 'FF0000', '700000']},
"Changes of NDVI  from 2015 to 2016" );

Export.image.toDrive({
  image: ndviChange2015_2016,
  description: 'NDVI_Change_15_16',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------
// 3.6 2014-2015
//----------------------------

var ndviChange2014_2015 =
clipped_composite2014_ndvi.subtract(clipped_composite2015_ndvi);

Map.centerObject(geometry)
Map.addLayer(ndviChange2014_2015, { min:-0.6, max: 0.6, palette:
[ '125000', '2fd000', 'ffffff', 'FF0000', '700000']},
"Changes of NDVI  from 2014 to 2015" );

Export.image.toDrive({
  image: ndviChange2014_2015,
  description: 'NDVI_Change_14_15',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//----------------------------
// 3.7 TOTAL CHANGE: 2014-2020
//----------------------------

var ndviChange2014_2020 =
clipped_composite2014_ndvi.subtract(clipped_composite2020_ndvi);

Map.centerObject(geometry)
Map.addLayer(ndviChange2014_2020, { min:-0.6, max: 0.6, palette:
[ '125000', '2fd000', 'ffffff', 'FF0000', '700000']},
"Changes of NDVI  from 2014 to 2020" );

Export.image.toDrive({
  image: ndviChange2014_2020,
```

```
  description: 'NDVI_Change_14_20',
  fileFormat: 'Geotiff',
  scale: 30,
  region: geometry,
});

//-------------------------------------------------------------------------------
// 4. CHARTS
//-------------------------------------------------------------------------------
//-----------------------------------------------------
// 4.1 CHART ANNUAL MEAN NDVI 2014 - 2020
//-----------------------------------------------------

var l8 = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')

var image = l8
          .filterDate ('2014-01-01', '2020-12-31')
          .filterBounds (geometry)
          .map(maskL8sr);

var ndvi_func = function (i) {
              var ndvi = i.normalizedDifference (['SR_B5', 'SR_B4']).rename ('NDVI')
              return i.addBands(ndvi);
              }

var image_ndvi = image.map(ndvi_func);

var year = ee.List.sequence(2014,2020);
var year_func = function(y){
              var range = ee.Filter.calendarRange (y, y, 'year');
              return image_ndvi.select('NDVI').filter(range).mean().set ('Year', y)
              };
var yearwise_ndvi = ee.ImageCollection(year.map(year_func));
print (yearwise_ndvi);

var chart = ui.Chart.image.series ({
  imageCollection: yearwise_ndvi,
  region: geometry,
  reducer: ee.Reducer.mean(),
  scale: 30,
  xProperty: 'Year'
}).setOptions ({title: "NDVI over time",
  hAxis: {title: 'Time of the year', format: 'year'}
});

print (chart);
```