Analysis of Flood Risk and Recovery In Germany

Project Github Link: https://github.com/alteregoyishan/groupwork_0025.git

Project Summary

The project addresses the significant challenges posed by the July 2021 floods in Central Europe, which resulted in extensive damage to settlements, infrastructure and ecosystems. A comprehensive post-disaster analysis framework is critical to understanding the spatial, temporal, and environmental impacts of disaster events and supporting effective recovery and risk mitigation.

Problem Statement

How did the July 2021 extreme flooding event in Central Europe impact different elements (settlements, vegetation, infrastructure), and what spatial patterns emerged during the recovery process as documented through multi-temporal satellite analysis?

End User

This application is designed for disaster management agencies, urban planners, and humanitarian organizations. It provides tools to monitor flood impacts on settlements, vegetation, and infrastructure, enabling informed recovery planning and mitigating risks for future extreme weather events.

Data

Key datasets include Sentinel-1 SAR, Sentinel-2 optical imagery, DEM from SRTM, VIIRS nightlight data, OpenStreetMap infrastructure layers, and WorldPop population distribution. Supporting layers such as historical flood and climate change projections are also employed for comprehensive assessments.

Methodology

The methodology integrates: a) satellite-based flood mapping b) vegetation impact monitoring using NDVI indices c) infrastructure recovery tracking with VIIRS data d multi-criteria risk assessment. Uniform parameters such as spatial resolution, temporal thresholds and thresholds for flood detection and vegetation damage, ensure data consistency.

Interface

The interactive application offers tools like timeline sliders, heat maps, draw-a-region calculations, and vegetation/infrastructure recovery visualizations. These features prioritize usability, providing stakeholders with insights tailored to planning and recovery scenarios.

The Application

Replace the link below with the link to your application.

How it Works

The application integrates multilayered analyses into a Google Earth Engine (GEE)-based interface:

Flood Mapping

Using Sentinel-1 SAR data, flood extent is delineated for the July 12–18, 2021 disaster. The SAR backscatter threshold (-16 dB) distinguishes water bodies from land, accurately capturing flooded regions free from cloud interference. DEM analysis calculates water depth and flow dynamics.

```
var s1Collection = ee.ImageCollection('COPERNICUS/S1_GRD')
  .filterBounds(region)
  .filterDate('2021-07-12', '2021-07-18')
  .filter(ee.Filter.eq('instrumentMode', 'IW'))
  .filter(ee.Filter.listContains('transmitterReceiverPolarisation', 'VV'));
var vvImage = s1Collection.first().select('VV');
var waterMask = vvImage.lt(-16); // Flood detection threshold
Map.addLayer(waterMask, {palette: ['white', 'blue']}, 'Flood Extent');
```

Settlement Impact Assessment

VIIRS nightlight changes highlight economic recovery and rebuilding progress. Comparing pre-2021 floods, post-flood periods, and March 2022 data aids in identifying recovery lags.

```
var preFloodNL = getNightlight('202106', 'Pre-Flood Nightlights');
var nlChange = postFloodNL.subtract(preFloodNL);
var nlRecovery = recoveryNL.divide(preFloodNL).multiply(100);
Map.addLayer(nlRecovery, {min: 0, max: 120, palette: ['red', 'yellow', 'green']}, 'Recovery
```

Landscape Changes

Satellite imagery highlights significant landscape alterations, including erosion, sediment deposition, and land cover transitions. Comparing pre-change, post-change periods, and recent data helps identify areas with severe impact.

```
var preChangeImage = getSatelliteImage('202106', 'Pre-Change Landscape');
var postChangeImage = getSatelliteImage('202207', 'Post-Change Landscape');
var landscapeChange = postChangeImage.subtract(preChangeImage);
var changePercentage = landscapeChange.divide(preChangeImage).multiply(100);
Map.addLayer(changePercentage, {min: -100, max: 100, palette: ['blue', 'white', 'red']}, 'La
```

Vegetation Impact & Recovery

NDVI indices derived from pre- and post-event Sentinel-2 data capture vegetation loss and recovery. Damaged areas are defined as NDVI < 0.3, while recovery assessments track vegetation returning to pre-flood levels (NDVI > 80%).

```
var ndviLoss = preFloodNDVI.subtract(postFloodNDVI);
var recoveryNDVI = recoveryNDVI.divide(preFloodNDVI).multiply(100);
Map.addLayer(recoveryNDVI, {min: 0, max: 100, palette: ['red', 'yellow', 'green']}, 'Recovery
```

Infrastructure Recovery

Satellite and remote sensing data showcase infrastructure recovery trends, monitoring road networks, building repairs, and economic activity. Comparing pre- and post-disaster data helps assess progress and pinpoint recovery gaps.

```
var preDisasterInfra = getSatelliteImage('202001', 'Pre-Disaster Infrastructure');
var postDisasterInfra = getSatelliteImage('202207', 'Post-Disaster Infrastructure');
var infraChange = postDisasterInfra.subtract(preDisasterInfra);
var recoveryProgress = infraChange.divide(preDisasterInfra).multiply(100);
Map.addLayer(recoveryProgress, {min: 0, max: 150, palette: ['red', 'yellow', 'green']}, 'Inf
```

Risk Assessment

The module integrates flood depth, vegetation loss, infrastructure damage, and recovery indices into a weighted risk framework to identify highly vulnerable regions.

```
var totalRisk = floodRisk.multiply(weights.flood)
  .add(buildingRisk.multiply(weights.building))
  .add(channelRisk.multiply(weights.channel))
  .add(vegRisk.multiply(weights.veg))
  .add(infraRisk.multiply(weights.infra));
Map.addLayer(totalRisk, {min: 1, max: 5, palette: ['green', 'yellow', 'orange', 'red', 'dark
```