

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In the name of Allah, the Most Gracious, the Most Merciful

Revolutionizing Flood Monitoring: A Web-Based Application for Near-Real-Time Observation Using Satellite Imagery



Md. Imam Sohel Hossain

Senior Scientific Officer

Leather Research Institute

Bangladesh Council of Scientific and industrial Research (BCSIR)

Background



- Problems
- World scenario-Pakistan, India, Libiya
- Bangladesh overview regarding latest researches



Monsoon in India: Floods leave nearly 200 dead in 4 states



Pakistan's catastrophic floods



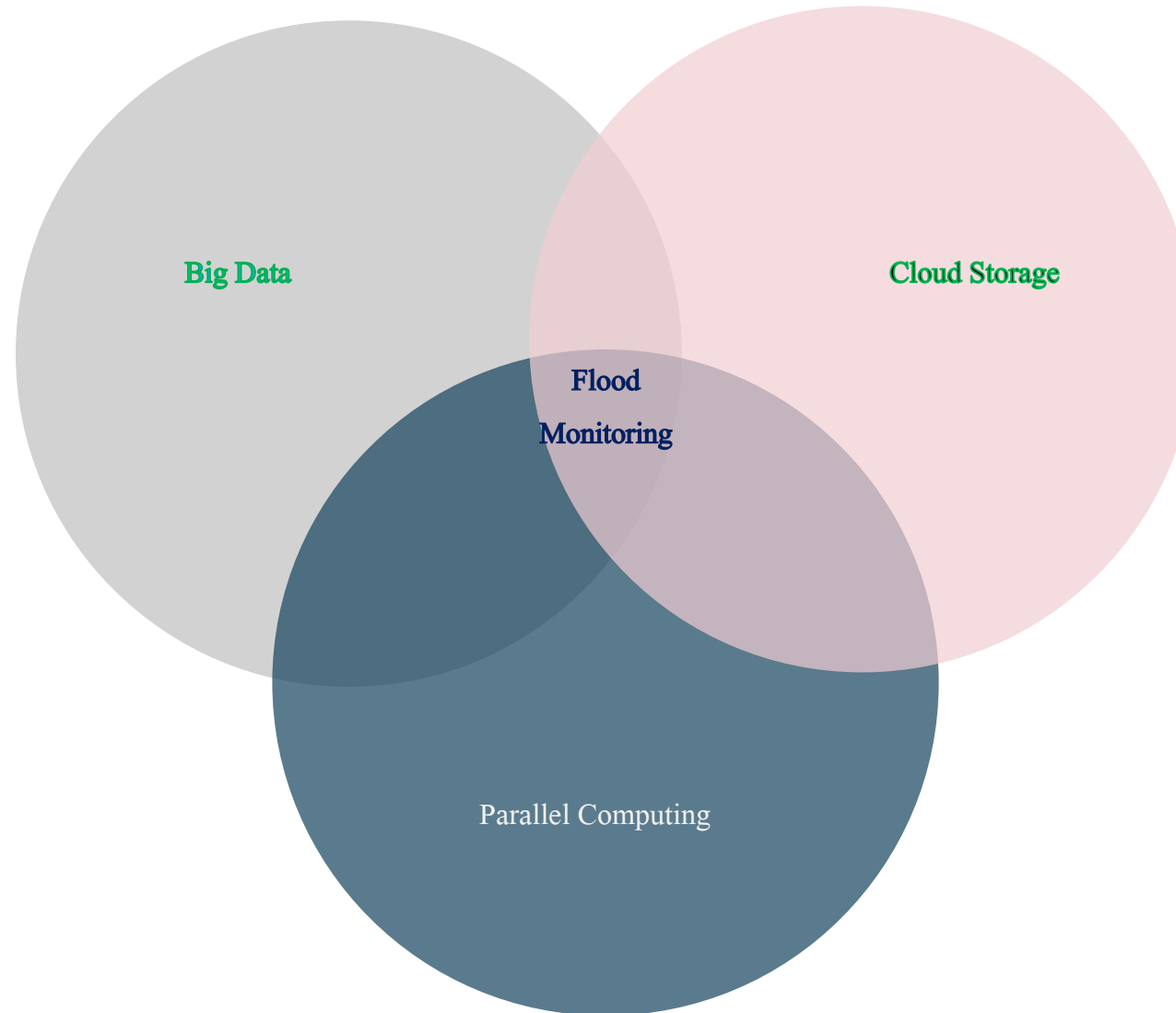
More than 5,000 presumed dead in Libya after catastrophic flooding breaks dams

Research gap with respect to critical analysis of literatures



- ⦿ Voluminous dataset store and analysis are tough in conventional way
- ⦿ In fact, traditional analysis is done by trained analysts on high powered computers, which can create a resource barrier for fiscally strained communities or those without advanced training
- ⦿ Moreover, flood monitoring in field based is expensive as well as time consuming
- ⦿ Readily observable field evidence of the largest or most recent natural disasters are difficult
- ⦿ For example, the timing and extent of a series of flooding events over many years will be difficult and expensive to determine with field methods alone
- ⦿ Apart from that field-verified inventories of spatially extensive events may take many months

Research Opportunity



Research Opportunity



- 🕒 **Game Changer**-Google Earth Engine is a remote sensing data analysis platform designed to take advantage of Google's infrastructure for data storage, access, processing, and visualization (Gorelick et al., 2017)

The Earth Engine Public Data Catalog



... and many more, updating daily!

> 200 public datasets

> 5 million images

> 4000 new images every day

> 5 petabytes of data

Google Earth Engine

1 petabyte= 1024 TB= 1million GB

1. Gorelick et al., 2017. <https://doi.org/10.1016/j.rse.2017.06.031>, 2017

Objectives



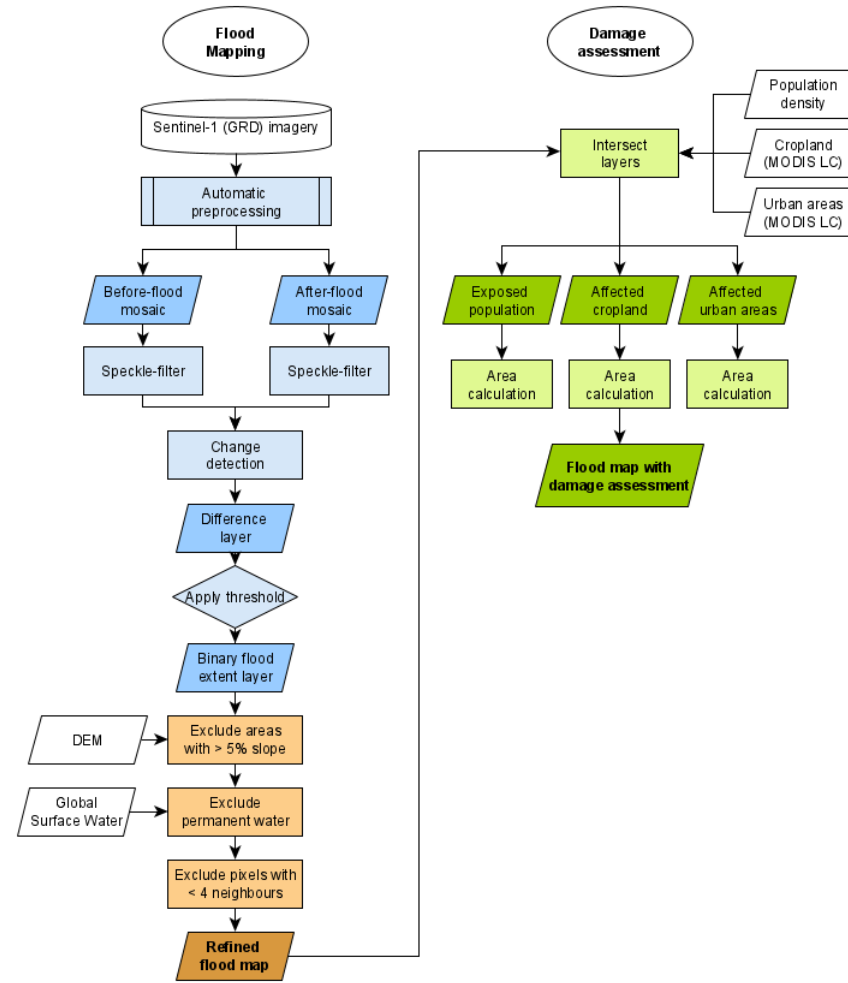
- ① Develop an cloud based **application** which could fetch data continuously from voluminous data.
- ① **Fast and reproducible estimation** of the damage from local to regional scale regarding flood extent, population exposed, affected cropland and urban areas
- ① **Map** flooded affected areas, croplands, populations and urban areas in near real time using Sentinel-1 SAR data, the GEE cloud computing platform

Open a platform for scientists and non scientists to explore and characterize the spatial pattern of flood by making it **open source**. The power of parallel computing will **save** our time for **understanding** the flood dynamics and spatial pattern for **predicting** future hazards and eventually **decision** making.

Methodology



- Image differencing
- Before and during/ after flood
- Data used
- Human settlement 2015, Modis 2015



Reference: UN Spider

Findings-Cloud-Based App Development



<https://imamsohel1991.users.earthengine.app/view/bangladesh-flood-cloud-computing>

Input Variables	Definition	Example
Select area of interest	Choose an area to observe the flood condition	Sylhet, Gaibandha
Select Period Before Floods (start date, end date)	The range of date prior to the event	01 May 2022, 15 May 2022
Select Period During Floods (start date, end date)	The range of date during the event	16 May 2022, 30 May 2022
Calculate the result	Click to show the result	
Clear map output	Click to clear the output	

Dataset	Sentinel-1, Revisit time 6-12 days	Copernicus SAR(GRD) dataset
---------	------------------------------------	-----------------------------

Flood in Bangladesh

This app allows a user to visualize the flooded area within the flood prone area in the north-eastern part of Bangladesh. It uses Sentinel 1 and it allows a user to select an area of interest, before floods period and after floods period. On the background, the script does an image difference between the two periods selected and assumes that whatever has changed between the two periods is the addition of floods. Additional information such as urban areas, population and crop lands affected is also added to the panel.

Select area of interest

Bangladesh

Note: The difference between start and end date should be at least 12 days.

Select Period Before Floods

Start Date(YYYY-MM-DD) End Date(YYYY-MM-DD)

2022-05-01 2022-05-15

Select Period During Floods

Start Date (YYYY-MM-DD) End Date (YYYY-MM-DD)

2022-05-16 2022-06-30

Calculate the result

Clear Map Output

Author: Md. Imam Sohel Hossain, Scientific Officer, IMMM, BCSIR, Bangladesh.

Findings-Regional Scale Flood Mapping and Estimation



code.earthengine.google.com/#

Google Earth Engine

Search places and datasets...

Scripts Docs Assets

NEW ADD A PROJECT

CLOUD ASSETS

- ee-imamsohel1991
 - BGD_adm1
 - BGD_adm2
 - BGD_adm3
 - Gaibandha_sadar
 - Gowainhat
 - Parhatnir

Apps/FloodMapBD_BCSIR_Congress

```

65 var Bangladesh = ee.FeatureCollection("users/imamsohel1991/BD_Assets"),
66     Syhet_Division = ee.FeatureCollection("users/imamsohel1991/Syhet_Division"), // I have the data
67     Habiganj = ee.FeatureCollection("users/imamsohel1991/Habiganj"),
68     Sunamganj = ee.FeatureCollection("users/imamsohel1991/Sunamganj"),
69     Sylhet = ee.FeatureCollection("users/imamsohel1991/Sylhet"),
70     Gaibandha = ee.FeatureCollection("users/imamsohel1991/Gaibandha"), // jhamele kore semicolon.//
71     Maulvibazar = ee.FeatureCollection("users/imamsohel1991/Maulvibazar"),
72     Kurigram = ee.FeatureCollection("users/imamsohel1991/Kurigram"),
73     Gaibandha_Sadar_Upazila = ee.FeatureCollection("projects/ee-imamsohel1991/assets/Gaibandha_sadar"),
74     Gowainhat = ee.FeatureCollection("projects/ee-imamsohel1991/assets/Gowainhat"); // jhamele kore semicolon. check double
75
76
77

```

Inspector Console Tasks Profiler

Viewing 149 profiles, 0 from API calls and 149 from map tiles.

EECU's	Peak Mem	Count	Description
283.701	620M	4716	Algorithm Image.log10 computing pixels
249.248	205k	2349	Algorithm ImageCollection.mosaic
203.281	308M	784	Algorithm Image.gradient computing pixels
127.534	38M	450	Reprojection precalculation between (...) and (...)
85.021	85M	145218	(plumbing)
62.918	324k	996	Algorithm (user-defined function)
56.947	10M	60588	Loadina assets: (...V(...)

Results

Flood status between:
2022-05-16 and 2022-06-30

Estimated flood extent:
Please wait...
1692257 hectares

Estimated number of exposed people:
based on GHSL 2015 (250m)
3430582

Estimated affected cropland:
based on MODIS Land Cover 2020 (500m)
702612 hectares

Estimated affected urban areas:
based on MODIS Land Cover 2020 (500m)
20317 hectares

Select area of interest

Bangladesh

Note: The difference between start and end date should be at least 12 days.

Select Period Before Floods

Start Date (YYYY-MM-DD) End Date (YYYY-MM-DD)

2022-04-01 2022-05-15

Select Period During Floods

Start Date (YYYY-MM-DD) End Date (YYYY-MM-DD)

2022-05-16 2022-06-30

Calculate the result

Clear Map Output

Author: Md. Imam Sohel Hossain, Scientific Officer, IMMM, BCSIR, Bangladesh.

Legend

- potentially flooded areas
- affected cropland
- affected urban

Exposed population density > 200

0

Layers Map Satellite

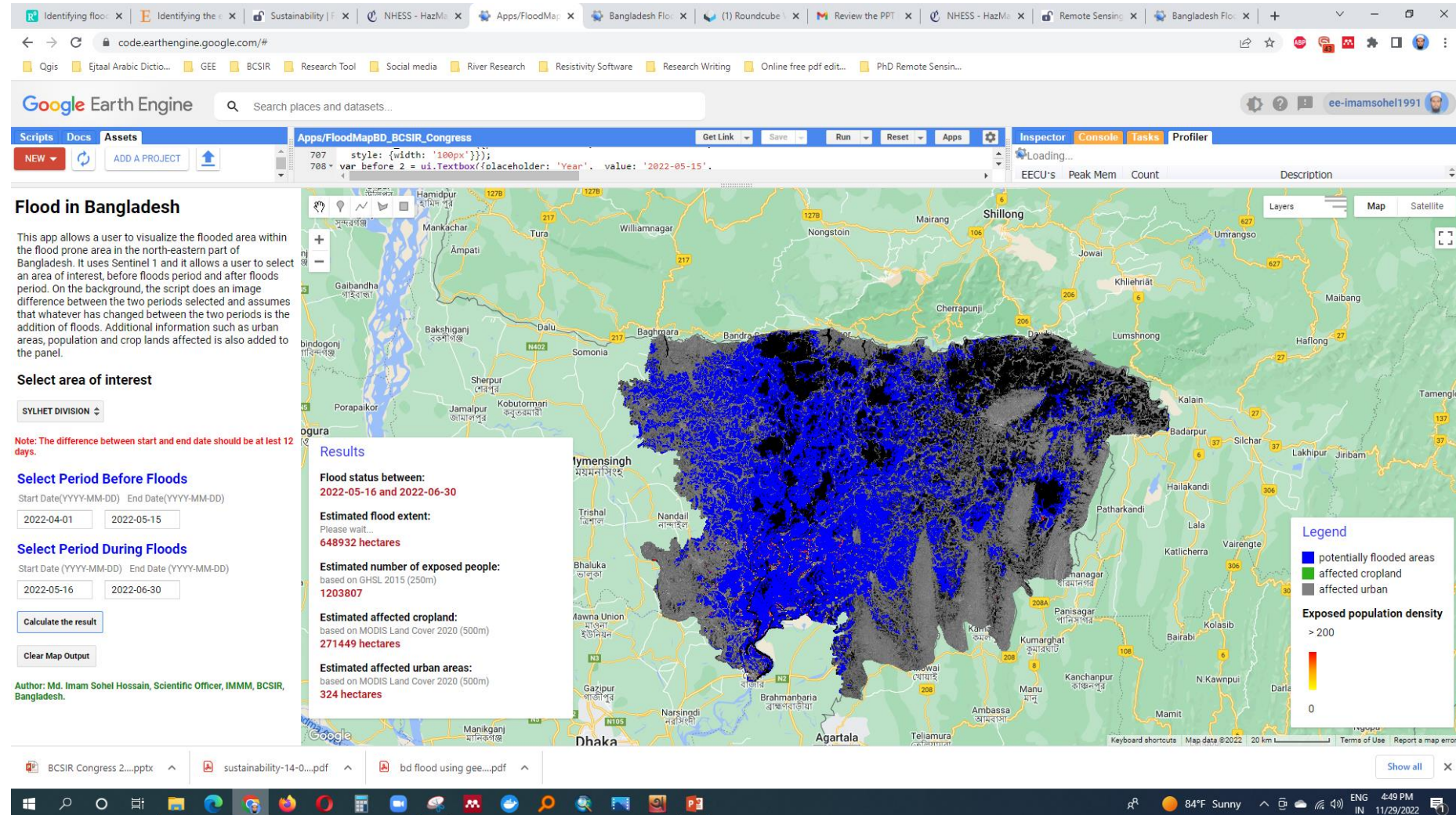
Keyboard shortcuts Map data ©2022 Google 50 km Terms of Use

Show all

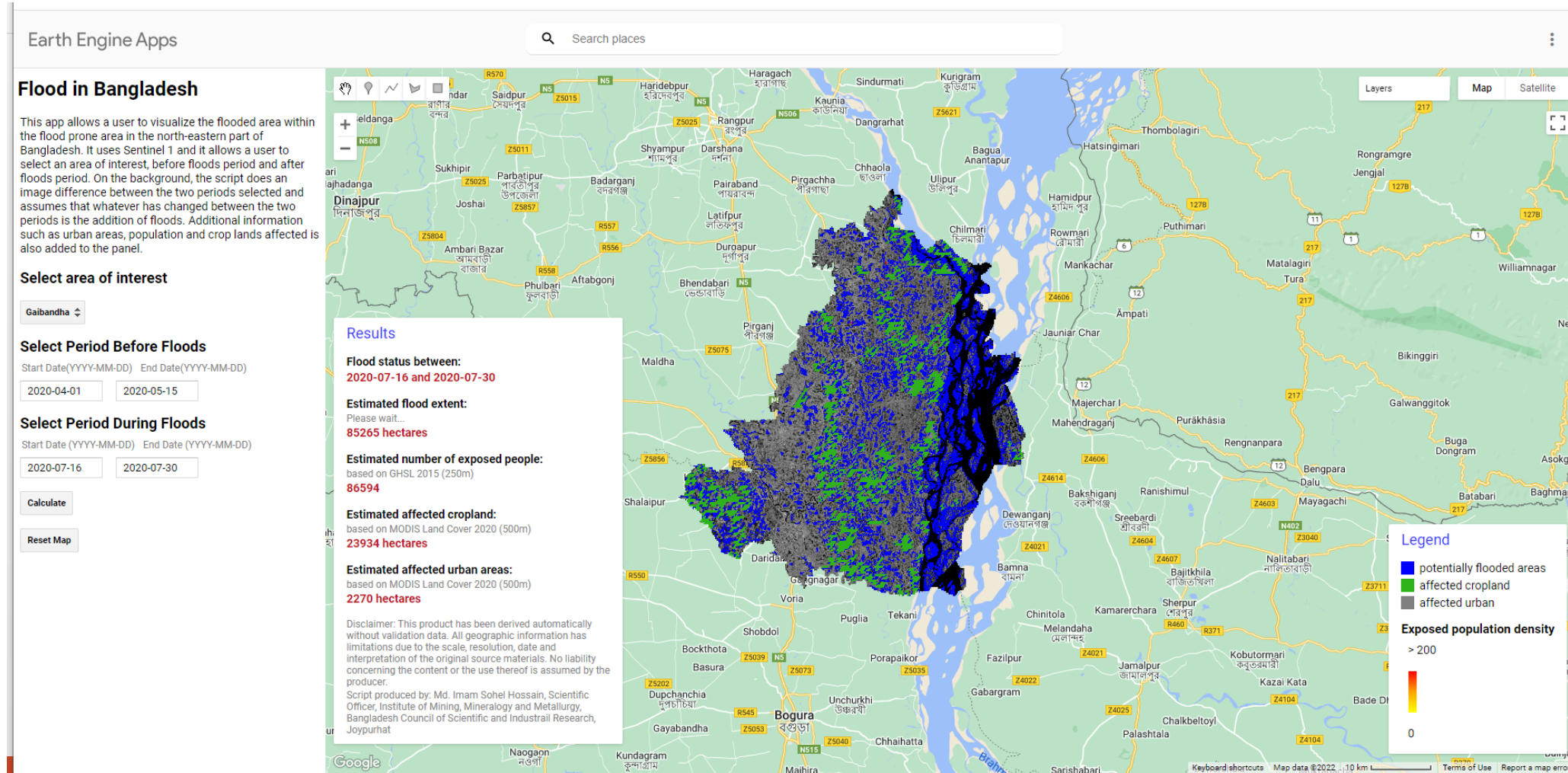
BCSIR Congress 2...pptx sustainability-14-0...pdf bd flood using gee...pdf

83°F Sunny 4:36 PM 11/29/2022

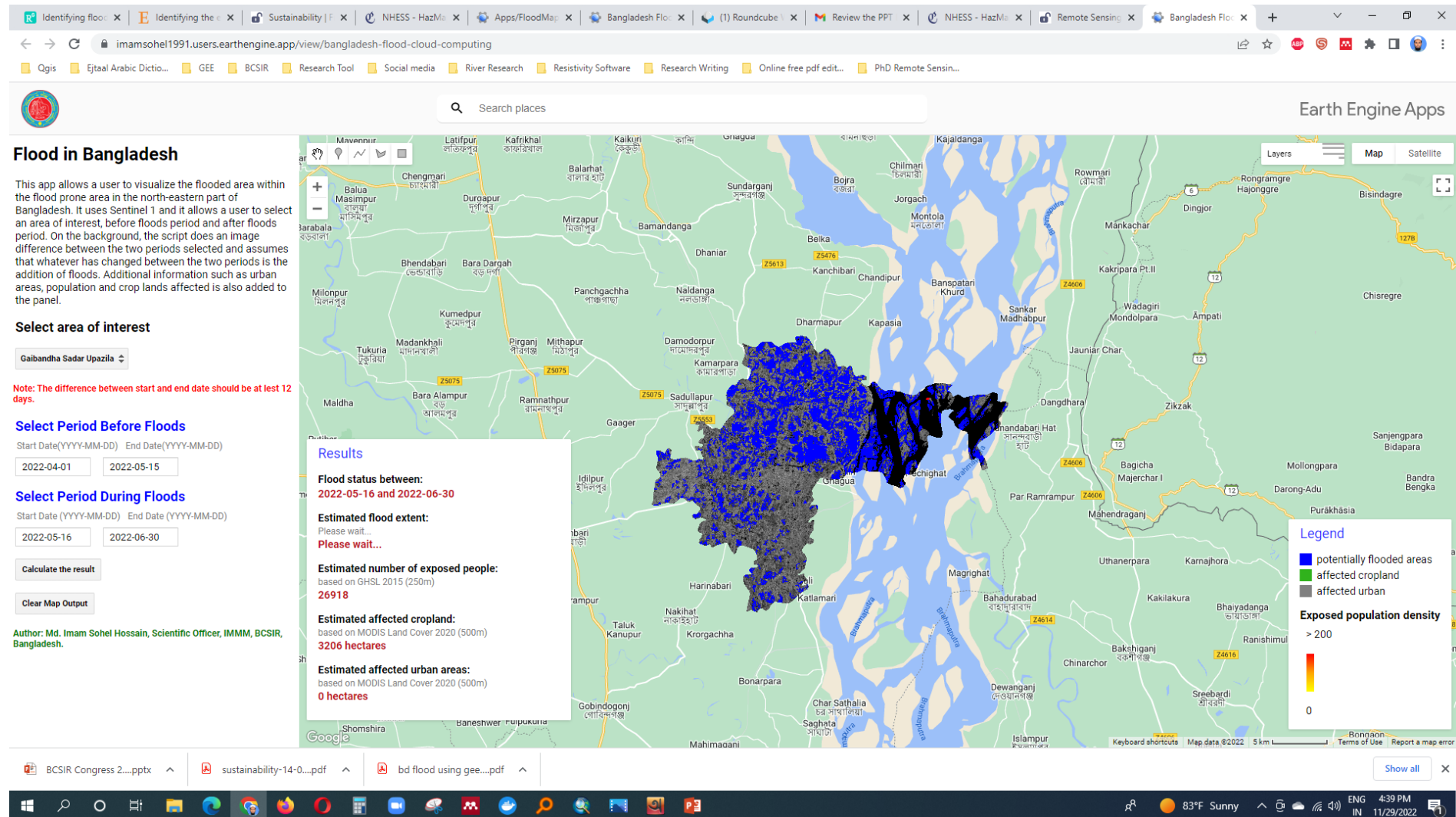
Findings-Divisional Scale



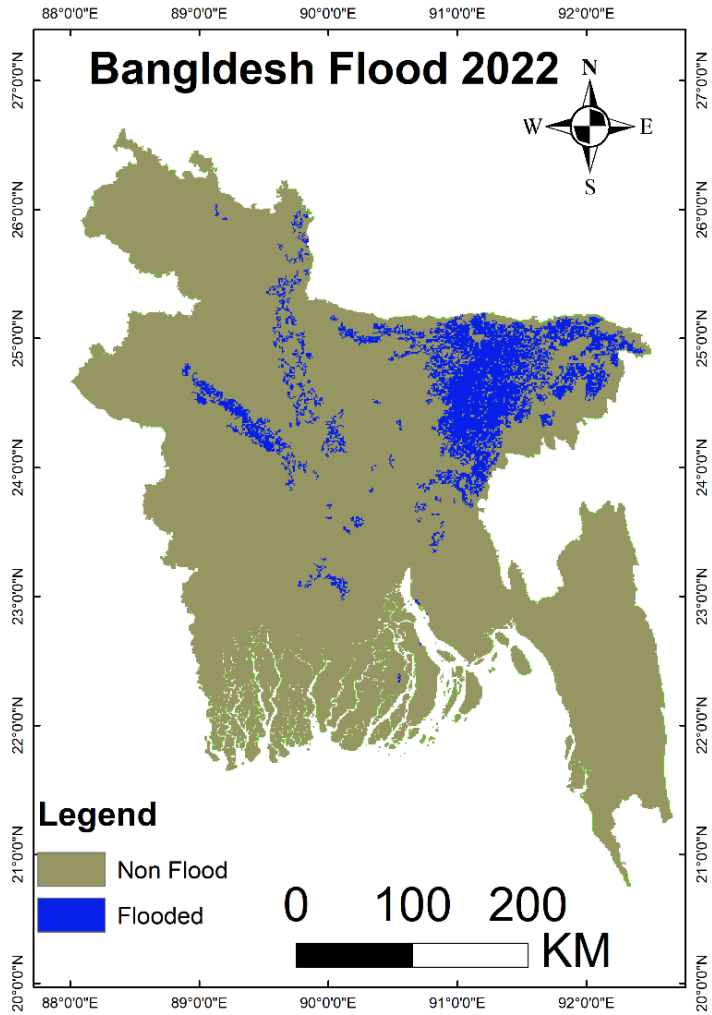
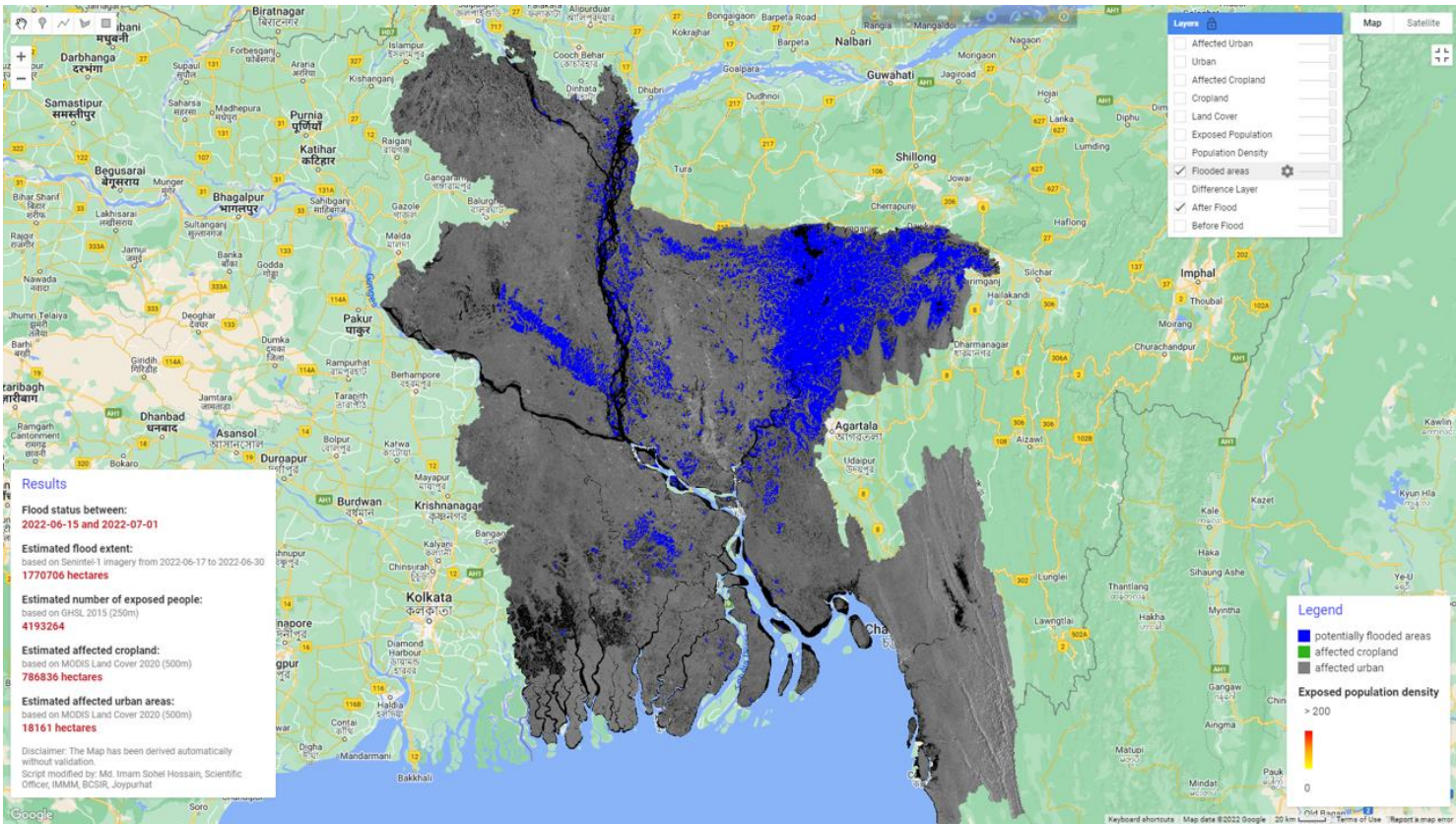
Findings-District Scale



Findings-Subdistrict/Upazila Scale



Findings-Future Flood Mapping and Modelling



Discussion



- ① We **developed** the App and it is designed in an effective and efficient way to analyze big data
- ① It is designed to **map** local to regional level flood which is aligned with the previous researches
- ① However, our app is designed to **estimate fast and reproducible** flood areal extent, exposed population, cropland and urban area than other studies (Key Contribution)
- ① Open a **platform** for future research -Technical and non technical
- ① Specifically, aid to **understand** natural disaster occurrences and their spatial pattern
- ① Thus, increase **predictive** capabilities for natural hazard events.
- ① In the era of big data and cloud computing, our cloud based application will **increase** the pace at which researchers, policy makers can **evaluate** flood hazard in Bangladesh

Limitations and Future Recommendations



- ① The tool **only** accesses datasets publicly hosted within the Google Earth Engine Data Catalog. While many researchers have the funding to pursue the use of datasets acquired on a **near-daily** basis (e.g., from Planet Labs, Inc.), it currently does not have a mechanism for ingesting these data
- ① **Validation** of estimated data sets
- ① With all of these limitations, it is important to recognize that Google is regularly making **improvements and modifications** to Earth Engine. We intend to monitor these activities and **update** the our application as needed to develop with **future** changes to Earth Engine

Revolutionizing Flood Monitoring using Cloud Computing

Md. Imam Sohel Hossain
Senior Scientific Officer, BCSIR

References



- ① Notti, D.; Giordan, D.; Caló, F.; Pepe, A.; Zucca, F.; Galve, J.P. Potential and Limitations of Open Satellite Data for Flood Mapping. *Remote Sens.* 2018, 10, 1673. <https://doi.org/10.3390/rs10111673>
- ① Ali, I.; Cao, C.; Naeimi, V.; Paulik, C.; Wagner, W. Methods to Remove the Border Noise From Sentinel-1 Synthetic Aperture Radar Data: Implications and Importance For Time-Series Analysis. *IEEE.* 2018, 11, 3. <https://doi.org/10.1109/JSTARS.2017.2787650>
- ① Canty, M. & Nielsen, A. Spatio-temporal analysis of change with Sentinel imagery on the Google Earth Engine. *ESA Conference on Big Data from Space (BiDS)*, Toulouse, France. 28-30 Nov 2017. <https://doi.org/10.2760/383579>
- ① Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D., and Moore, R.: Google Earth Engine: Planetary-scale geospatial analysis for everyone, *Remote Sens. Environ.*, 202, 18–27, <https://doi.org/10.1016/j.rse.2017.06.031>, 2017.