Application of Geospatial Technologies in Developing Climate Change Adaptation Tracking Mechanism (ATM) in Bangladesh

Sheikh Tawhidul Islam, PhD (Durham, UK)
Professor
Department of Geography and Environment
Director
Institute of Remote Sensing
Jahangirnagar University, Bangladesh.

and

Krishna Prosad Mondal

USAID
NASA
SERVIR HKH

BANGLADESH HAZARD PROFILE

DROUGHT
Affects 2.3 m ha crop land. Loss of grazing fields, dried up ponds, water shortage. In 2006, reduced food grains by 1 million tons.

FLASH FLOOD
Damages standing crops, infrastructures and facilities. Unpredictable, uncertain.

FLOOD
Inundates 20% (normal years) to 75% of land area during monsoon, increases river erosion, breaches embankments, damages infrastructures. Loss of crops, fisheries, livestock, biodiversity.

SALINITY INTRUSION
Damages biodiversity, crop lands, livelihoods, safe water sources. Spreading intrusion from 0.75 to 1.5 m ha (2009); 53% of coastal area affected. Projected displacement: 6-8 million people by 2050

CYCLONE
Remains the deadliest, most destructive hazard. Recurring events, lingering aftermath, complex recovery.
Improved preparedness (CPP, shelters, embankments).

AND

CLIMATE CHANGE HAZARDS, EARTHQUAKES, FIRE BREAKOUTS, INFRASTRUCTURE COLLAPSES, ETC.

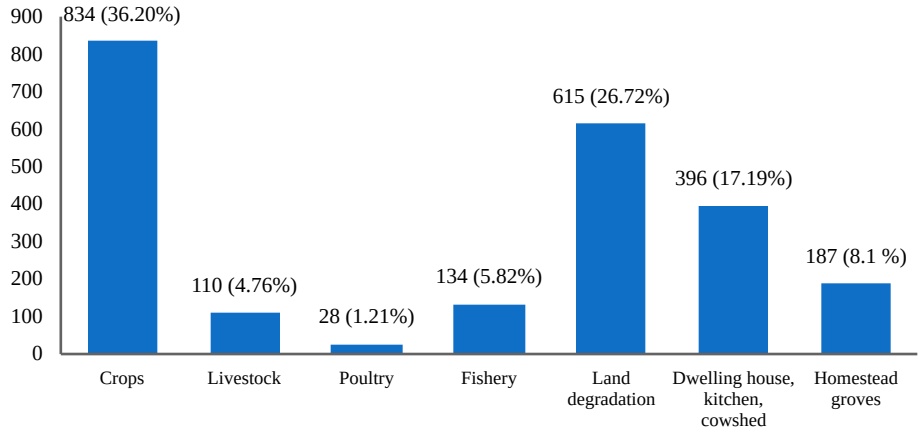


Figure: Loss and damage caused by disasters (2009-2015) in different sectors (figures in million USD). Source: BBS 2015.

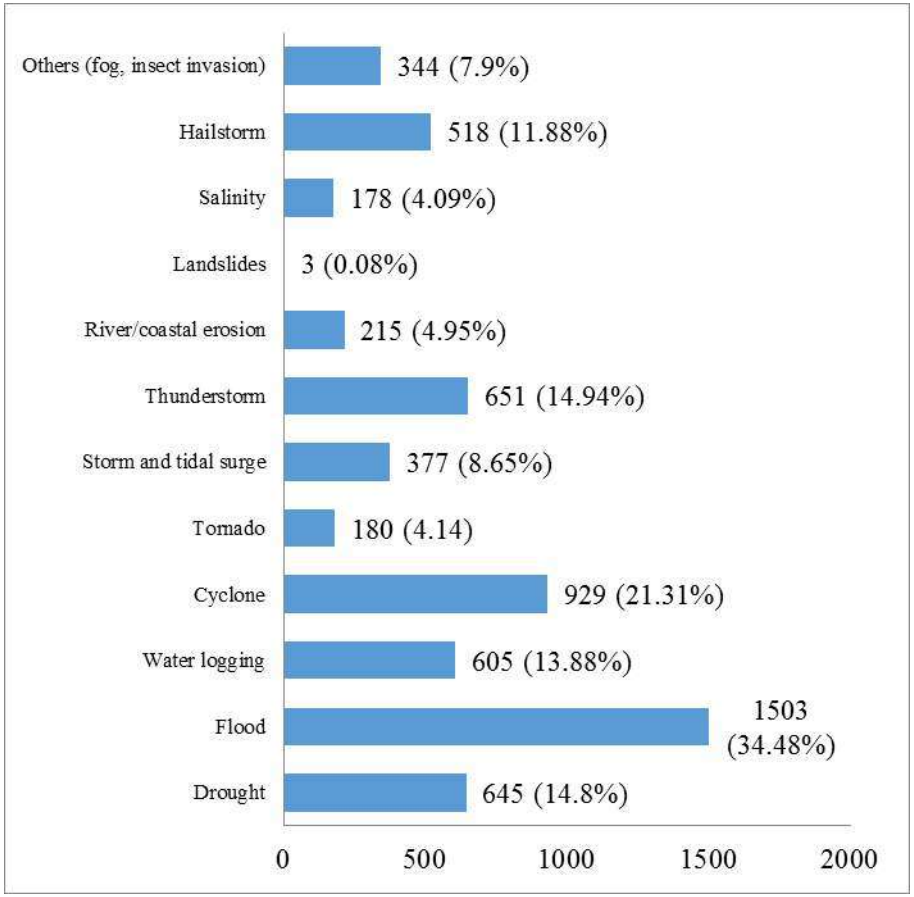


Figure 9: Number of affected people from various types of disasters drawn from the sample population (BBS 2015).


NAWABGANJ
BANGLADESH
RAJSHAHI
INDIA
NATORE
KUSHTIA
PABNA
RAJBARI
10 0 10 km
end
Common River 1973-2009
Accretion 73-09
Erosion 73-09

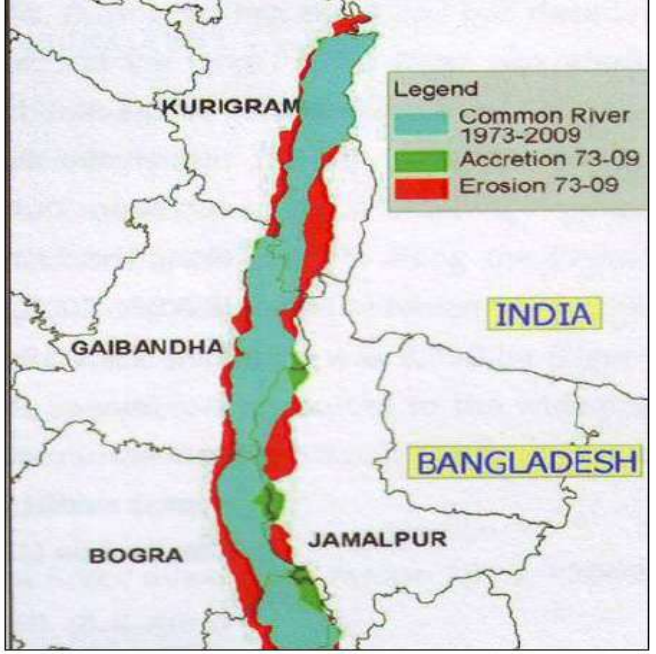

KURIGRAM
Legend
Common River 1973-2009
Accretion 73-09
Erosion 73-09
INDIA
GAIBANDHA
BANGLADESH
BOGRA
JAMALPUR

Figure: Physical context of Chouhali study site, Sirajgonj district.

Physical context of Chilmari study site, Kurigram district.

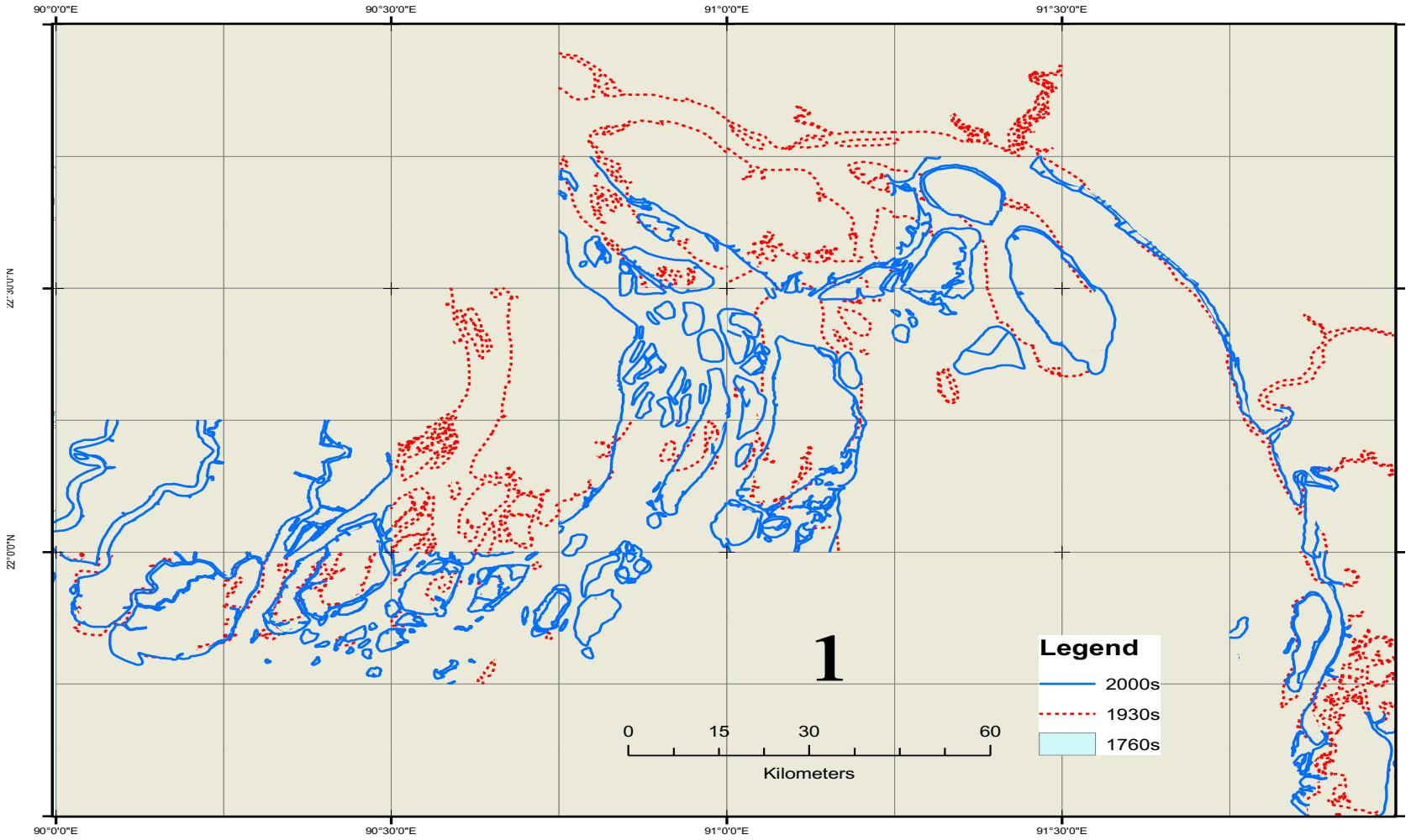
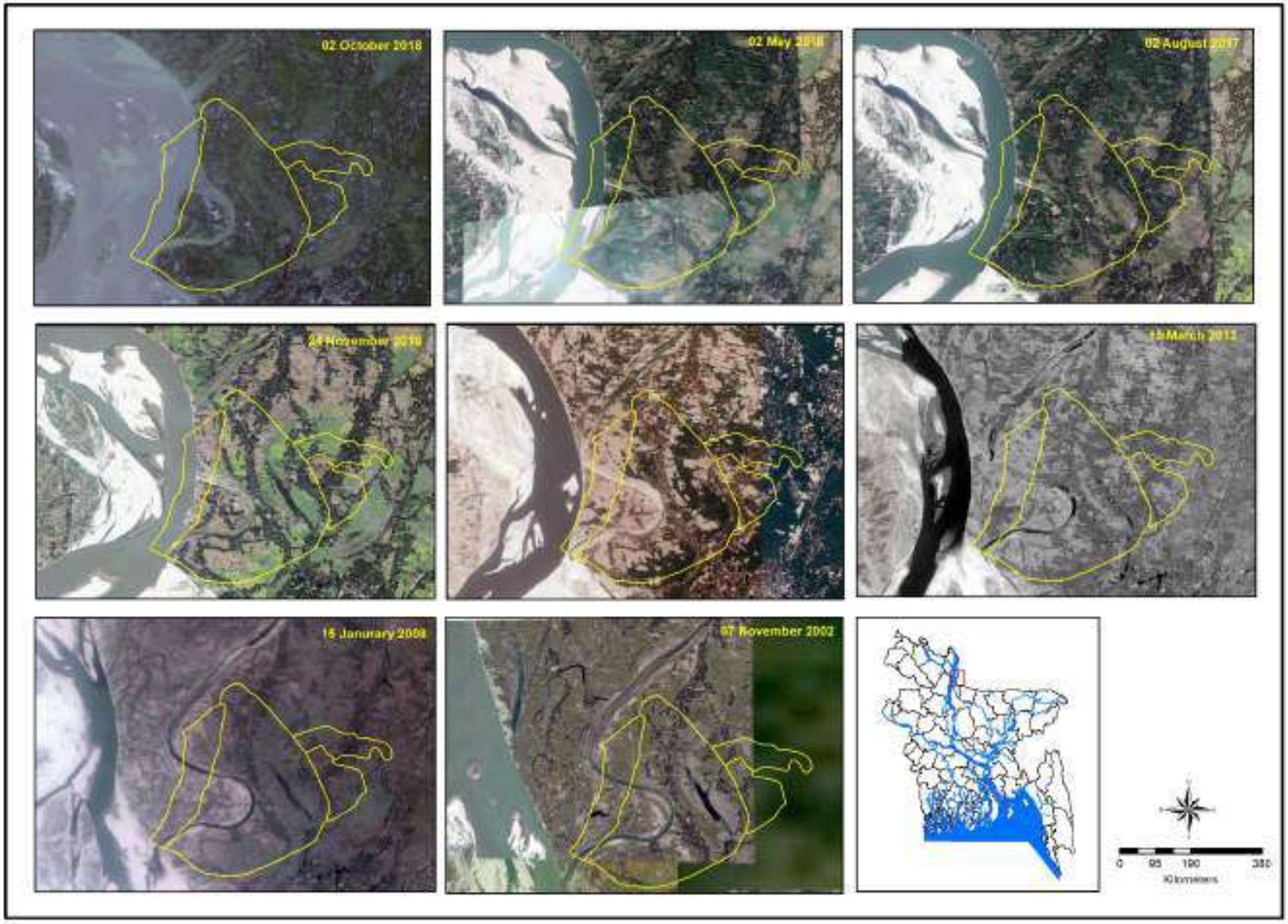
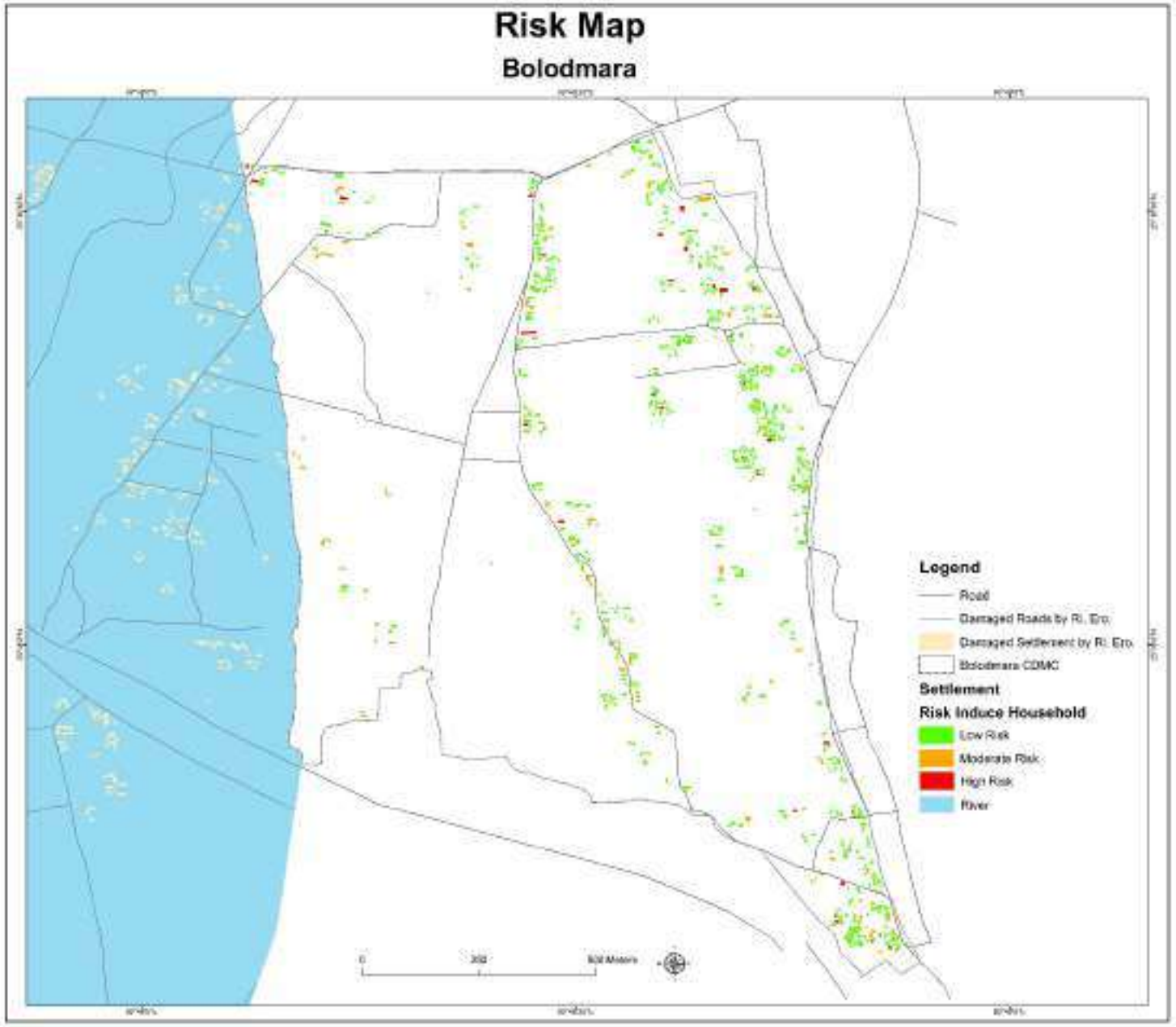


Figure 9: Block wise accretion-erosion and changes in the GBM estuary during the last 240 years. Source: Rashid *et* al. 2008.


02 October 2018
02 May 2018
02 August 2017
24 November 2016
15 March 2013
15 January 2008
07 November 2002
0
95
190
380


Risk Map
Bolodmara
Legend
Road
Damaged Roads by Ri. Ero.
Damaged Settlement by Ri. Ero.
Bolodmara CDMC
Settlement
Risk Induce Household
Low Risk
Moderate Risk
High Risk
River

Data Relating to Loss and Damage happened due to Disaster Impacts

2005-2015, Total damage in '000 USD, EM-DAT		
2007	Flood	14000
2007	Flood	100000
2007	Storm	2300000
2009	Storm	270000
2013	Storm	20000
2014	Flood	160000
2015	Storm	4000
2015	Storm	40000
2015	Flood	40000
		2948 million USD Total

Damage and loss caused by disasters (2009-2015), BBS 2015.		
Disasters	**Million BDT**	**Million USD**
Drought	10569	132
Flood	42807	535
Water logging	16062	200
Cyclone	28384	355
Tornado	4299	54
Storm/Tidal surge	12676	158
Thunderstorm	10940	136
River/Coastal erosion	36408	455
Landslides	249	3
Salinity	6072	76
Hailstorm	11471	143
Others	4306	54
Value of total loss and damage	184247	2301

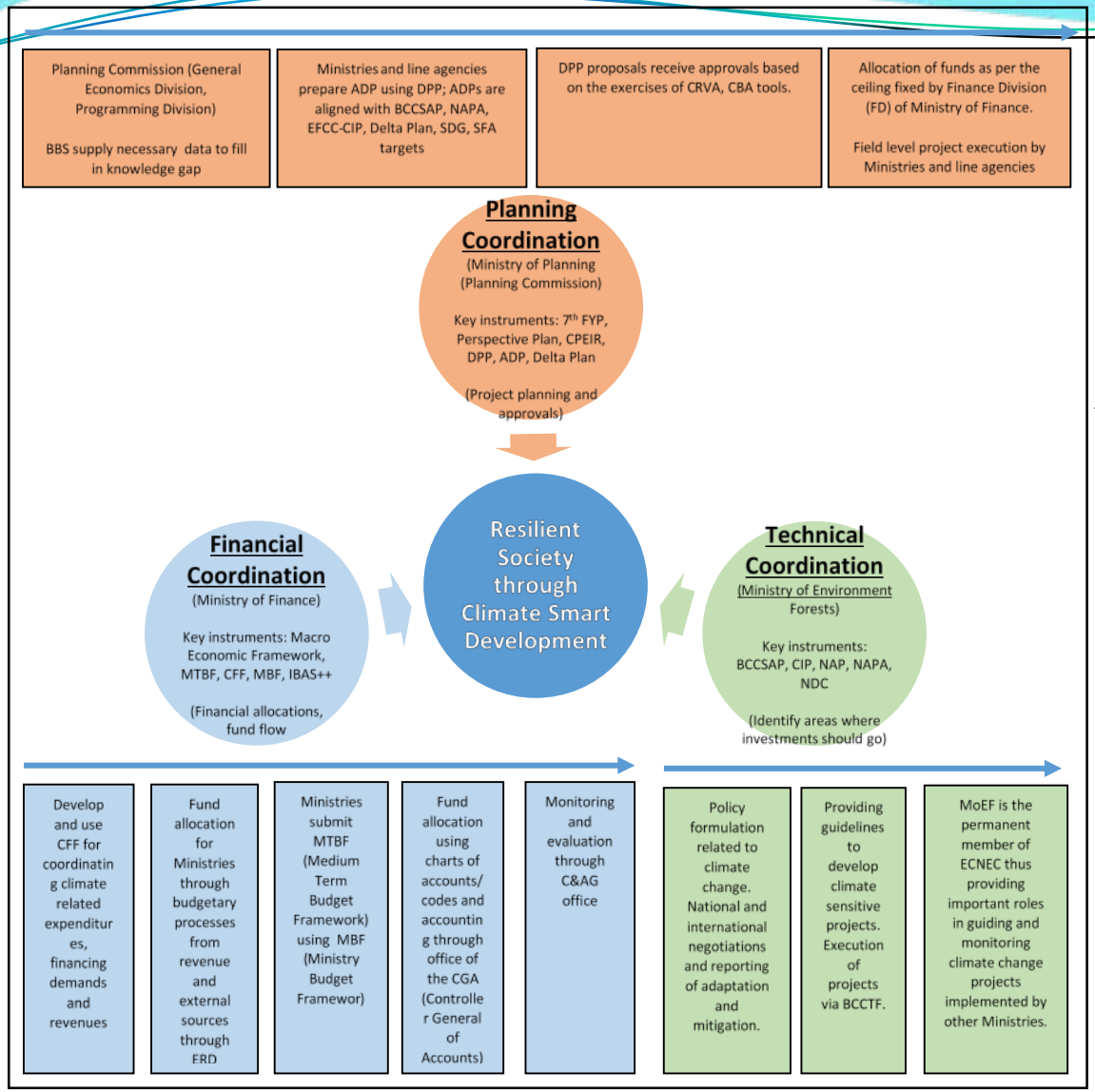
Policies

- NPDM (National Plan for Disaster Management)
- Disaster Management Act
- Standing Orders on Disasters
- National Adaptation Programme of Action
- BCCSAP (Bangladesh Climate Change Strategy and Action Plan)
- CIP (Climate Investment Plan)
- 7^{th} Five Year Plan
- SDG attainment plan (BESF)

Loss and damage information collected by the D Form of DDM

Information category	Description	Information category	Description
1	Name of Upazilla and district affected disasters	15	Damage of mobile phone towers
2	Number of wards/unions affected	16	Damage of structures of religious institutions
3	Affected area in square kilometres	17	Information on the damage of road networks of different categories
4	Affected people (man, women, children)	18	Number of bridge and culvert damage
5	Physically challenged persons (man, women, children)	19	Damage of embankments in kilometres
6	Affected households (partial, total)	20	Affected forest areas in hectares
7	Number of affected house (concrete, semi-concrete, thatch made)	21	Number of affected educational institutions
8	Affected disaster shelters (partial, total)	22	Affected industries (agriculture and non-agriculture)
9	Value of livestock lost (goats, lamb)	23	Number of affected tubewells
10	Value of livestock lost (cow, buffalo)	24	Affected toilets/latrines
11	Value of birds/poultry lost (chicken, duck)	25	Affected water reservoirs in numbers
12	Affected crops and seedbeds in hectares	26	Affected health centers (hospitals, clinic, community health centers)
13	Damage of other farms (e.g. shrimp hatchery etc.)	27	Loss of fishing boats and gears (boats, trawlers, fishing nets)
14	Damage of power lines (partial, total)		

Provided assistance to MoDMR in using high spatial resolution drone image in disaster impacts recovery prcess in Banshkhali (Chittagong).



Coordination Mechanisms of Climate Change Investments in Bangladesh.

ATM Architecture

Category	Primary key in the user interface software	Variables	Statistical treatment	Category of divisions
1. Vulnerability	***Meteorological data***	***Temperature***	***- Characteristics - Average/Pattern - Threshold (monthly, seasonal and yearly) - Anomalies - Projected scenario/prediction (statistical down scaling: GCM simulation) - Interpolation***	***By year By area/station By Agro-ecological zones By hazard types***
		Rainfall		
	Hazard and disaster impacts	***Floods (seasonal)***	***- Hazard maps - Change in the river bank line - Scenario prediction mapping***	***By year By administrative boundary By Agro-ecological zones***
		Floods (flash type)		
		River bank erosion		
		Waterlogging		
		Cyclone		
		Drought		
		Salinity		
	Infrastructure	***Roads***	-	***By administrative boundary***
		Rails		
		Embankments		
		Social institutions		
	Land use pattern including land elevation	***Application of drone technologies***	***- Reference flood level for local level planning***	***By year By administrative boundary By Agro-ecological zones***
		Application of low resolution DEM (SRTM or Sentinel data of ESA)		
2. Adaptation interventions	***Vulnerability and interventions***	Household (HH)	- Locational information of the household, photograph and mobile phone number - Database (vulnerability, sensitivity and exposure) against HH ID	Baseline Interventions Impacts
		Community (CBO, Local Government)	- Locational information, information about the representation and mobile phone number - Database (vulnerability, sensitivity and exposure) against HH ID	Baseline Interventions Impacts
	Major project activities in the area	At local level	Project attributes	Pre project During project Post project scenario
3. Tracking Measuring and Reporting	***Numeric reporting***	Allocation of funds	- Distributions of HH with specific financial allocations (may be range of value is used) - Allocations of funds to different social/local institutions	By adaptation intervention category By locations, hazard types
		Vulnerability, sensitivity and exposure of the HH and local institutions		
	Qualitative reporting	CRA/RRAP for the union		
		MoDMR reporting (based on D form)		
		Case stories		
	Spatial analysis (converting to kml)	Production of maps based on user needs and queries		

ATM (Data and Methods)

- Climate Change Risks **(variability and change in the climatic variables)**
- Erratic rainfall; shifting precipitation pattern **(Statistical assessment and reporting; using R)**
- Heat spells over threshold level **(Statistics using R, modelling, thermal band of RS)**
- More floods, untimely floods **(use of series of satellite images, DEM/drone and reporting, OSM)**
- Increased river bank erosion **(use of series of satellite images and reporting)**

ATM (Data and Methods)

- Increased, prolonged drainage congestion **(GIS/spatial analysis and RS)**
- Salinity intrusion into surface water, ground water and soil **(GIS, RS, Secondary data analysis)**
- More cyclone, storm surges with higher intensities **(RS, DEM/drone)**
- Reduced water availability for households and agricultural crops **(RS, GIS)**
- **Also information about land topography, settlements/village, physical information, institutions, commonplaces, land use, disaster prone/affected areas**


The Daily Star
Madhupur forest severely exists


The Daily Star
Forest-landfile projects deforestating Madhupur


Toponyms of Bangladesh: Footprints of History
বাংলাদেশের
স্থাননাম


TRANSPARENCY
INTERNATIONAL

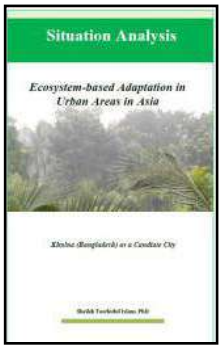

Do we really care about saving our environment?


CLIMATE CHANGE EDUCATION
FOR SUSTAINABLE DEVELOPMENT


Bangladesh


Bangladesh


Disaster Management
Education and Training
Facilities in Bangladesh


Situation Analysis
Ecosystem-based Adaptation in
Urban Areas in Asia

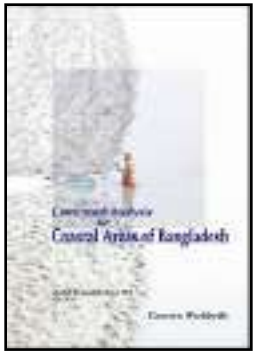

CLIMATE CHANGE
IN
BANGLADESH


Mainstreaming Disaster Risk Reduction


Final Report


Terminal Evaluation


ADB


Coastal Areas of Bangladesh

Components of FDES

1. Environmental Conditions and Quality
2. Environmental Resources and Their Use
3. Residuals
4. Extreme Events and Disasters
5. Human settlements and Environmental Health
6. Environmental Protection, Management and Engagement

Table 3.1: FDES uses a multi-level approach

Component	Sub-component
1	2
Component 1: Environmental Conditions and Quality	Sub-component 1.1: Physical Conditions Sub-component 1.2: Land Cover, Ecosystems and Biodiversity Sub-component 1.3: Environmental Quality
Component 2: Environmental Resources and their Use	Sub-component 2.1: Mineral Resources Sub-component 2.2: Energy Resources Sub-component 2.3: Land Sub-component 2.4: Soil Resources Sub-component 2.5: Biological Resources Sub-component 2.6: Water Resources
Component 3: Residuals	Sub-component 3.1: Emissions to Air Sub-component 3.2: Generation and Management of Wastewater Sub-component 3.3: Generation and Management of Waste Sub-component 3.4: Release of Chemical Substances
Component 4: Extreme Events and Disasters	Sub-component 4.1: Natural Extreme Events and Disasters Sub-component 4.2: Technological Disasters
Component 5: Human Settlements and Environmental Health	Sub-component 5.1: Human Settlements Sub-component 5.2: Environmental Health
Component 6: Environmental Protection, Management and Engagement	Sub-component 6.1: Environmental Protection and Resource Management Expenditure Sub-component 6.2: Environmental Governance and Regulation Sub-component 6.3: Extreme Event Preparedness and Disaster Management Sub-component 6.4: Environmental Information and Awareness

Table 3.2: FDES Components, Sub-components with Statistics

1 digit	*2 digits*	*3 digits*	*4 or 5 digits*
Component	Sub-component	Statistical Topic	Statistics

Objectives of BESF 2016-2030

(i) identifying main quantifiable aspects of the environment,

(ii) identifying components, sub-components and topics that are relevant and statistically feasible according to defined national needs and priorities,

(iii) facilitating the development of a national programme of environmental statistics,

(iv) contributing to the assessment of data requirements, sources, availability and gaps,

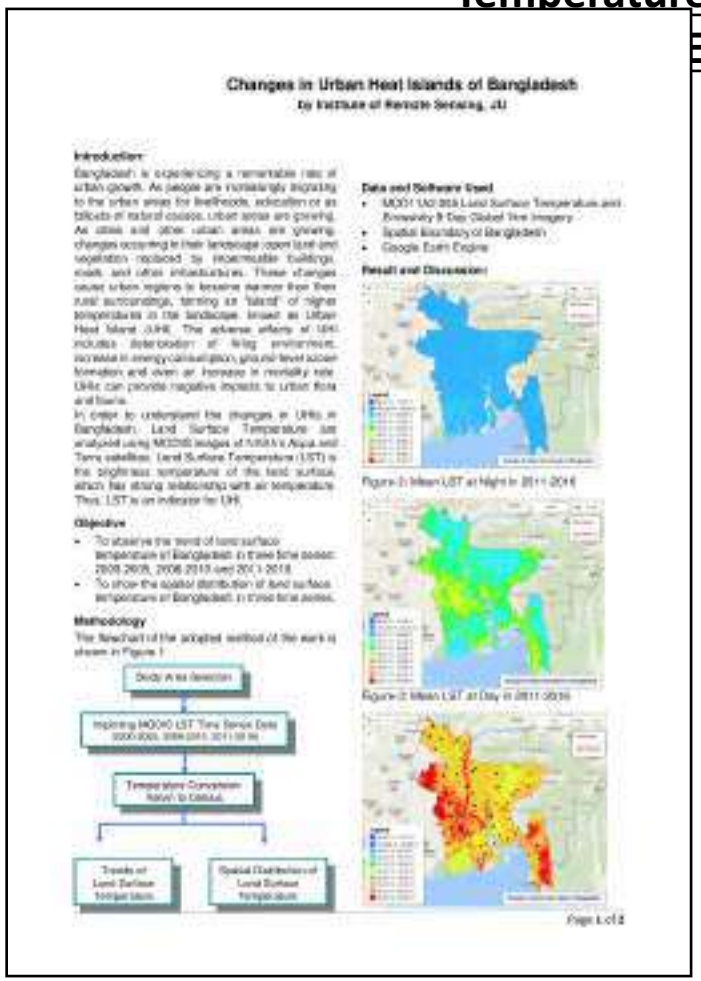
(v) guiding the development of databases that can be used for multiple purposes and

(vi) assisting the co-ordination and organization of environmental statistics given the inter-institutional nature of the domain.

Reports to be developed proposed in the BESF (2016-2030)

1.	Compendium of Environmental Statistics
2.	Compilation of Resource Accounts following SEEA (on land/soil, water, forests, natural gas, energy, fish)
3.	Climate Change and Natural Disaster-related Statistics
4.	Compilation of Social Accounting Matrix
5.	Poverty Environment Accounts (PEA) in light with SEEA
6.	Experimental Ecosystem Accounts (EEA) in light with SEEACF
7.	Household Survey of Health and Sanitation in Disaster Prone Areas of Bangladesh
8.	Urban/Rural Waste Generation Recycling and Management survey
9.	Environmental Protection and Resource Management Expenditure Accounts
10.	Disaster Risk Reduction Expenditure Accounts
11.	Climate Change and Natural Disaster Impacts Vulnerability Index
12.	Pre-crisis Data Gathering Tools as Baseline Information
13.	Climate and Natural Disaster Induces Survey
14.	Urban/Rural Water generation Use and Management survey
15.	Developing a Web Based Data Sharing Reporting and Ensuring Access to Stakeholders

Temperature analysis of 40 years



Changes in Urban Heat Islands of Bangladesh

by Institute of Remote Sensing, JU

Introduction

Bangladesh is experiencing a remarkable rate of urban growth. As people are increasingly migrating to the urban areas for livelihoods, education or as refugees of natural causes, urban areas are growing. As cities and other urban areas are growing, changes occurring in their landscape (open land and vegetation replaced by impermeable buildings, roads and other infrastructures). These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape known as Urban Heat Island (UHI). The adverse effects of UHI includes deterioration of living environment, increase in energy consumption, ground level ozone formation and even air hotness in mortality rate. UHIs can provide negative impacts to urban flora and fauna.

In order to understand the changes in UHIs in Bangladesh, Land Surface Temperature are analyzed using MODIS images of MODIS Aqua and Terra satellites. Land Surface Temperature (LST) is the brightness temperature of the land surface, which has strong relationship with air temperature. Thus, LST is an indicator for UHI.

Objective

- To observe the trend of land surface temperature of Bangladesh in three time period: 2000-2005, 2006-2010 and 2011-2016
- To show the spatial distribution of land surface temperature of Bangladesh in three time period.

Methodology

The flowchart of the adopted method of the work is shown in Figure 1

Data and Software Used

- MOD11A2 8A Land Surface Temperature and Emissivity 8 Day Global Time Imagery
- Spatial Boundary of Bangladesh
- Google Earth Engine

Result and Discussion

Figure 2: Mean LST at Night in 2011-2016

Figure 3: Mean LST at Day in 2011-2016

Page 1 of 2

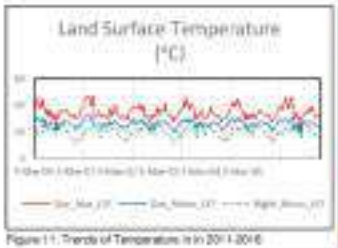


Figure 11: Trends of Temperature in in 2011-2016

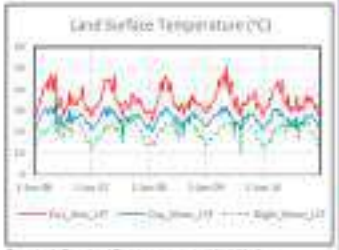


Figure 12: Trends of Temperature in in 2006-2010

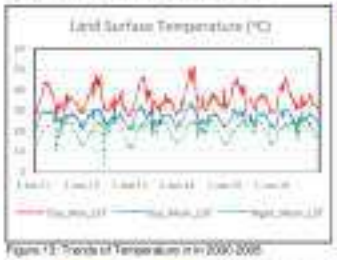
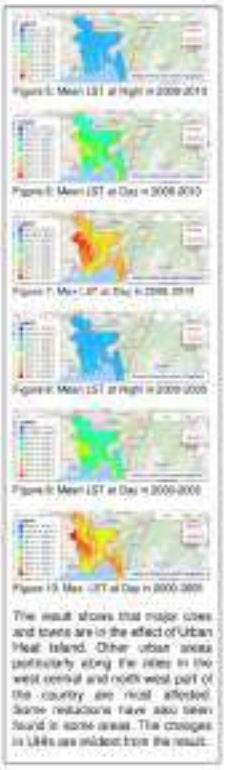


Figure 13: Trends of Temperature in in 2000-2005

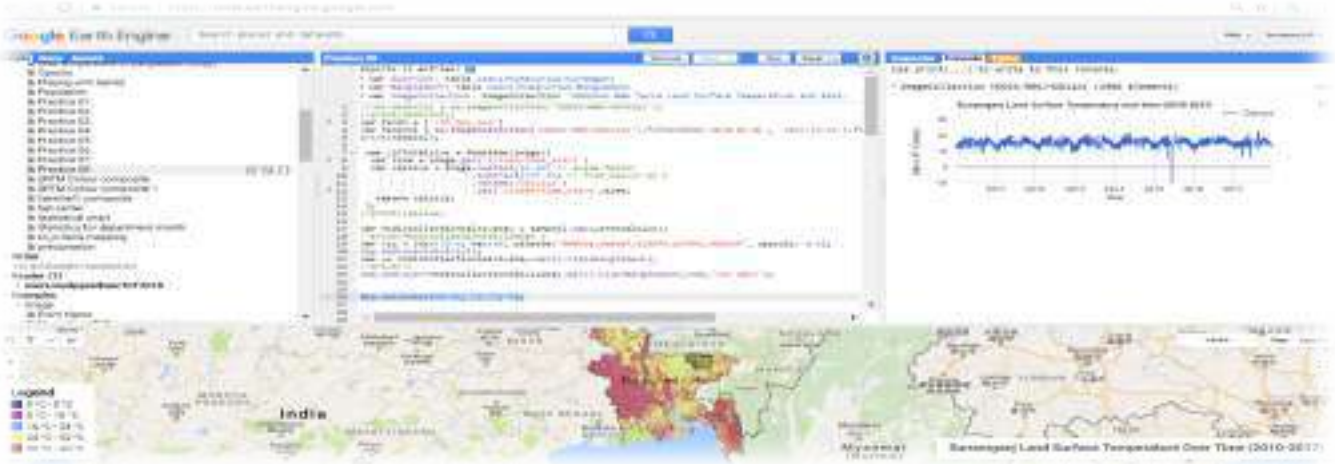


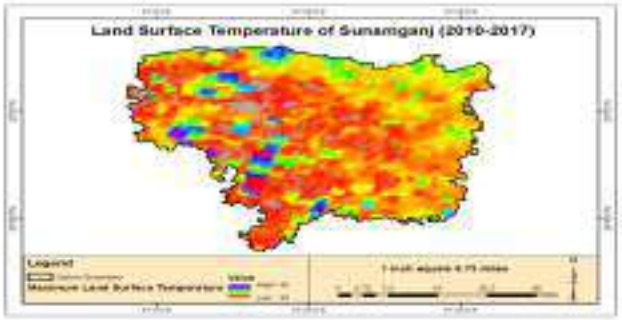
The result shows that major cities and towns are in the effect of Urban Heat Island. Other urban areas particularly along the rivers in the west central and north west part of the country are most affected. Some reductions have also been found in some areas. The changes in UHIs are evident from the result.

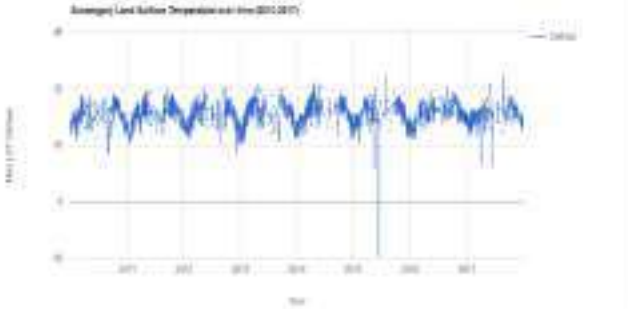
Link:

Page 2 of 2

Rainfall and Temperature Dynamics







Flood Monitoring in Bangladesh

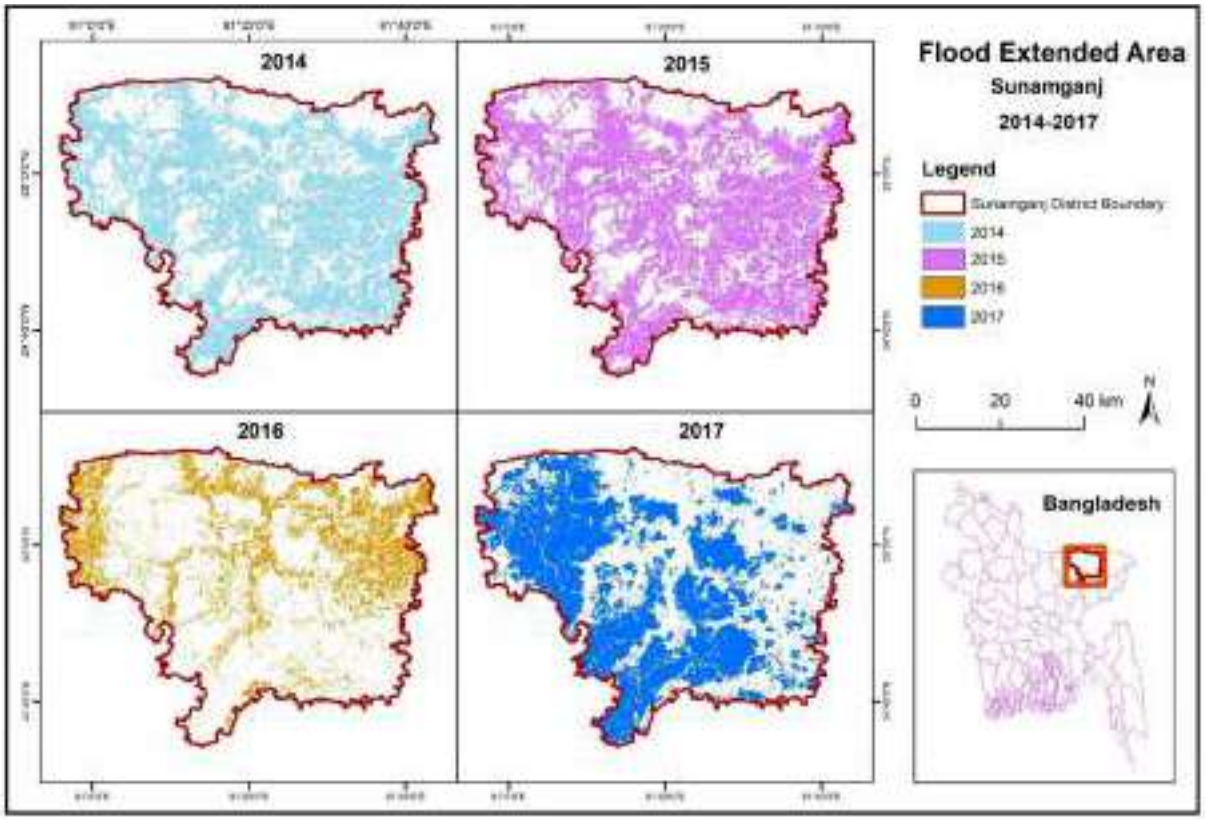


Chart NDVI Over Time

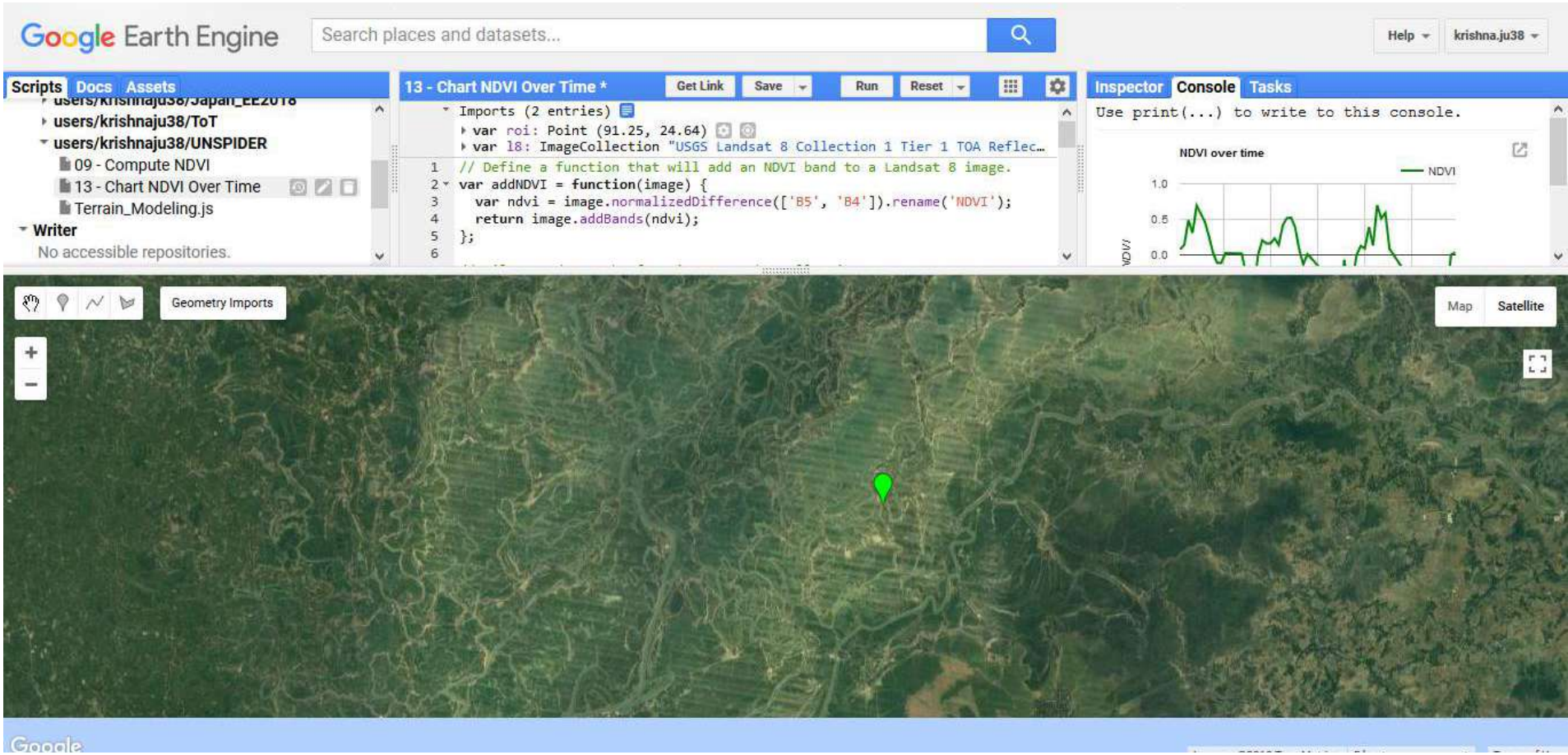
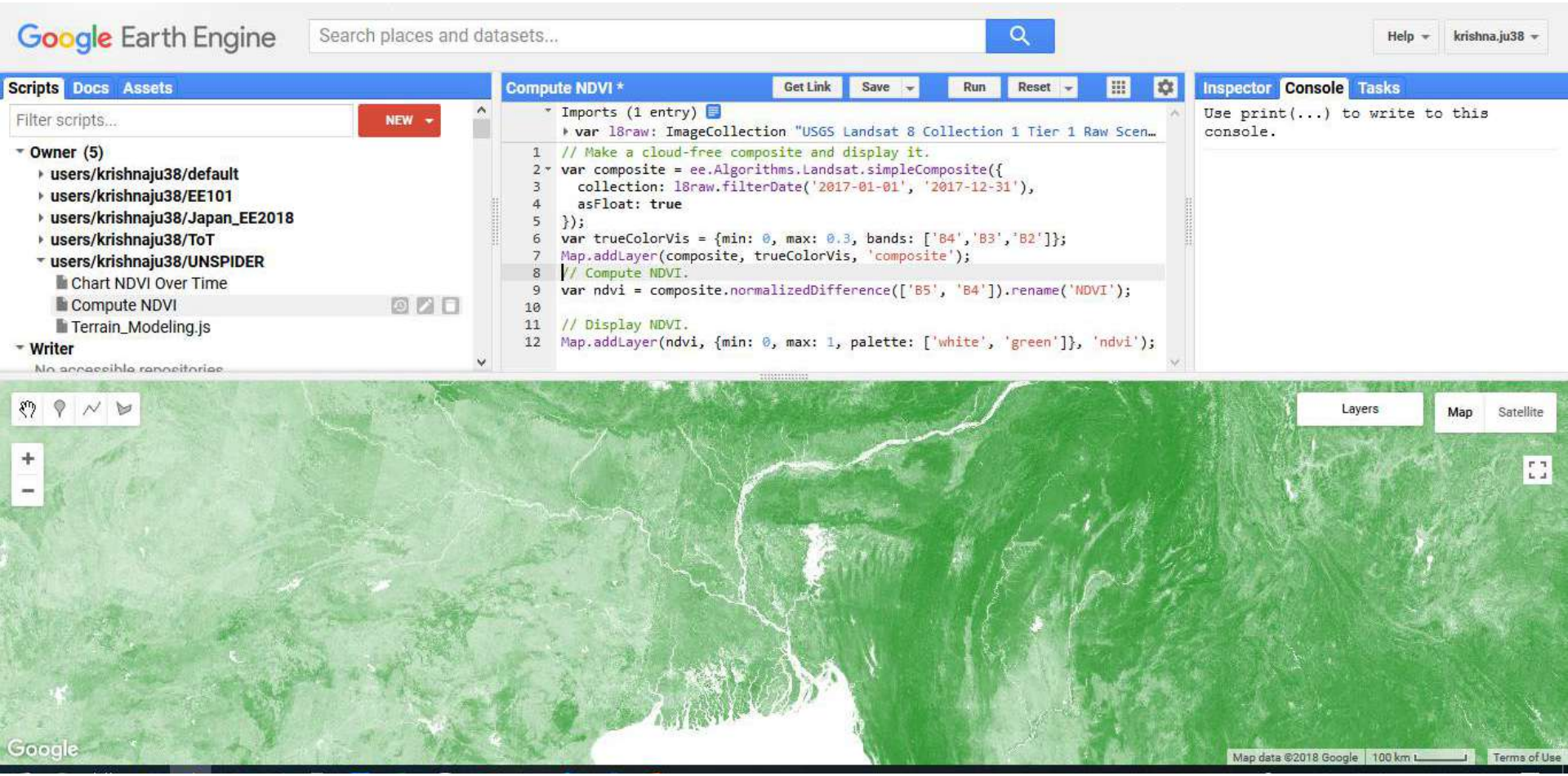
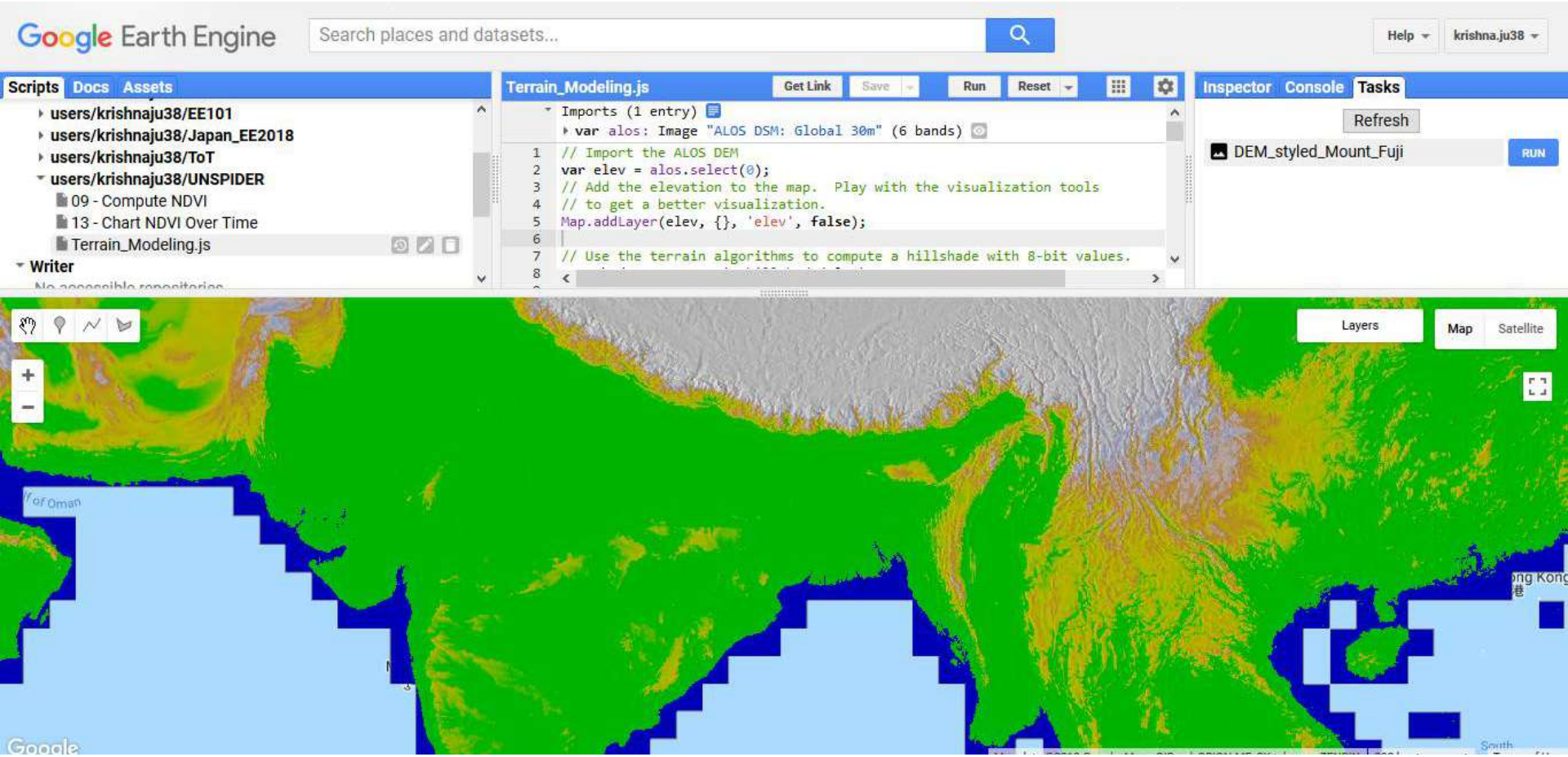


Chart NDVI Over Time

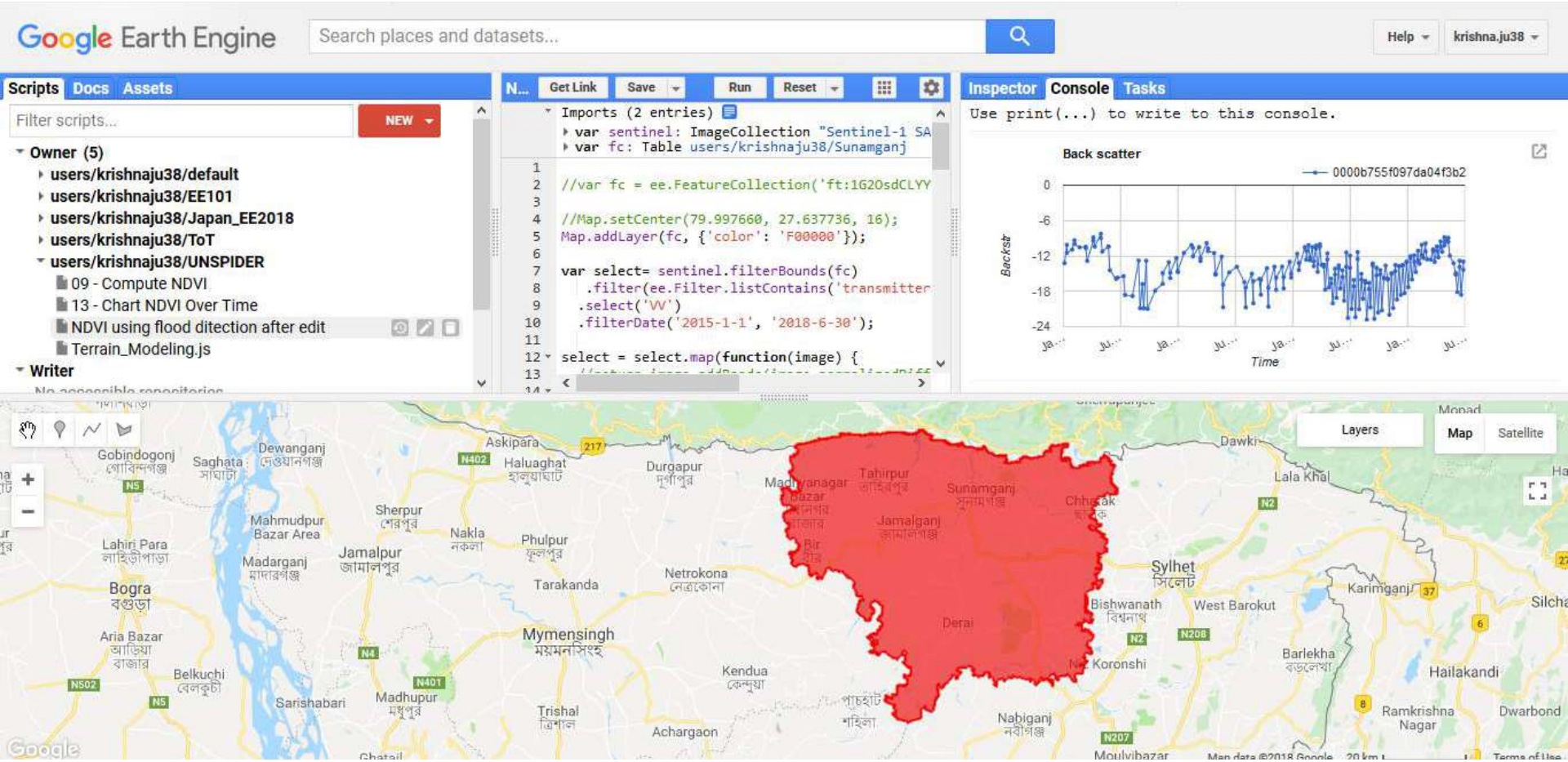
Compute NDVI



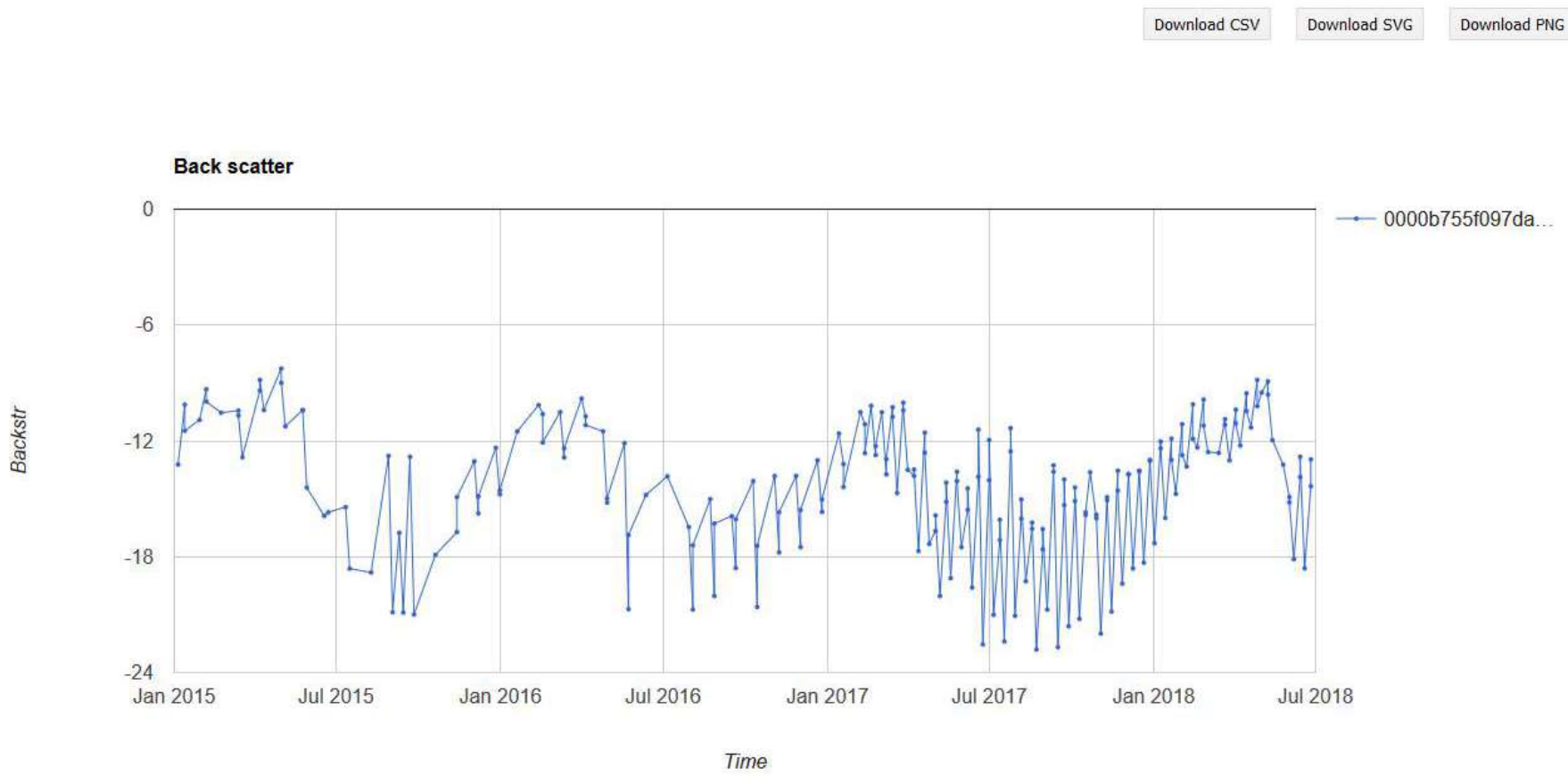
Terrain Modeling



Terrain Modeling



Terrain Modeling



Flood Monitoring