# Big Data to Solve Local Problems

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# Backdrop: Disaster Related

- Loss of Life and Livelihood

- Under Preparedness of State

- Future Uncertain
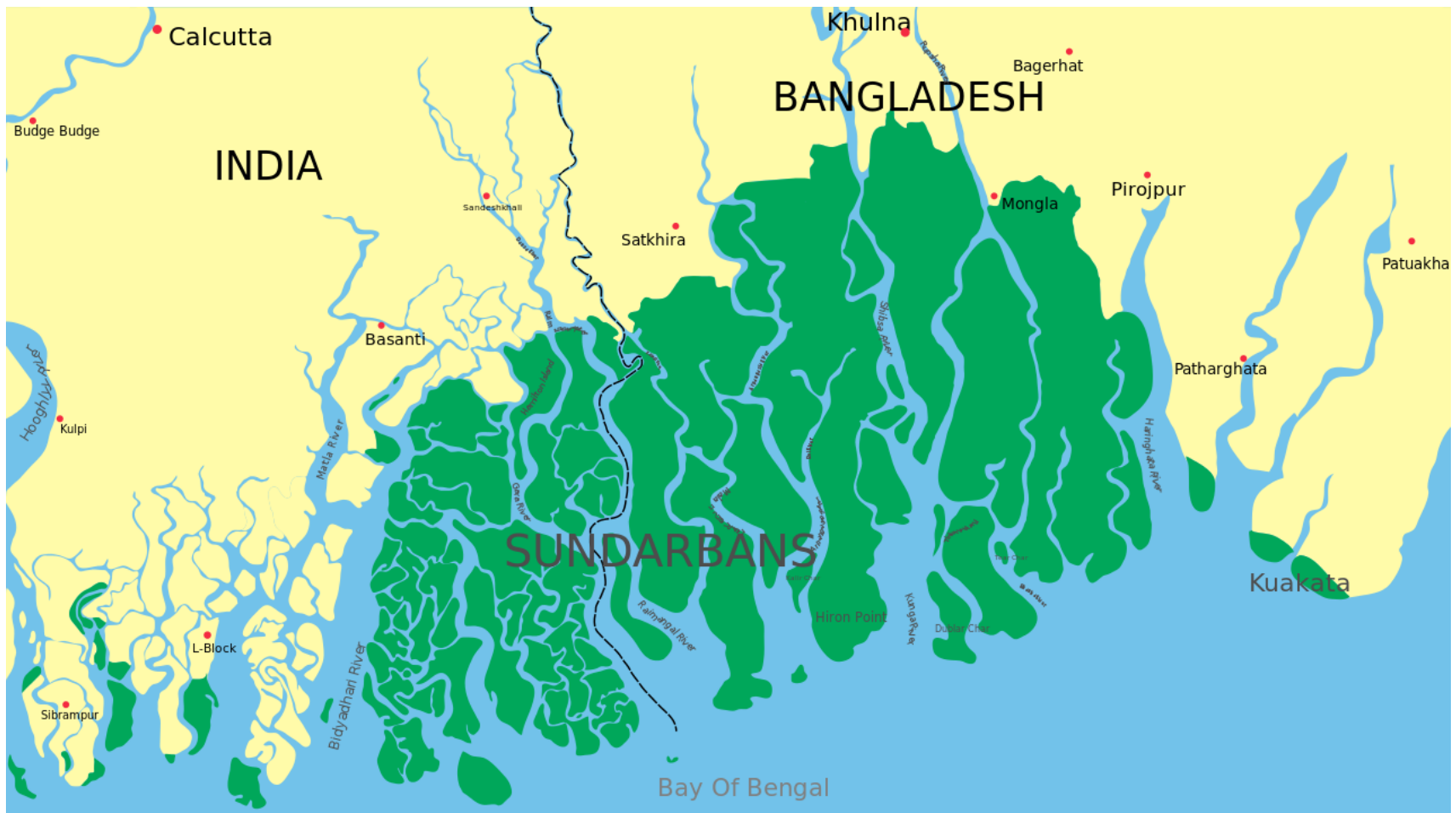
- High frequency of such disasters

# Motivation

- Major issues:

    -Remote Areas

    -Extremely Marginalised People
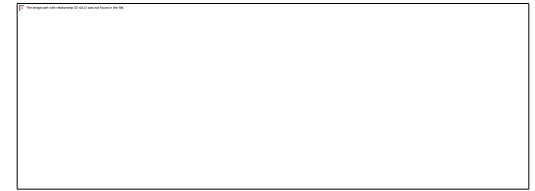

  Local Shocks

Loss of livelihood

# Going where we don't go….

# Indian Sundarbans…

- Largest Mangrove Deltas

- 102 islands…54 settled

- Poorest

- Paddy cultivation

- Sea level rising

# Sundarbans: Global warming

- Relative sea level rise in the regions is about 8 mm/year (Pethick and Orford, 2013; and Hazra et al, 2002).

- Sea level may rise beyond the year 2100 (Rahmstorf,2007 ).

- The region is already about 1° C warmer and is projected to warm by up to 3.7° by 2100 (CarbonBrief, 2018).

# Area of Interest: Mousuni
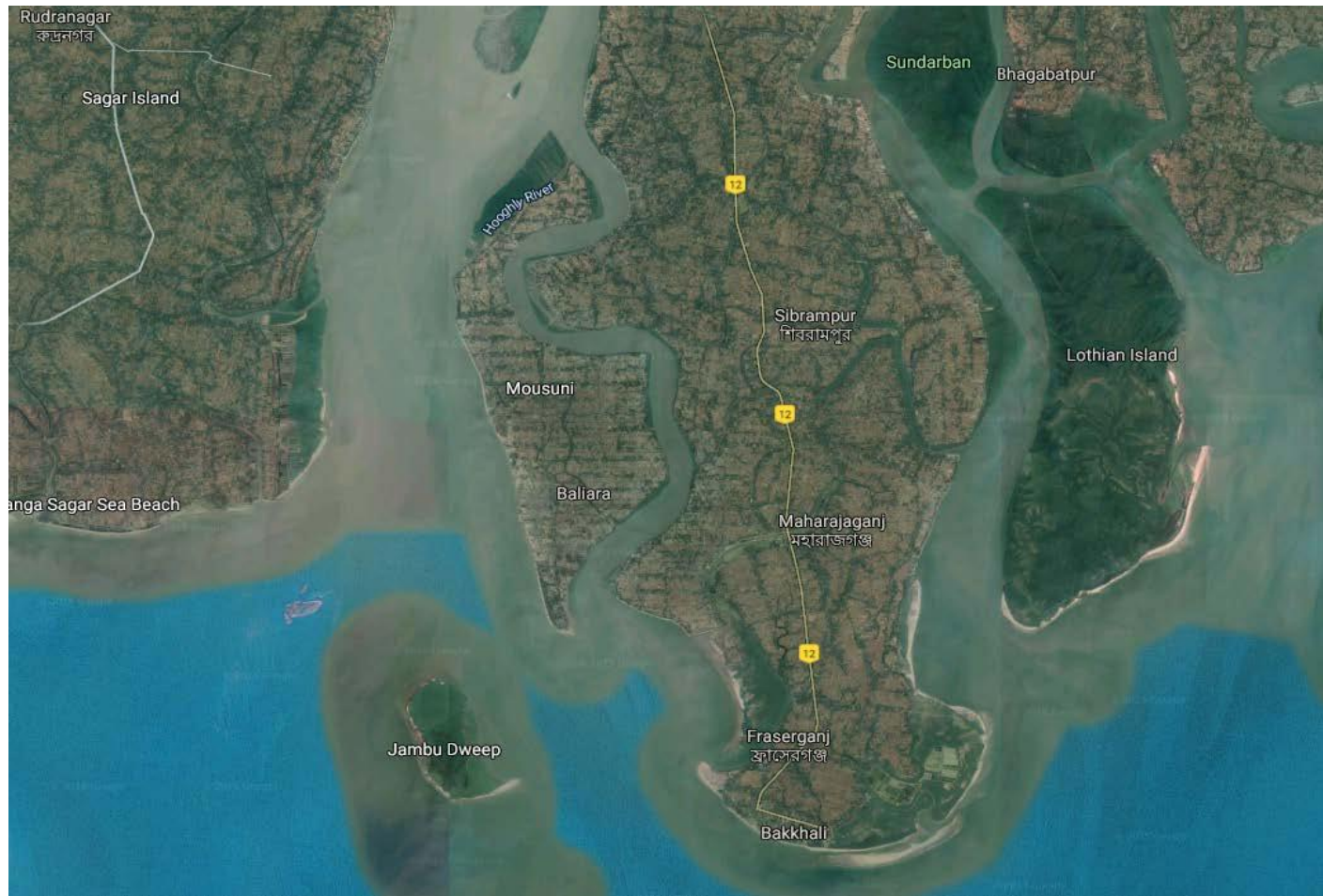
# Why Mousuni

- Mukherjee and Siddique (2019): Vulnerability Index

-  Baliara and Iswaripur mouzas are highly vulnerable; Narayanpur, Mousuni and Kusumtala moderate

- Bagdanga, Patibania mouzas are least vulnerable.

- Mousuni most vulnerable Samanta et al (2016), Hajra et al (2017) Studargue a decline in agricultural land area in Ghoramara as well as Mousuni island.

- Ghoramara had shrunk to less than five square miles (thirteen square kilometres), about half its size in 1969.

- Ghoramara island once had a population of 40,000. As of 2016 the island has 3,000 residents.

# Villages in our study

| Village | Household | Population |
|---|---|---|
| Baliara | 1746 | 8672 |
| Mousuni | 723 | 3578 |
| Dakshin Durgapur | 1234 | 5439 |
| Bagdanga | 901 | 4160 |
| Kusumtala | 1289 | 5663 |
| Debnagar | 1431 | 6582 |
| Radhanagar | 1161 | 5292 |
| Patibania | 1535 | 6987 |
| Rajnagar | 1263 | 5055 |
| Sibnagar Abad | 1365 | 6045 |
| Shibpur | 1386 | 6269 |
| Dakshin Chandranagar | 1224 | 5719 |
| Debnibas | 634 | 2711 |
| Haripur | 1824 | 7842 |
| Dwariknagar | 1888 | 7733 |
| Uttar Chandanpiri | 1234 | 4751 |
| Dakshin Chandanpiri | 929 | 4129 |
| Total | 21767 | 96627 |

# Big Data?

- Can Remote Sensing Map Distress? Warn Even? Mitigate?

- Use of Satellite Image

- Satellites

- Pixels

- Bands

# Image Sensing Relevant Literature

- Satellite Earth Observations missions, start: 1972 with Landsat-1 (Belward and Skøien, 2015).

- Land cover mapping programs became operational in the 1990s and the early 2000s (Vogelmann et al., 2001; Wulder et al., 2008a).

- Gomez et al (2018) for an excellent survey

- Ma et al (2017) -various supervised techniques that have been used for land classification.

# Remote Sensing: Sundarbans

- **Change in Land cover**
- Islam (2014, 2018)shows changes in vegetation cover of Sundarbans 1975 -2006 using Landsat imagery.
- Mondal (2017) –correlation of population and  impact of climate change on the forest
- **Vulnerability**
-  S Hazra, et al (2016), Hajra, et al(2017) Vulnerability Study along with ground level household data

# Using Satellite Images..

- QGIS: Create Shape Files

- Create Area of Interest

- Process Satellite Images

# The Shape File
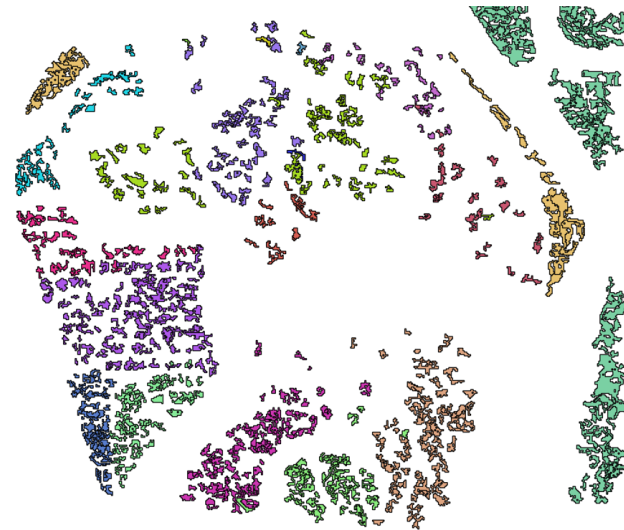
Legend

Shape_mapped

- Bagdanga
- Baliara East
- Baliara West
- Dakshin Chandanpiri
- Dakshin Chandranagar
- Dakshin Durgapur
- Debnagar
- Debnibas and Haruipur
- Dwariknagar
- Kusumtala
- Mangrove_Forest
- Mangrove_Habitation
- Mousani
- Patibania
- Radhanagar
- Rajnagar
- Shibpur
- Sibnagar Abad
- Uttar Chandanpiri

# Area covered in Study

- 830 polygons - basis of 2009 image.

- We cover around 31 square kilometres around Mousuni island.

- Our main area of interest in Mousuni island (approximately) 22 sq Kilometres.

- From Mousuni, we consider Baliara with approximately 1400 pixels resulting in 1.26 Sq Km and the rest of Mousuni island, with 7322 pixels and forming 6.59 Sq Km. Together this two area make up 35.67% of Mousuni island.

-  Covers almost entire area of Baliara West

# Images Used

- Landsat 7

- Less than 10% cloud Cover

- 2003-2018

- November and December


- Data Preprocess using QGIS 2.18.1

- Data work using R

# Landsat Bands

| Bands | Type | Wavelength |
|---|---|---|
| B1 | Coastal | 0.433-0.4553 |
| B2 | Blue | 0.450-0.515 |
| B3 | Green | 0.525-0.600 |
| B4 | Red | 0.630-0.680 |
| B5 | Near Infra Red(NIR) | 0.845-0.885 |
| B6 | Short Wavelength Infra (SWIR) | 1.560-1.660 |
| B7 | Short Wavelength Infra (SWIR) | 2.100-2.300 |
| B8 | Panchromatic | 0.500-0.680 |
| B9 | Cirrus | 1.360-1.390 |
| B10 | Long Wavelength Infra (LIR) | 10.30-11.30 |
| B11 | Long Wavelength Infra (LIR) | 11.50-12.50 |

# Indices we consider

- Normalized Difference Vegetation Index (ndvi)

- $NDVI = \frac{(\rho_{NIR} - \rho_{Red})}{\rho_{NIR} + \rho_{Red}}.$

- Negative/low: water… close to 1 forest…

- Normalized Difference Water Index (ndwi)

- $MNDWI = \frac{(\rho_{Green} - \rho_{SWIR})}{\rho_{Green} + \rho_{SWIR}}$

- High: Water

- USERS HANDBOOK https://landsat.gsfc.nasa.gov/wp-content/uploads/2016/08/Landsat7_Handbook.pdf
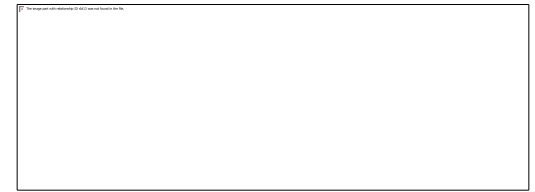
# Baliara (Feb, 2013)
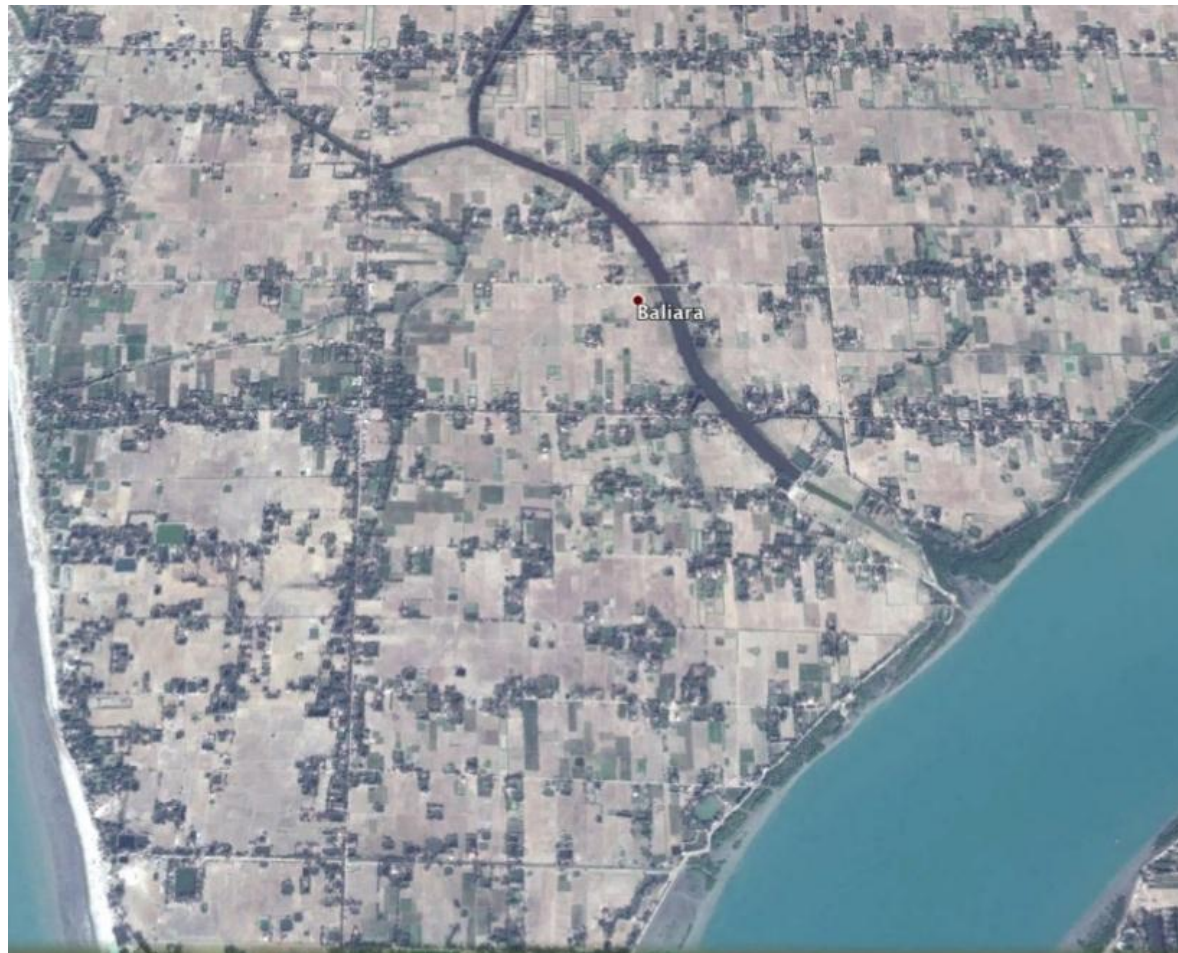
# Baliara (Nov 2015)
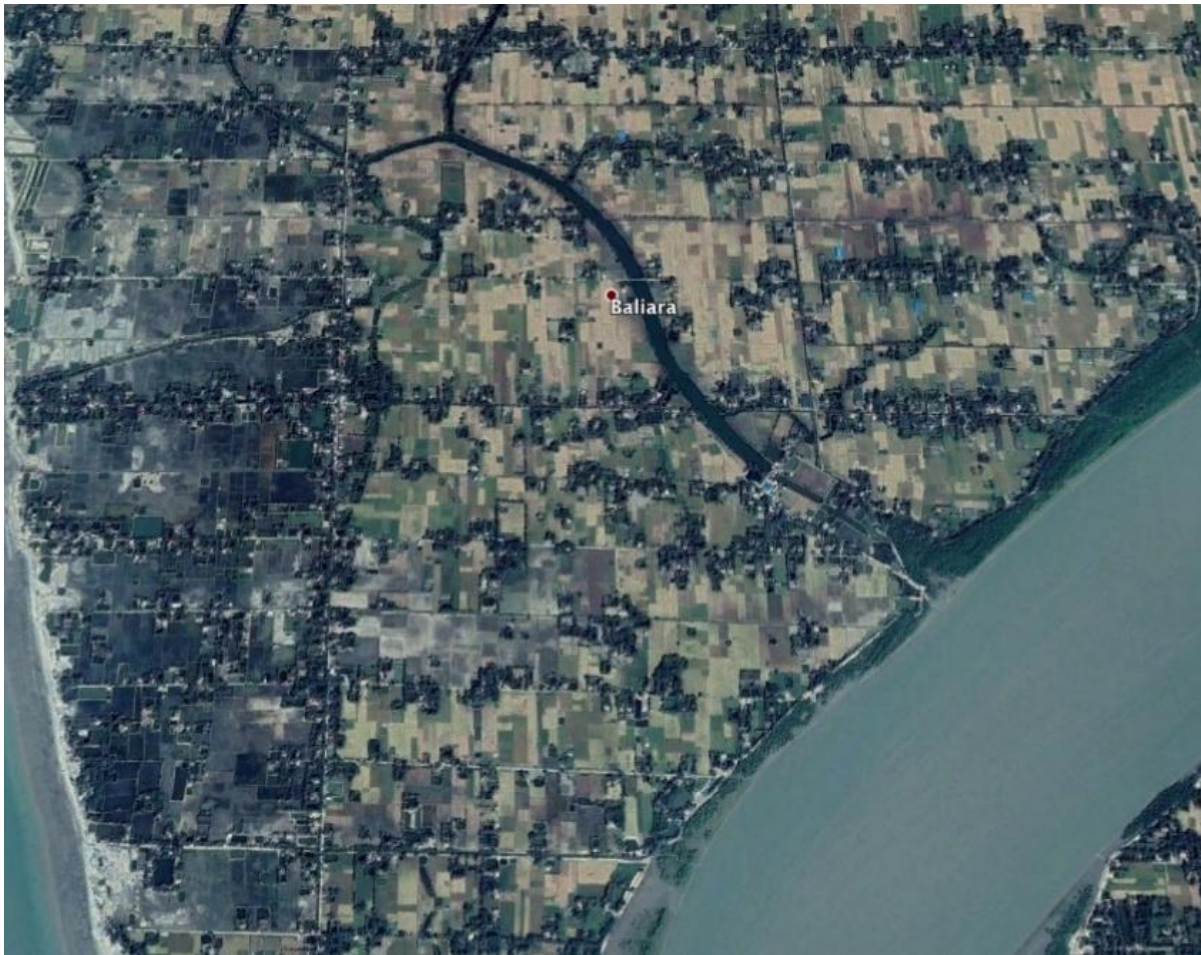
# After effects

- Dhara amd Paul (2016) --in the entire Mousuni island. Baliara constitutes 2200 metres of that.

- 150 families in Baliara have already left permanently. They could not sell their land

- *Drop in enrolments (class 1-5) vis a vis control?*

- https://www.wwfindia.org/news_facts/feature_stories/surging_sea_wreaks_havoc/

- http://www.cansouthasia.net/a/pdf_files/Mousuni%20Island%20-%20Rising%20Tides,%20Sinking%20Lives.pdf

- https://www.thethirdpole.net/en/2018/01/15/rising-sea-swamps-island-along-bengal-coast/

# Extending the Work

- Work in Progress

- 1047 revenue villages across 19 sub districts and 2 districts

- Vulnerability mapping based on images

- 2003-2015

- Recall methodology to assess poverty status

# Possible Way Out?
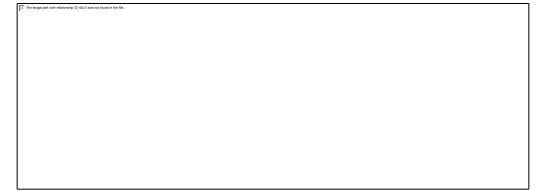
- Relocation?

  (Cernea 2014, Danda et al 2019)

- But that means acquiring land somewhere else?

# Problems of Acquiring

- Major issues:
  -Compensation

  -Consent

  -Claimants

# Land Auctions?

- Can Land Auctions Satisfy All? What About Private Values?

# Ghatak and Ghosh (2011)

- *"The proposed factory ….1,000 acres. Demarcate an area …2,000 acres. This should include the project site itself (core) and a belt of additional farmland surrounding (periphery). All owners within this …2,000 acres will be asked to submit tender bids for selling their land … The 1,000 acres on which bids are the lowest will be procured against cash compensation, and all of them will be paid a uniform price equal to the bid on the 1,001th acre of land when they are arranged in ascending order of asking price."*

- *".. however, that the area of land within the core that remains unsold in the auction must be exactly equal to the area of land procured in the periphery. The last step of the process is to take land from farmers in the core who have not sold for cash and compensate them with the plots of equal size procured in the periphery."*

# Ideal Compensation Mechanism

- Truth revealing (T):

- Efficiency(E):

- Minimum coercion (IRC):

- No excess land grab (NE):

- Minimum alternate use (MA):

- No holdup (NH):
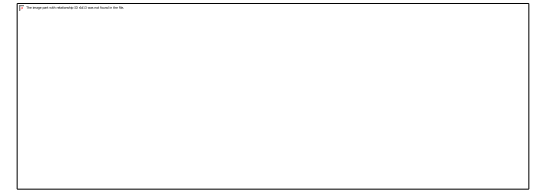
# Modified Dutch Auction; St1

- Suppose, the firm needs $k$ acres of land. It invites $n, n > k$ landowners each with 1 acre plot (say).

- The plot owners know $k$ but not $n$.

# Modified Dutch Auction; St 2

- *"The firm starts with an offer price -plot owners decide -stay or quit.*

- *Stay $<k$ , called off.*

- *If Stay $> k$ ; firm gradually lowers the offer price till the last landowner quits.*

## Modified Dutch Auction: St3

- *The transfer mechanism is as follows. The price where $k + 1$ th landowner quits, leaving behind only $k$ landowners in the auction, is the price paid to all the $k$ plot owners in exchange of their plot. A final balancing (if needed) is done with land swap*

Thank you