Climate change impacts and adaptation in Bangladesh
An agent-based approach (p.207)

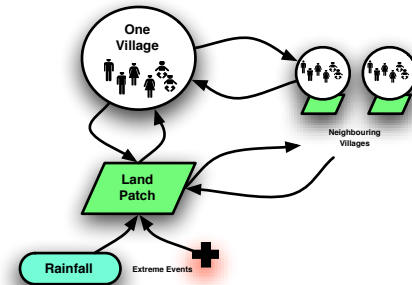## *Simon Angus*
Dept. Economics
`simon.angus@buseco.monash.edu.au`

Brett Parris
Dept. Economerics & Business Stats
`brett.parris@buseco.monash.edu.au`

Behrooz Hassani-M.
Dept. Econometrics & Business Stats
`Behrooz.Hassani.Mahmooei@buseco.monash.edu.au`

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Introduction

Motivation

Bangladesh faces **significant development** challenges:

1. High **poverty rate**
2. Very large **population density**;
3. High **agricultural** economic fraction;
4. Potentially **unstable (uncooperative) neighbours**.

And .. a very **unforgiving set of Climate Change** risks:

1. Susceptible to **flooding**
   - by sea (**storm surges, tsunamis**)
   - by 'air' (**monsoonal** rain patterns)
   - by 'land' (**huge river catchments**, snow melts)
2. Susceptible to **damaging wind/wave** incursions (cyclones)
3. **Poor neighbours** with their own problems (little help)

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Challenges in Bangladesh
Of people, and poverty

Population Density

http://www.theglobaleducationproject.org/
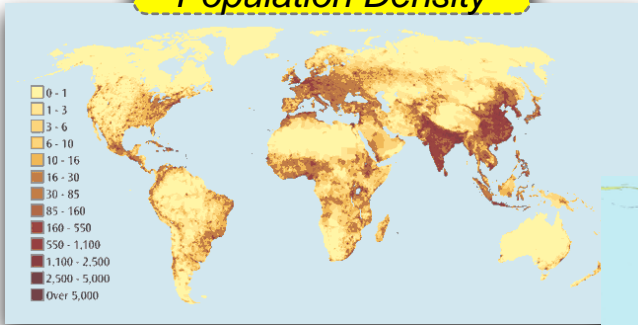
Population

Poverty

Worldmapper Project: http://www.worldmapper.org/

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Challenges in Bangladesh
The 1998 Flood

1998 Flood of Bangladesh (more than 2/3 of country)

Area flooded per thana
- 0 - 15 %
- 15 - 30 %
- 30 - 50 %
- 50 - 75 %
- > 75%
- No data

The map is derived from RADARSAT ScanSAR Narrow 2 image of 10 September '98. The image was classified for open water flooded areas. The classified image was overlayed with the thana map to calculate percentage of thana area under open water flooding.
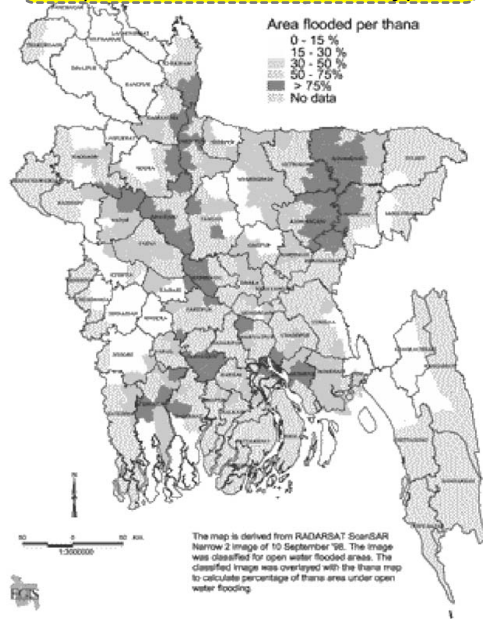
EGIS

Fig. 2. The 1998 flood in Bangladesh, which inundated more than two-thirds of the country. Source: Environment and Geographic Information Systems (EGIS, 1998).
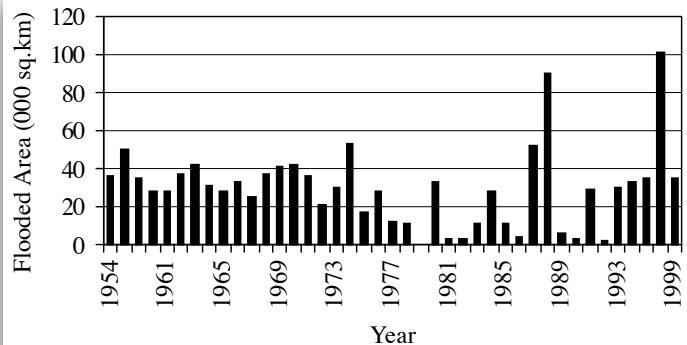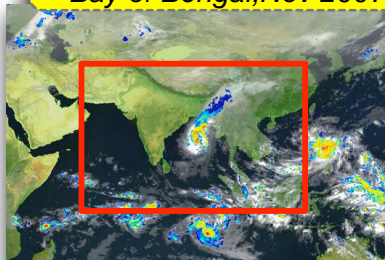

Fig. 3. Flooded area in Bangladesh during 1954–1998.

Monirul Qader Mirza, Global Environmental Change (2002) vol. 12 pp. 127-138
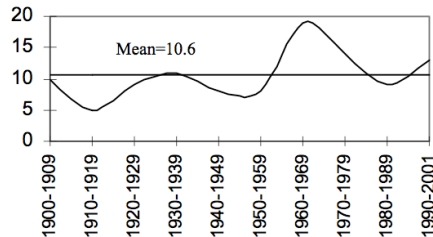
Challenges in Bangladesh
Cyclones and storm surges
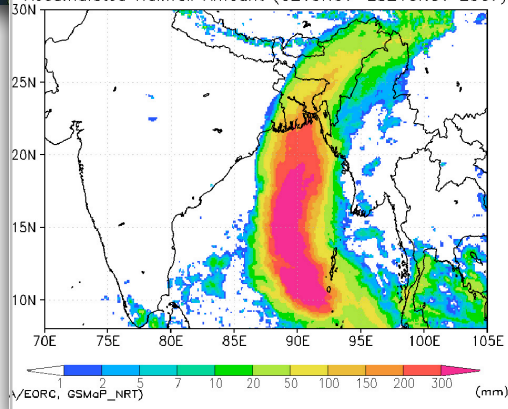
Rainfall due to Cyclone, Bay of Bengal, Nov 2007

Islam and Peterson. A Climatological Study on the Landfalling Tropical Cyclones of Bangladesh. 26th Conference on Hurricanes and Tropical … (2004)
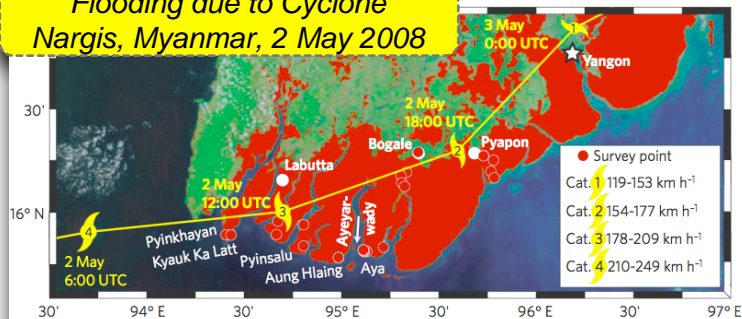

Fig-2: Frequency of storms in 10 year period from 1900-2001

Mean=10.6

Flooding due to Cyclone Nargis, Myanmar, 2 May 2008

3 May 0:00 UTC
Yangon
2 May 18:00 UTC
Bogale
Pyapon
2 May 12:00 UTC
Labutta
Pyinkhayan
Kyauk Ka Latt
Pyinsalu
Aung Hlaing
Ayeyar-wady
Aya
2 May 6:00 UTC

Survey point
Cat. 1 119-153 km h⁻¹
Cat. 2 154-177 km h⁻¹
Cat. 3 178-209 km h⁻¹
Cat. 4 210-249 km h⁻¹

http://www.eorc.jaxa.jp/en/imgdata/topics/2007/tp071212.html

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Fritz et al. Cyclone Nargis storm surge in Myanmar. American Geophysical Union (2009) vol. 2 (7) pp. 448
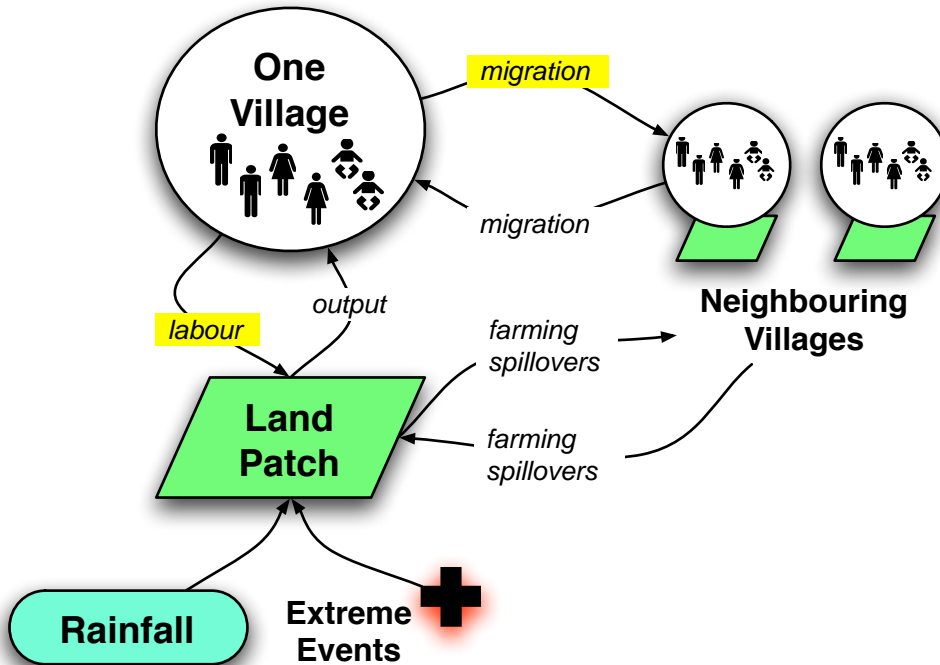
Introduction

Aims

*To build an **integrated** socio-economic **pilot** model of Bangladesh (to explore the difficulties and requirements for a 'less-pilot' model in the future).*

Approach / Overview

- 100 year time-scale (but 1 week time-steps, why?)
- 10,000 person agents (to accommodate 120 million ppl)
- District-level (not *taka*, or region)
- ***Agents***
    - *Person*
    - *Household*
    - *Firm*
    - *District*
    - *Climate/Weather*
    - *(Rest-of-world)*

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One
Village

migration

migration

Neighbouring
Villages

output

labour

Land
Patch

farming spillovers

farming spillovers

Rainfall

Extreme
Events

Concept ('world')
Migration, Groundwater, Rainfall
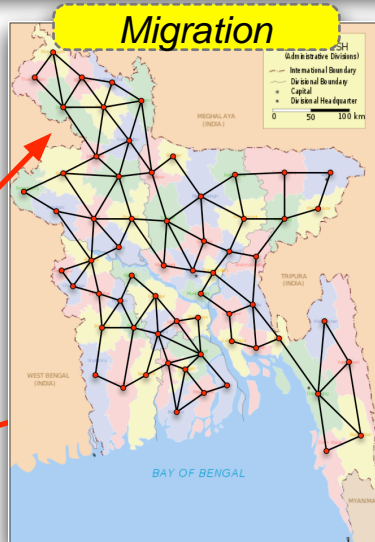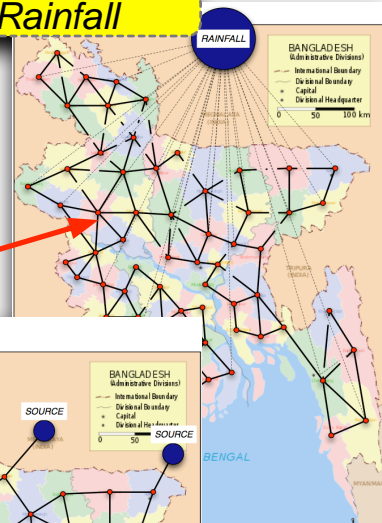
Migration

Rainfall

Ground-water

GIS underlay

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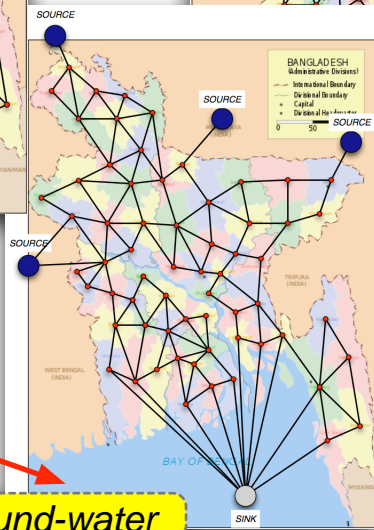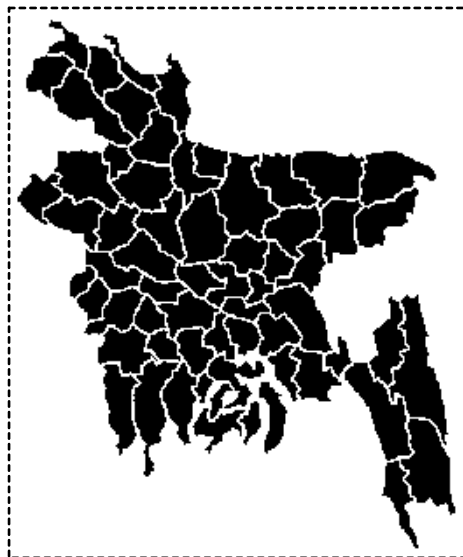
GIS underlay
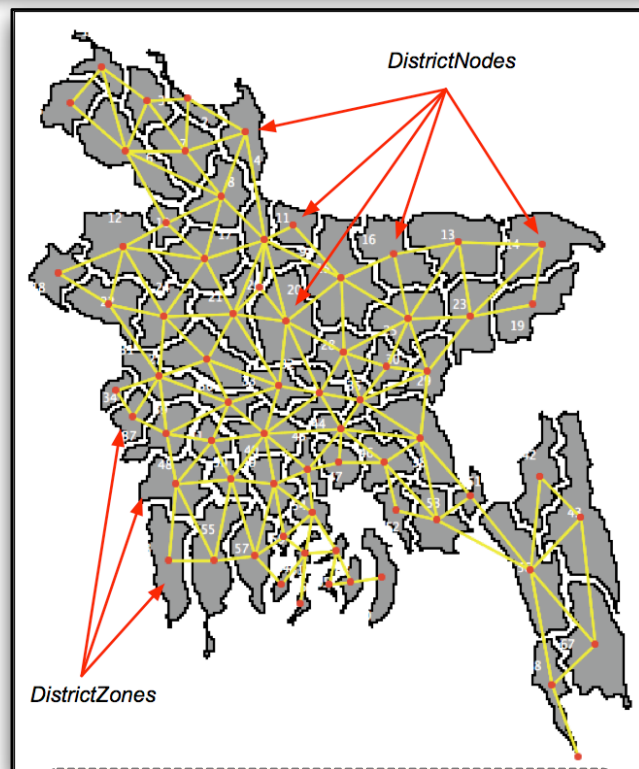
Automatic District-to-District Identification

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DistrictNode

Firm

Households

People

DistrictZone

DistrictNodes

DistrictZones

PERSON

AG-ID: int
AG-Age: (int set)
AG-InitialAge: int
AG-Health: int
AG-Female?: boolean
AG-Working?: boolean
AG-IsSick?: boolean
AG-Loc: int (0,1,2)

Metabolism()
Age()
Birth()
Death()
Disease()

HOUSEHOLD

HH-ID: int
HH-Loc: int (0,1,2)
HH-Wealth: int
HH-Members: (int set)
Urban?: boolean
HH-Count: int
HH-FoodStore: int
HH-NonFoodStore: int
HH-Riot?: boolean

AllocateProduce()
  SellAtMarket()
  ToConsume()
  SaveForSeed()
MarketActivity()
  BuyFood()
  BuyNonFood()
  SellFood()
Migrate()
PayHHTaxes()
DoRiot()

DISTRICT

D-Loc: int
D-District-ID: int
D-UrbanQ: [0,1]
D-AgQ: [0,1]
D-Temp: int
D-H2O: int
D-Infras: [0,1]
D-Count: int
D-AvgWellBeing: int
D-Inequality: [0,1]
D-ElderYouthR: double
D-PopDensity: double
D-Unemployment: [0,1]

InitiateFirm()
InternalMethods()
  CalcAvgWB()
  CalcEYR()
  CalcInequality()
  CalcPopDens()
Conflict()

GOVERNMENT

G-HHTaxRate: [0,1]
G-FirmTaxRate: [0,1]
G-Revenue: int
G-AllocationVars ...

CollectTaxes()
  Firms()
  Households()
ExpendRevenue()
  ImportFood()
  HHWelfare()
  DistrictInvestment()
  SuppressConflict()

CLIMATE

CL-TempInputs: ...
CL-RainfallInputs: ...
CL-CycloneInputs: ...
CL-RiverInputs: ...
CL-IPCCScenario: ...

DoClimateScenario()
  Rainfall()
  Cyclone()
  Temperature()
  IncomingWater()
  RiverFlows()

REST OF THE WORLD

RW-ClimatePolicy: int
RW-Disease?: boolean
RW-Fprice: double
RW-NFprice: double
RW-NFdemand: double
RW-Fdemand: double
RW-AidValue: int

ImportDisease()
ClimateDecision()
WorldMarket()
  ImportGoods()
  ExportGoods()
GiveAid()

FIRM

FI-ID: int
FI-Worker-IDs: {int set}
FI-LabourNeeds: int
FI-NonFGoodNeeds: int

ProductionFunction()
PayWages()
PayCompanyTaxes()
BudgetSet()
DeclareBankruptcy()
ImportingNF()
ExportingNF()

**BANGLADESH
DEVELOP-UML
v0.2, 10 Feb 2009**

Hurdles and opportunities

- *Choice of software*
    - *Fast development cycle*
    - *Incorporation of GIS data*
    - *Agent-based architecture*
    - *Fast run-time*
    - *Handles multi-parameter experiments*
- *Climate scenarios + weather (district-level, weekly, 50year outlook)*
- *Market and trade (internal, external)*
- *Rest-of-world (price, GHG decisions, migration)*
- *Money ... (inflation, price, wage, budget, central policy)*
- *...*

```
Simon: simon.angus@buseco.monash.edu.au
Brett: brett.parris@buseco.monash.edu.au
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