GCOE –HSE Program, Kyoto University

Integrated Disaster Risks Management for Megacity Mumbai

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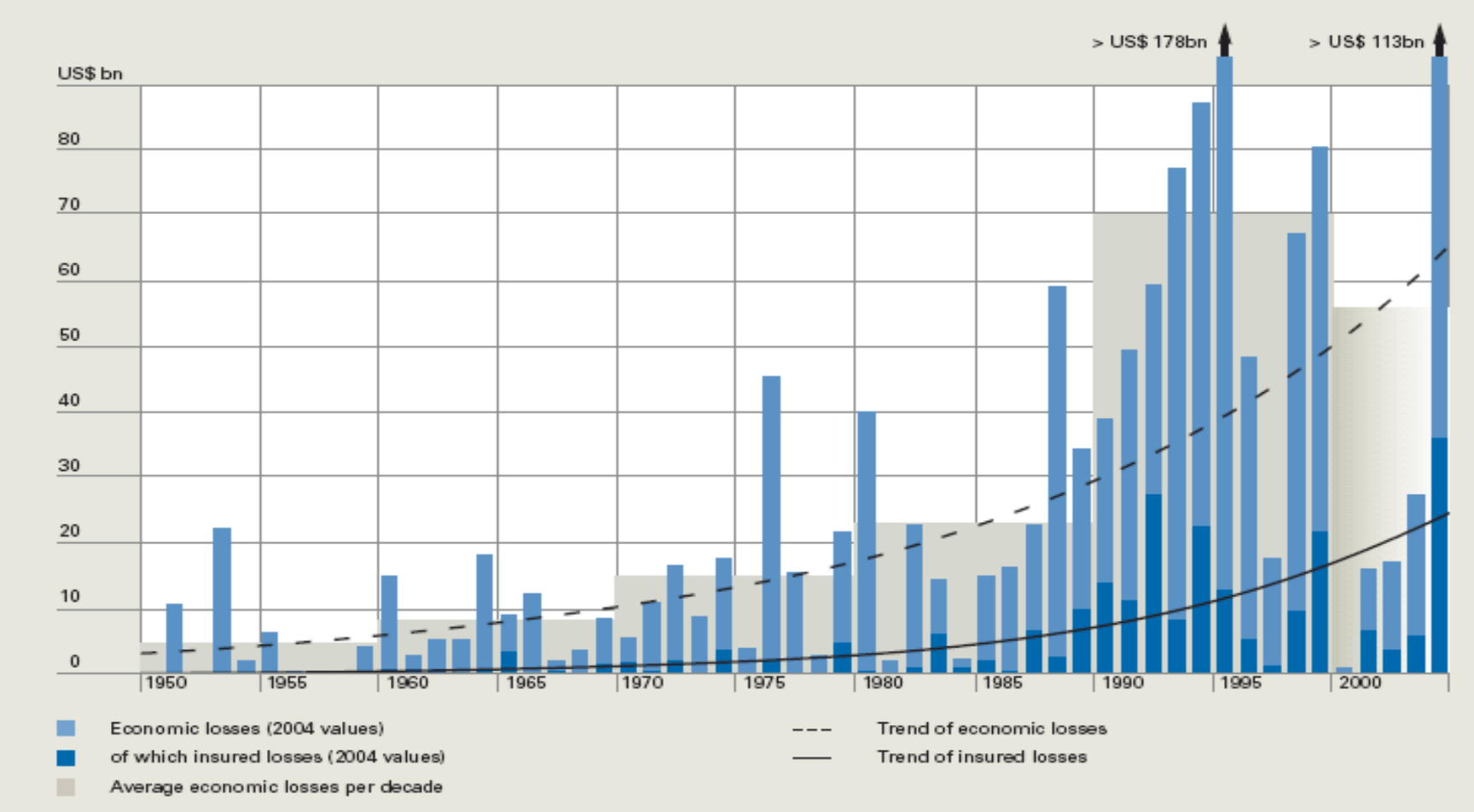
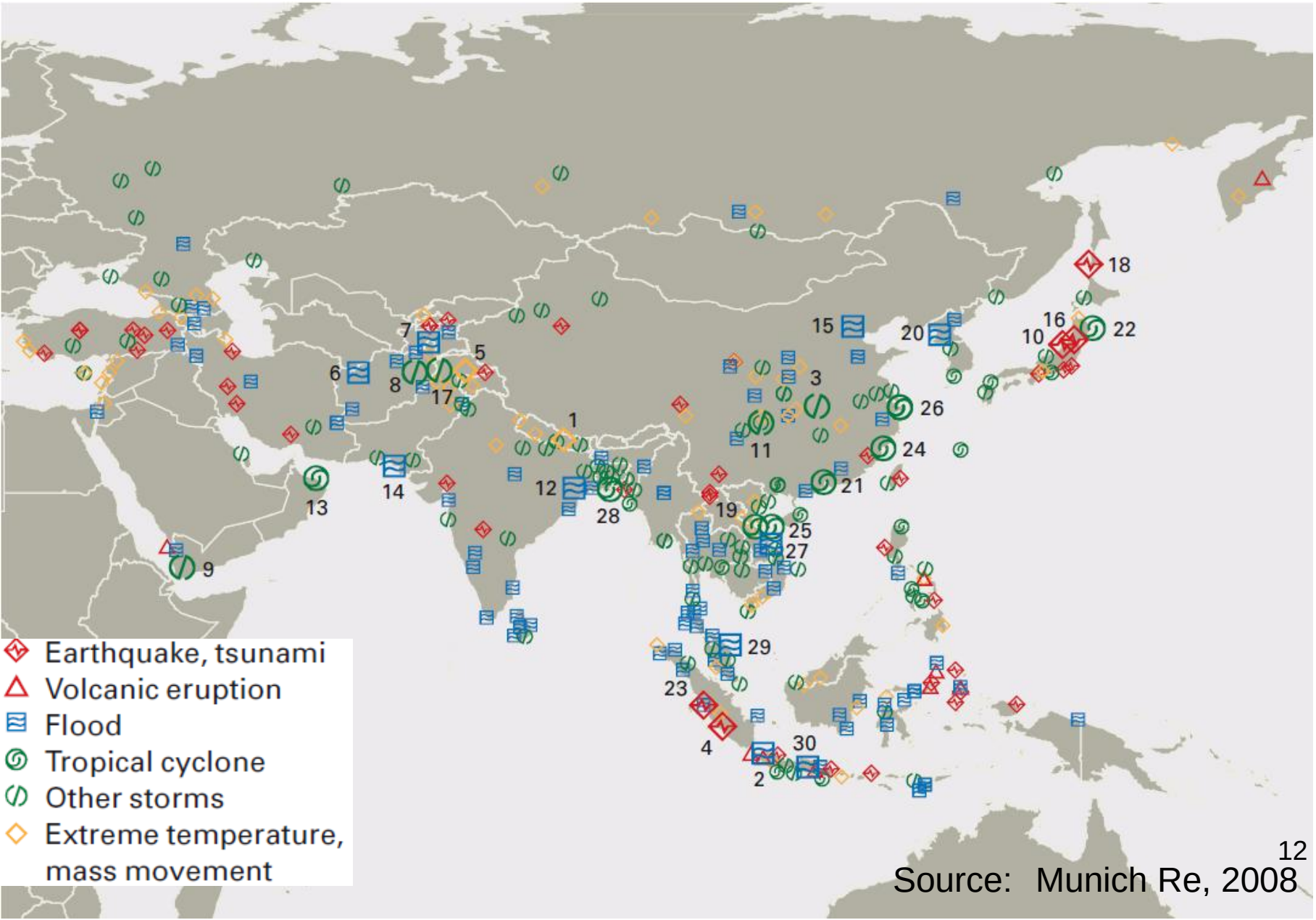
Economic losses and insured losses with trend



Source: Munich RE. 2005

Disasters in Asia, 2007



Source: Munich Re, 2008

Trend of Natural Disaster in the world

- **Larger catastrophic disaster is more likely to occur.**
  - **Number of Disaster for which some international aid is executed.**
  - **60s：90s=1:3**
- **Economic losses increased in high rate**
  - **60s：90s= 1:9**
- **Insured losses increased in higher rate**
  - **Anti-catastrophe insurance available in high-income countries**
  - **60s：90s =1：16**

What is happening?

- Increase in exposure : Population and assets are concentrating to hazardous area
- Vulnerability : Population and assets have not enough resistance against natural hazards

IDRiM- Building up its architecture

We are not DOING enough

And not at the most challenging scenarios – the HOT SPOTS

Hence,

Much of our knowledge remains isolated NOT integrated

Much of our technology remains inadequately tested OR untested.

Result,

Over promise and under achieve

We do not win hearts and minds over disaster reduction deliveries.

IDRiM

Everybody's concern- risks engulf us all and hazards and disasters impact all

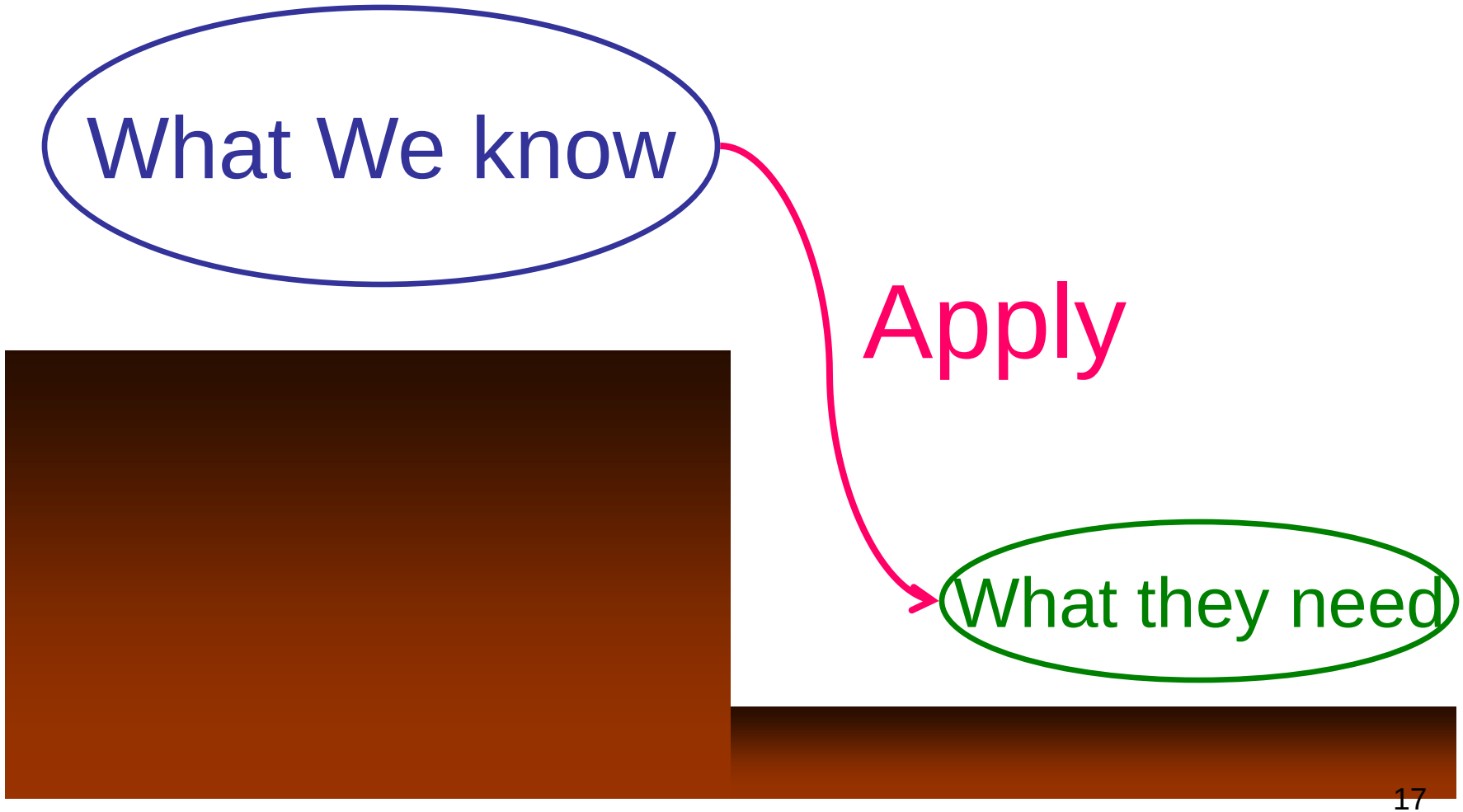
How do we move from CONCEPT TO REALITY

From lab to evidence based practice & to find useful

& transferable technologies

From ideas to implementation

Learning through doing & develop success models


What We know
Apply
What they need

PURPOSE OF HOT SPOTS
IN
BUILDING IDRiM ARCHITECTURE

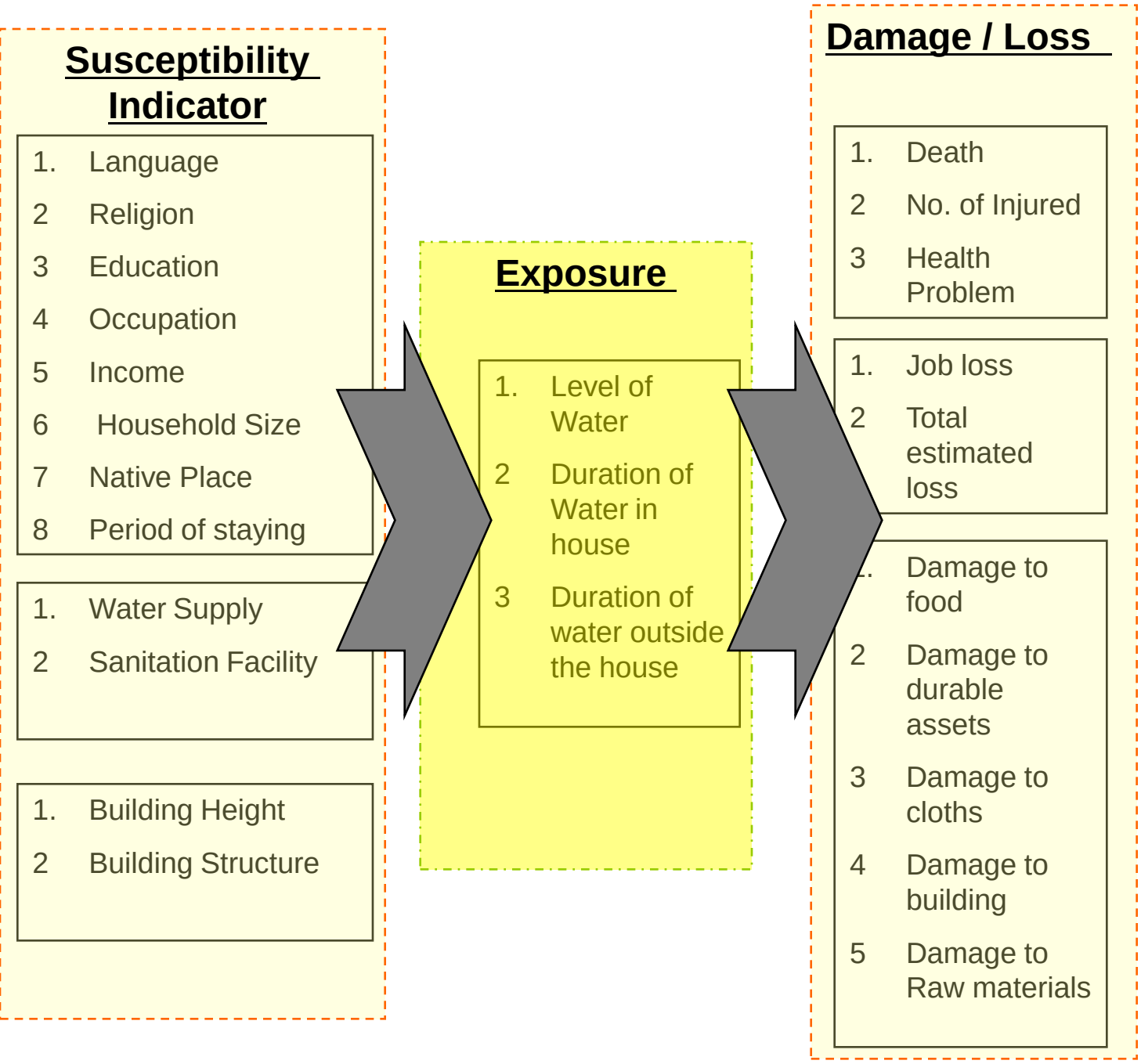
Hot Spots present most challenging scenarios but also opportunities to innovate and generate new ideas. From technology only solutions to Social solutions & better Management solutions.

Hot Spots urge us to be sensitive to human values and emphasize the human face of technology.

Hot Spots provide opportunities to work and learn together with the stakeholders and on-the –ground feed back.

Hot Spots help to observe disaster reduction structures as those emerge and function under stressful conditions.

The Process of "Knowing the People"


Susceptibility Indicator
1. Language
2 Religion
3 Education
4 Occupation
5 Income
6 Household Size
7 Native Place
8 Period of staying
1. Water Supply
2 Sanitation Facility
1. Building Height
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1. Death
2 No. of Injured
3 Health Problem
1. Job loss
2 Total estimated loss
1. Damage to food
2 Damage to durable assets
3 Damage to cloths
4 Damage to building
5 Damage to Raw materials


MUMBAI
THANE
BRIHAN
MUMBAI
NAVI
MUMBAI
ARABIAN
SEA
ARABIAN
SEA
Sanjay
Gandhi
National
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Harbour
Legend
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90 Feet Rd
Jasmine Mill Rd
Mahatma Gandhi Rd
Road No 24
Road No 27
Road No 29
Road No 28A
Road No 28
Chhotani Rd
Pitamber Ln
Bhaggoji Keer Rd
Sulochana Shetty Rd
Road No 15
Fink Rd W
Shitala Devi Temple Marg
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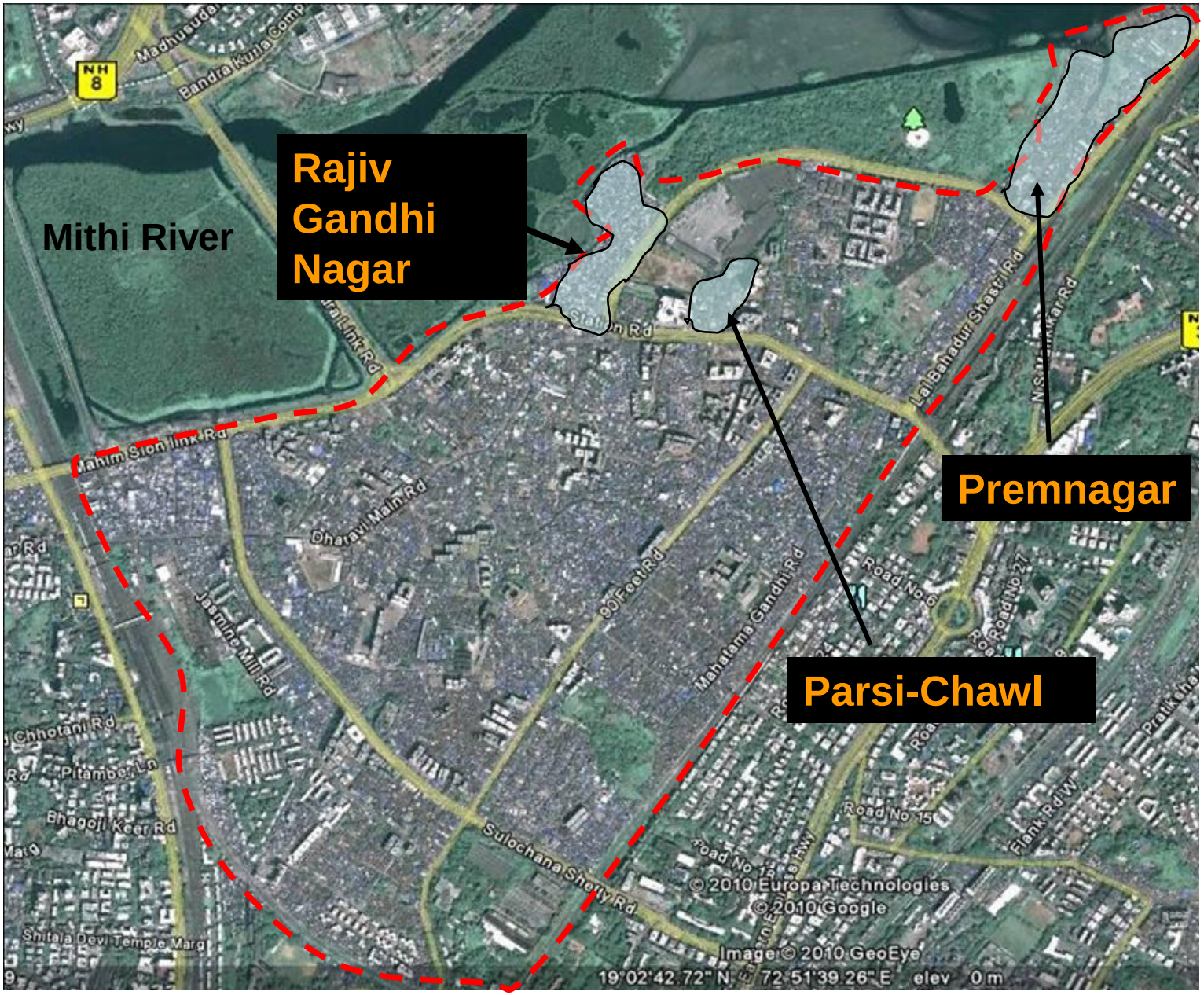
Image © 2010 GeoEye
19°02'42.72" N 72°51'39.26" E elev 0 m

Dharavi

Selected Hotspots at Dharavi



Premnagar

Population : 5000 to 7000
(Approximate)

Age of the settlement : 25 - 30 Years approximately

Settlement Features :

- Situated on the bank of Mithi river.
- The land was used to be a marshy land occupied by mangrove forest
- The settlement is situated 3 to 4 feet below from road level
- One of the most severely affected settlements of 2005 Mumbai flood and prone to local flood every year

Premnagar

•**Education:** 23 % illiterates, 19 % can only write their names

•**Income structure:** Average income is Rs 4647 and 76 % people earn less than Rs 5000 per month.

•**Religion:** 61 % people are Hindus and the rest 39 % people are Muslims

•**Mother Tongue:** 94 % people are Hindi speaking

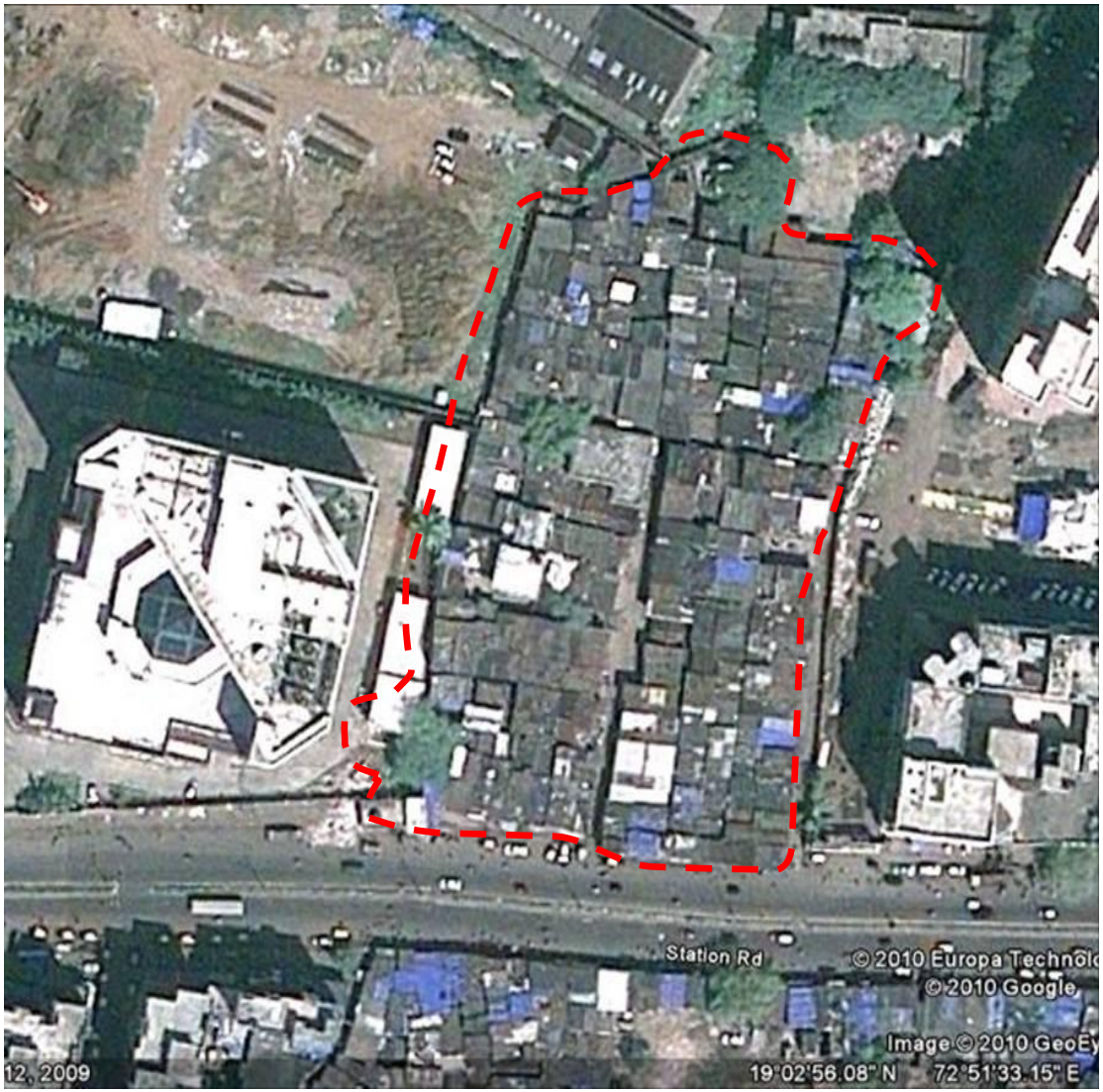
•**Household size:** Average household size is 6

•51 % of households have 1 **working member**

•**Average period of stay:** 23 years

•**Migration Status:** Majority of people are immigrants from Uttar Pradesh; it is likely that the major reason for immigration is better job opportunities.

Parshi-Chawl



Population : 1500 (300 households) approximately

Landuse : Mainly residential

Age of settlement : Around 50 years or more

Settlement Features :

- Situated 3 to 4 feet below the road level
- Severe flood on 2005 and presence of water logging or local flood in every year
- Settlement is much clean and environmentally much better to stay

Parshi Chawl

•**Education:** 9.4 % illiterates, 3.4 % can only write their names

•**Income structure:** Average income is Rs 5122 and 58 % people earn less than Rs 5000 per month.

•**Religion:** 97 % people are Hindus

•**Mother Tongue:** 78 % people are Marathi speaking

•**Household size:** Average household size is 5

•57 % of households have 1 **working member**

•**Average period of stay:** 33 years

•**Migration Status:** Majority of people are immigrants majorly from different parts of Maharashtra, Mumbai and also from Uttar Pradesh; it is likely that the major reason for immigration is better job opportunities or change of place for women after marriage.

Rajiv Gandhi Nagar

Population : 10000

Age of Settlement : 15 Years

Landuse : Mainly residential

Settlement Characteristics :

- Developed in the verge of Mithi river bed which was previously a marshy land bound by mangrove forest
- Most recently developed in Dharavi Slum area
- Prone to Flood (water loggings for few hours are also observed)

Rajiv Gandhi Nagar

Education: 38 % illiterates, 4.4 % can only write their names

•**Income structure:** Average income is Rs 4348 and 80 % people earn less than Rs 5000 per month.

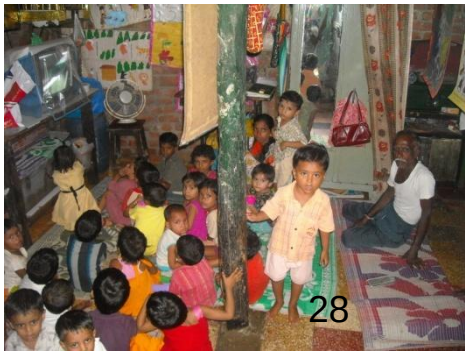
•**Religion:** 73 % people are Hindus and 17 % are Muslims

•**Mother Tongue:** Majorly Hindi and Kannad and also Marathi

•**Household size:** Average household size is 5

•80 % of households have 1 **working member**

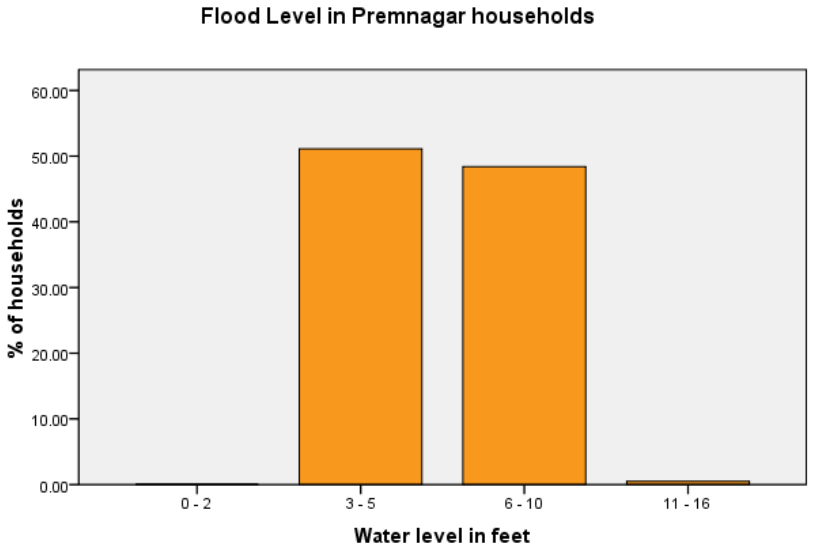
•**Average period of stay:** 15 years



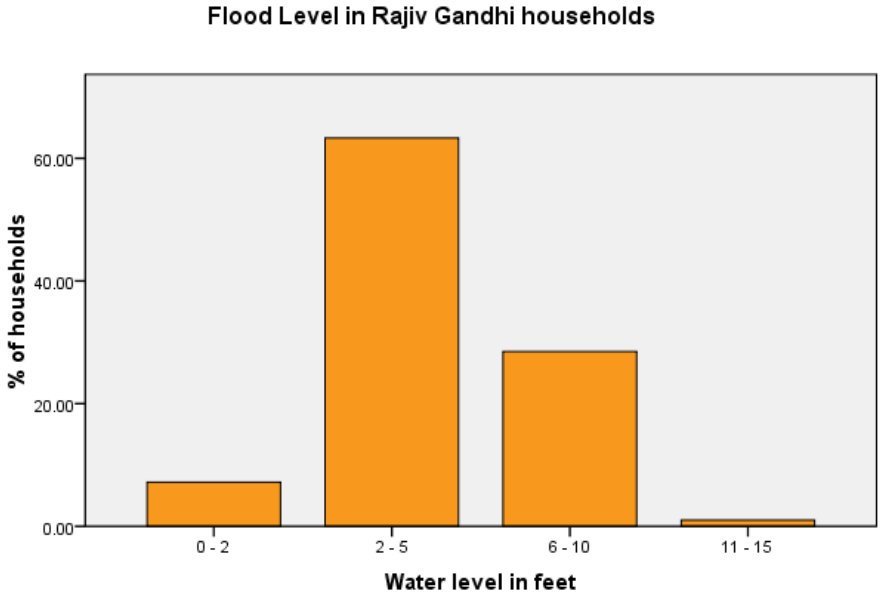
•**Migration Status:** Majority of people are immigrants majorly from Karnataka and Uttar Pradesh; it is likely that the major reason for immigration is better job opportunities.

MAGNITUDE & IMPACT OF FLOOD

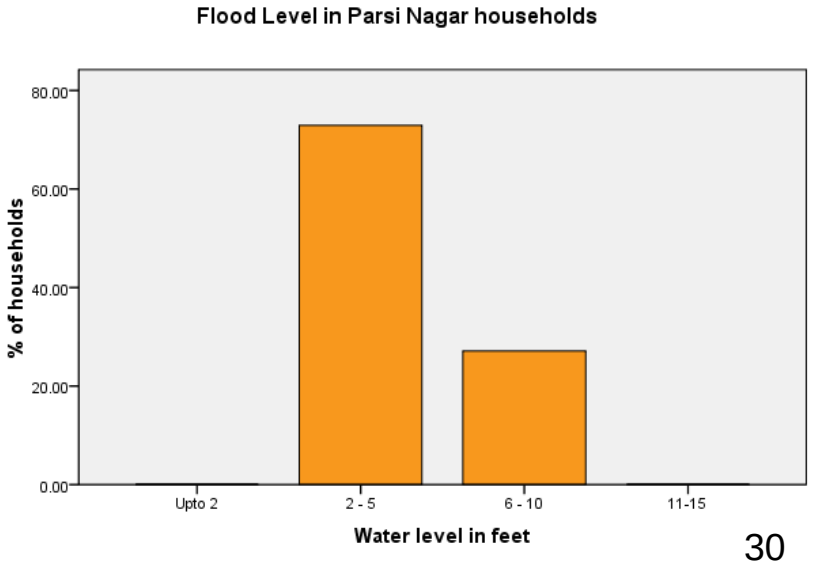
Flood levels



Besed on 184 survey samples



Besed on 208 survey samples



Besed on 203 survey samples

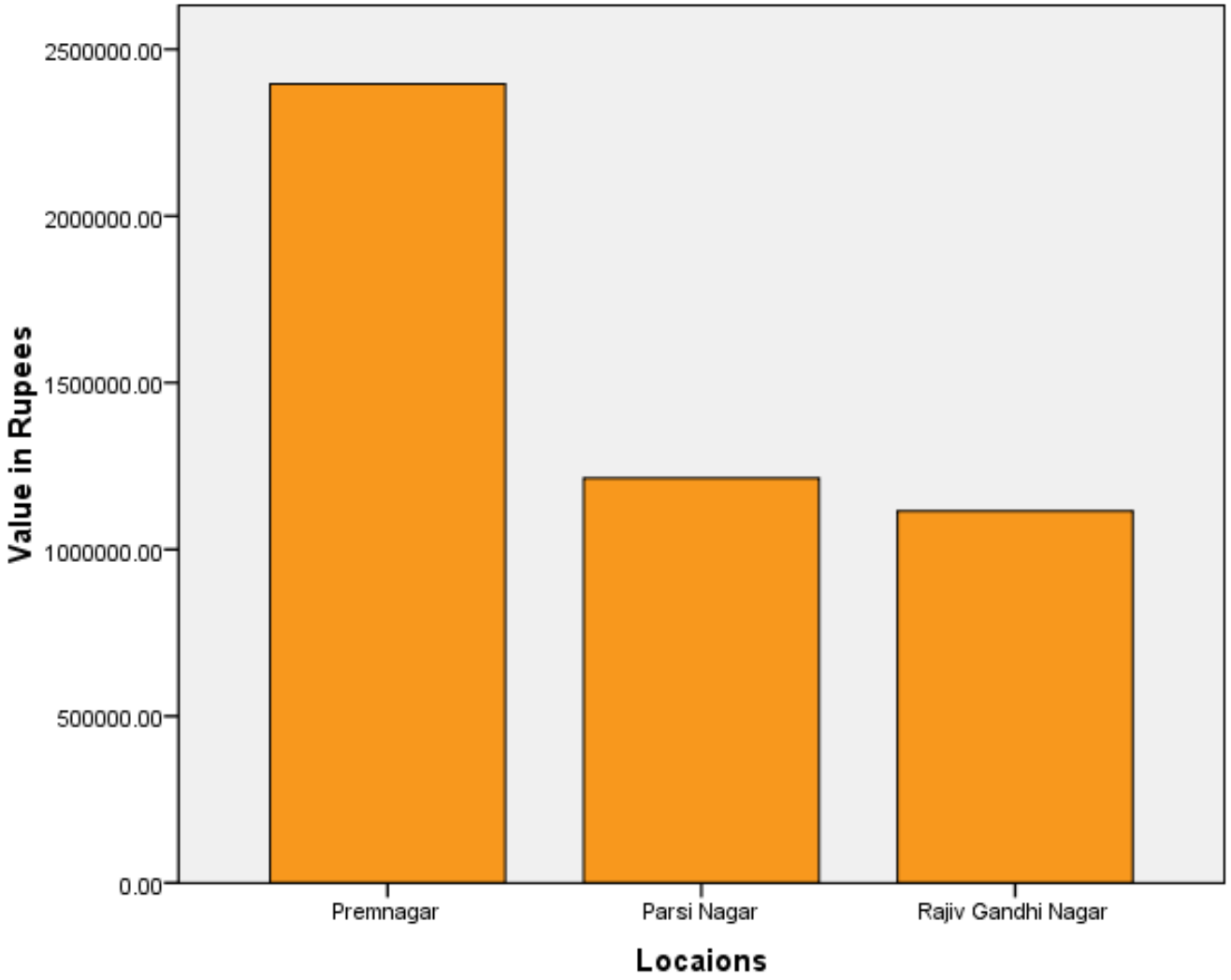
Duration of Flood : 2005

	Premnagar	Parsi-Chawl	Rajiv Gandhi Nagar
Duration of Flood inside the house (in Hours)			
Mean	**31.27**	**35.99**	**42**
Duration of flood water outside the house (surrounding streets)			
Mean	**37.43**	**45.60**	**47.55**
Maximum	**96**	**96**	**120**

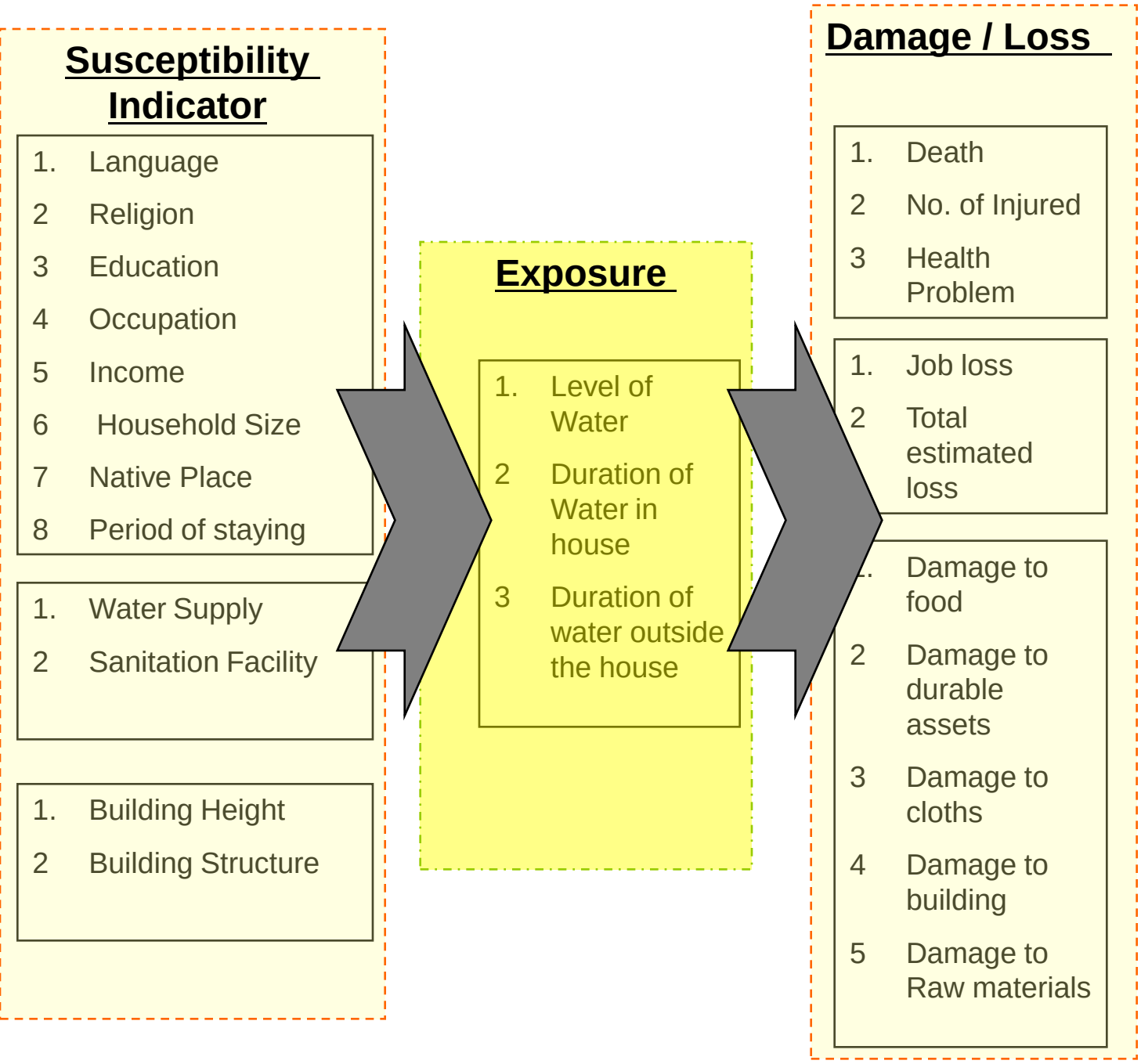
Impact of Flood : 2005

	Premnagar	Parsi-Chawl	Rajib Gandhi Nagar
Impact of Flood (No. of persons)			
No. of Death	0	0.0099	0.0048
No. of Injured	1	0.0049	0.024
No. affected by disease	2	1	1
% of water-borne disease	60.1 %	40.4 %	55.8 %

Extent of damage in terms of money



This is based on the survey of 184 to 208 households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2 Damage to durable assets
3 Damage to cloths
4 Damage to building
5 Damage to Raw materials

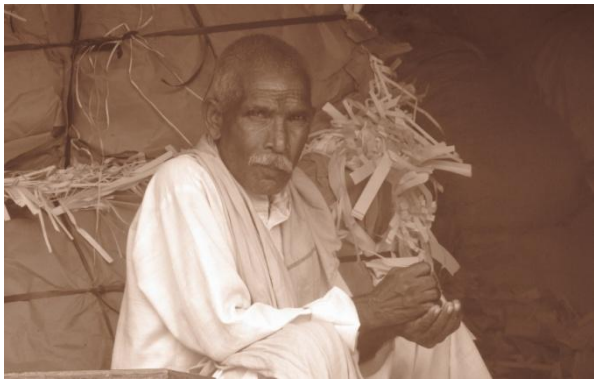
Factors contributing flood vulnerability (Regression Analysis)

- **Parshi Chawl** : Income, level of water , occupation
- **Rajiv Gandhi Nagar** : Period of staying, Education, Language (linguistic group), Native place, Level of water
- Premnagar : Occupation, Duration of Water inside the house, Education , Income, level of water

Will you leave to another place in case of big flood

NO

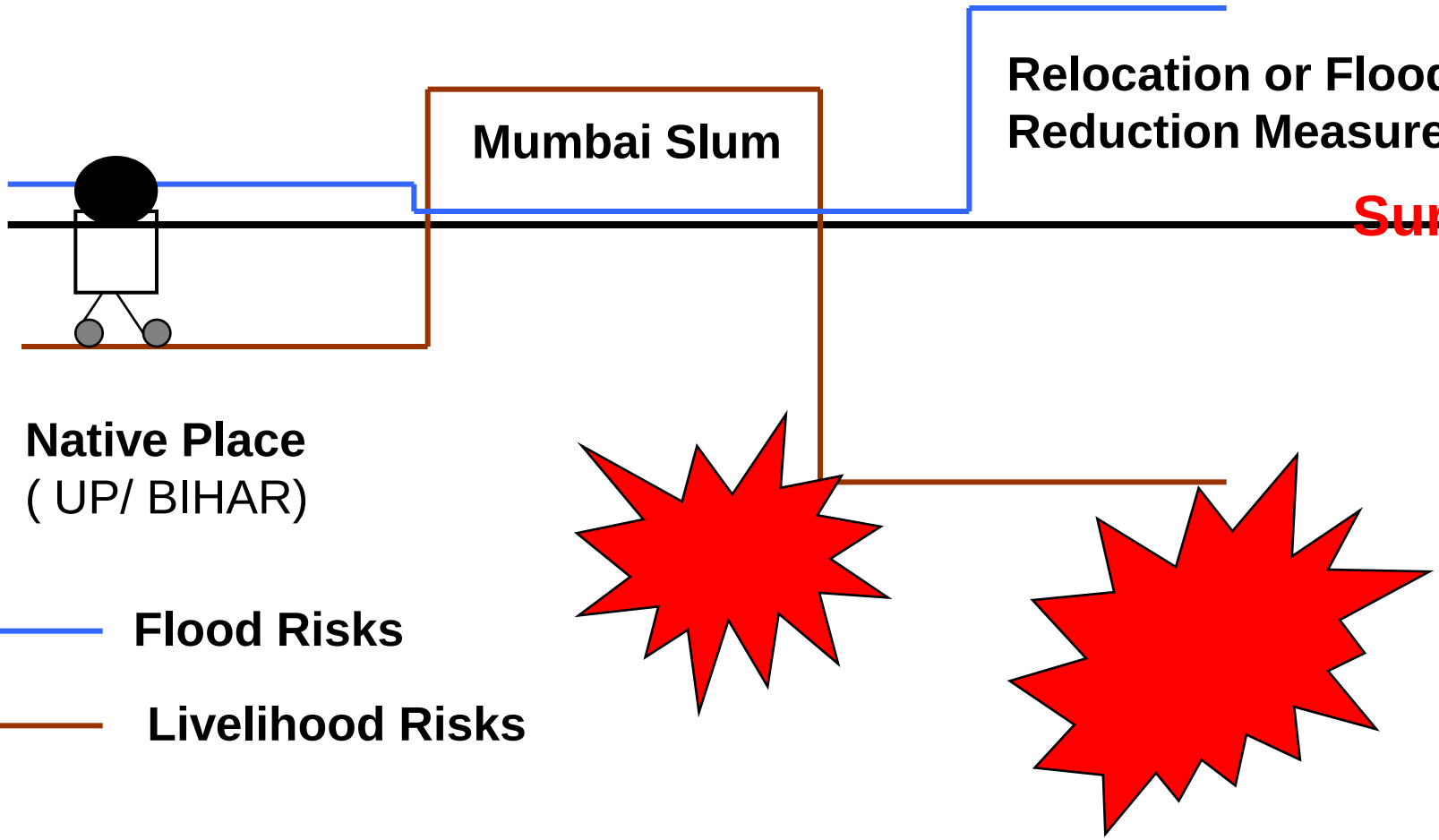
“Flood will come and go , but if our property goes , it will not come”



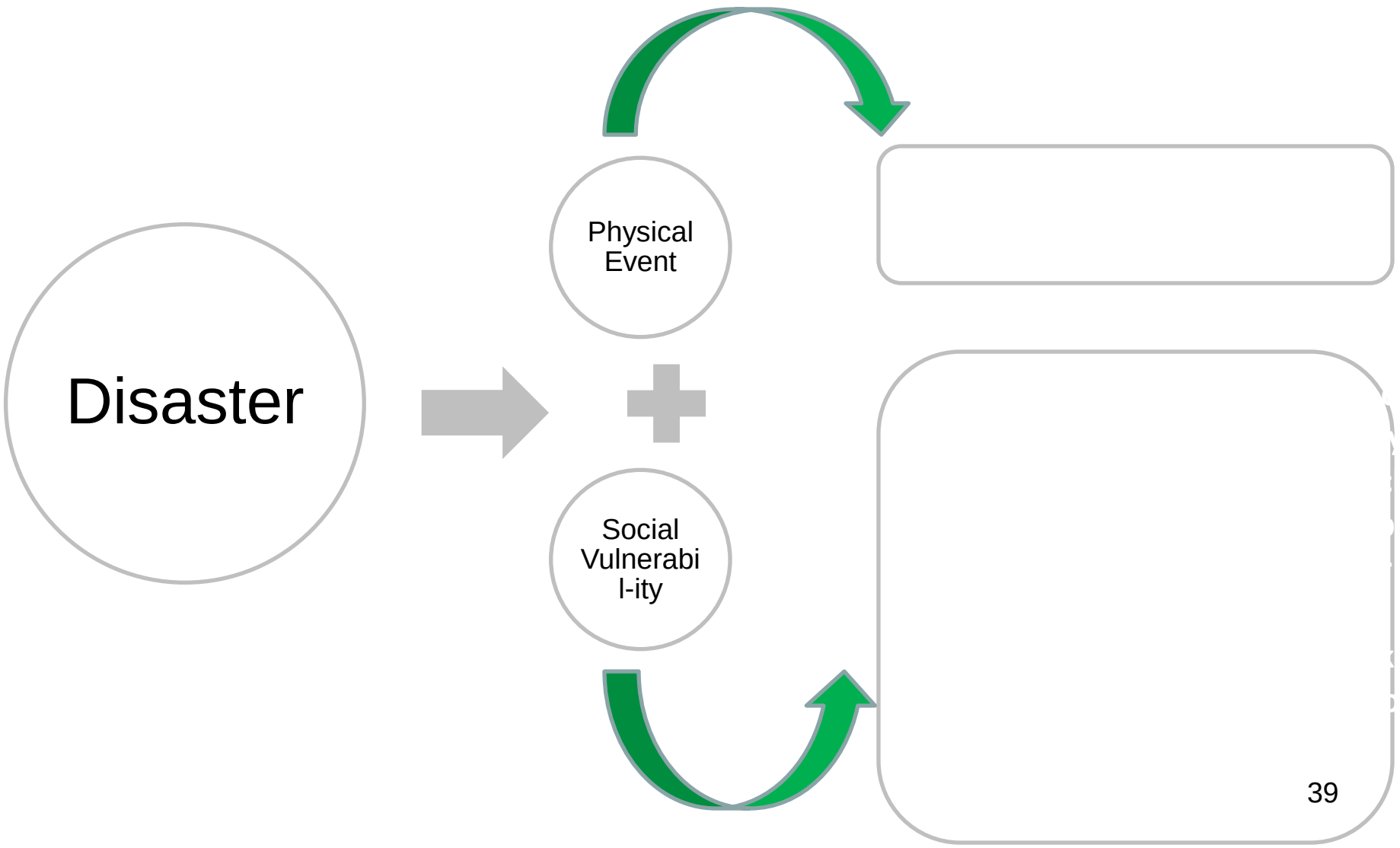
“We are brave, and a brave person must face the reality ”

“Who will give us bread and butter ? We left our native to secure our food ”

Livelihood Risks / Backgroun d Risks



Vulnerability



Factors for Measuring ***Vulnerability Pattern***

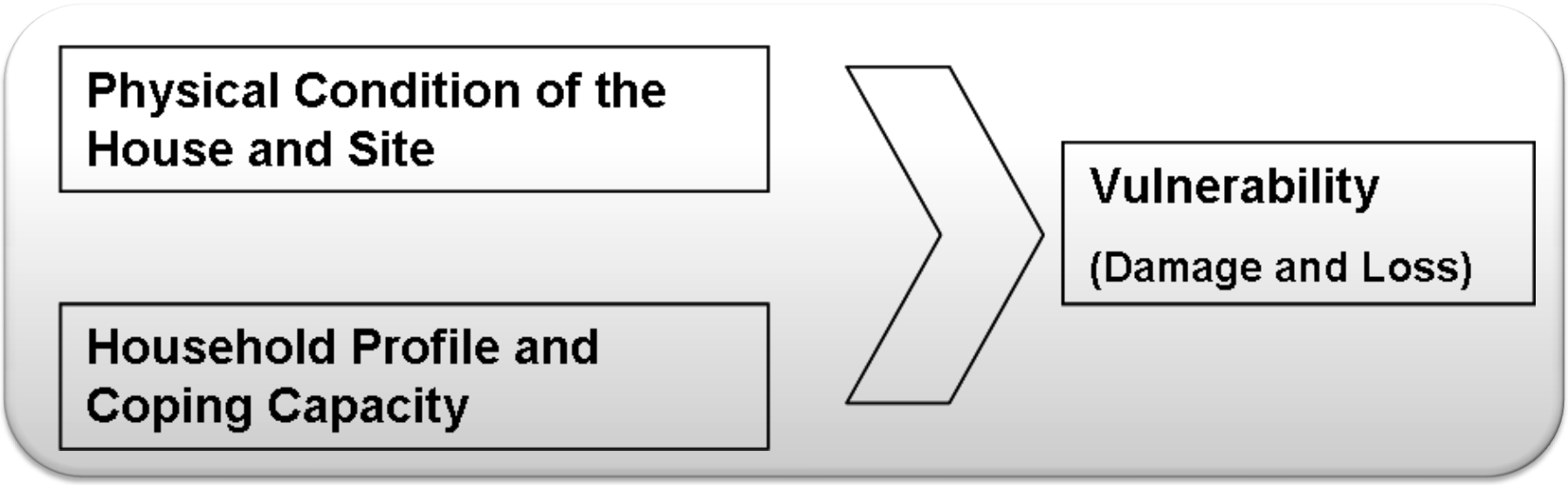


Figure: Conceptual framework of household vulnerability elements

Indicators and variables of Household Profile	
Indicator	**Variable**
Socio-economic Characteristics	Religion
	Mother Tongue
	Native Place (The place from where the head of the household actually migrated)
	Period of Staying
	Education (Education level of the head of the household)
	Income (Income of the head of the household)
Housing Characteristics	Housing Type (Types of building materials)
	Building height
Infrastructure	Source of water supply
	Duration of receiving water
	Sanitation Facility

Revealed Characteristics of Clusters

Household Characteristics	Cluster 1	Cluster 2
Religion	Hindus & Muslims uniformly distributed	Predominantly Hindus
Education	(not much variation with cluster 2)	(not much variation with cluster 1)
Income	More income	Less income
Household Size	Larger	Smaller
Period of Stay	newer to the place	older migrants
Building Height	Most of the higher storey structures concentrated here,	Predominantly ground storey buildings
Building Structure	Mostly pucca structures	Mostly semi-pucca structures

- ***Household characteristics -*** two types of clusters can be observed

Cluster 1

- More Prosperous, Heterogeneous and Multi cultural = Prosperous

Cluster 2

- Relatively weak and homogeneous = Puny

Indicators and variables of "Physical Condition of The Site And House"

Indicator	Variable
Extent and magnitude of flood	Level of flood water inside the house (in feet)
	Duration of flood water inside the house
	Duration of flood water outside the housing or immediate surrounding areas

Note : All the variables of Physical Condition Of The Site And House are self reported.

Results And Discussion

- Premnagar Community is divided into two clusters based on ***physical condition of the site and house***

Cluster 1

- More Flood Prone

Cluster 2

- Less Flood Prone

Vulnerability Level / Pattern (Damage / Loss) ??

		Household Profile	
		Rich	Poor
Condition of the site and the site	High Flood Prone	??	??
	Low Flood Prone	??	??

Vulnerability Level

Damage / Loss

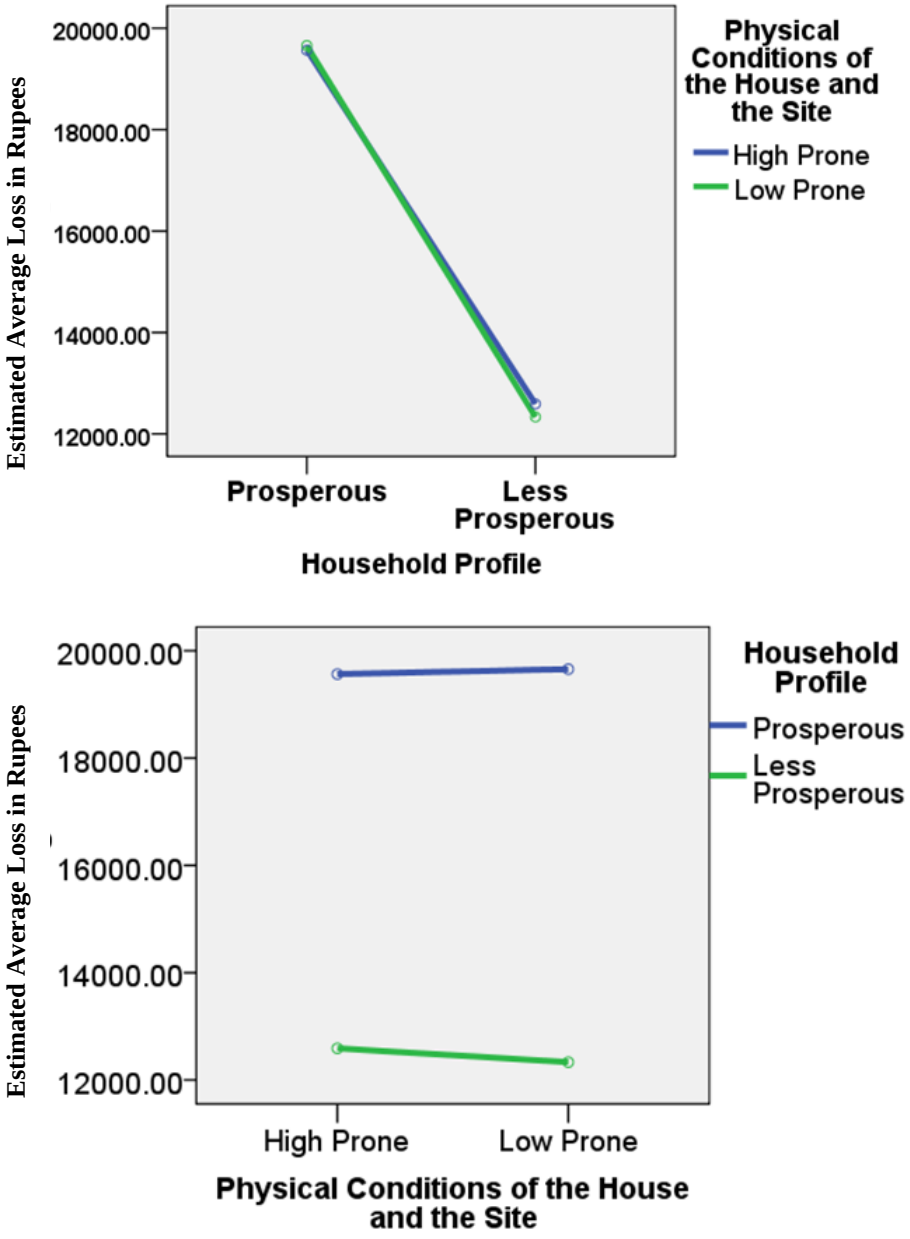
1) Total Monitory Loss
2) Damage to Cloths
3) Damage to Food
4) Damage to Household durable assets
5) Damage to building materials

Observed Vulnerability Pattern

- ***"Two way ANOVA"*** was performed to examine the vulnerability pattern of Premnagar, considering two factors:

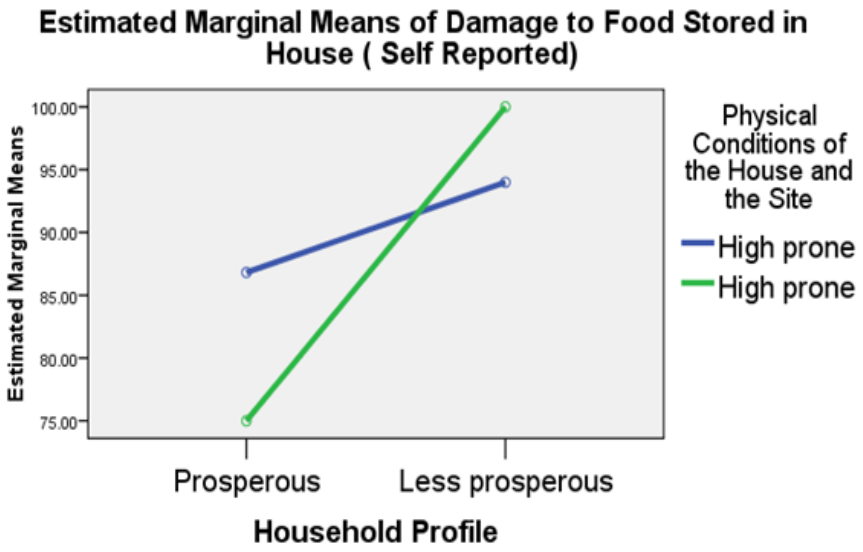
  - **Household Profile**
  - **Physical Condition Of The Site And House**

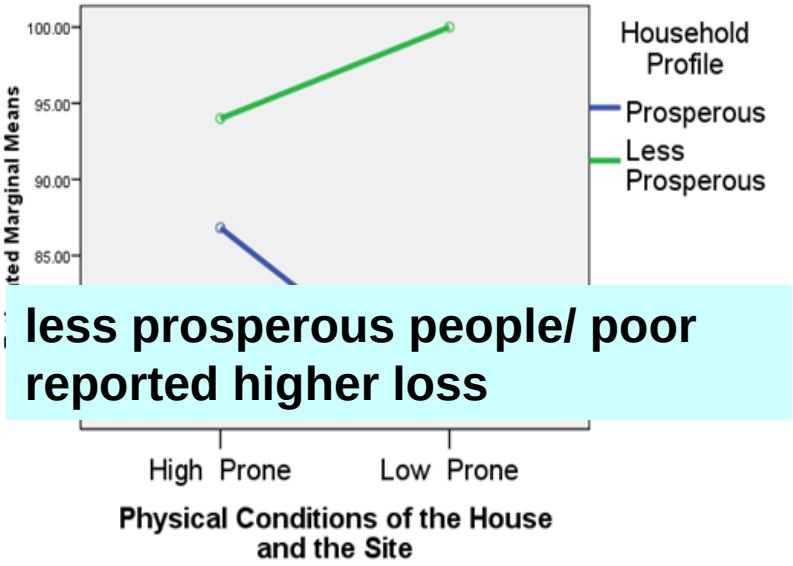
Figure: Estimated Marginal Means of Total Estimated Loss (Self Reported)



Damage of the prosperous people is much higher than the less prosperous people irrespective of physical conditions of the house and the site.

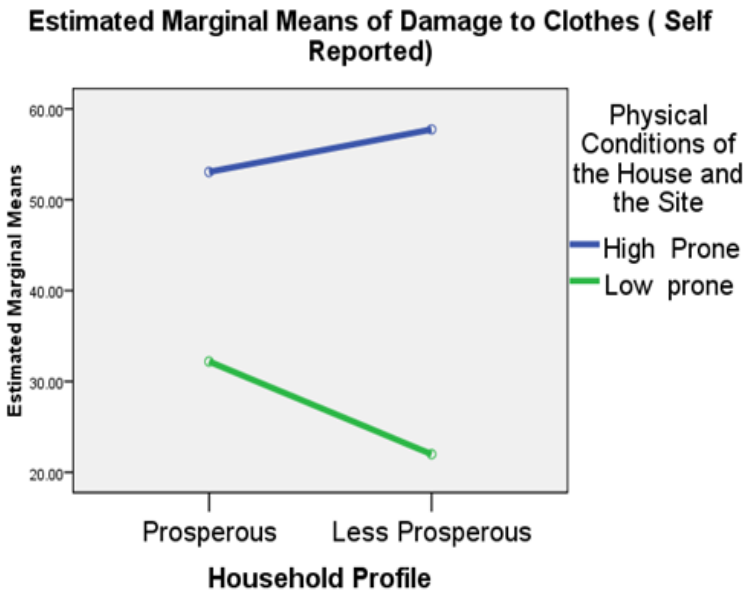
Damage to Food

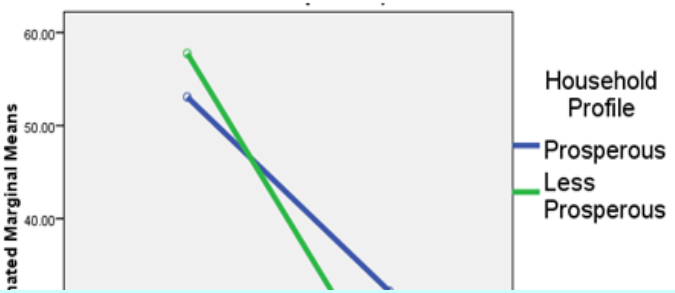




less prosperous people/ poor reported higher loss

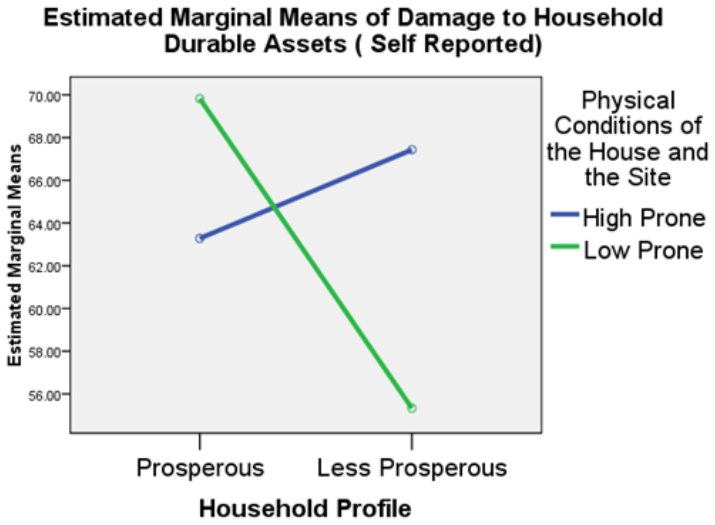
Damage to Cloths

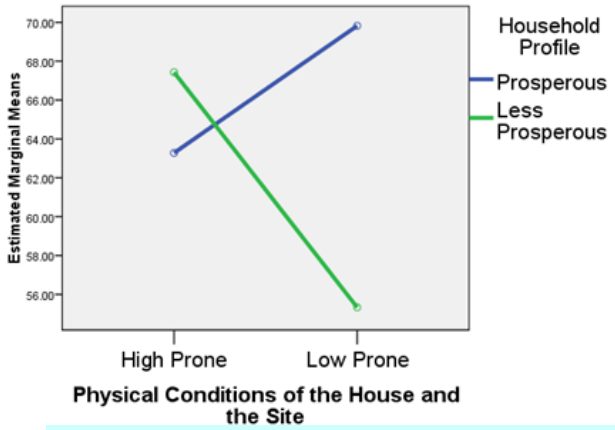




Households who are high prone to flood is more vulnerable irrespective of their household profile background

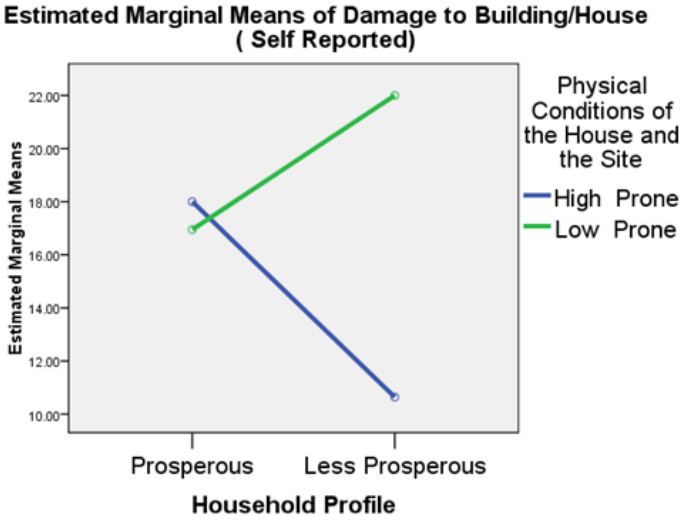
Damage to Durable assets

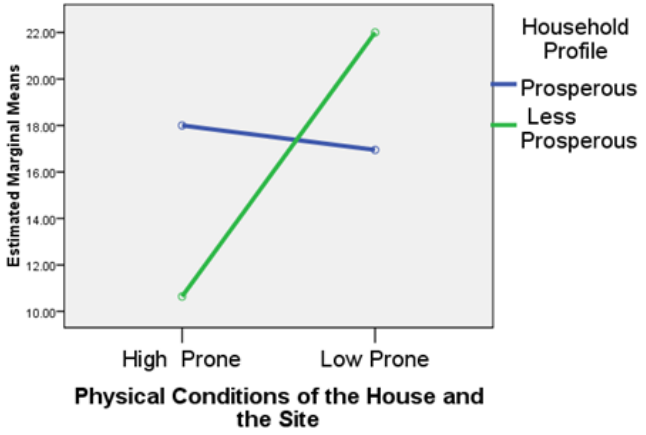




Both factors influence the vulnerability

Damage to Building/House





Conclusions

- **Prosperous people have more money loss than poor irrespective of the level/exposure of flood**

- Poor People have more damage to food stored in house than prosperous group irrespective of their level of hazard.

- Household of high flood prone category reported more loss to clothes than low flood prone category irrespective of their household profile.

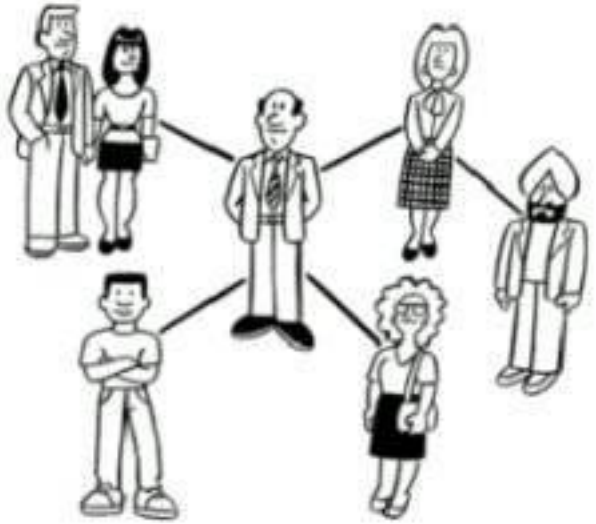
Conclusions

- Combined impact of household profile and physical condition of the house and the site is observed in all kinds of damage, but no particular pattern of common impact on vulnerability has emerged.

Working with the People

Why Participatory Approach?

	Affected Communities First To Respond To Emergencies
Direct / First Hand Experience Revealed	Local Perceptions & Priorities are known
Easier To Know People's Coping Strategies, Adaptation	Easier To Assess Their Needs & Analyze Problems
Use of Local / Indigenous Knowledge	Easier Acceptability of Projects & working collectively



Sharing Direct Experiences from Affected Communities Helps to Pinpoint the Problems at the Grass-root Level and Hence Ensures Successful Implementation of Strategies.

Spatial Components of Flood Risks…

❑**Physical Features**

Slope
Land Cover
Soil Type
Proximity to Waterbody

❑**Built Environment**

Building Age
Building Height
Building Materials
Building Condition
Plinth Level
Built-up Area
F.A.R.

❑ **Landuse**

Evolution of Existing Land Use
Existing Landuse
Non-conforming Landuse
Housing Density

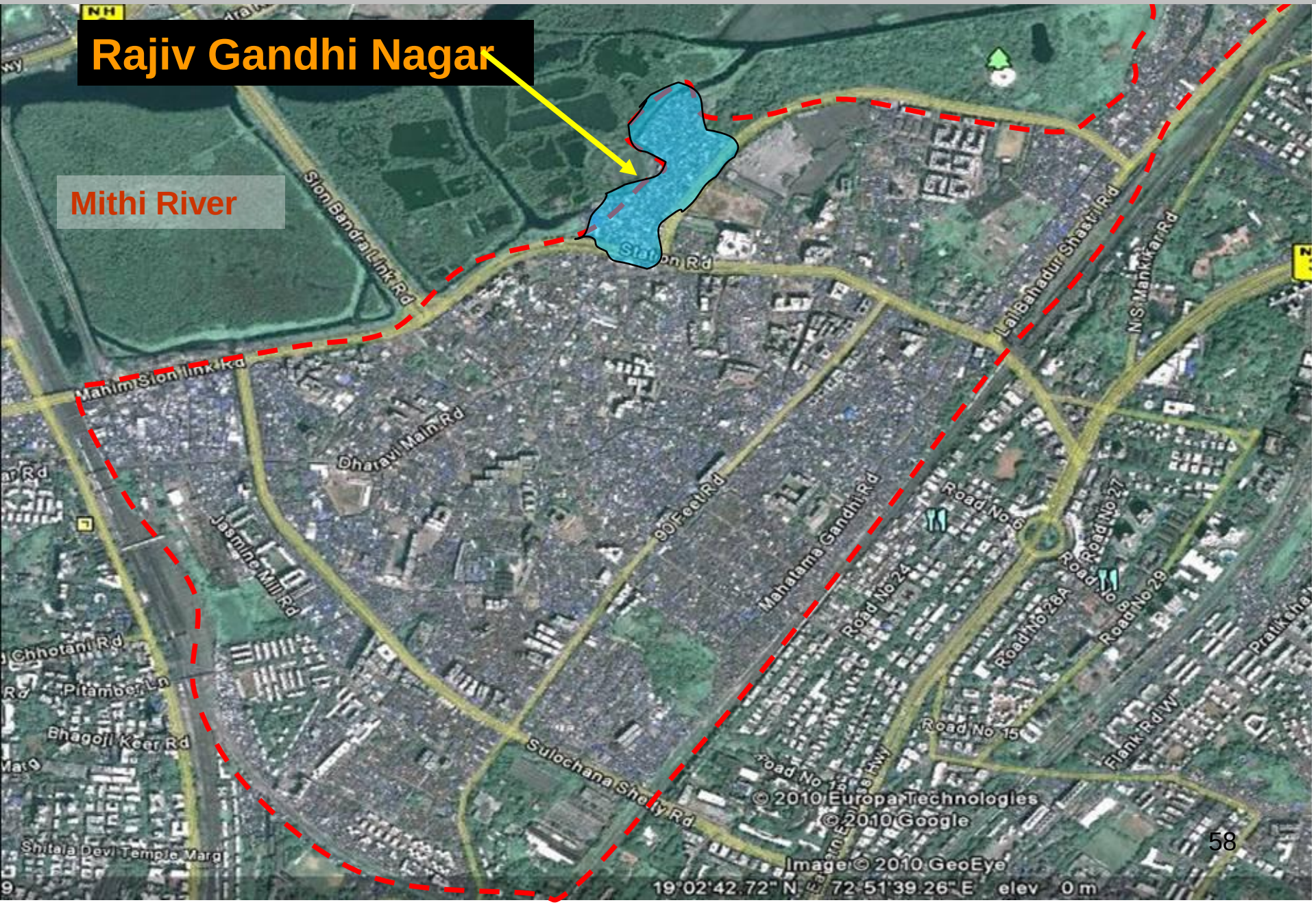
❑**Critical Infrastructure**

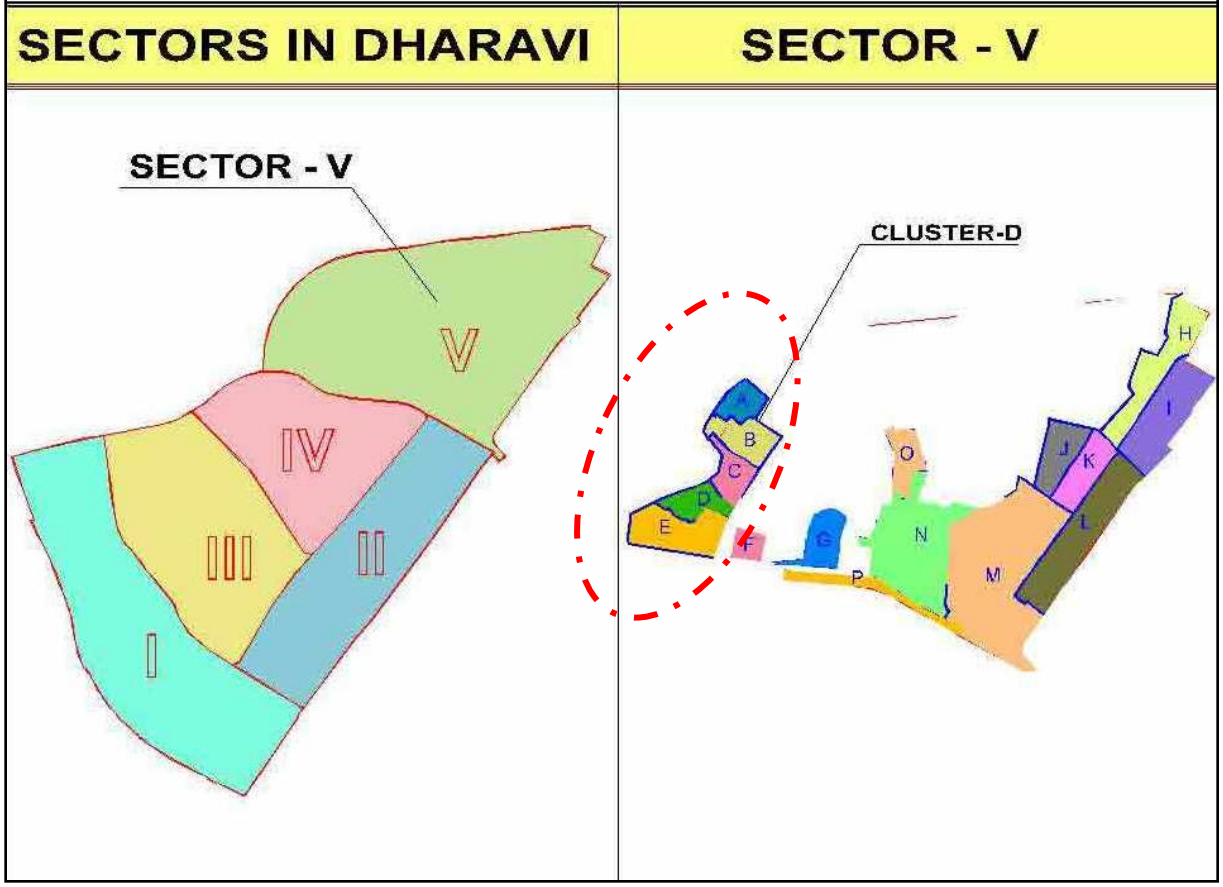
Width & type of Road
Water Supply lines layout
Sanitation especially solid waste dumps
Open Drain layout

Hazard Exposure Determinants…

- Flood Duration
- Water Level during Flood
- Velocity of water flow
- Frequency of Flood
- Flood water mix with debris, wastes and chemicals.

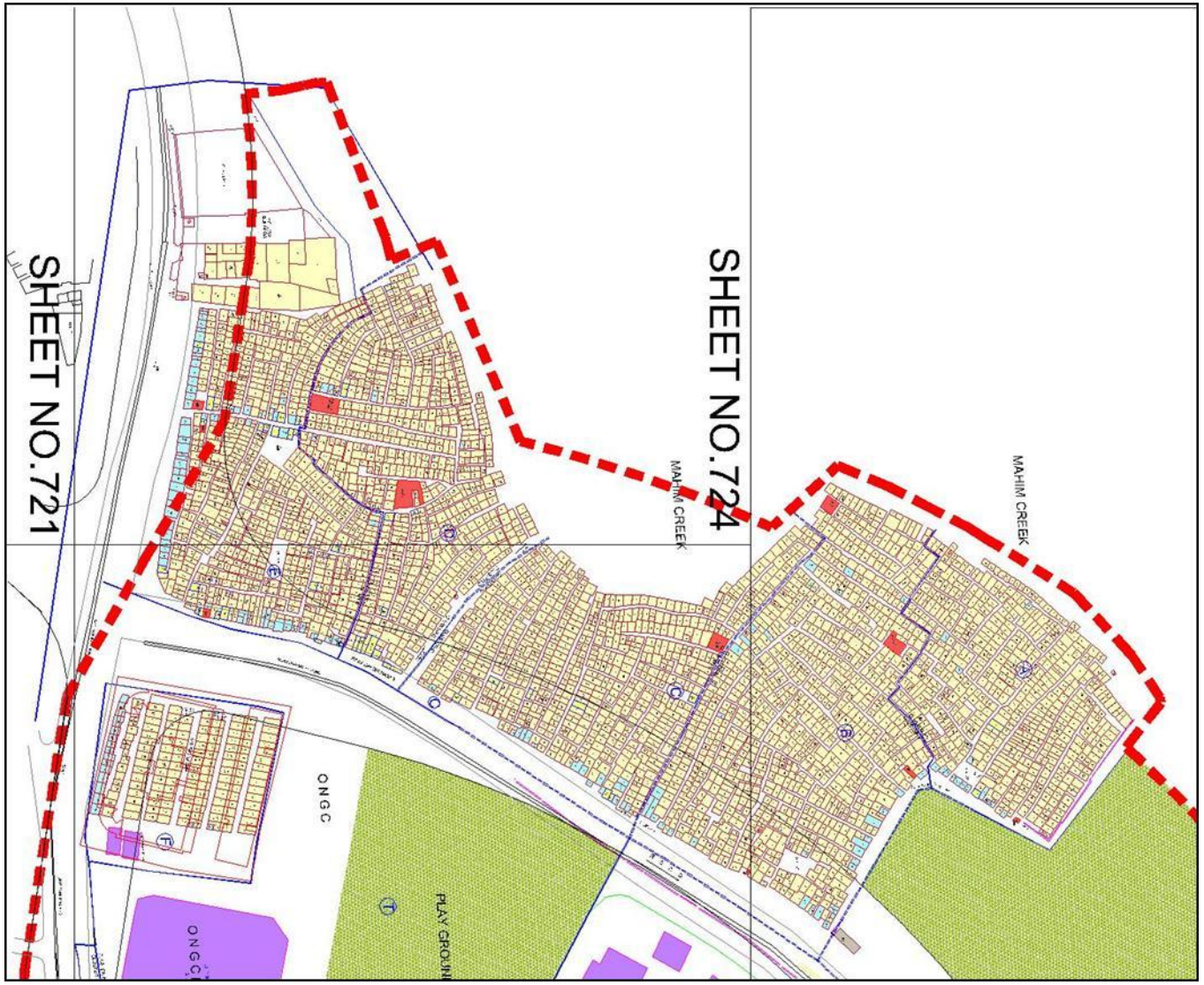
Micro Hotspot @ Dharavi





- Dharavi Redevelopment Authority (DRA) divided entier Dhravi into 5 sectors. Each sector consists of several clusters.
- The case study area, Rajiv Gandhi Nagar, belongs to the sector V and it is comprised of 5 clusters including cluster A, B, C, D, E

Rajiv Gandhi Nagar



Rajib Gandhi Nagar

Rajiv Gandhi Nagar

Population : 20,000 (Approximate)

Area : 100 sq.m

Age of the Settlement : 25 – 30 Years

Landuse : Mainly residential

Settlement Characteristics :

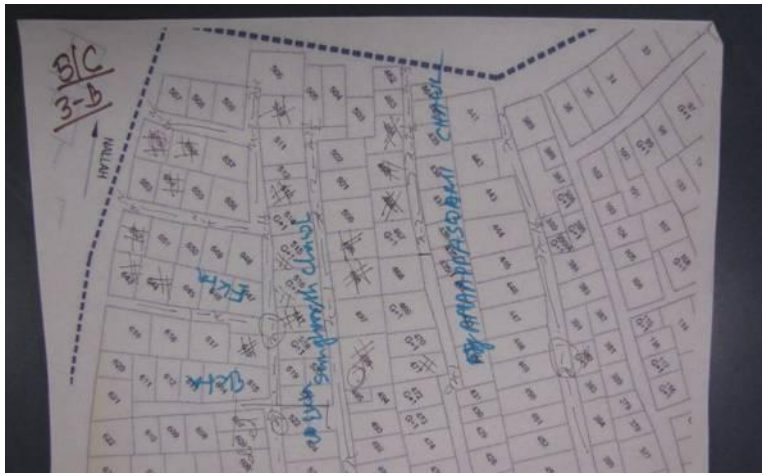
- Located on a site which previously was a marshy land with mangrove forest in the flood plain of the Mithi River.
- Most recently developed portion of Dharavi Slum area
- The area was very severely affected by the 2005 flood disaster and because of the low lying terrain the area experiences water logging or local flood every year.

Applied Tools / Techniques

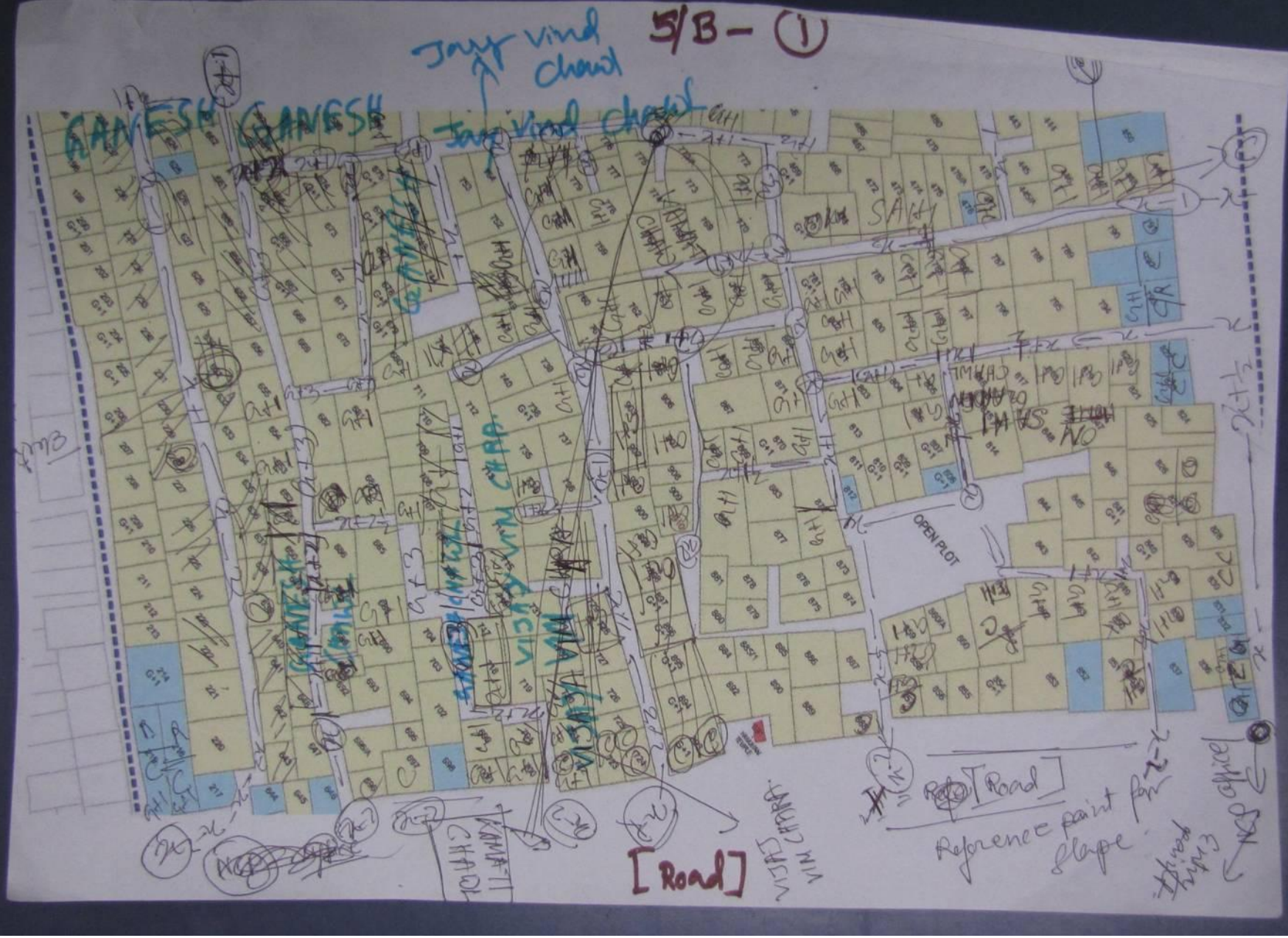
Observation Technique

- Mapping
- Open ended interview with key informants
- Group discussion
- Town watching
- Observation
- Photography
- Secondary data collection techniques/ methods (Example : Content analysis)

Open Ended Interview



Group Discussion



A sheet of landuse survey Map

Participating Stakeholders/ Agency

Participating Stakeholders	Level of Participation
GCOE Research Team (including surveyors)	**Highly Active**
Local Community Members	
MCGM (Field Officers)	
Political/ Religious Organization	**Less Active**

Roles and Involvement of Stakeholders

Stakeholders	Roles/ Activities
GCOE_HSE Research Team	• Mapping • Key Surveyors • Explaining and introducing community the role and objectives of the survey • Co-ordination between different stakeholders
Local Community	• Key Informant (flood , exiting socio-economic conditions, settlement characteristics)
MCGM (Field Officials)	• Worked as a facilitator • Introducing GCOE research team to the area • Source of information (flood , exiting socio-economic conditions, settlement characteristics) • Providing secondary information
Religious / Political Organization	• Key Informants • Introducing and supporting the research team (including surveyors) with the area and people

Scope of Survey (Risk mapping – 1st Phase/ Stage)

LANDUSE	INFRASTRUCTURE
Residential	Religious Structures
Commercial	Doctor’s Clinic
Industrial	Community Toilet
Public / Semi-Public	Community Tap
Playground / Parks	School / Balwadi
Water bodies / Ponds	Burial Ground
Roads	Drains / Nallas
	Waste Dumping Site
	Water Pipe Line
	High Tension Lines

1. **Hazard Parameters**
   - Flood Duration
   - Water Level During Flood
   - Areas Frequently Affected During Flood
2. Built Environment

CATEGORY	CODES
Building Height	G, G+1, G+2, G+3…
Building Materials	Pa, Sp, Sp
Building Condition	
Plinth Level	In Feet

Building Materials

- **Pa.** Pucca: All RCC
- **Sp.** Semi-Pucca: Structure made of both permanent (RCC) and temporary (mud, tin) materials
- **Ka.** Kuchcha: Walls, Roof and Floor made of temporary materials like mud, tin, asbestos

Note down the following information in the map:

1. Width of Roads
2. Name of Roads / Gali Number
3. Name of Neighborhood (if any)
4. Areas of Mixed Landuse (Residential + Commercial / Industrial)
5. Any particular building category not enlisted above
6. Spot Height (Take the Road as Reference Point)

Steps of 1st Phase (Stakeholders Identification & Base-map Preparation)

of Participatory Risk Mapping , Rajiv Gandhi Nagar

Steps	Activities	Stakeholder participation
Step – I	Area identification/selection	GCOE – HSE Mumbai; MCGM
Step – II	Stakeholder identification	GCOE – HSE Mumbai , MCGM
Step – III	Information collection from secondary sources (Exam. map, drainage network, demographic data)	GCOE – HSE Mumbai
Step – IV	Rapport building with stakeholders	GCOE – HSE Mumbai with other stakeholders
Step – V	Fixing time and methods of risk mapping	GCOE-HSE Mumbai, MCGM

Steps	Activities	Stakeholder participation
Step – VI	Town watching and area appraisal (observation and exchanging dialogue) (including identification of landmarks and boundary of the area)	GCOE-HSE Mumbai, Local Political Organization, MCGM,
Step – VII	Landuse mapping , building use, risk identification and mapping, resource identification etc by exploiting observation, group discussion, face to face open ended interview etc.	GCOE – HSE Mumbai , Local Community

Steps	Activities	Stakeholder participation
Step – VIII	Translating data/ map info from paper to electronic copy	GCOE-HSE Mumbai,
Step – IX	Data analysis and preparation of base map including landuse, building use, flood risks	GCOE – HSE Mumbai ,
Step – X	Reporting the result and developed map to all stakeholders including local community, MCGM, local religious organization	GCOE-HSE Mumbai, Local Community, Political/ Religious organization, MCGM
Step – XI	Feedback from the stakeholders and revision of developed base map	GCOE –HSE Map

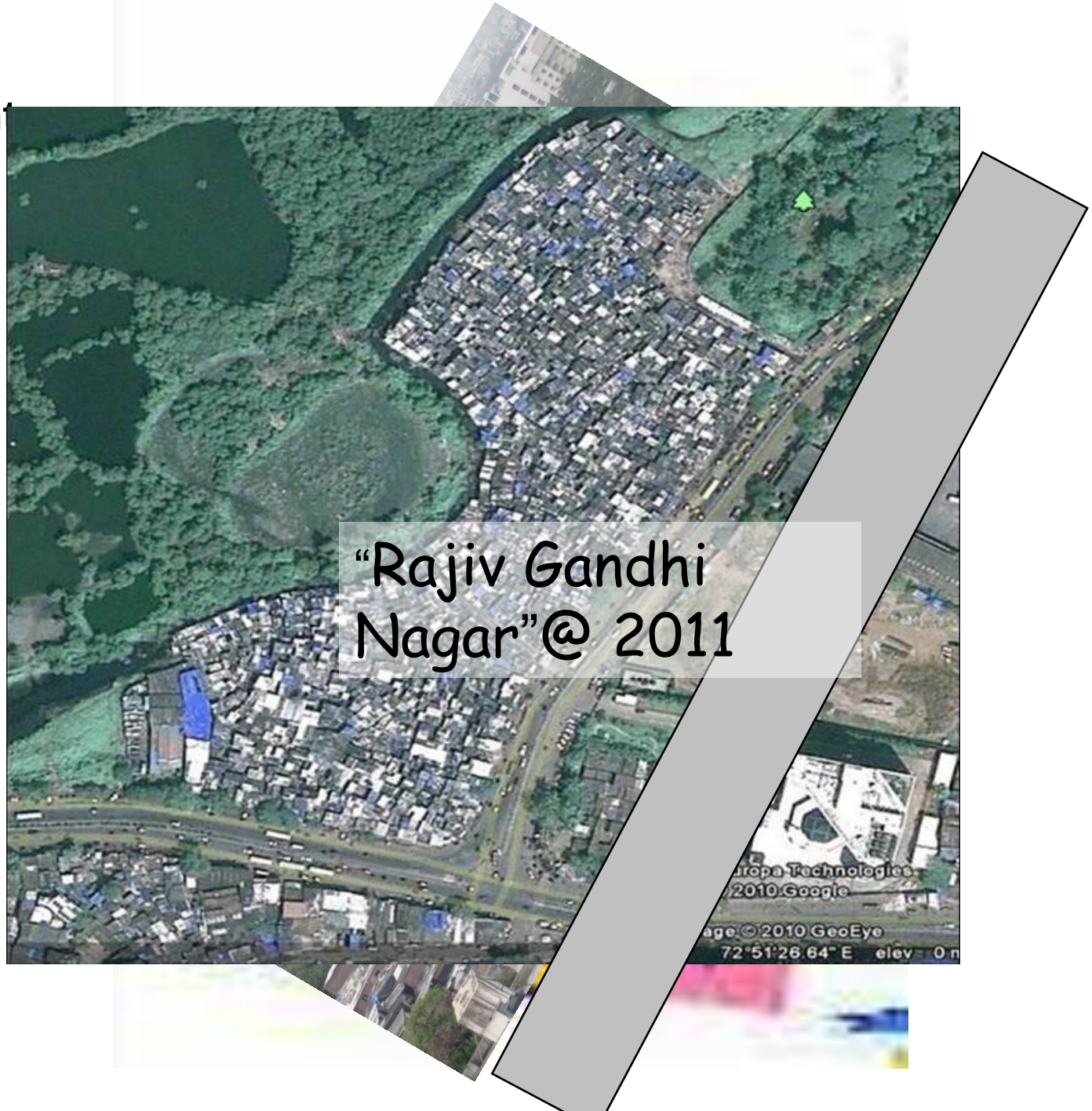
Yet to be done

Fact Findings

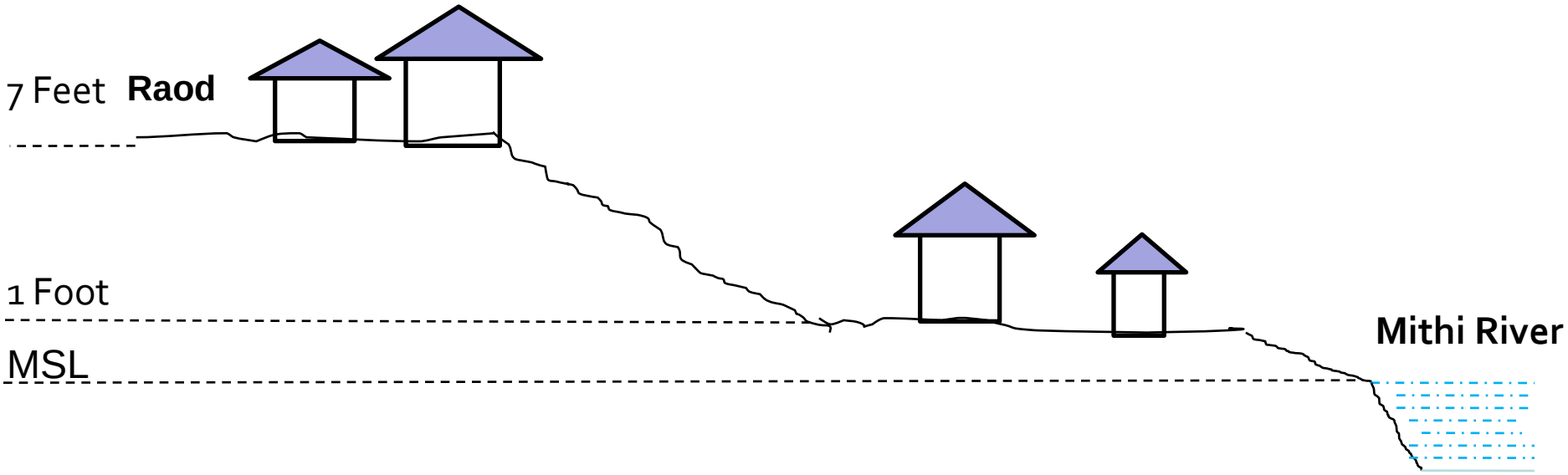
We have just finished the survey or more to say it is still going on, so the digitization of map and transferring data into electric file have not been completed yet. The findings mentioned here are some general observation

Origin and Growth of the settlement

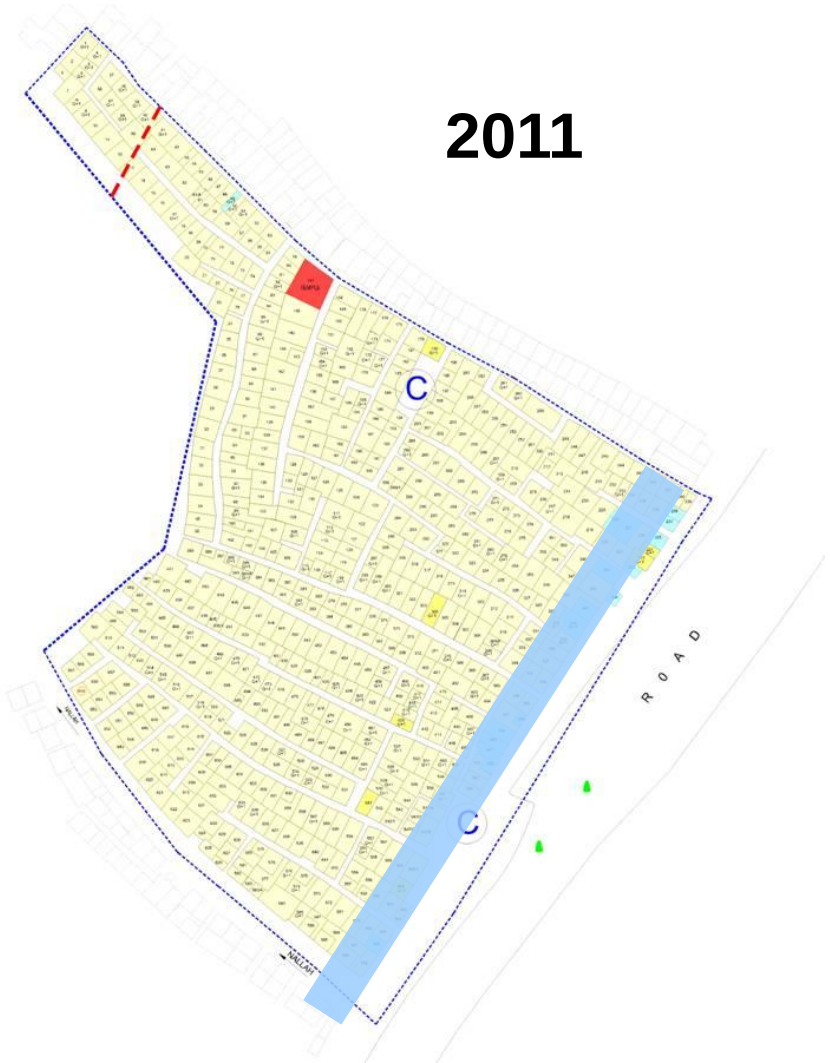
Growth of the Settlement



Those who came early were able to settle down close the road, whereas a relatively late comers were forced to encroach areas close to the river and set up their houses. Closer to the river, higher is the flood risk



Landuse and Built Environment



Residential

Commercial

Landuse has not changed much after the flood, only the roadside plots changed to commercial use.

- A significant number of residential structures turned into G+ 1 structure after the flood.
- Semi – concrete structures turned into concrete structures

Community reported a bulk number of them built G+ 1 structure after the flood in order to avoid flood risks

G + 1 construction is illegal in Rajiv Gandhi Nagar

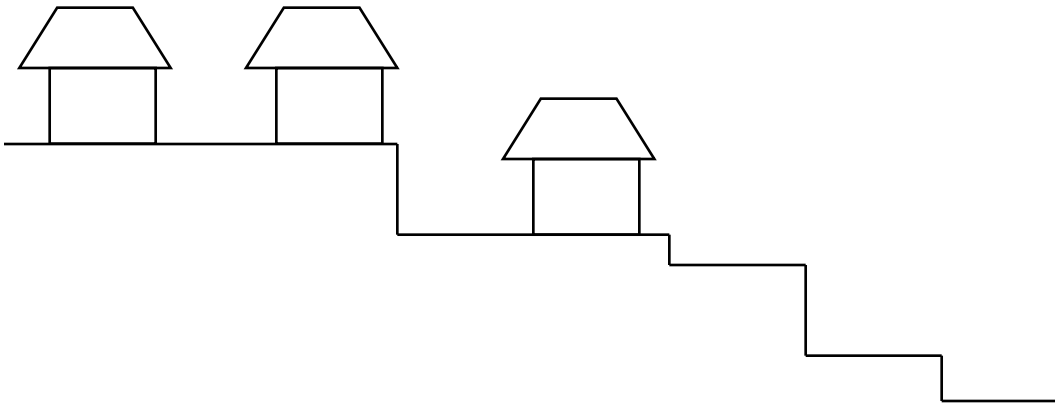
Infrastructure

Water Supply

- Pipe water supply in form of free public taps and private supply with cost was introduced by BMC in 2009 to parts of the community.
- In areas where people do not yet have pipe water supply people buy water from BMC water tanker (INR 200/ month)
- One public water-tap is shared by 4 to 5 households
- Water supply is for 5 to 6 hours in the morning .
- Those who could not pay or afford the water pipeline installation cost, normally borrow water from those who have private water pipe line and in return pay 200/300 INR to the owner

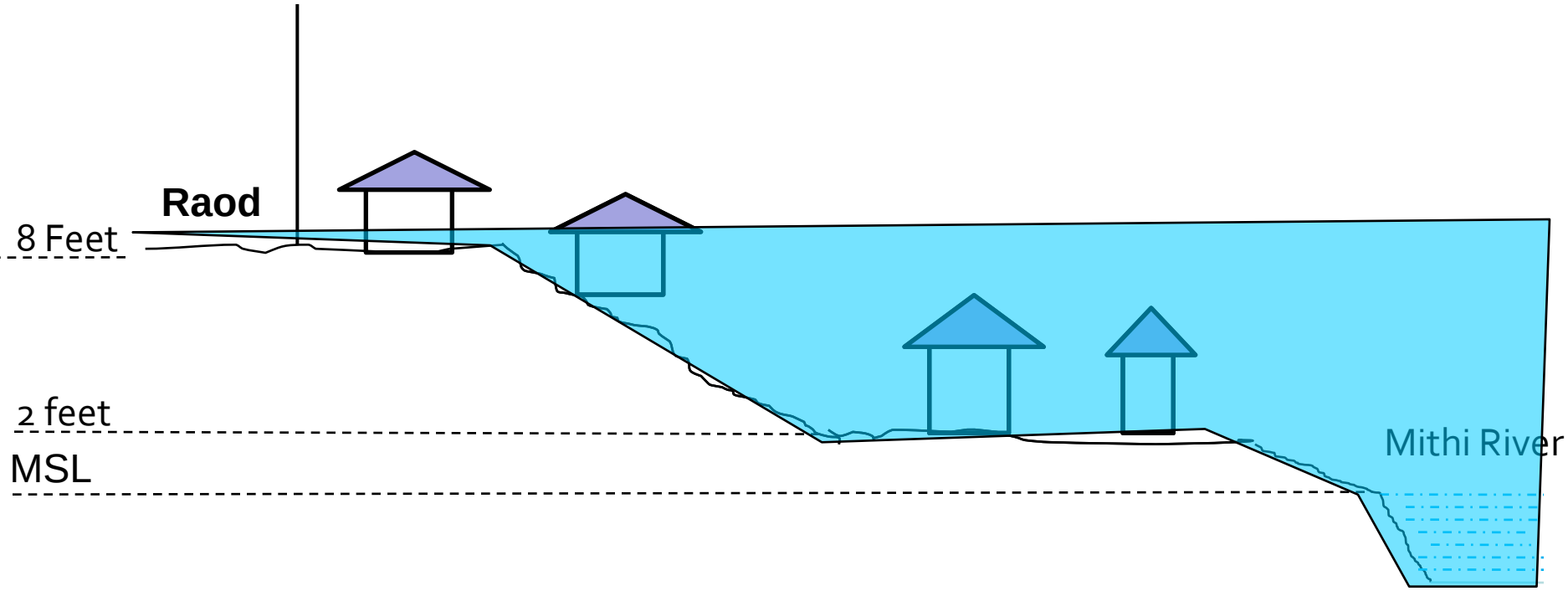
Electricity supply is now in the community.

- Access streets are narrow (average width 2 to 3 feet)
- A large number of streets are raised (1 to 2 feet) by the inhabitants after the 2005 flood disaster to keep out flood water.



Flood @ 2005

Flood @ 2005



Common Reasons for Not Early Evacuation during 2005 Flood

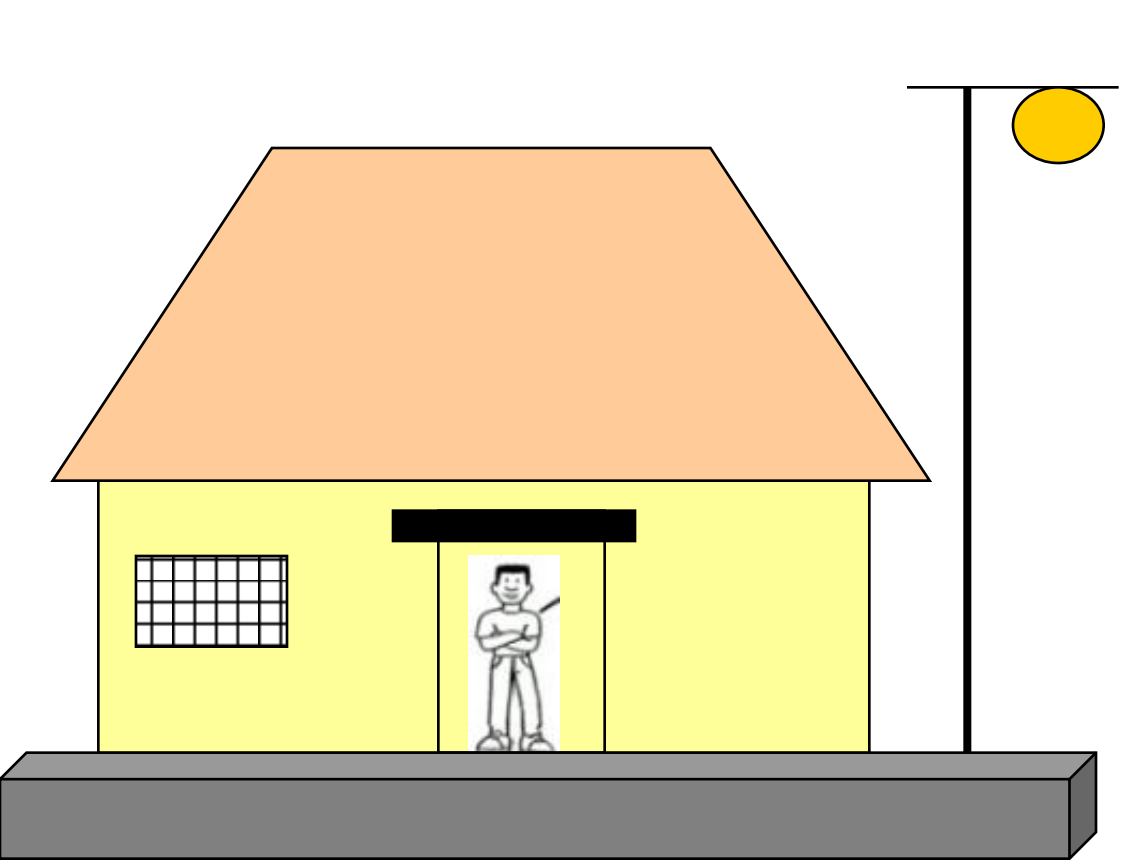
(Hierarchical order)

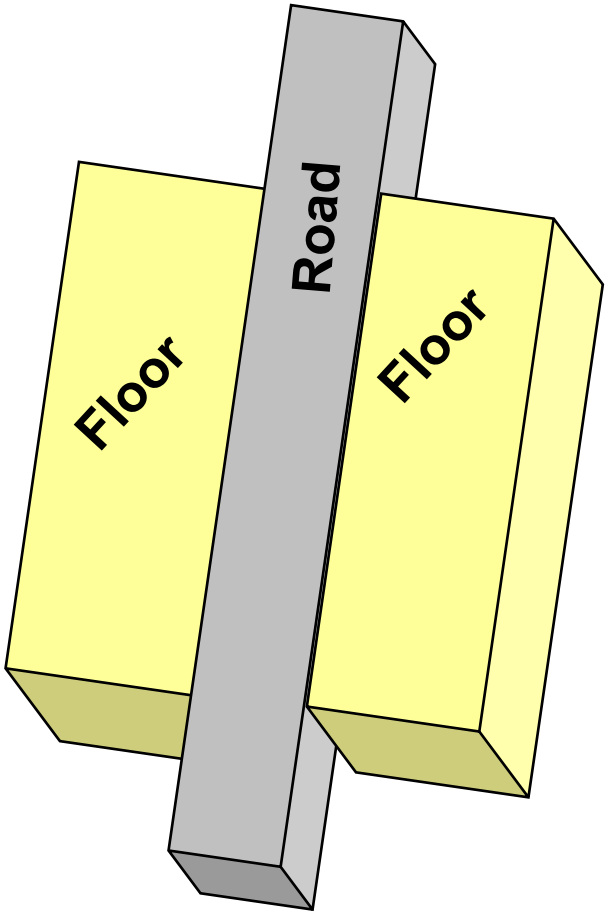
- Flood was unpredictable: Community thought flood water would flash back as the tide flow.
- No early warning by mass media / local Govt./ Non-Govt. organization and no planning for evacuation.
- The head of the household (male member) was outside the house and could not came back to house during flood as the roads were blocked. In the absence of male members, the family members could not decide whether they will evacuate or not.
- It was too late to evacuate when they decided to evacuate as the roads were already submerged and unusable.
- Fear of loosing property
- No knowledge with the people where to evacuate to and of course the least risky route of evacuation.
- Within short time the entire area was submerged, shelter at only roof tops or on to the road at higher level than flood..

Nature of Evacuation

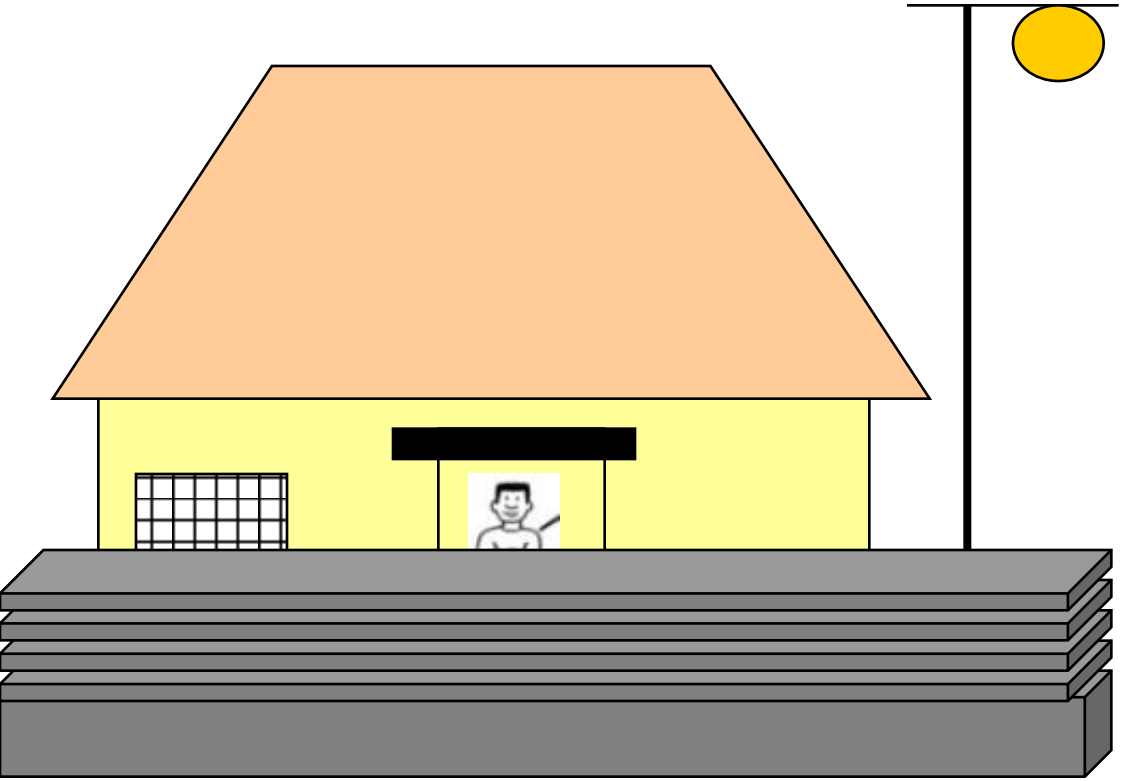
- Majority of them evacuated to the nearby roadside or railway station at the last moment when flood water already reached 3 feet height
- A few stayed on their own house (on the roof) as because when they decided to evacuate it was impossible to evacuate as roads were already submerged.
- A very few went to their upper floor or neighbors' house having upper floor (G+ 1 Structure)

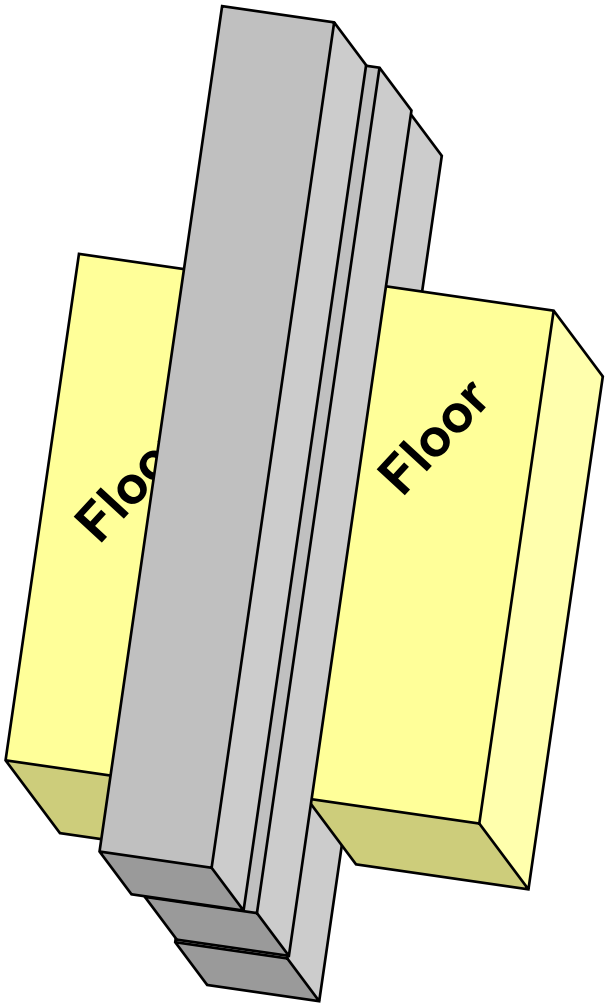
Before Flood

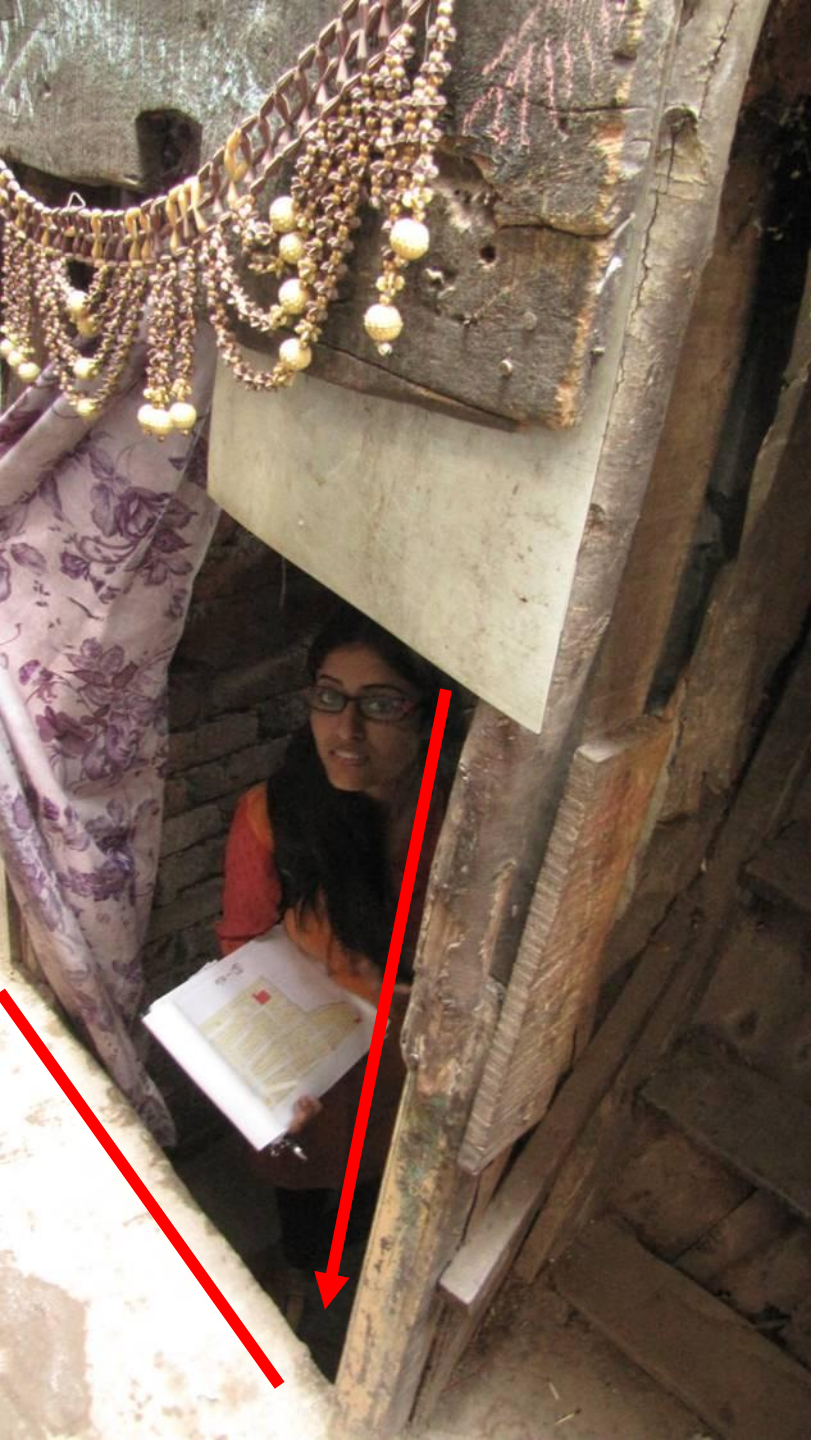


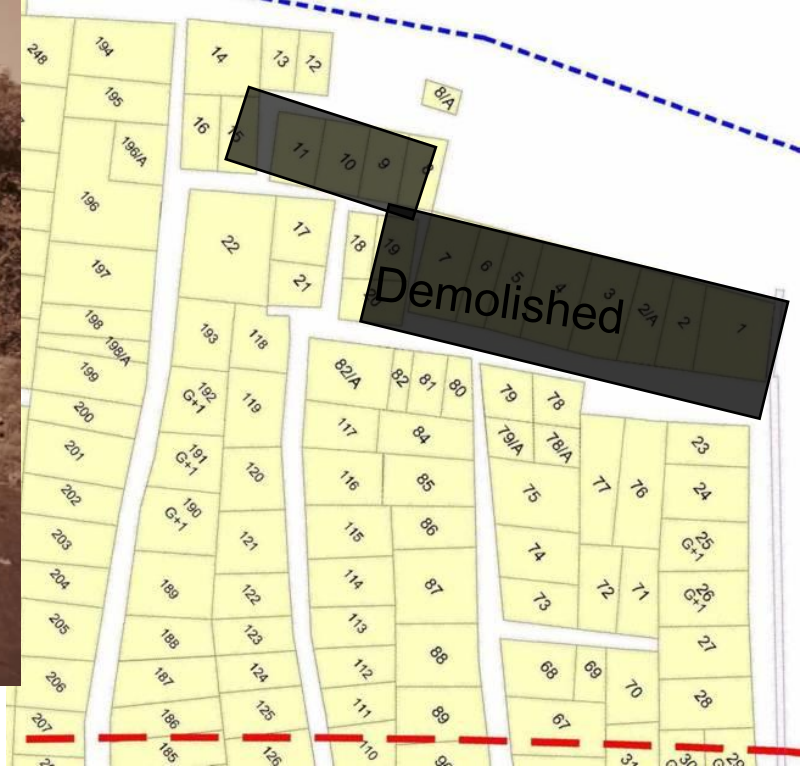


After Flood









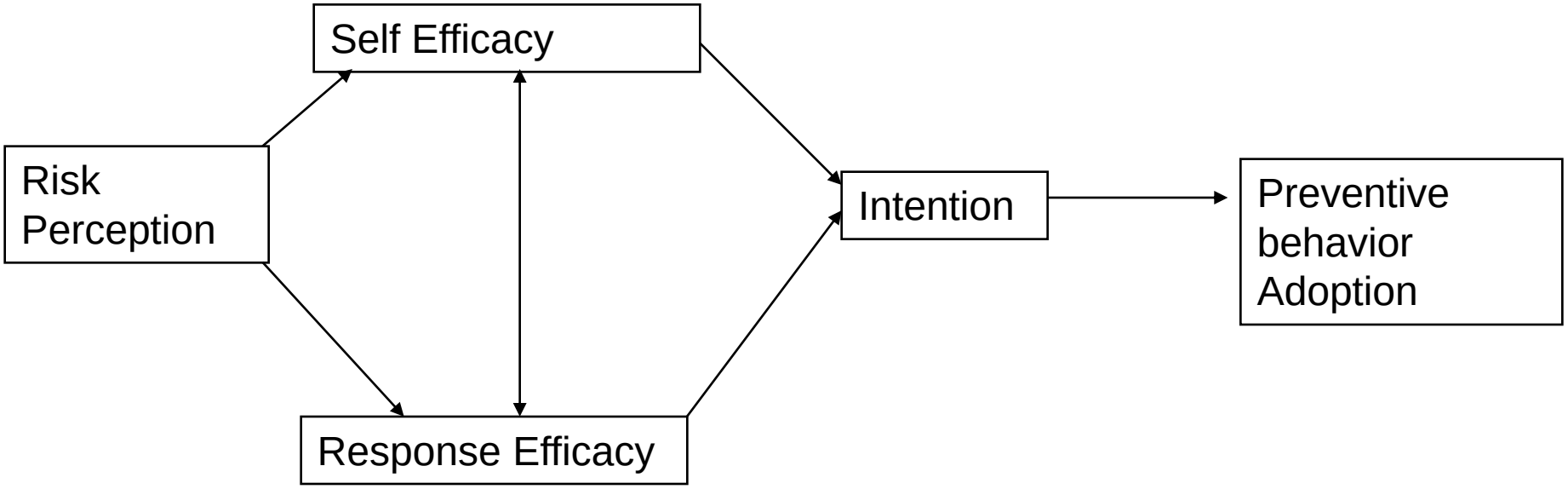
Recently MCGM (Local Municipal Govt.), demolished 7 to 8 buildings built on the highly risky river bank . Despite the 2005 disaster infiltration and encroachment is still going on at the high risk river bank.

The Outcome of 1st Phase Participatory Risk Mapping

- Developing base map & documenting base information (Objective Findings) – Knowing the process of developing and updating base information (spatial risk nature and characteristics) by involving various stakeholders, particularly the local participants
- Reducing data gap
- Built up network and interaction between stakeholders
- Creating and building platform for implementation of Integrated Community Action Plan (Example. Yomenkaigi System)
- Strengthening the process of stakeholder selection for practicing participatory risk mapping and action plan

Coping Capacity Process

(Mental Model)



Model to explain behavioral intention and the role or influence of Self – Efficacy

1st Stage/ Phase Risk Typefication

- Perceived Probability of Hazard
- Perceived Severity of Hazard
- Fear / Anxiety
- Risk Priority
- Knowledge / Information
- Past Experience
- Level of Awareness
- Social Acceptance/ Approval

2 Stage/ Phase Response

- Outcome Expectancy (Negative/Positive)
- Self Efficacy (Positive / Negative)
- Community Participation
- Past Experience
- Level of Awareness
- Knowledge / Information
- Social Acceptance/ Approval

Last Stage/ Phase Last Mile Action

Intention

- Money
- Time
- Power
- Trust
- Plan

Major findings from Parshi Chawl (N= 40) (Structural Equation Modelling)

1) High Outcome Expectancy + Low self efficacy = Fatalist (Low intention)
2) High risk perception + low self efficacy = Fatalist (Low intention)
3) High Risk perception + high self efficacy = Higher Intention
4) High response efficacy + high self efficacy = Higher Intention

THANK YOU