

A photograph of an urban area in Delhi, India, showing a polluted stream or canal. The water is dark and surrounded by trash and debris. In the background, there are several rickshaws with blue canopies, a yellow auto-rickshaw, and a utility tower. The sky is overcast.

Wastewater Disposal Related Risks to Urban Health: A Case Study of Megacity Delhi

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ARBEITSKREIS FÜR MEDIZINSCHER GEOGRAPHIE

Jahrestagung-2006

5th -7th October

Remagen

Acknowledgements:

This study is a part of the project

**Vulnerability in Mega Cities: New approaches to analyse the urban
water system in Delhi / India**

Funded by German Research Foundation (DFG)

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Megacities:



- Megacities grow beyond imaginable proportions, particularly in the developing world. Urban issues therefore warrants and receives increasing attention.
- There are 21 mega cities (10 million+ pop.) in the world , 17 are estimated to be in developing countries, 3 in India.
- Megacities, with respect to large number of inhabitants on one hand and complex risk factors on other faces certain type and degree of vulnerability.
- Delhi as a megacity is accompanied by tremendous environmental concerns and infrastructure deficits.
- Practically half Delhi population lives in informal settlements: either in unauthorized colonies or in squatter settlements.

Why study Delhi?



1. Delhi is affected by a high degree of **fragmentation** between urban upper class quarters and squatter settlements of the urban poor (**Heterogeneity**).
2. Due to the emerging “fragmentation”, the increasing “social gradients” and physical and social boundaries different types of access to water and sanitation infrastructure develop – sufficient and insufficient / formal – informal and also legal and illegal”
3. The issues underpinned here are not only limited to Delhi but has numerous similarities with other cities too.

Delhi presents classic examples of water and wastewater related problems of mega cities

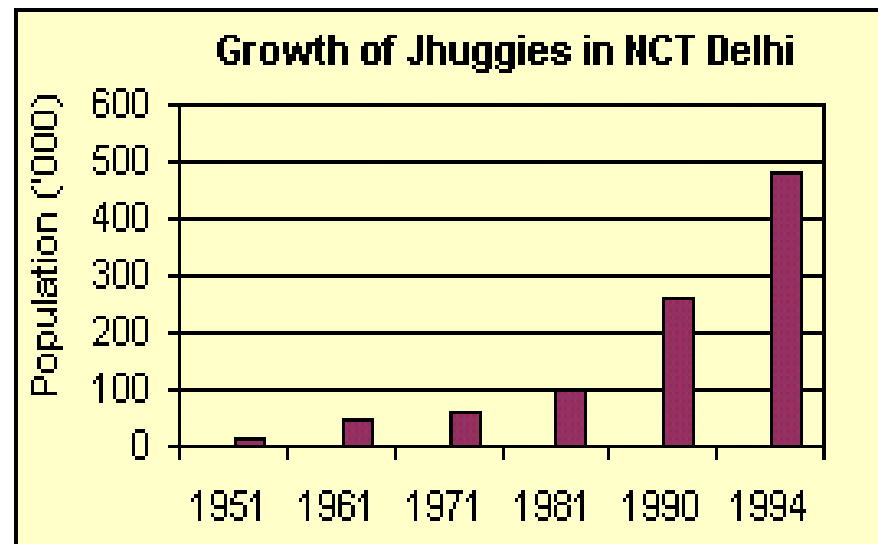
Pressures in the context of Megacity Delhi.....



TYPE OF SETTLEMENT & POPULATION

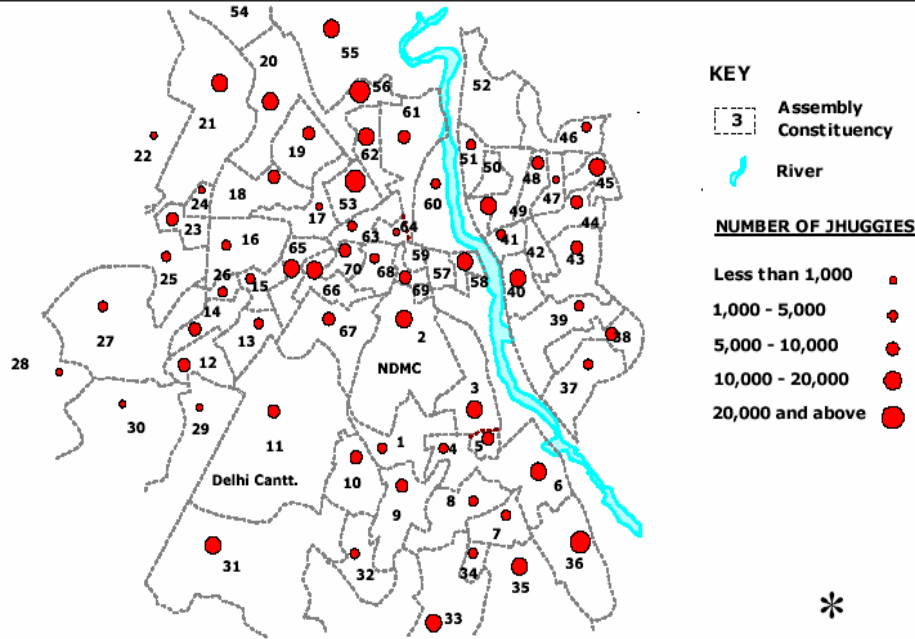
| S. No | Type of settlement | Approx. Population in lakh (2000) |
|-------|-----------------------------------|-----------------------------------|
| 1 | J.J. Clusters | 20.72 |
| 2 | Slum Designated Areas | 26.64 |
| 3 | Unauthorised Colonies | 7.40 |
| 4 | Resettlement Colonies | 17.76 |
| 5 | Rural Villages | 7.40 |
| 6 | Regularised-Unauthorised Colonies | 17.76 |
| 7 | Urban Villages | 8.88 |
| 8 | Planned Colonies | 33.08 |

Source : DUEIP-2021



- **Delhi is growing at an incredible rate.**
- **Such a high growth is leading to proliferation of slums and development of squatter settlements.**
- **Failure of Master Plan.**
- **Ageing and deteriorating infrastructure.**
- **Increase in the number of urban poor.**
- **Epidemic-prone disease Outbreak.**
- **Diseases linked to water and sanitation**

Jhuggies-Jhopris Clusters in Delhi



The sewerage services as per present policy are not being provided in unauthorized colonies and JJ Clusters.

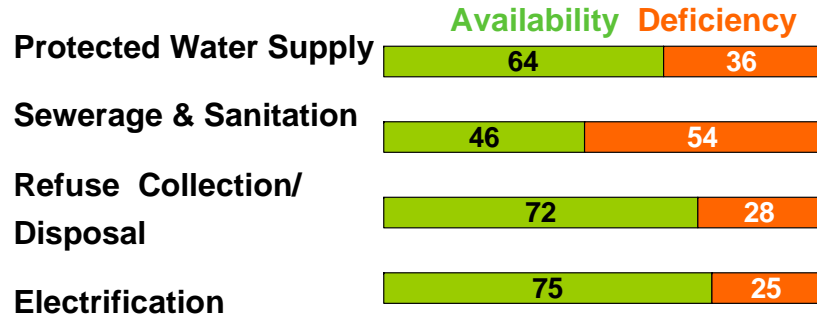
Source: Slum Wing MCD-Design and Planning Cell

| Sl. NO. | Type of Settlement | Total No. of Settlements | | | Sewage facilities in the settlements | | |
|---------|-----------------------------------|--------------------------|------|------|--------------------------------------|------|------|
| | | 1999 | 2000 | 2003 | 1999 | 2000 | 2003 |
| 1 | Resettlement Colonies | - | - | 44 | - | - | 44 |
| 2 | Urban Villages | 126 | 135 | 135 | 84 | 84 | 93 |
| 3 | Regularised/Unauthorised Colonies | 567 | 567 | 567 | 294 | 366 | 402 |
| 4 | Unauthorised Colonies | - | - | 1017 | - | - | - |
| 5 | JJ Resettlement Colonies | 44 | 44 | 44 | 27 | 34 | 44 |

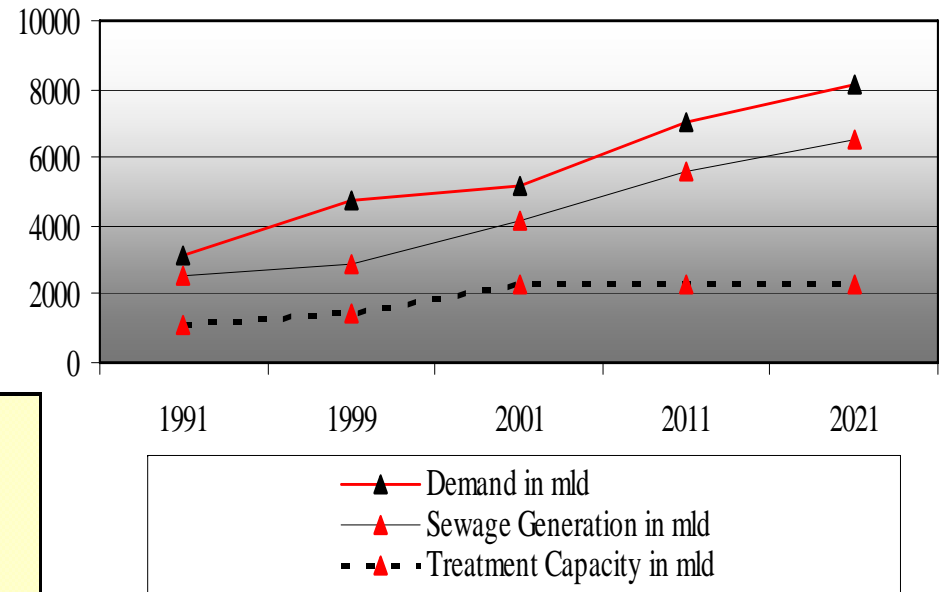
Lack of Infrastructural Upgradation



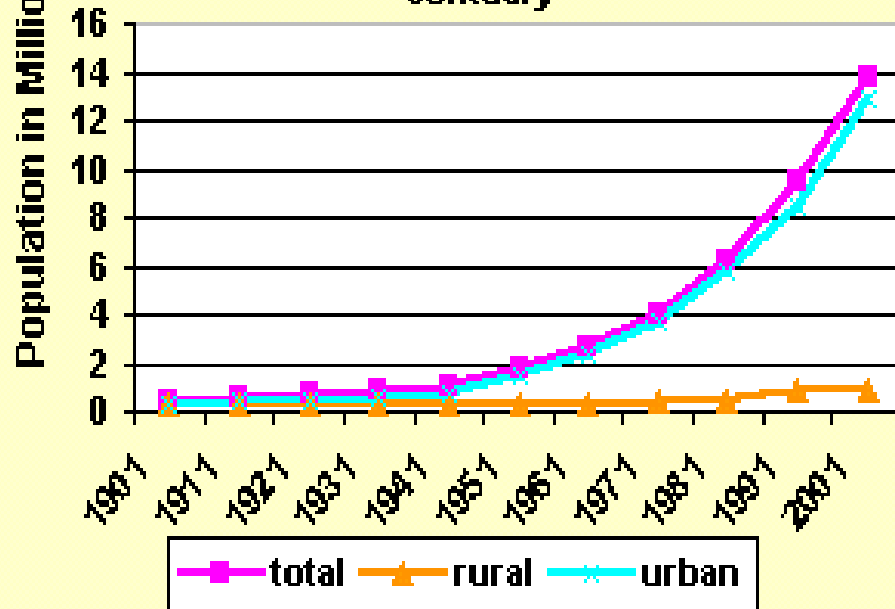
Urban Population Coverage (%) (National Average)



WATER SUPPLY AND SEWAGE SENARIO IN DELHI



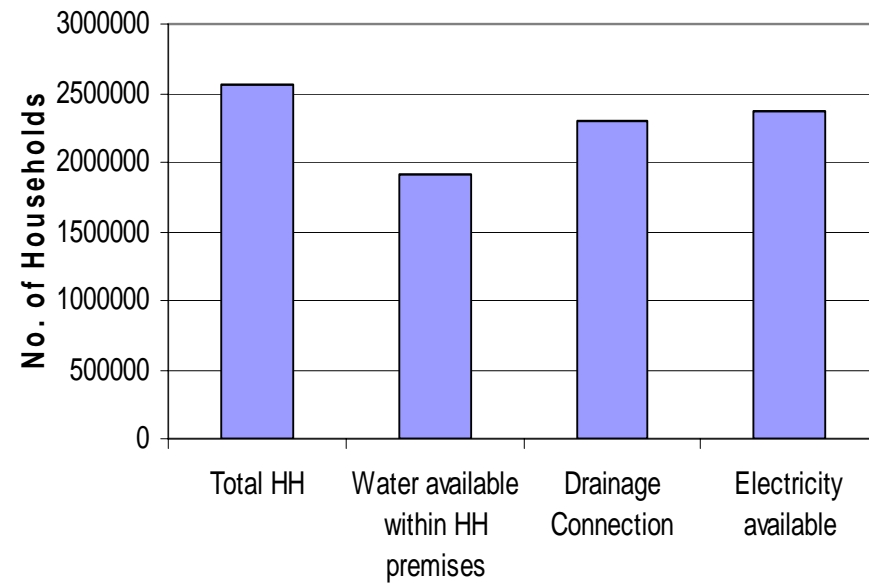
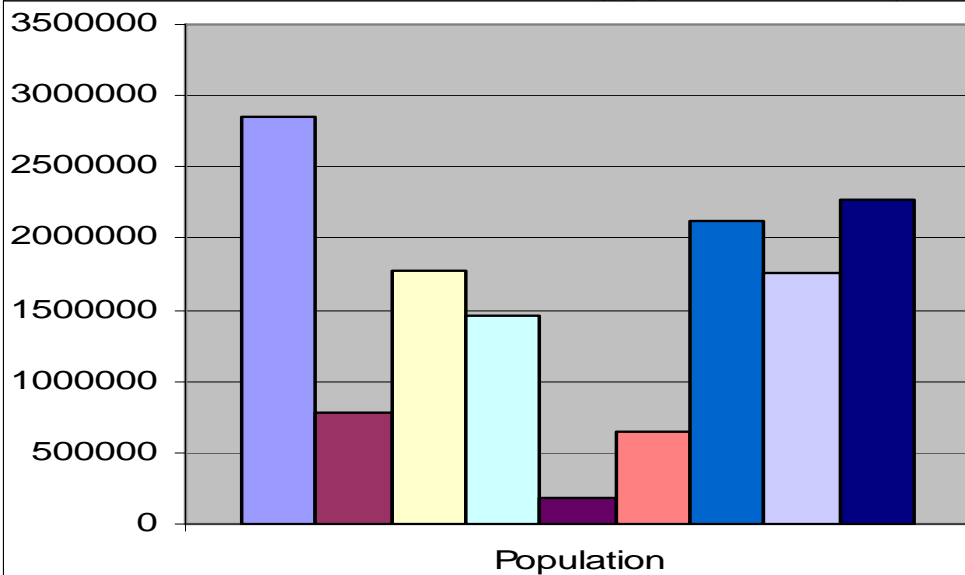
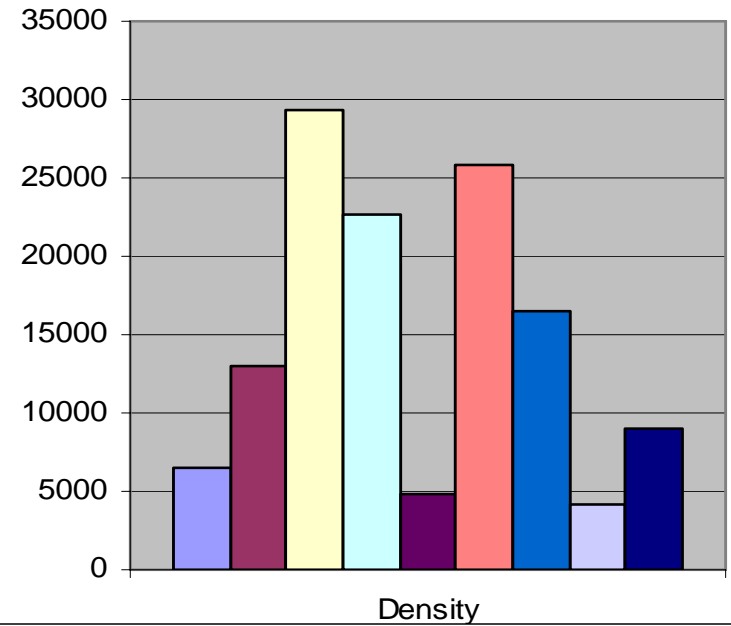
Population growth of Delhi in the last century



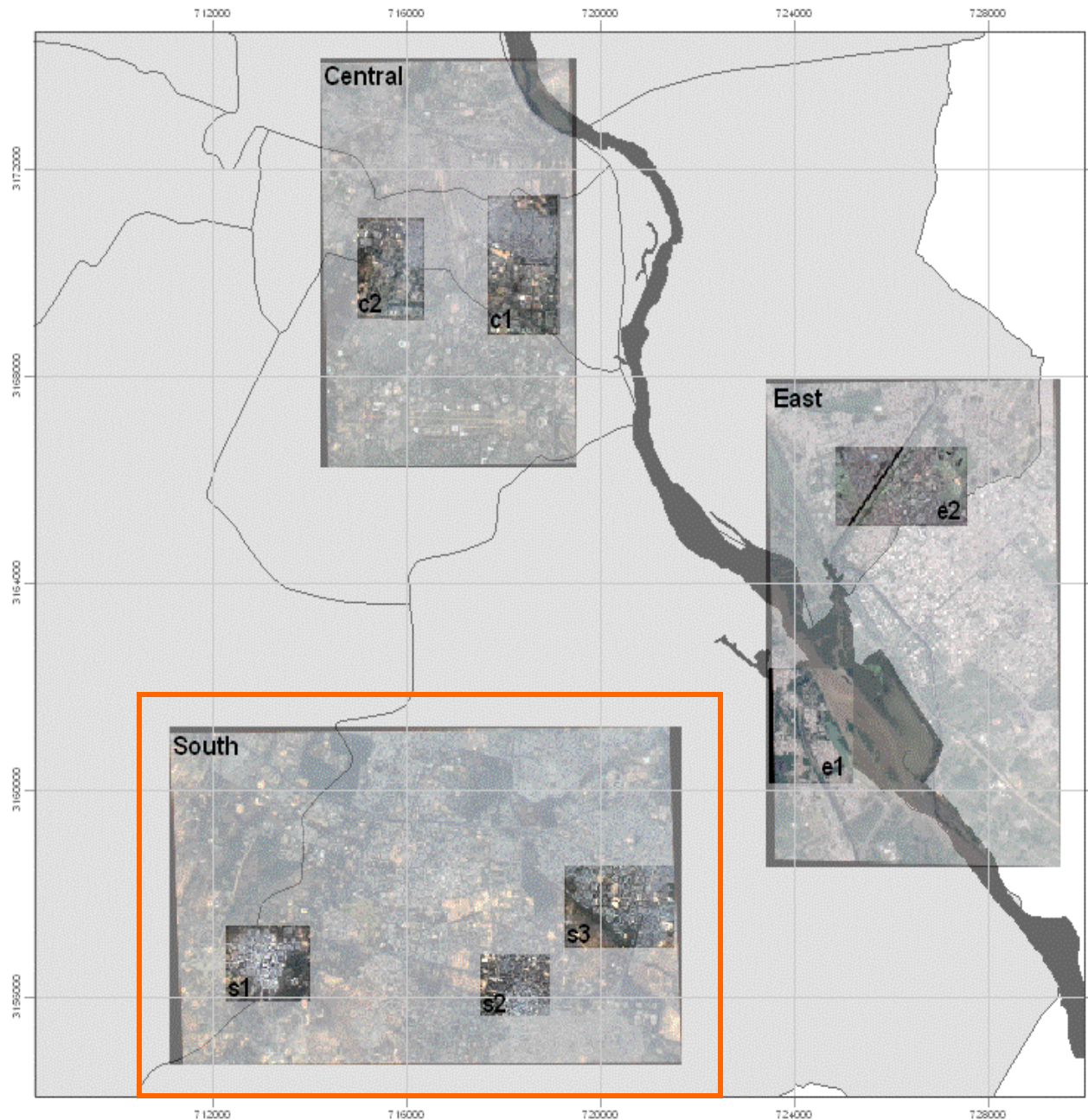
Demand for water and sewage generation rising along with the Rising population curve, But the Sewage treatment capacity gets static after 2001.



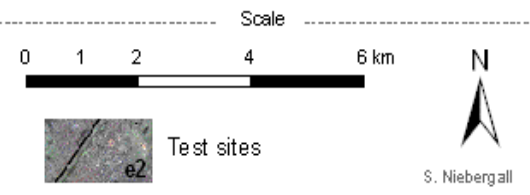
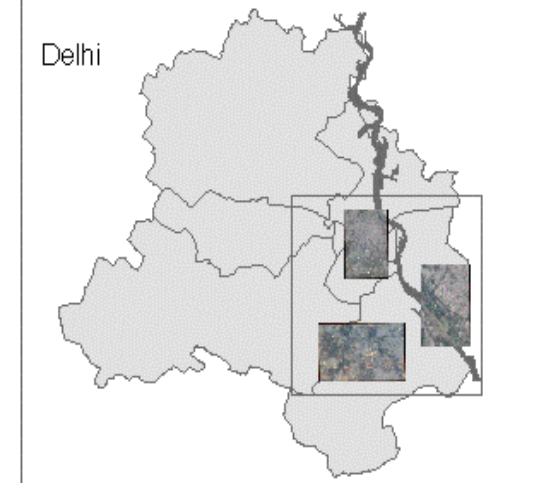
- North West
- North
- North East
- East
- New Delhi
- Central
- West
- South West
- South



Delhi / India - metropolitan area, acquired QuickBird scenes and chosen test sites



Test areas / QuickBird scenes



Central Questions



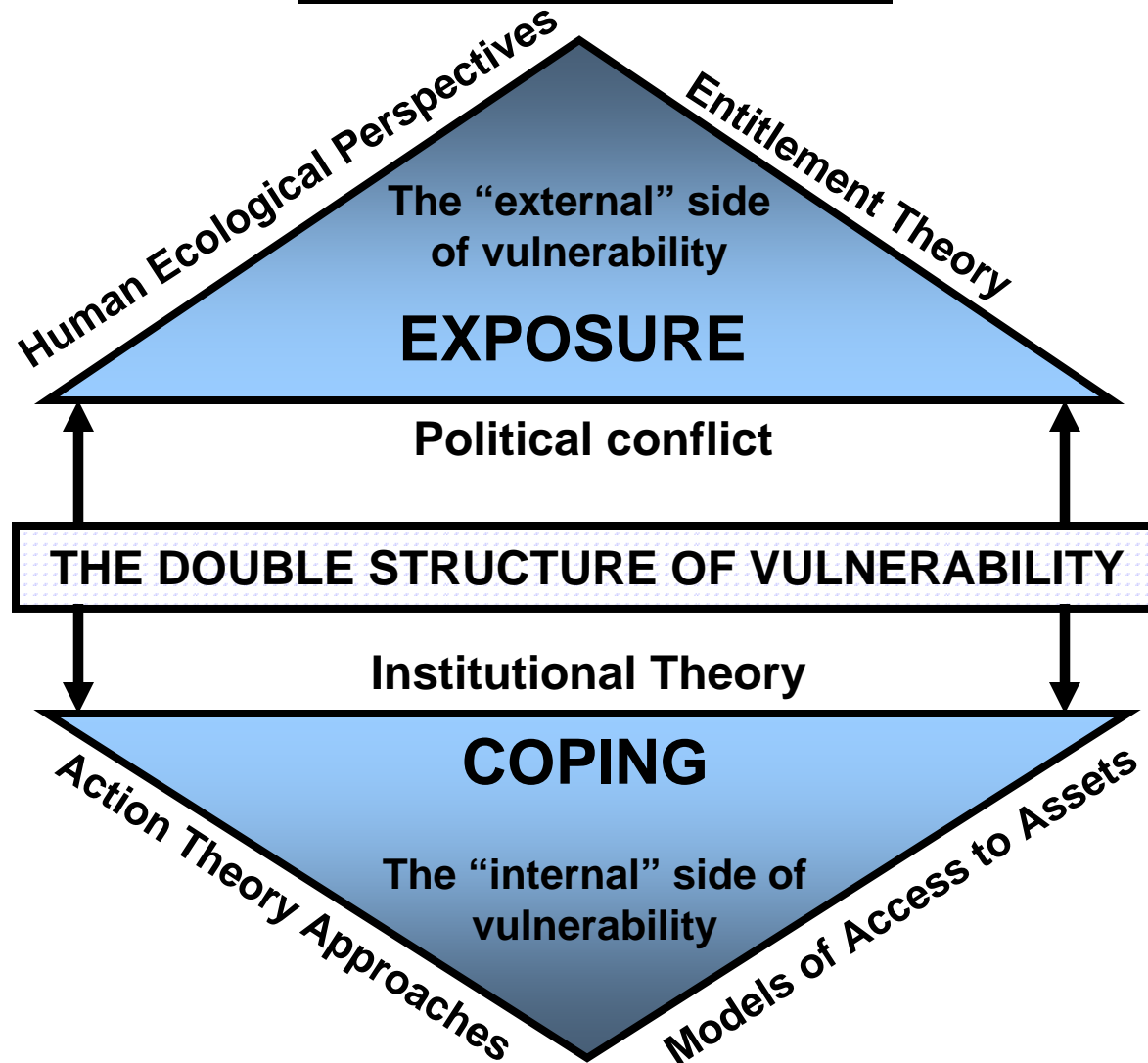
- What type of wastewater is generated by the selected areas and what are the disposal mechanism in different localities?
- In localities with sewerage network existing, is the connected population really protected against the nuisances of wastewater?
- What are the kind of wastewater related problems faced by the different residential areas.
- What is people's perception regarding the existing condition?
- How do they response within their given conditions?

Aims and Objectives

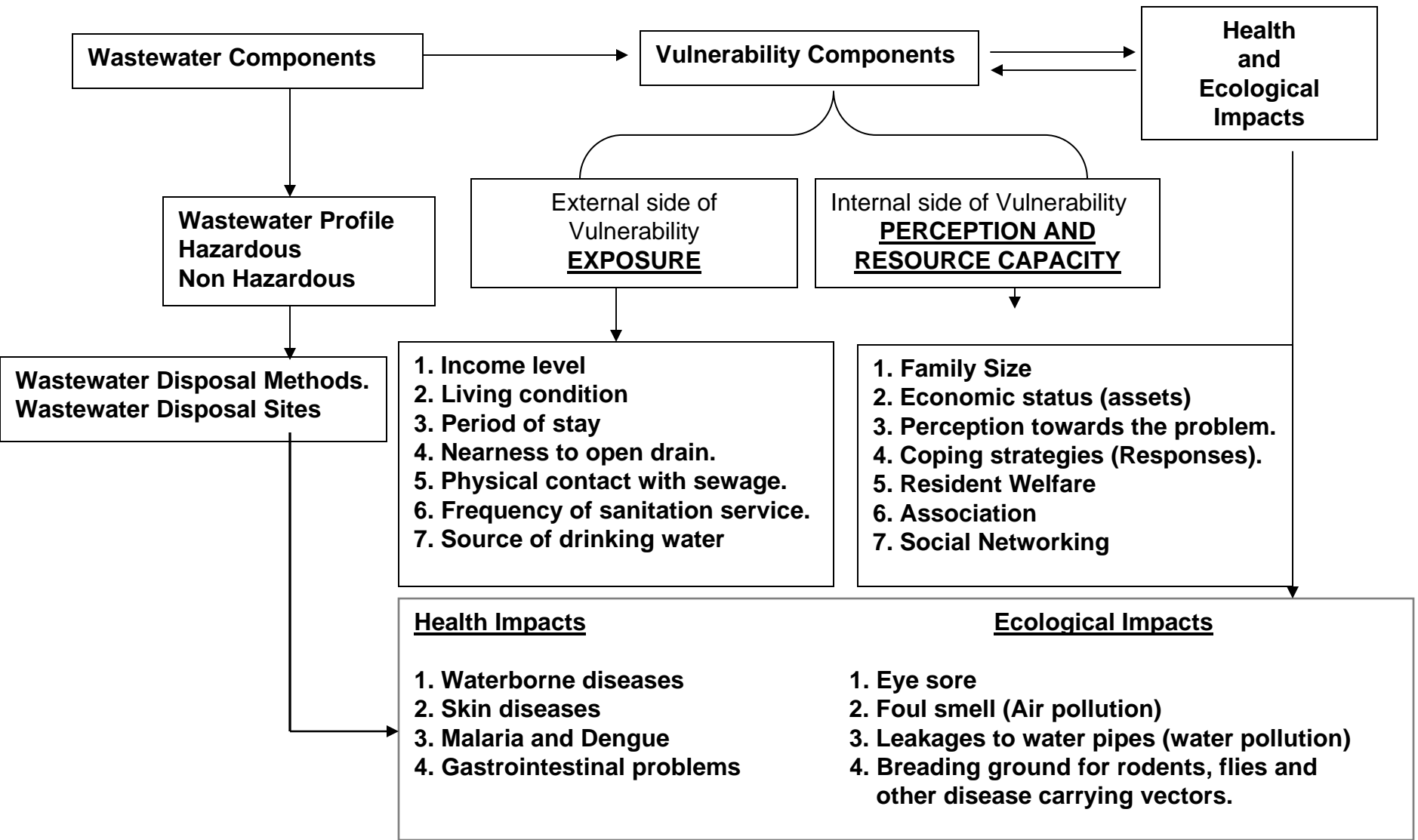


- To understand the nature of wastewater related problem and the factors contributing to it.
- To study environmental impacts due to wastewater nuisances in the selected areas.
- To study the potential health risks (Risk Assessment).
Exposure Assessment (Involving determination of the nature of population and the route of exposure).
Incidence of Health Effect
- To identify the vulnerable communities (Relatively).

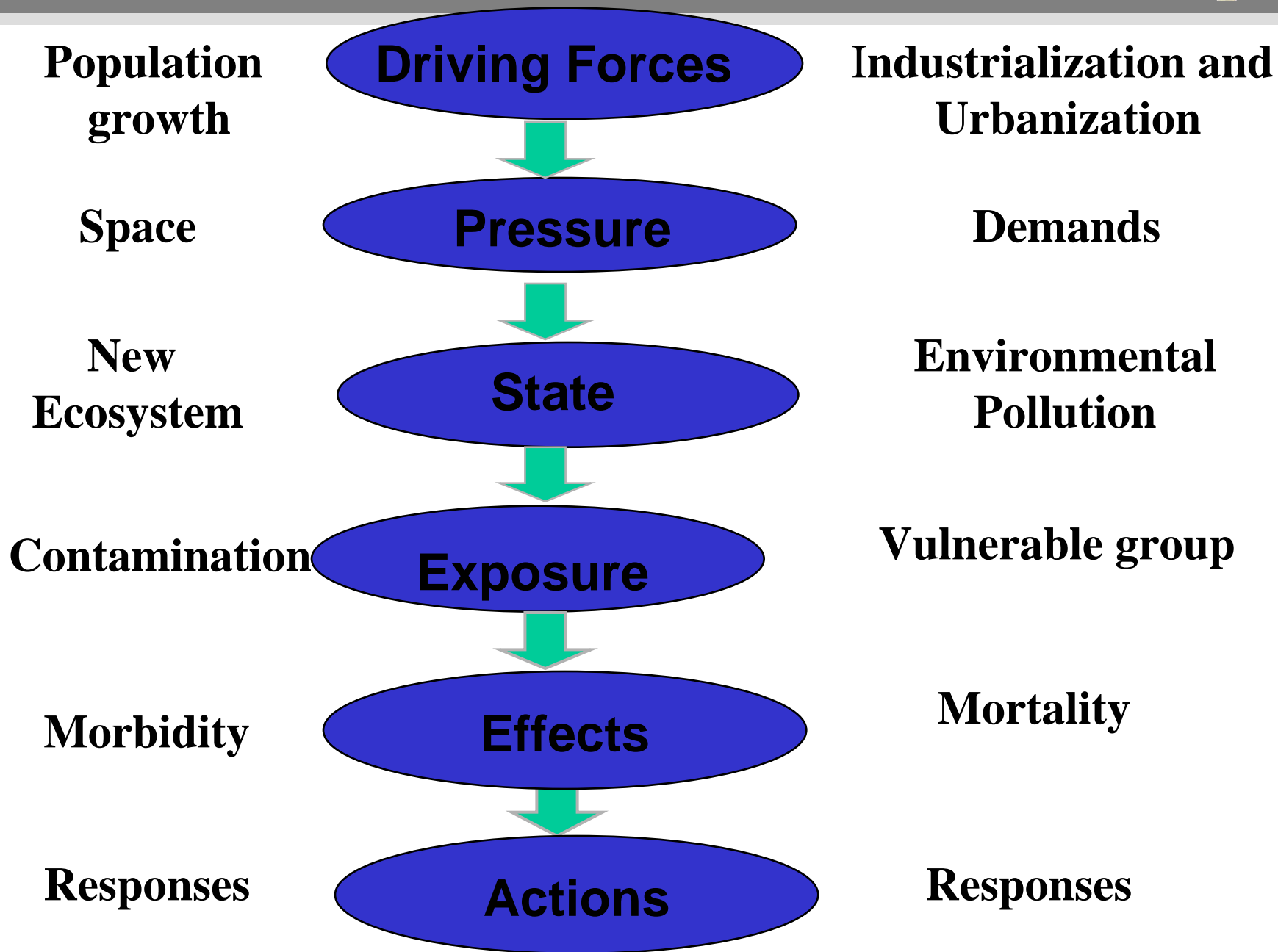
Double Structure of Vulnerability (After Bohle, 2001)



Framework for Assessing Wastewater related Vulnerability and Health Risks



DPSEEA Model (David Briggs for WHO)



Application of DPSEEA Model for Studying Wastewater and Health linkages



DRIVING FORCES

- Population Growth.
- Urbanisation
- Locational Marginalisation
- Ageing and insufficient Infrastructure

PRESSURE

- Planning failure
- Increased Wastewater generation
- Improper sewage network
- Inadequate and underutilized STPs

STATE

- Environmental and Health hazards.
- Eye-sore
- Water pollution
- Air pollution
- Breeding ground for infection carrying vectors.

EXPOSURE

- Income Level
- Period of Stay
- Physical contact

EFFECTS

- Outbreaks of diseases
- Morbidity
- Poor living conditions

ACTIONS

- Improvement of sewage infrastructure.
- Low wastewater generation strategies.
- Wastewater Recycling and Reuse.
- Environmental Impact Assessment.
- Monitored quality of water supply.
- Provision of regular sanitation services at residential colonies.
- Awareness and Education
- Social Networking (RWAs)

SECONDARY DATA BANK

PRIMARY DATA BANK

GIS LAYERS

Census Data at district level

- No. of Household
- Size of Household
- Total population
- Sex Ratio
- Literacy Levels
- Sources of water supply
- Accessibility to different types of sanitation within HH
- Type of drainage connectivity
- Sources and location of drinking water within HH
- Availability of electricity
- Structure of HH
- HH classified by building material
- HH classified by roof material
- Census houses and uses they are put (Land Use data)

DJB and CPCB data

- Water supply
- Volume of wastewater generated
- Location of WTP and STP
- Sewerage network

Groundwater Quality

- Level of groundwater
- Level of depletion
- Physio-chemical data

Health

- Water-related diseases reported.
- No. of gastrointestinal cases

Field Observations/ Ground Truthing

- Mapping
- Digital photographs
- GPS measurements
- Personal field observations
- Geo-referencing of surveyed households

High Resolution Remote Sensing Data

7 Test Sites

- Land Use
- Land Cover
- Site Density
- Building Size
- Detection of formal and informal settlements
- Water infrastructure

Household Survey

N=720

Quantitative Data

- Economic strata
- Educational Qualification
- Age-Sex Structure
- Family size
- Hinterland of in-migration
- Duration of stay
- Sources of water supply
- Expenditure on water
- Duration of supply
- Level of water consumption
- Frequency of water crisis
- Accessibility to sanitation infrastructure
- Physical contact
- Frequency of sanitation problem
- Magnitude of the problem

Qualitative Data

- Kind of water problems
- Kind of sanitation problems
- Health profile
- Perception
- Adaptation strategies/ Responses

Expert Interviews

N=x

- Water managers
- RWA leaders

Identification of dilapidated structures and risk locations

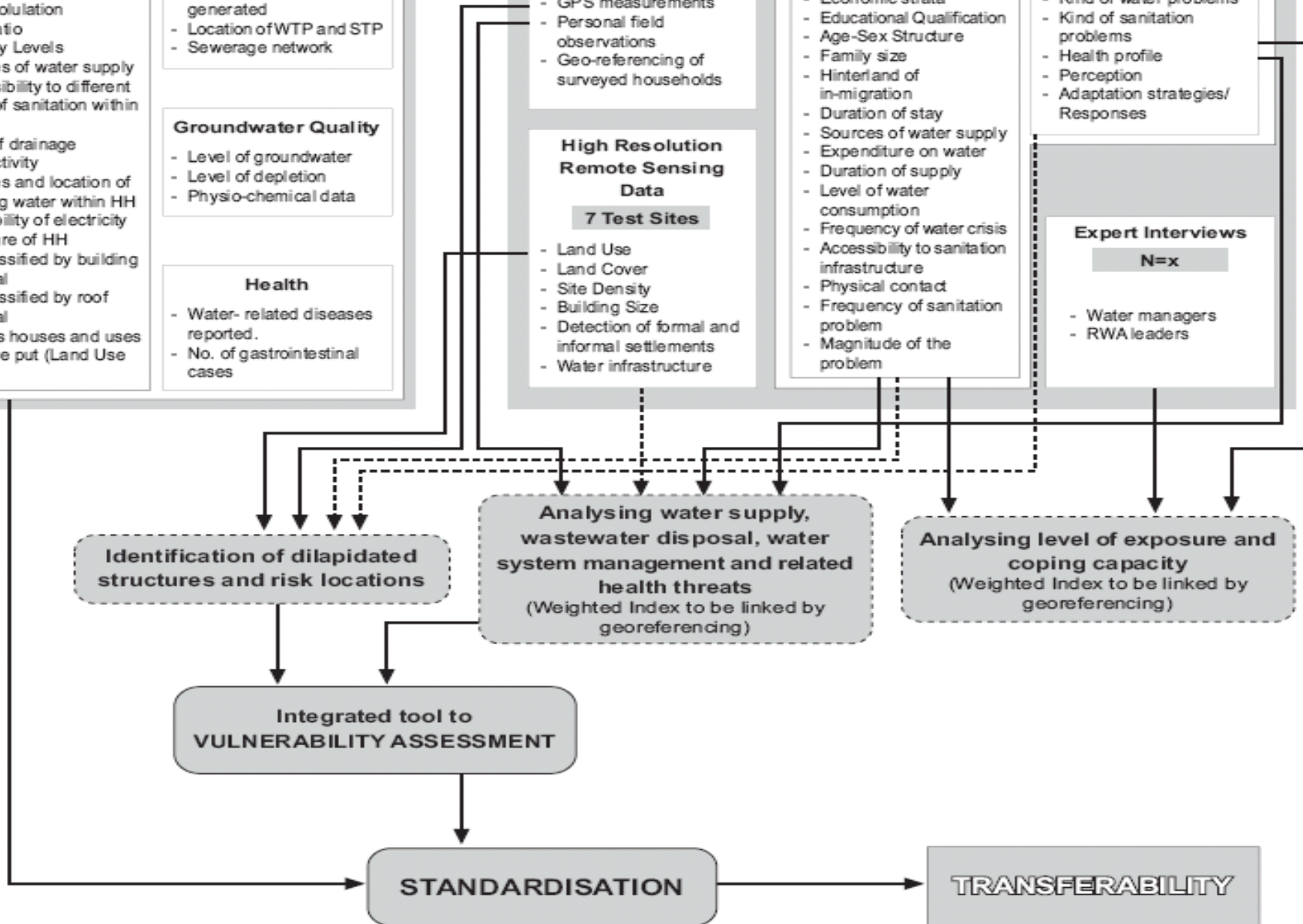
Analysing water supply, wastewater disposal, water system management and related health threats
(Weighted Index to be linked by georeferencing)

Analysing level of exposure and coping capacity
(Weighted Index to be linked by georeferencing)

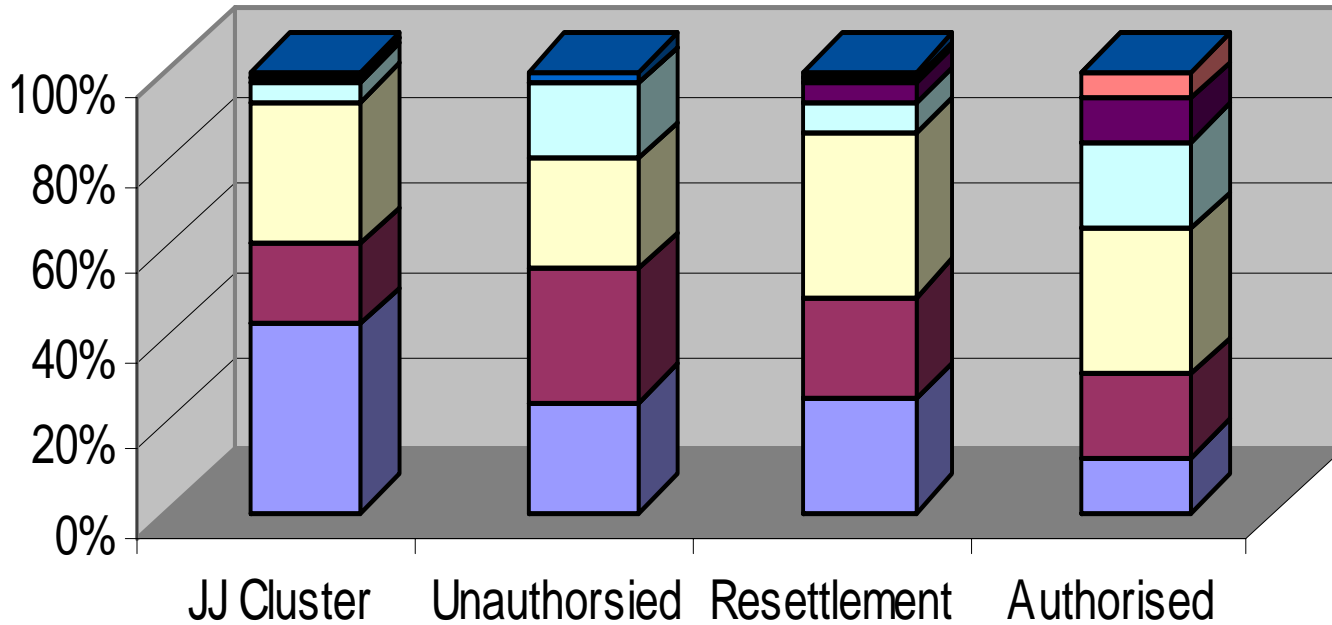
Integrated tool to VULNERABILITY ASSESSMENT

STANDARDISATION

TRANSFERABILITY

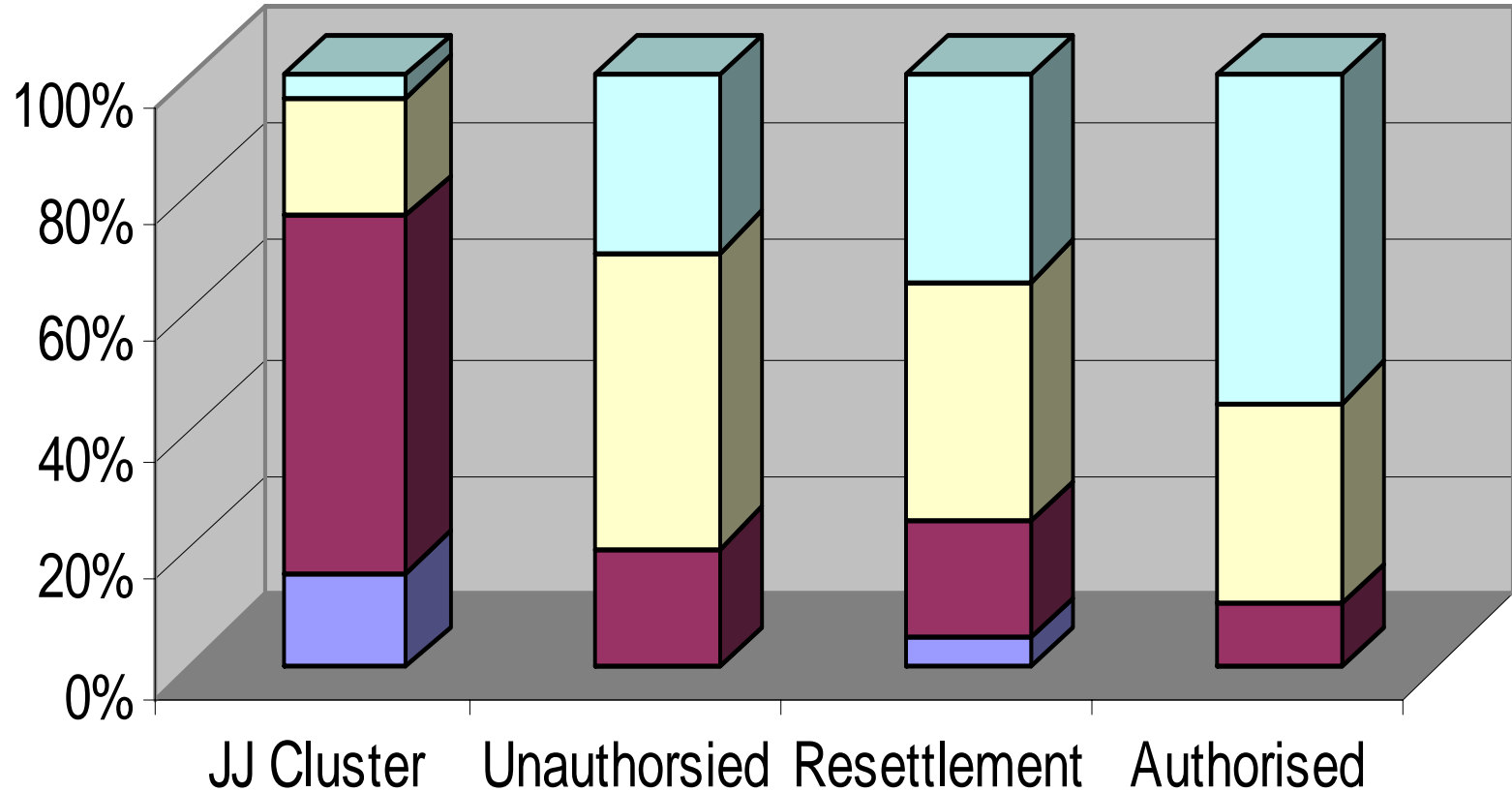


Educational Qualifications of the Respondents (South)



- No school education
- Primary
- Secondary
- Graduation
- Post graduation
- Technical education
- others

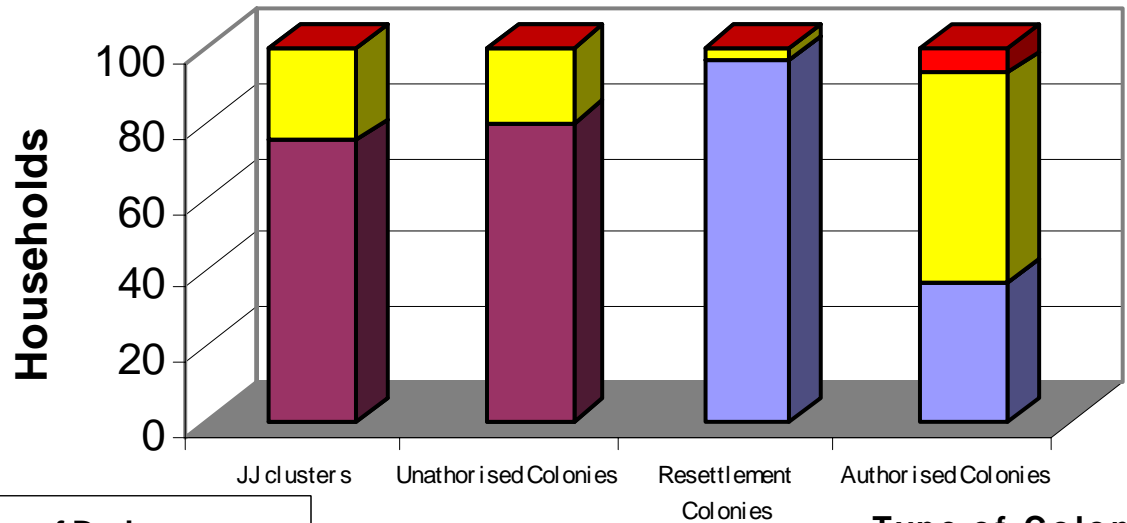
Household income of the Respondents (South)



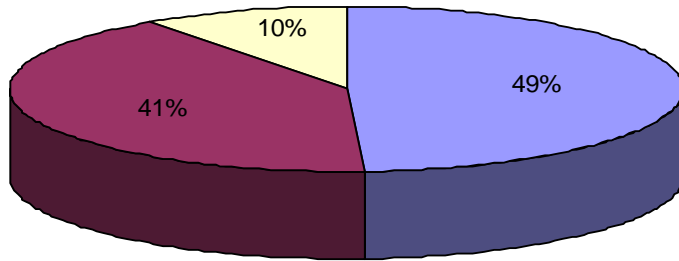
■ Less than 2000
 ■ 2000-5000
 ■ 5000-10,000
 ■ More than 10,000



Percentage of Sewer Coverage



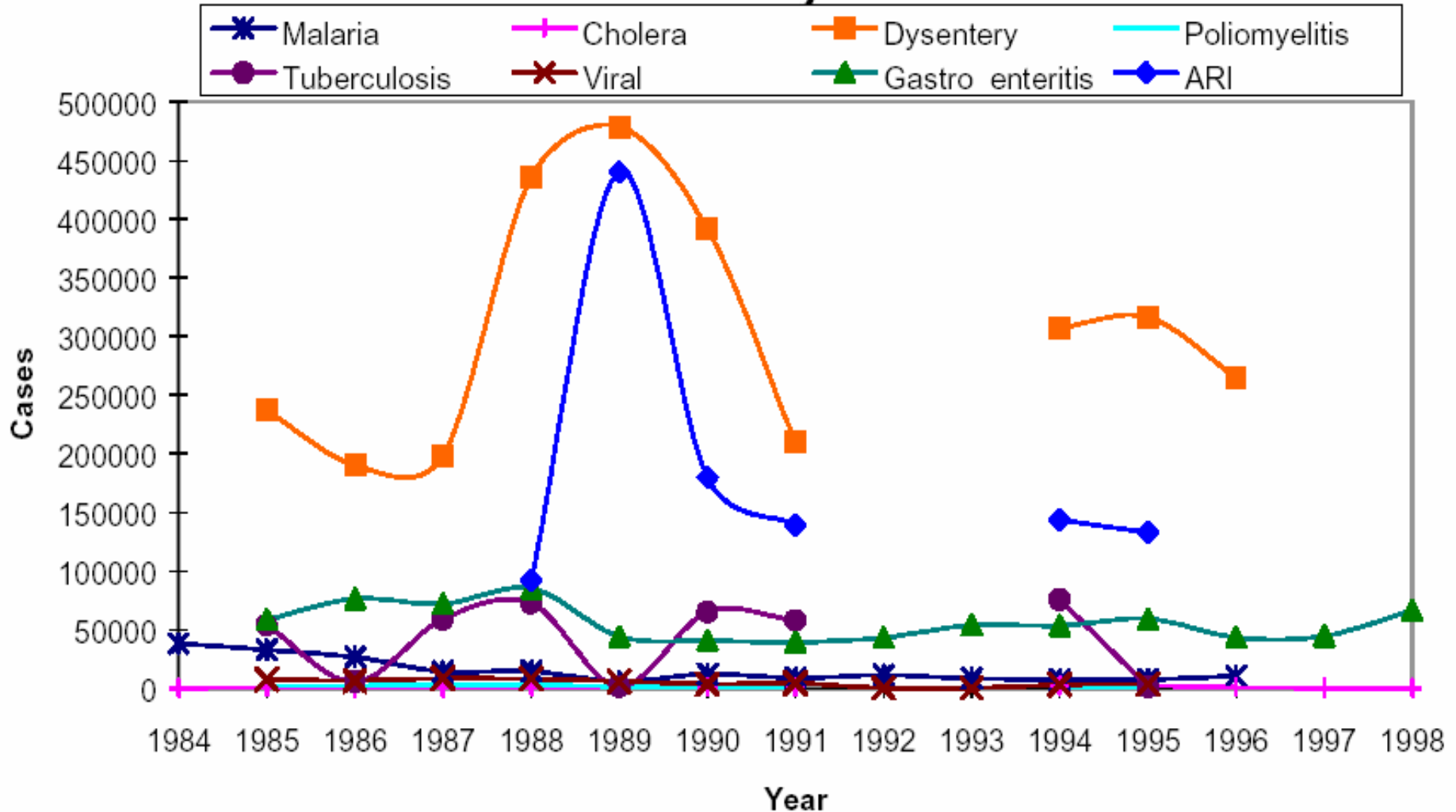
Distribution of Households by Types of Drainage Connectivity: NCT Delhi



■ Closed drainage
 ■ Open drainage
 ■ No drainage

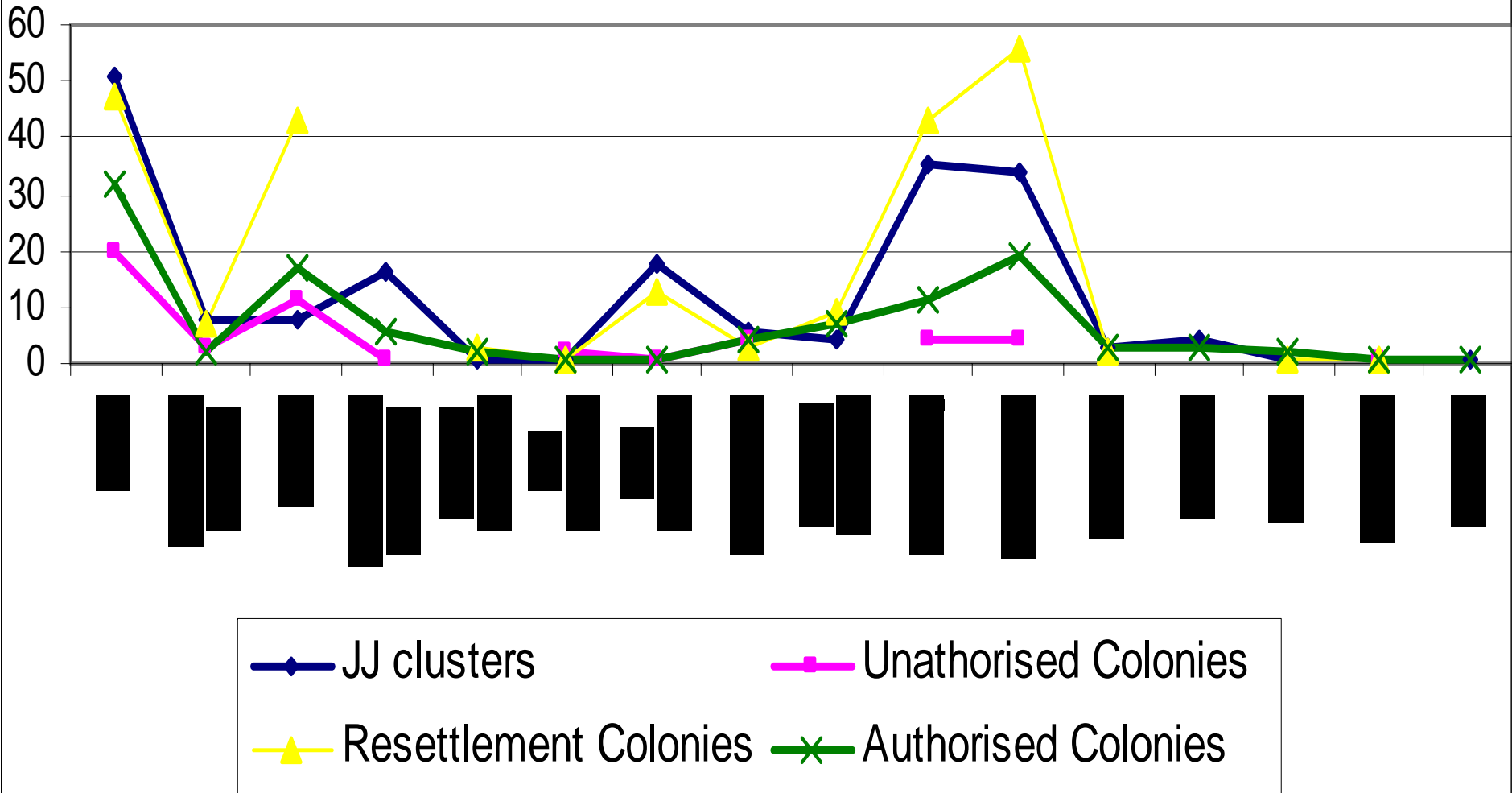
- Existant but not functional
- Privately connected to the main sewer
- No connection to sewer
- Connected

Morbidity



Source: Department of Health and Family Welfare, GNCTD

Morbidity in the study area (South Delhi)



•Summers mark the season for cholera and gastro enteritis (severe water problems)

•Monsoon and post monsoon sees a rise in cases malaria and dengue

COMMON NEWS HEADLINES

Cholera cases trouble national capital:-

New Delhi | May 19, 2005 7:43:45 PM IST

Malaria cases on rise in city

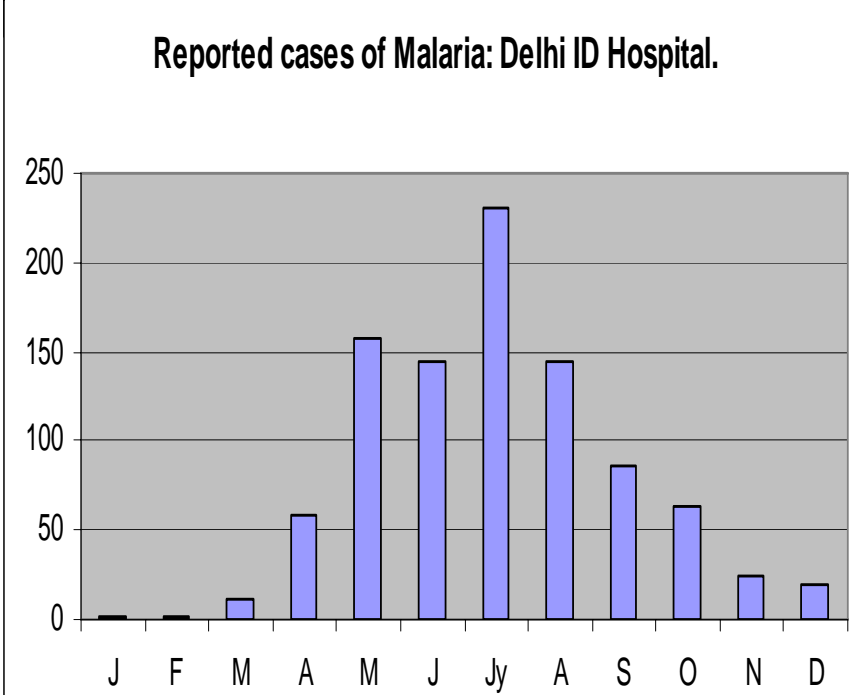
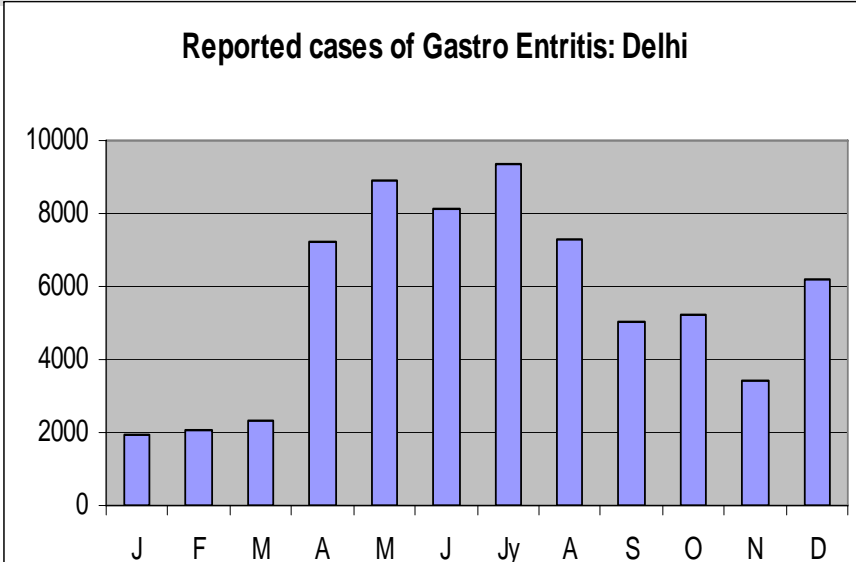
TIMES NEWS NETWORK

8th June, 05

197 cases of cholera reported in Delhi in two months : NEW DELHI, MAY 30 (PTI)

This year, no specific MCD plan to deal with disease

New Delhi, June 2: It's the ideal season for water and mosquito-borne diseases and cases of cholera, malaria and gastroenteritis are piling up, even as the meningococemia epidemic dies down. But the MCD does not have any specific plans this year, to deal with diseases that could turn into epidemics.



Data Source: MCD Health Deptt, 2005



Mushrooming of new residential areas,
irrespective of marginal locations and absence of
civic amenities.

The flood plain of River Yamuna
Photo: 21st Sept. 05, RS.



New constructions in densely packed conditions.
(Unauthorised colony)
Photo: 21st Sept 05, RS.



Lanes getting flooded with sewage water in the absence of proper sewage facility.

(Unauthorised settlement)

Photo: 24th Oct 05, RS.



Squatter settlements on the floodplain, residing with complete absence of anykind of water or wastewater infrastructure.

Photo: 28th Sept 05, AZ.



Breeding grounds for disease carrying vectors, overflowing drains.
Photo: 24th Oct. 05, RS.



Human exposure to sewage. Muck from the drains being manually removed.
Photo:24th Oct. 05, RS.



Physical contact with sewage water. Manually draining the sewage water entering the residence at Mehrauli.
Photo: 18th Nov. 05, RS.



Public water point tank being setup at the garbage dumping site. Bhumiheen camp.
Photo: 6th Nov. 05. RS.



Public water handpump along the open sewerage
Photo: 24th Oct. 05. RS.

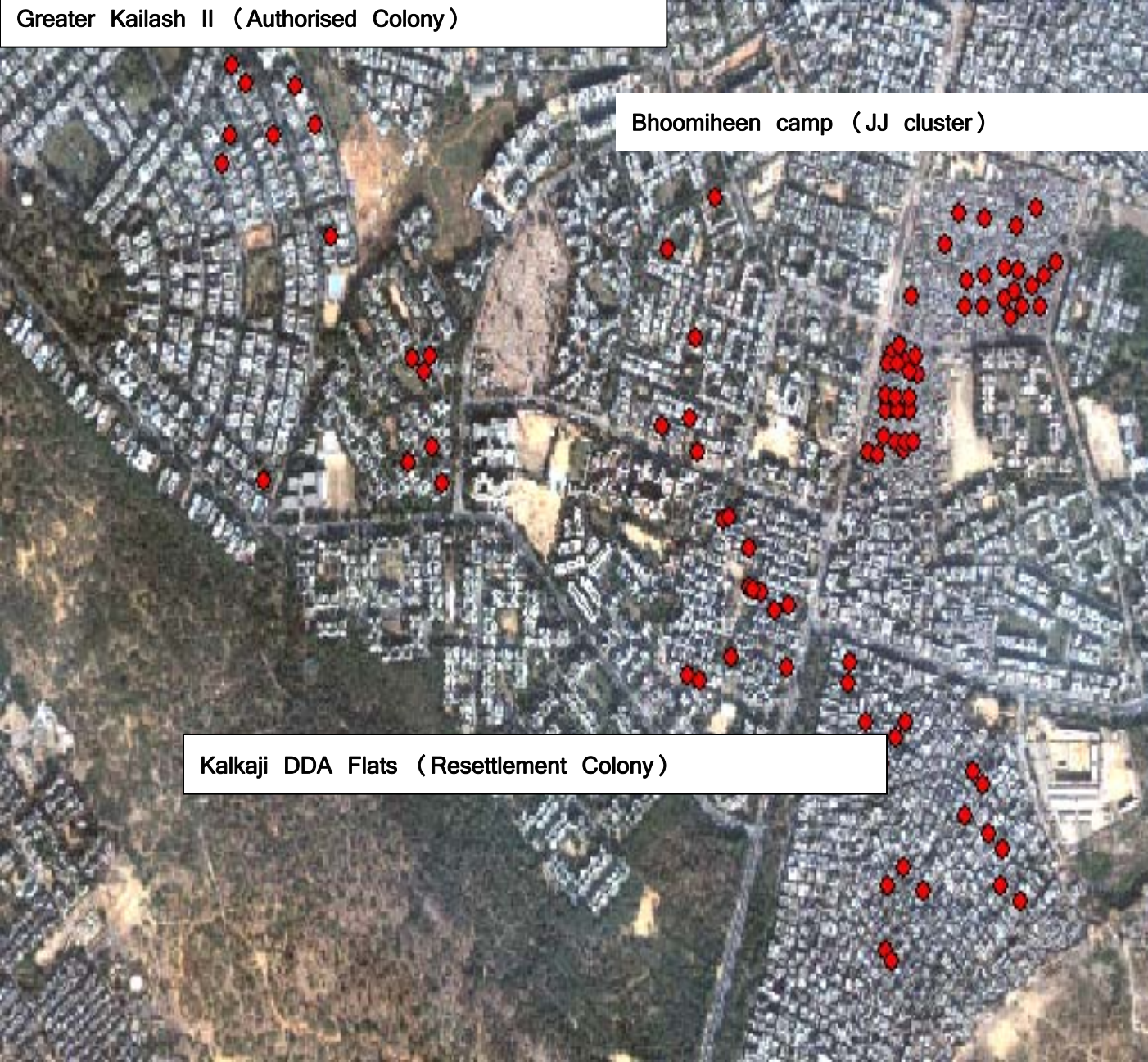
Unsafe water points



Mehrauli, South Delhi



Greater Kailash II (Authorised Colony)



Bhoomiheen camp (JJ cluster)



Kalkaji DDA Flats (Resettlement Colony)



Location: *Bhoomiheen Camp*

Type of area: *JJ Cluster*

Income level: *Rs. 2000-4000 per month*

Average Family size: *7 members*

Source of water supply: *Community taps and common tanks,*

Connection to sewer: *Not connected, open canals and ditches.*

Duration water availability: *No fixed timing. 1-2hrs spent in fetching water everyday, more in summer.*

Drinking water: *Tap water (no chlorination)*

Kind of water problem: *No individual connection, fewer connections in community, poor quality and insufficient supply with very less pressure and no fixed timings.*

Water Consumption: *approx. 80-100 lpcd*

Kind of sewage disposal problem: *Narrow lanes frequently flooded, choked drains and overflowing canals.*

Physical contact with sewer water: *Usually*

Water related disease reported: *Flu, gastrointestinal, respiratory, skin problems, malaria and dengue.*

Community participation: *Week community participation, absence of social networking*

General Perception: *Unhygienic environment, lack of sanitation facilities, governance neglect*

Risk: *High*

Exposure: *High*

Vulnerability Level: *High*



Location: *Kalkaji DDA Flats*

Type of area: *DDA allotment, Resettlement*

Income level: *Rs. 5000-10,000 per month*

Average Family size: *5 members*

Source of water supply:

Connection to sewer: Connected sewers and covered and semi covered drains.

Duration water availability: Tap in the household, twice daily by DJB, fixed water supply.

Drinking water: *Filtered tap water*

Kind of water problem: *No problems, only sometimes insufficient supply with less pressure, usually when the motor is not working, usually during summers)..*

Water Consumption: *approx. 200-300 lpcd*

Kind of sewage disposal problem: *Seasonal flooding but rare.*

Physical contact with sewer water: *rarely*

Water related disease reported: *Fever and cough (seasonally).*

Community participation: Community participation possible when problem is severe in the locality.

General Perception: *No serious environmental problem in the area, residents are satisfied with the available resource and civic facilities.*

Risk: *Less -medium*

Exposure: *Less- medium*

Vulnerability: *Medium*



Location: *Greater Kailash II*

Type of area: *Planned and Authorised.*

Income level: *more than Rs. 10,000 per month*

Average Family size: *4 members*

Source of water supply: *Municipal tap in house with private motor and booster pumps.*

Connection to sewer: *Yes, covered drainage.*

Duration water availability: *Twice daily for more than 4 hrs. Water is stored in overhead tanks and available round the clock.*

Drinking water: *Filtered water, mineral water*

Kind of water problem: *none*

Water Consumption: *approx. 400lpcd*

Kind of sewage disposal problem: *none*

Physical contact with sewer water: *never*

Water related disease reported: *none*

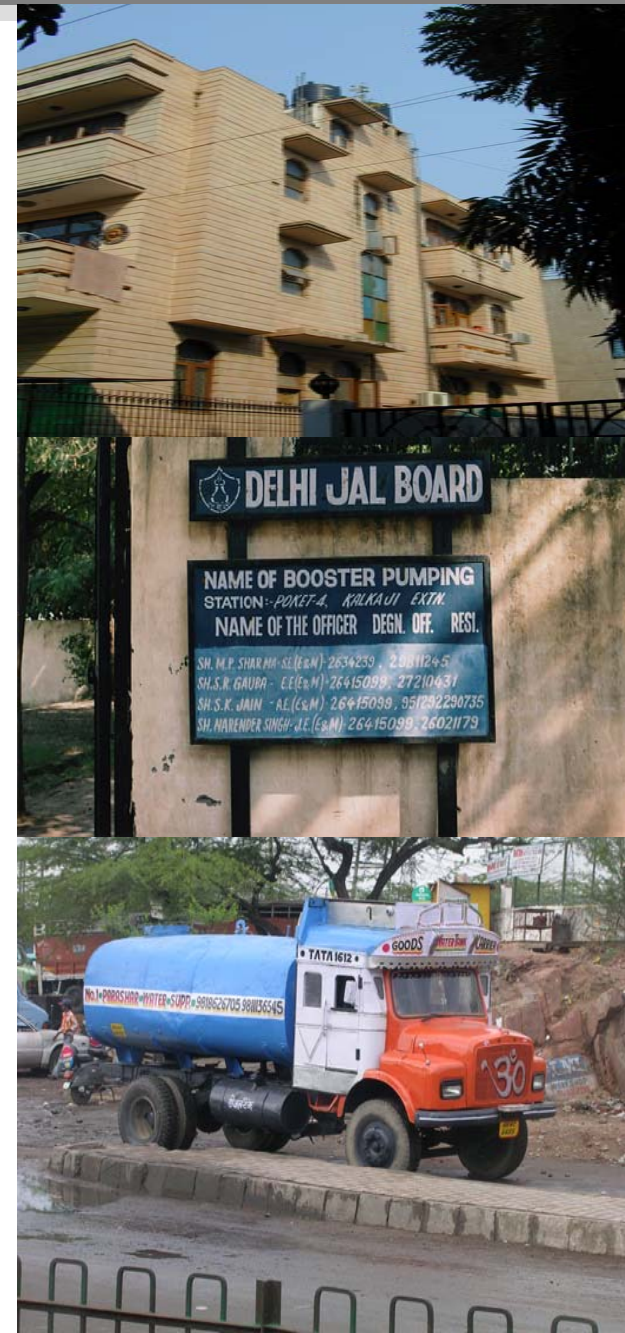
Community participation: *Strong social networking, active RWA existed. Rain water harvesting undertaken.*

General Perception: *No problem, nice surrounding, peaceful environment.*

Risk: *Low*

Exposure: *Low*

Vulnerability level: *Less*



Questions & Discussion

