Evaluating Municipal Solid Waste Burning, Improving Collection Efficiency, and Streamlining Stakeholder Management for Cleaner and Sustainable Urban Environments

Ajay Singh Nagpure, PhD

Princeton University, Princeton NJ,

Open burning of garbage in cities is important because of …..

NBT मेट्रो दिल्ली मुंबई लखनऊ

राजनीति प्रशासन क्राइम बिजली-सड़क-पानी अन्य खबरें पहले आप फ्यूचर नाउ लखनऊ टाइम्स

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AGRA: One of the major threats to the Taj Mahal — a high level of particulate matter (PM) responsible for masking the white marble sheen - is being released into air on account of large scale burning of municipal solid waste (MSW) in the city.

A joint study by the University of Minnesota and Georgia Institute of Technology to find a pattern in open burning of garbage within Indian cities has revealed that 2%-3% of garbage is burnt every day in Delhi, while at 24% it is almost 12 times more in Agra.

MSW being burnt nea service lane.

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ENVIRONMENT

How Trash Is Adding to Delhi's Air Pollution Problems

Introduction

What is open burning of Municipal Solid Waste (MSW):

"Open burning of MSW refers to MSW burned in urban neighborhoods, without the use of incinerators"

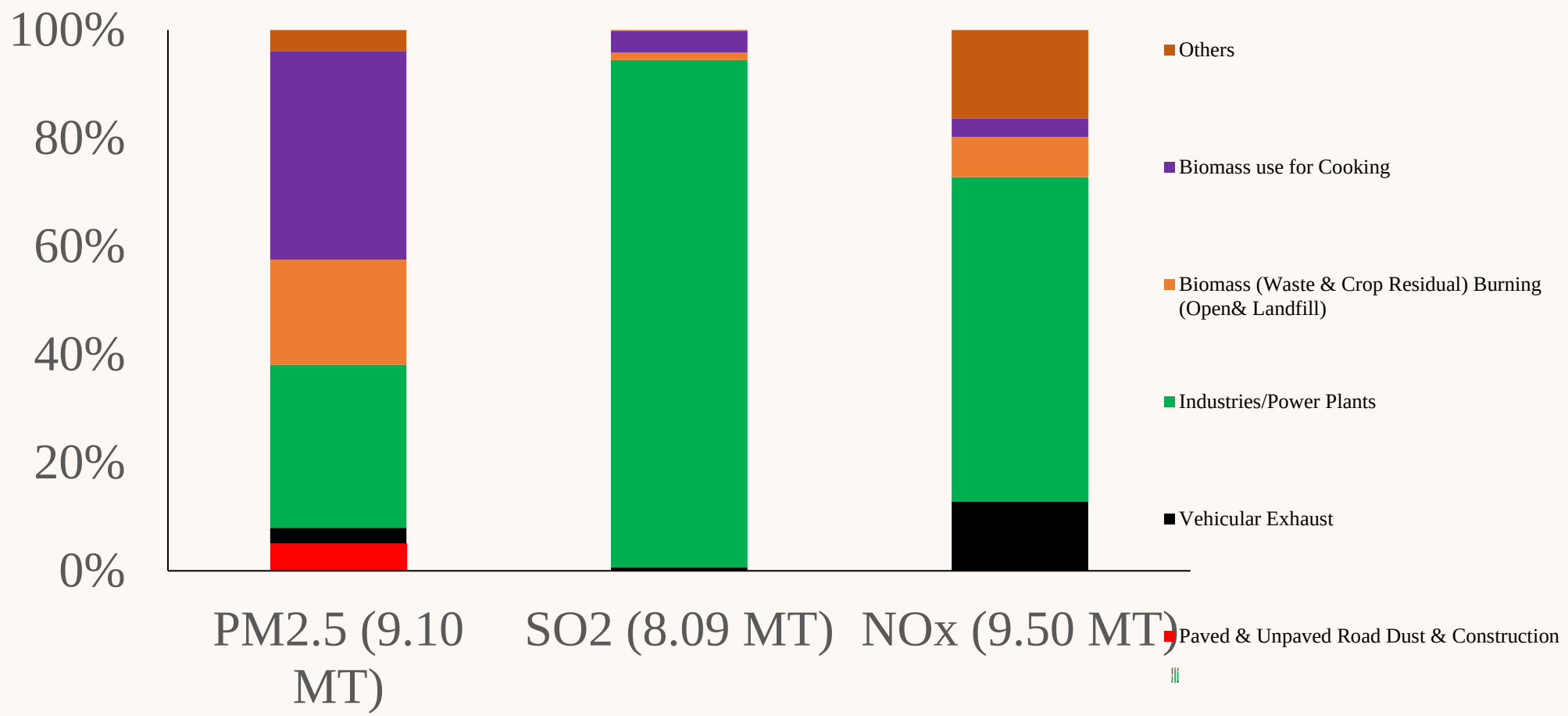
MSW-burning differs from biomass burning, as the latter traditionally has been used in the context of burning crop residues and other biogenic residues (such as dung-cakes).

MSW is not purely biomass, but includes plastics, rubber and metal-containing refuse, the burning of which releases toxic emissions.

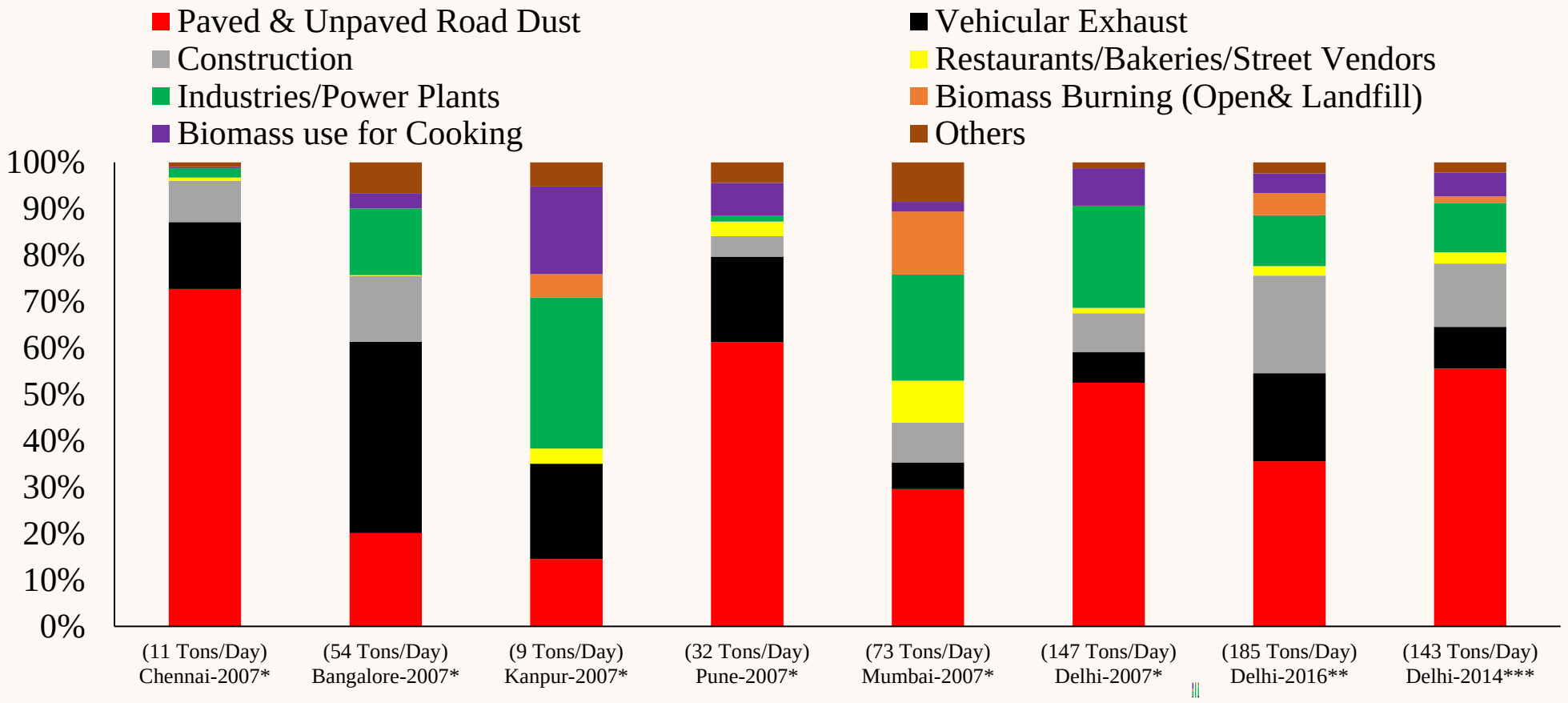
Why it is important?

- Several global estimated indicated that open burning of MSW contributes about 8% and 22% of direct PM emissions in India and China (Wiedinmyer et al., 2014)
    - Global estimates are based on top down or rules of thumb method
- No bottom up field data are available
    - Where burning is happening at the neighborhood scale in the city (spatial frequency of the MSW burning)
    - How is the frequency is affected by socio economic status (SES) of neighborhood
    - What is the composition and mass of burnt waste in the neighborhood and city
- Currently there is no field method available on assessing on intra-city variation of MSW burning phenomenon

Contributions (%) of different sources for PM2.5, SO2 and NOx in India for the year 2015



Contributions (%) of different sources for PM 10, in different Indian cities



Current Methods for MSW burning estimations (Wiedinmyer et al.,2014, IPCC, 2006)

Developing Countries

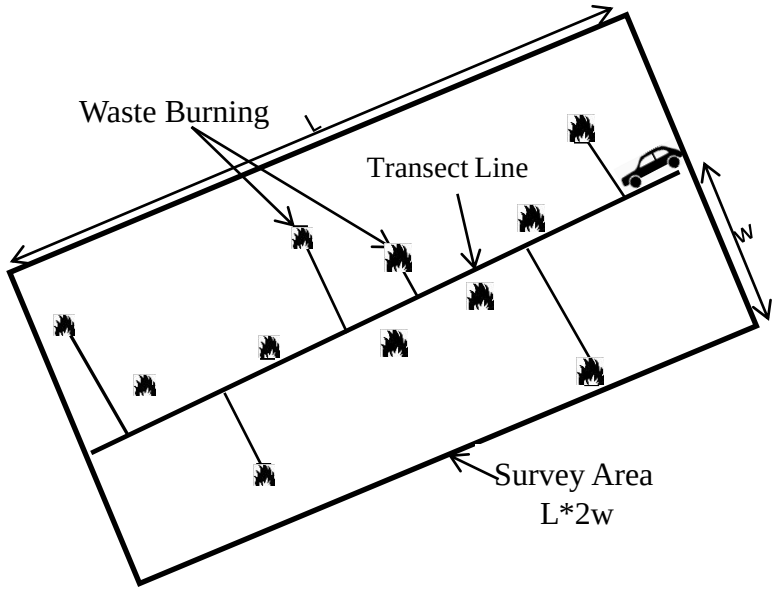
- Urban area: waste that is not collected is assumed to be burnable (assumption) .
- Rural Area: All rural population is burning waste (assumption)

Developed countries

- More than 80% urban population, no waste burning (Assumption)
- All rural population is burning waste (Assumption)

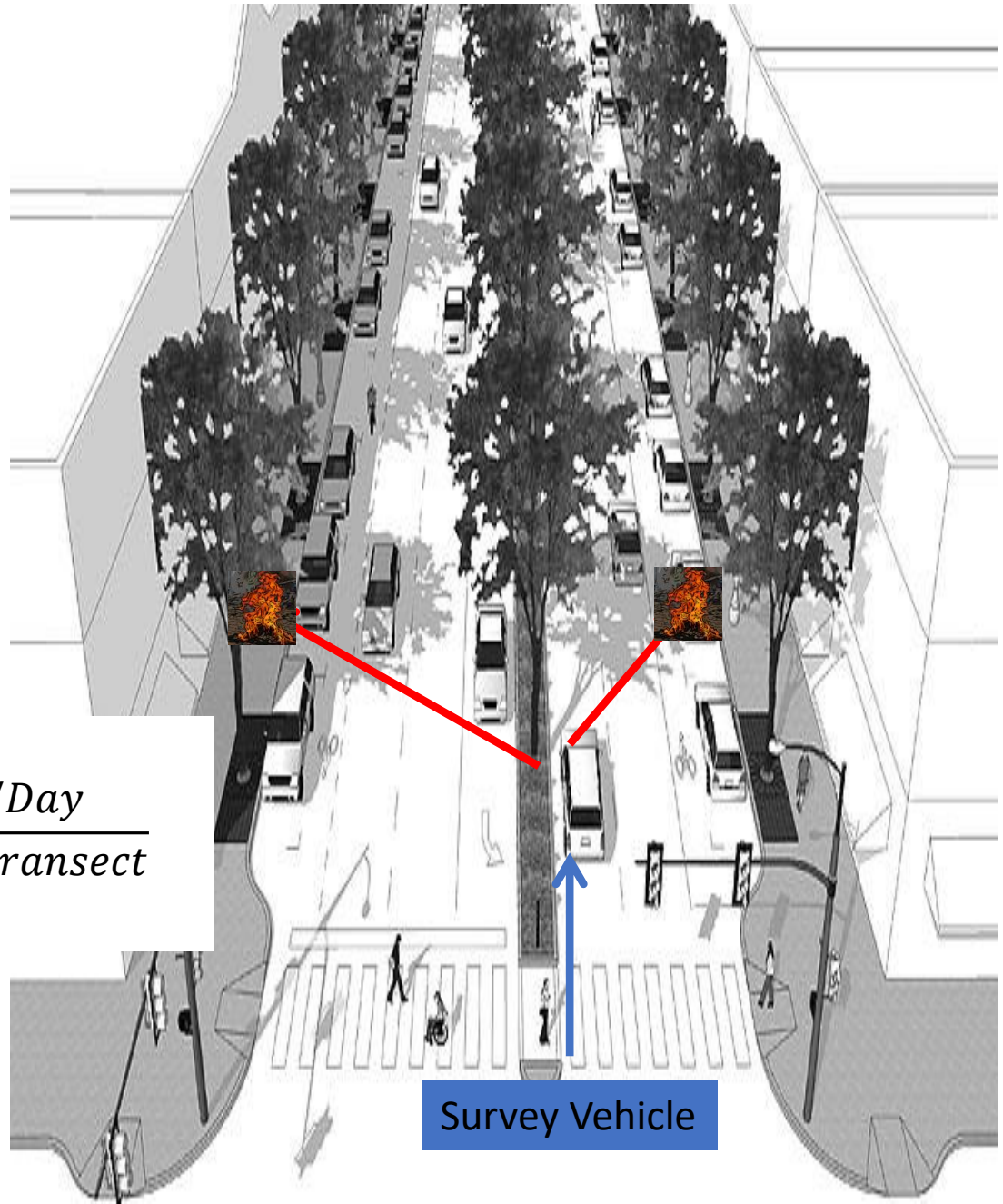
Method and Study Design

TRANSECT METHOD



Spatial Frequency

$$= \frac{Observed\ burning\ incidents\ /Day}{Width\ of\ Transect * Length\ of\ Transect}$$

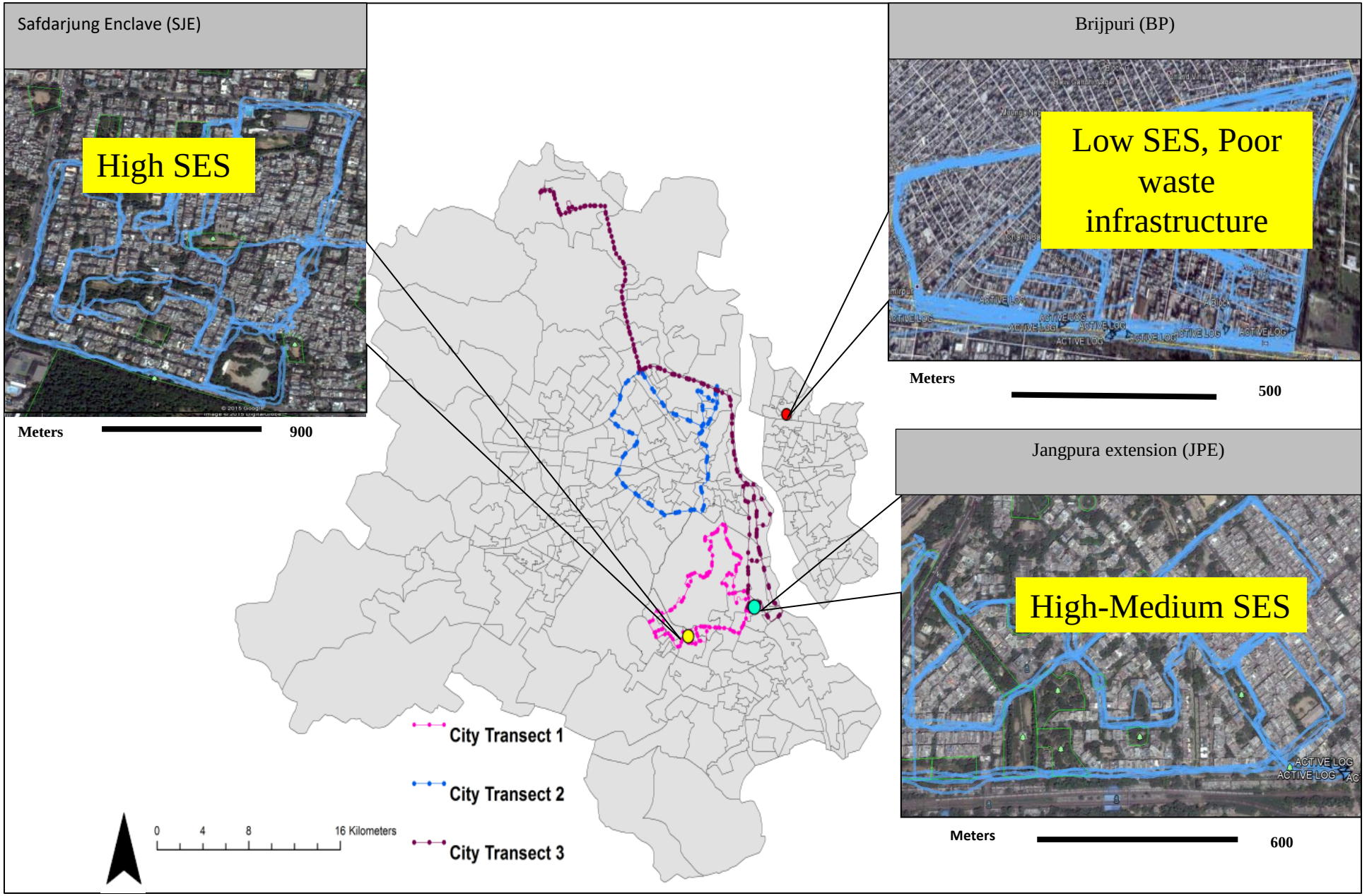


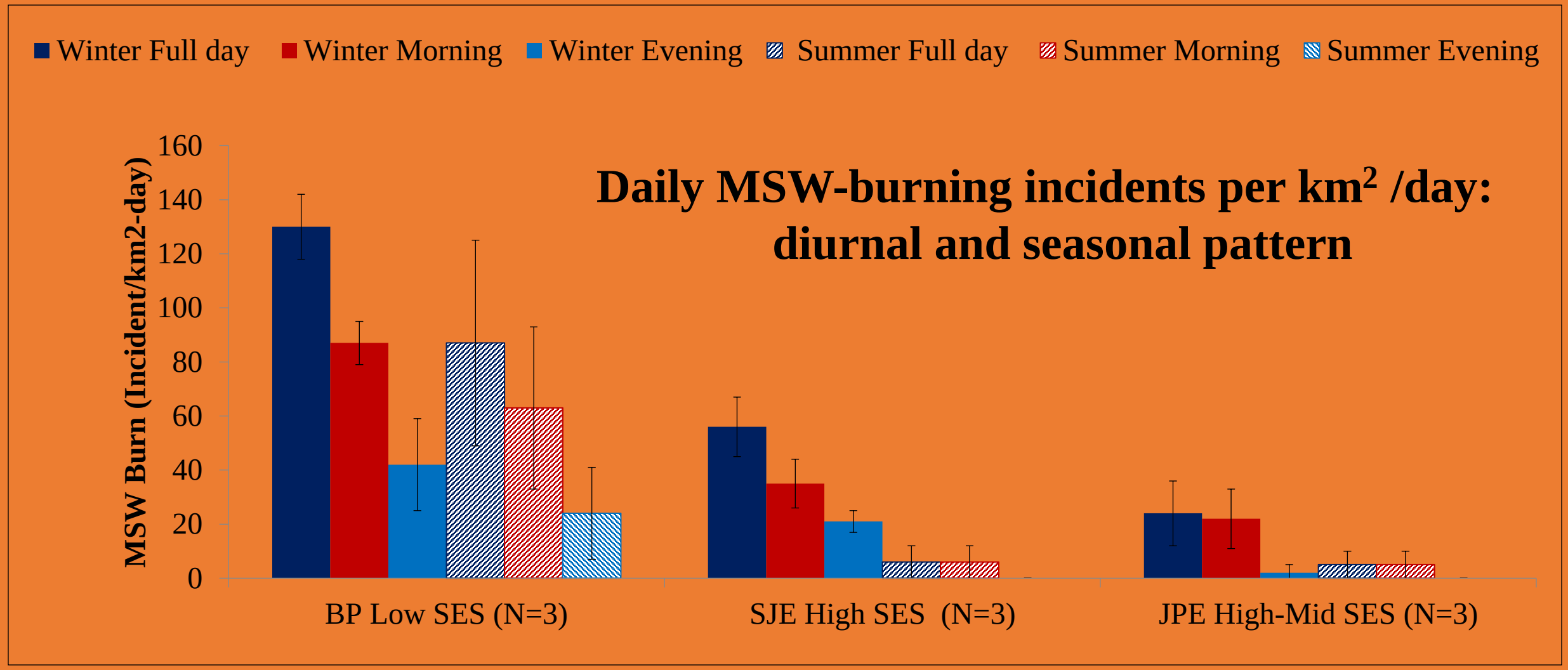
Waste Piles in Brijpuri

Why does MSW Burning happen even though it is banned by law ?

Qualitative interviews with waste handlers

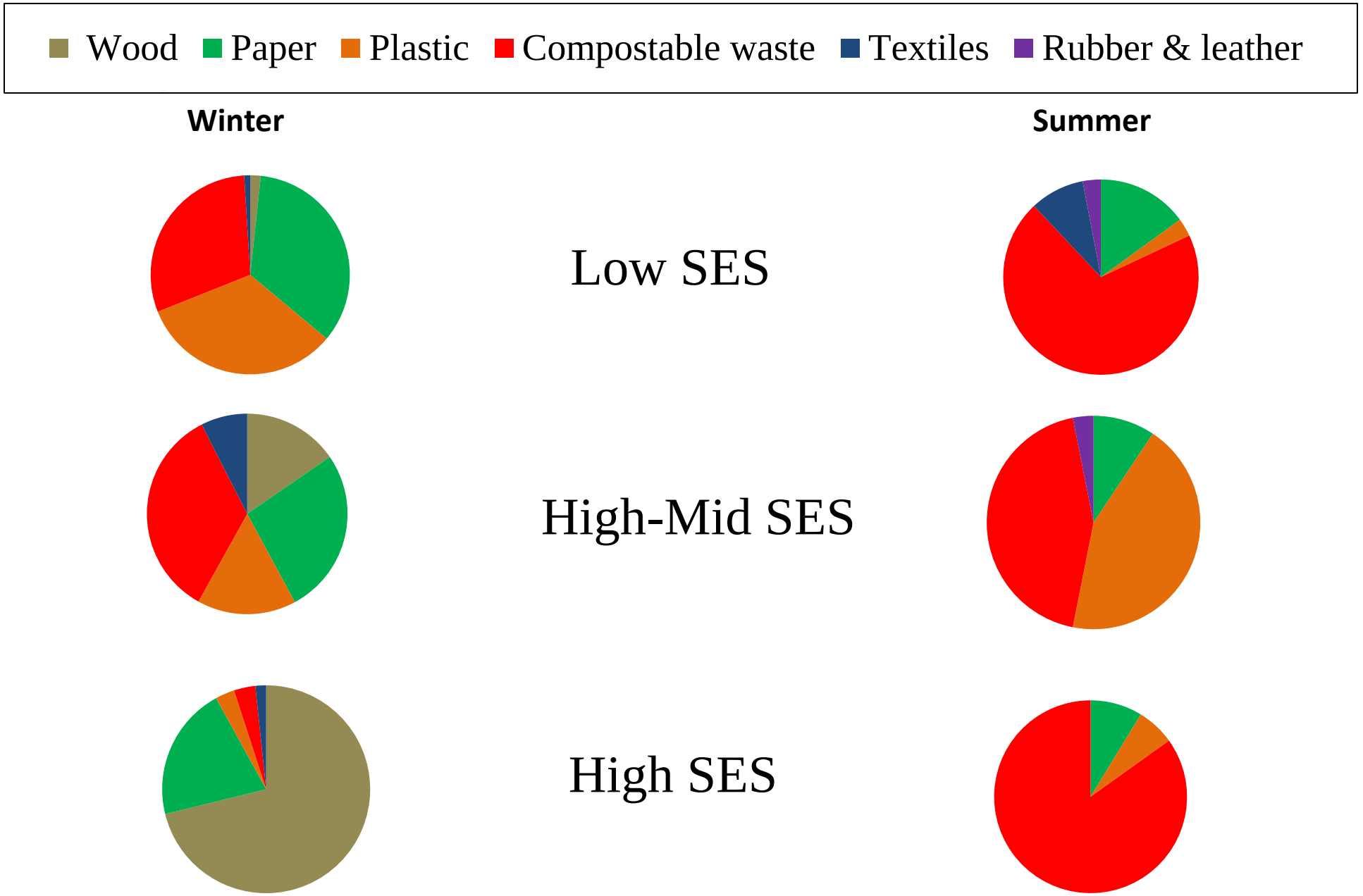
Neighborhood Selection: Brijpuri (BP): low SES; Safdarjung Enclave (SJE): high SES; Jangpura extension (JPE): high and medium SES;



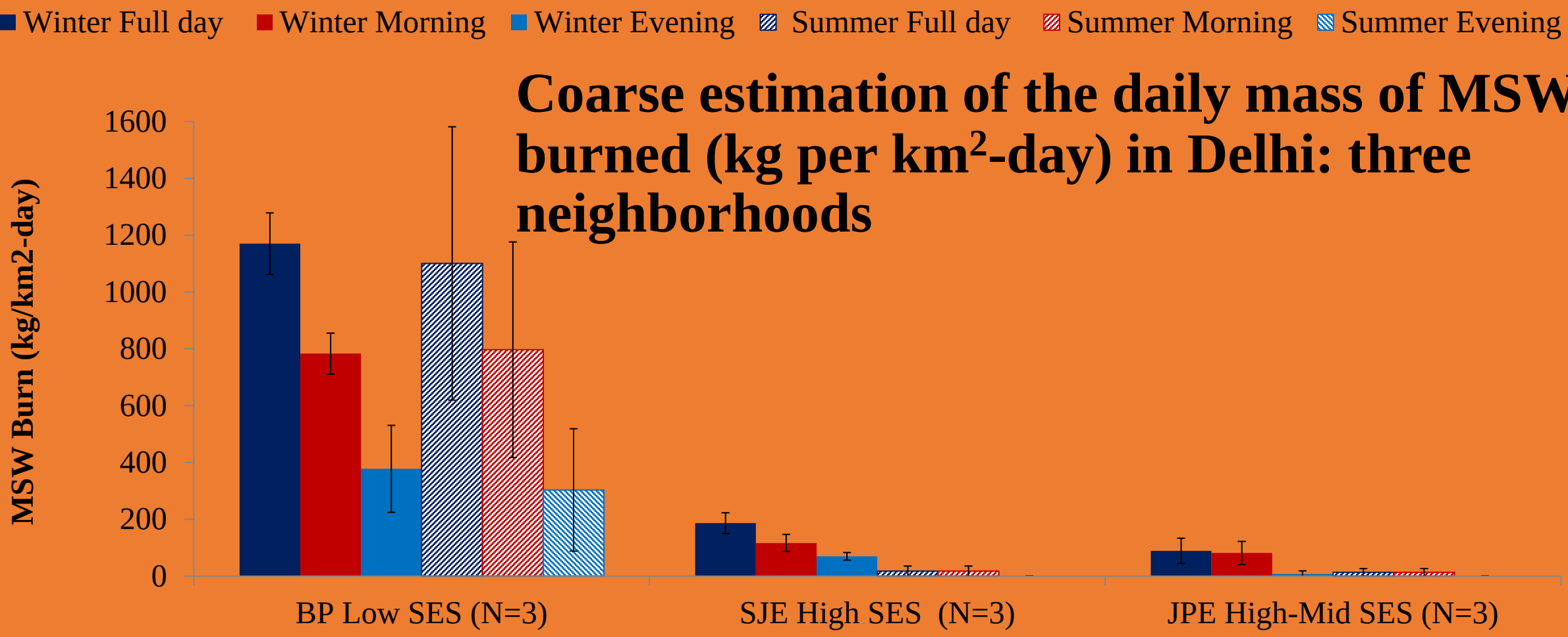


Daily MSW-burning incidents per km^2 /day: diurnal and seasonal pattern

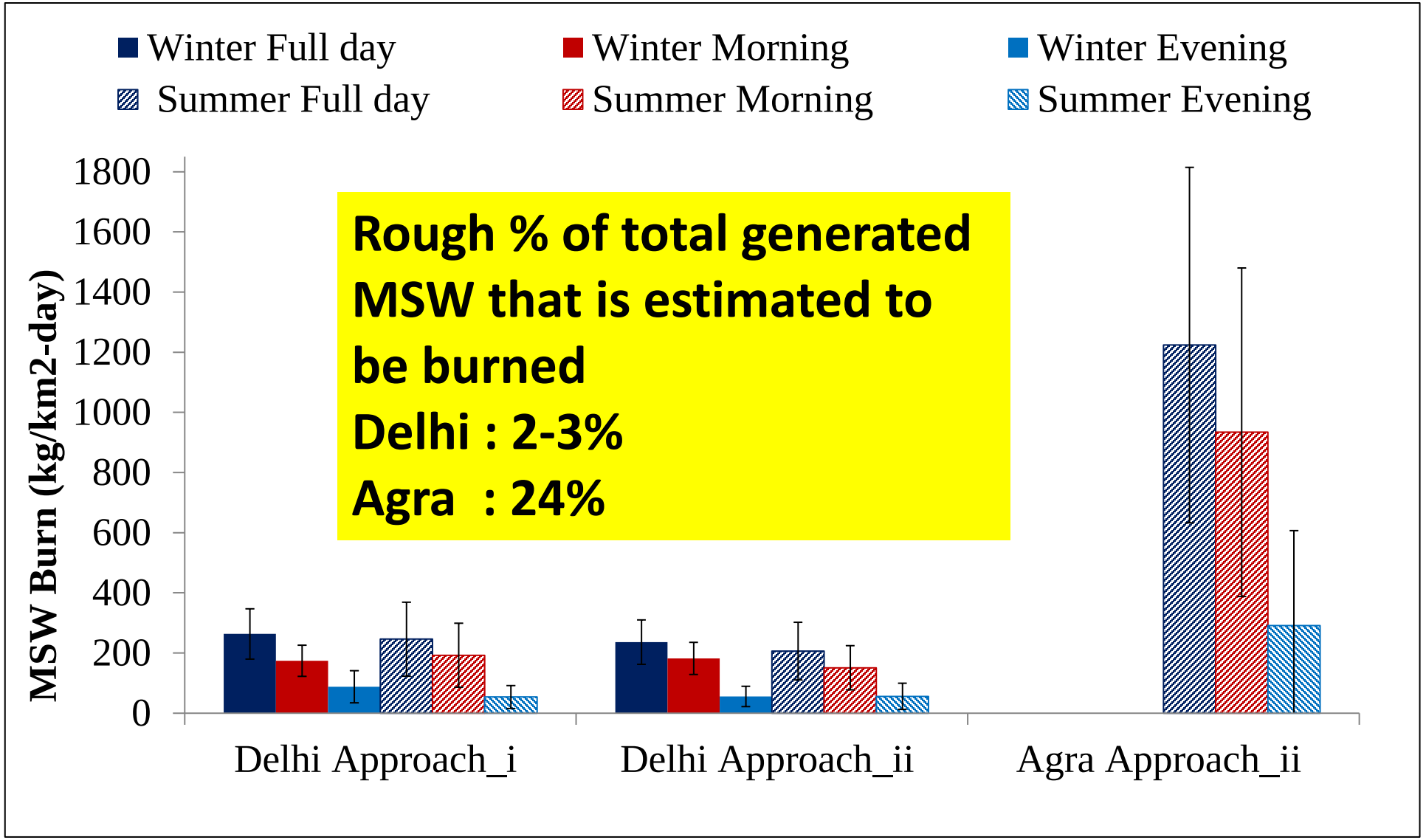
Composition of burnt MSW observed during transects in Delhi



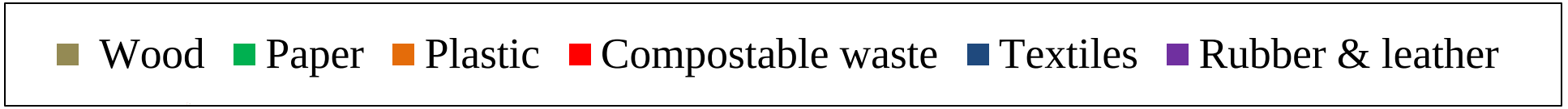
Coarse estimation of the daily mass of MSW-burned (kg per km^2-day) in Delhi: three neighborhoods



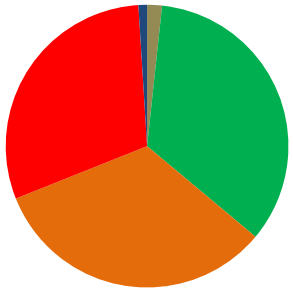
Coarse estimate of the city-average daily mass of MSW burned in kg per km^2 during winter and summer in Delhi and Summer in Agra



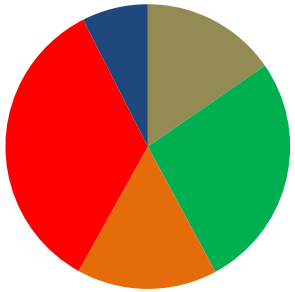
Composition of burnt MSW observed during transects in Delhi and Agra



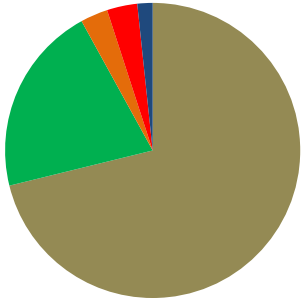
Winter



Low SES



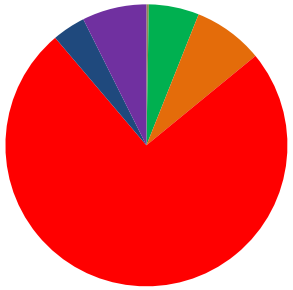
High-Mid SES



High SES

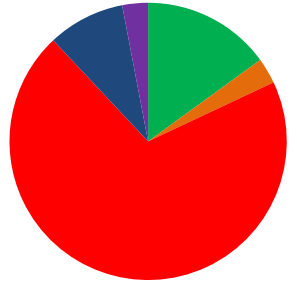
Summer

Cross City Agra

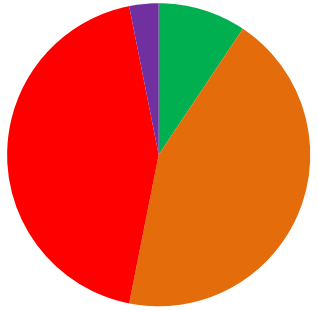


Cross city transect in Agra cover ed14 neighborhoods

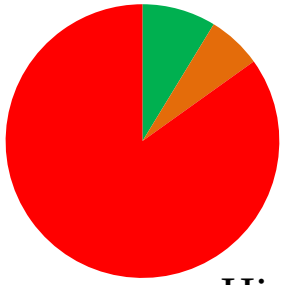
Summer



Low SES

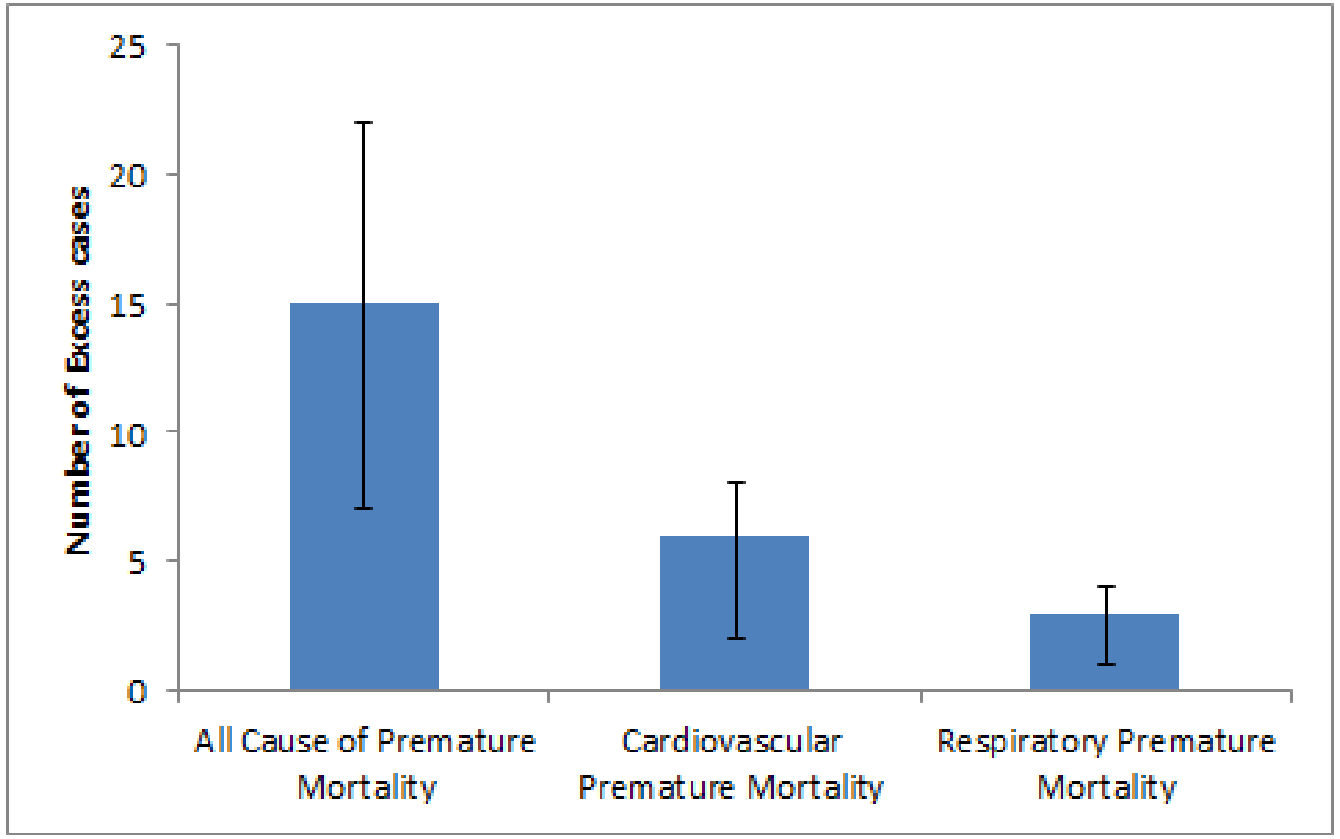


High-Mid SES



High SES

Combined Health Impacts Assessment from MSW and DC burning in Agra

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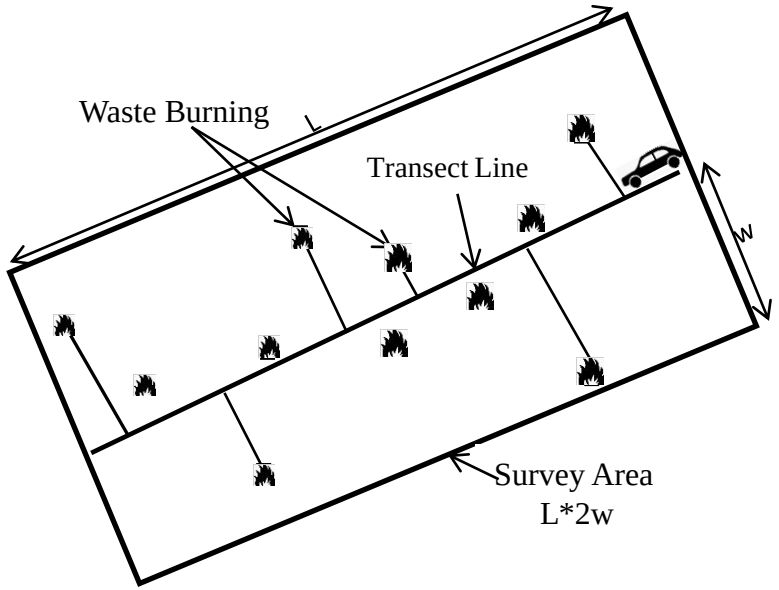
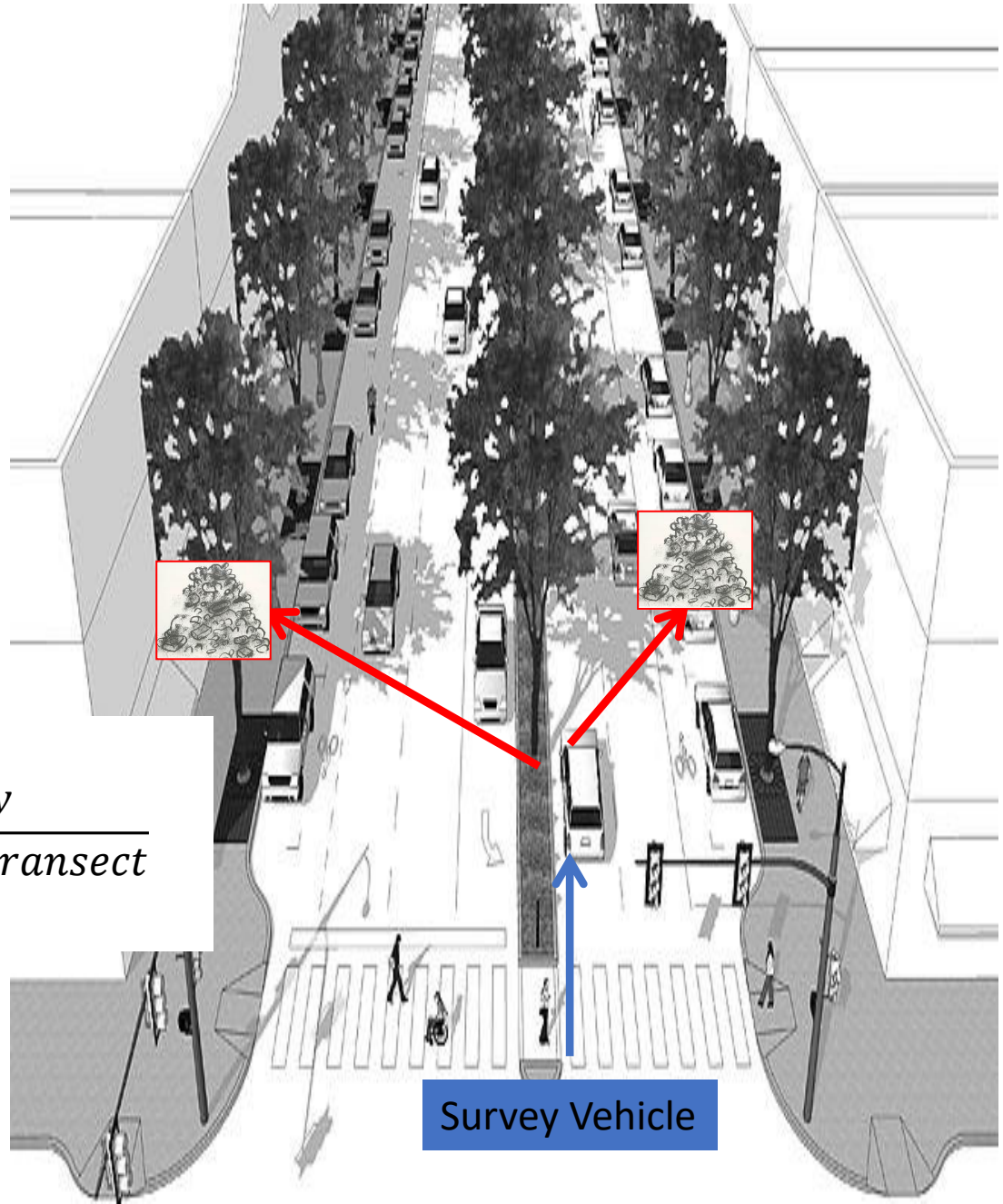


Spatial Frequency

$$= \frac{Observed\ MSW\ Piles\ /Day}{Width\ of\ Transect * Length\ of\ Transect}$$



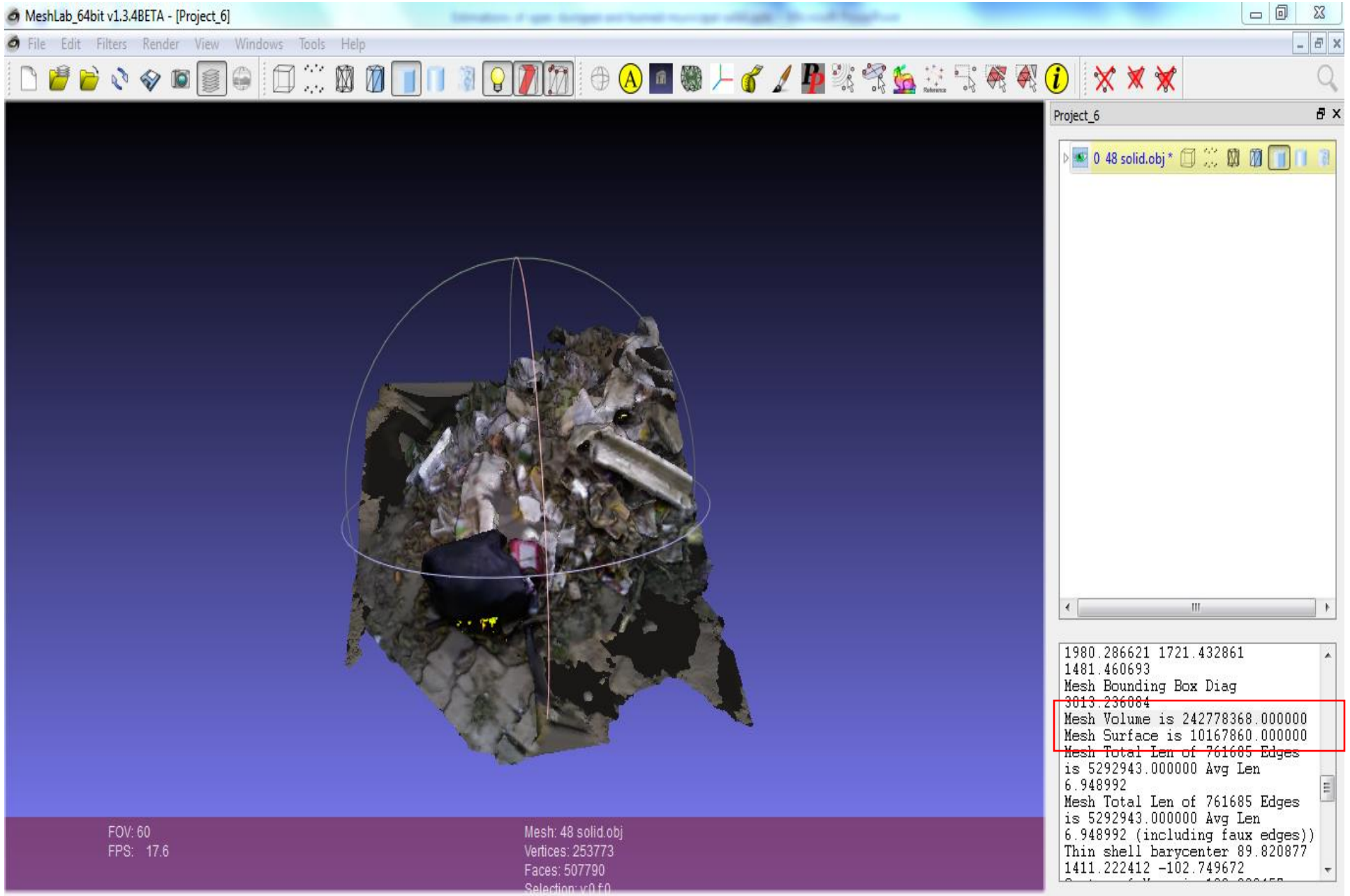
Mass and Composition Estimation

Direct measurement if MSW piles are small

For the bigger MSW piles

1. Bucket Volume = 0.02 m^3
2. Bucket Weight = 0.6 kg
3. MSW weight with bucket = 1.55 kg
4. MSW weight without bucket = 0.95 kg
5. MSW weight 1m^3 = 47.5 kg
6. MSW weight 0.24 m^3 = 11.53 kg

For 3d Scan Mesh volume estimation, MeshLab Software have been used

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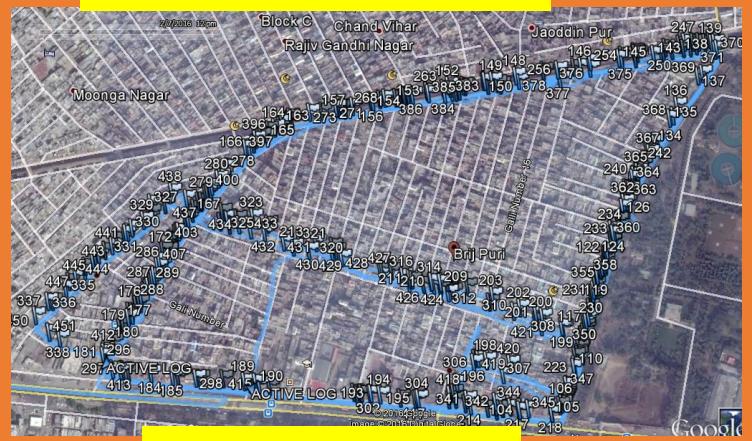
Study Areas

(1) Brijpuri & Chandbag (BP & CB),
(2) Jangpura Extension(JPE)
(3) Safdarjung Enclave (SJE)
(4) Bhogal (BG)

	BP & CB	BG	JPE	SJE
SES	Low	Medium	High & Medium,	High
MCD Colony Category	F&G	C	B	A
Population in person	34519	11300	7007	18344
Number of HH	5939	2441	1596	4341
HH Size	5.81	4.63	4.39	4.22
Area (km^2)	0.397	0.33	0.347	1.251
Density (Person/km^2)	86950	34105	20193	14663
Per capita MSW generation (kg)	0.172	0.385	0.385	0.396
Total Generation (kg)	5937	4351	2698	7264

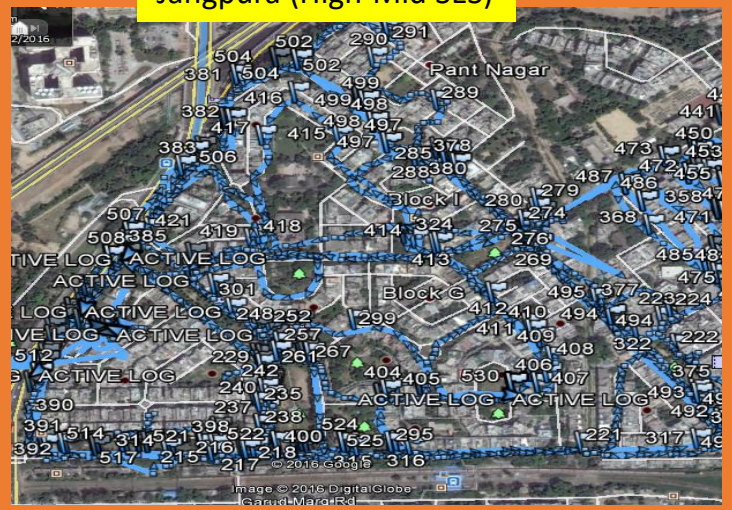
Study Areas

Brijpuri & Chandbag (Low SES)

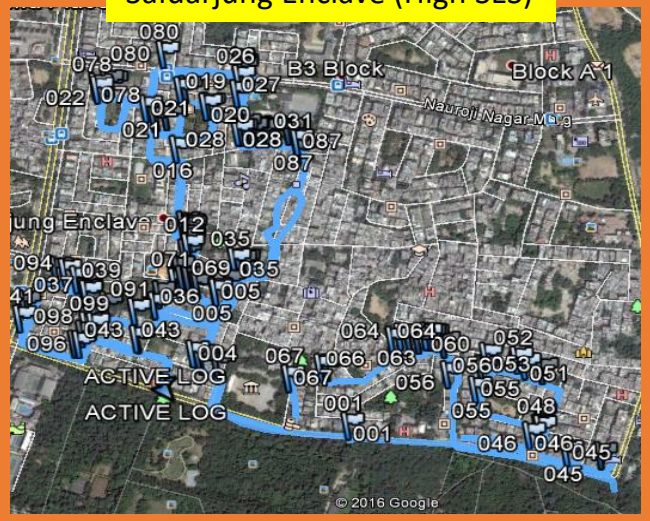


Bhogal (Mid SES)

Jangpura (High-Mid SES)

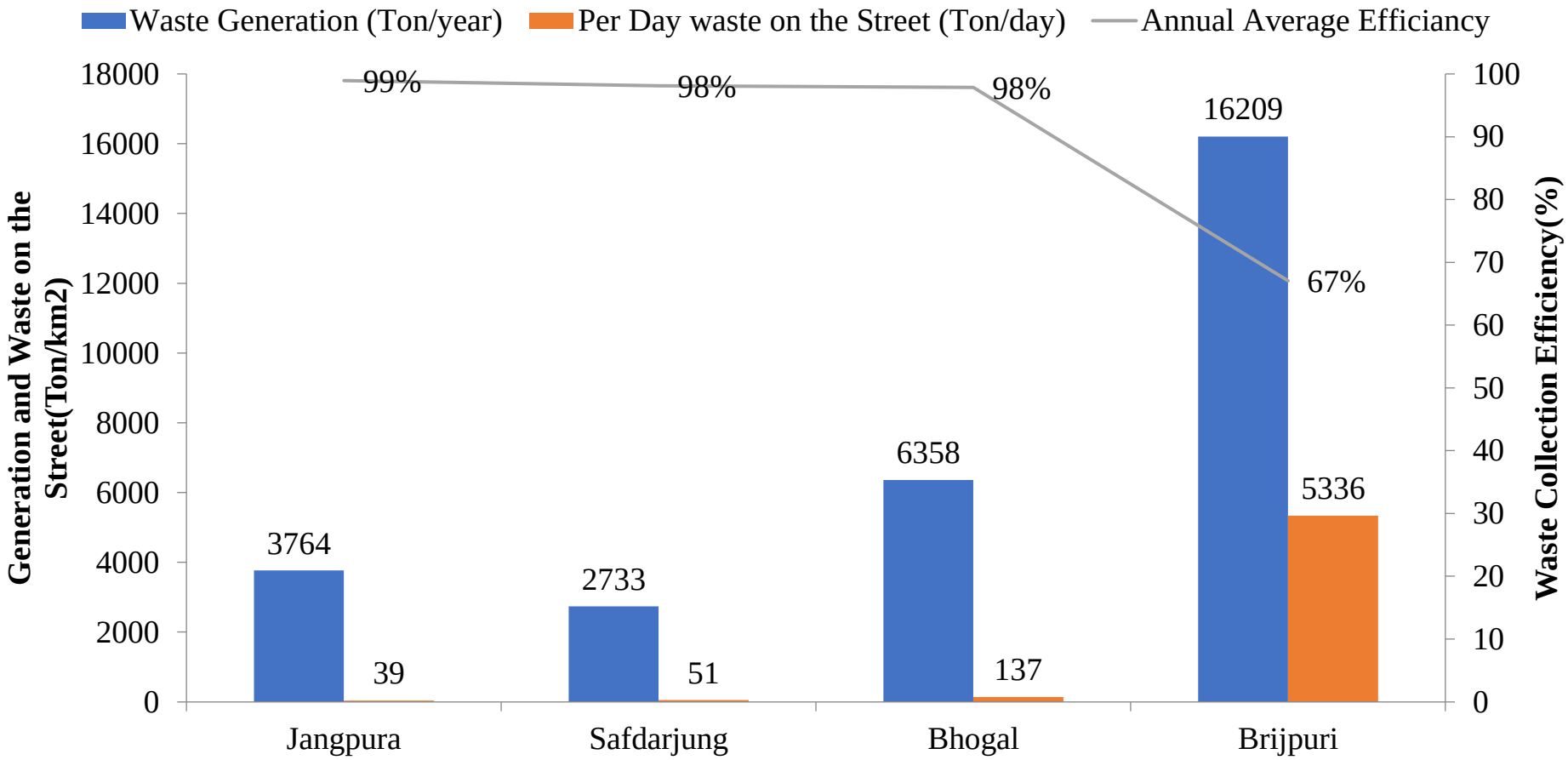


Safdarjung Enclave (High SES)



Result and Discussion

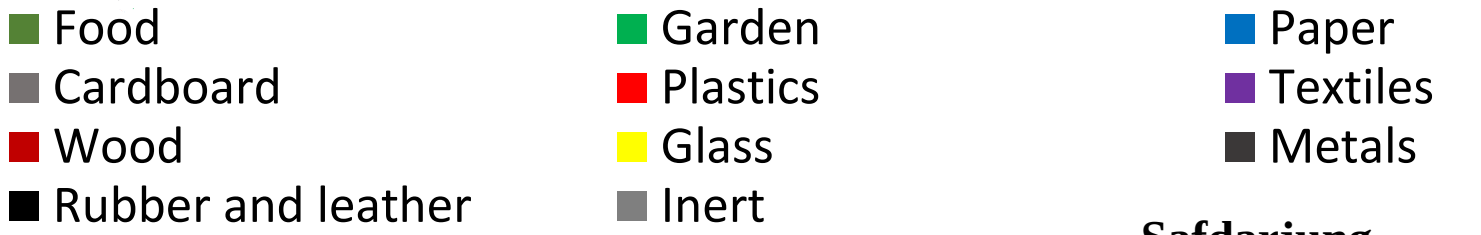
Waste Generation, waste on the street and waste collection efficiency

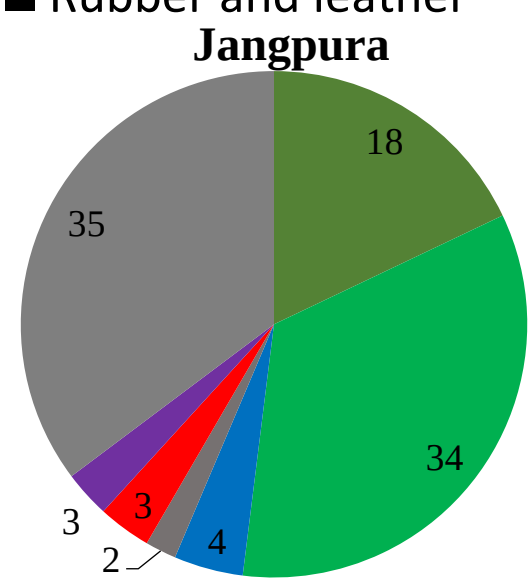


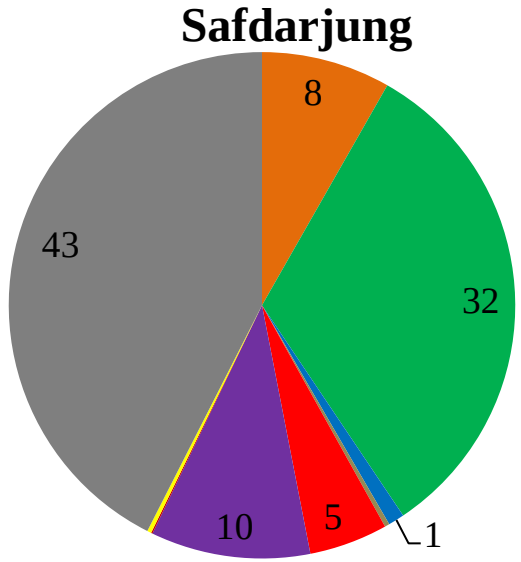
Note: Similar per capita generation data have been used for all neighborhoods, which is based on total generation data given for Delhi,

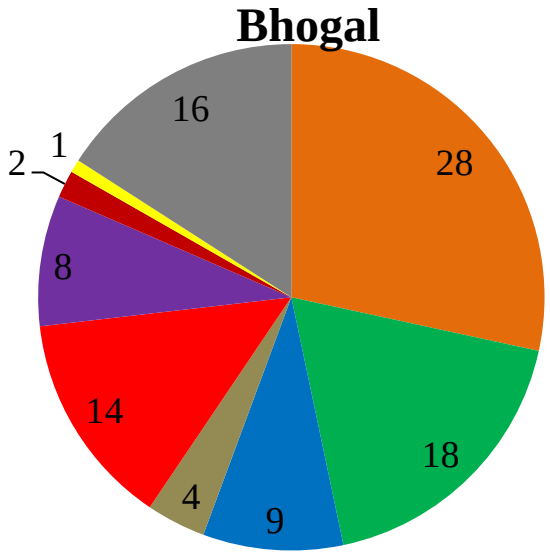
Since it is hard to predict waste accumulation time, therefore one year time have been consider for all waste accumulation

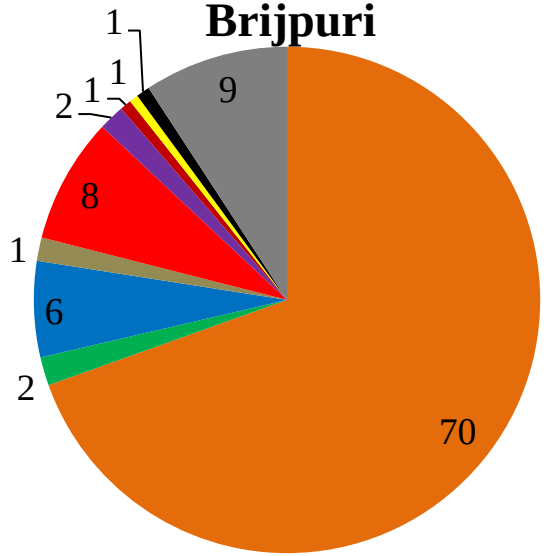
Composition (0-25 kg piles)



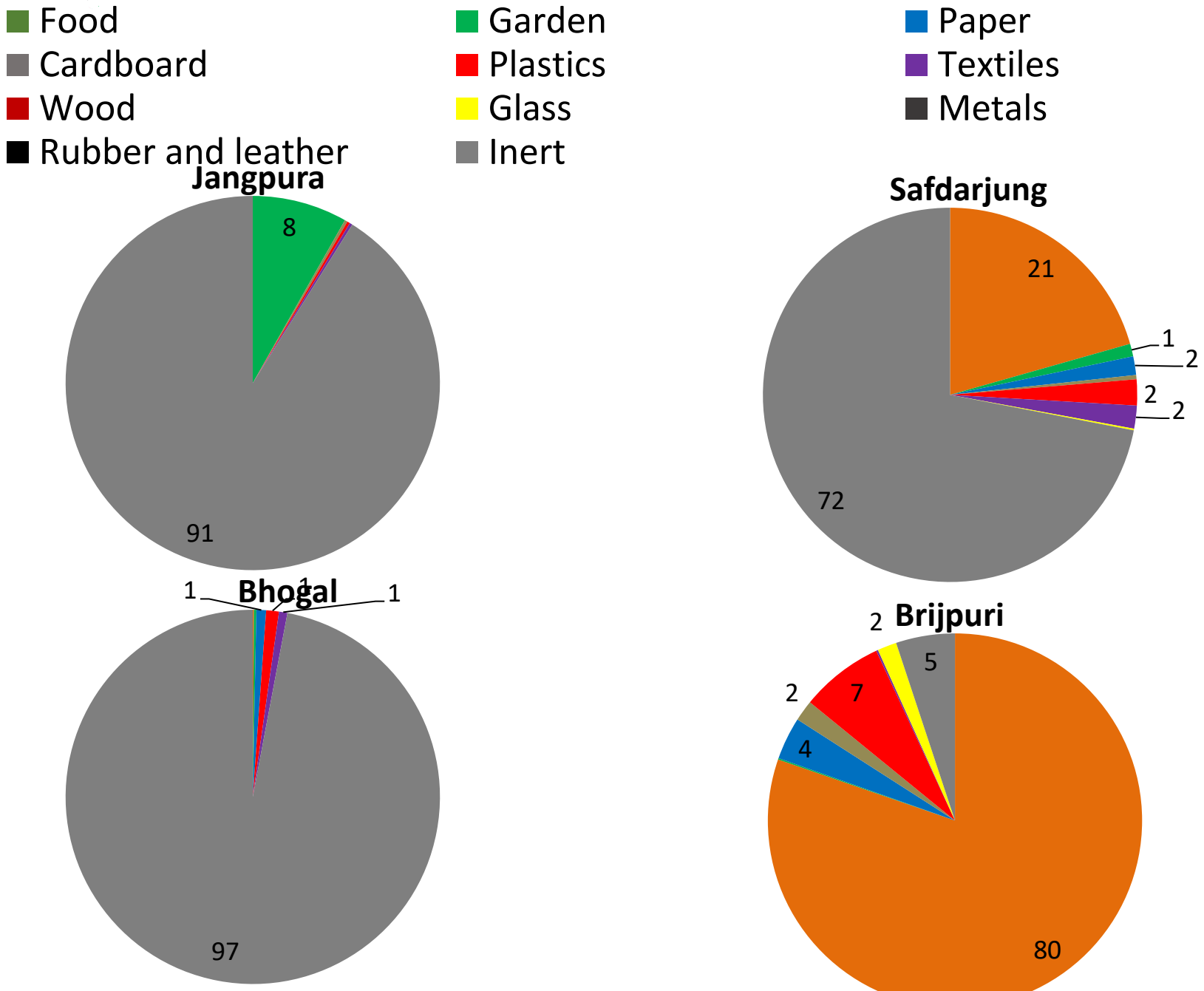




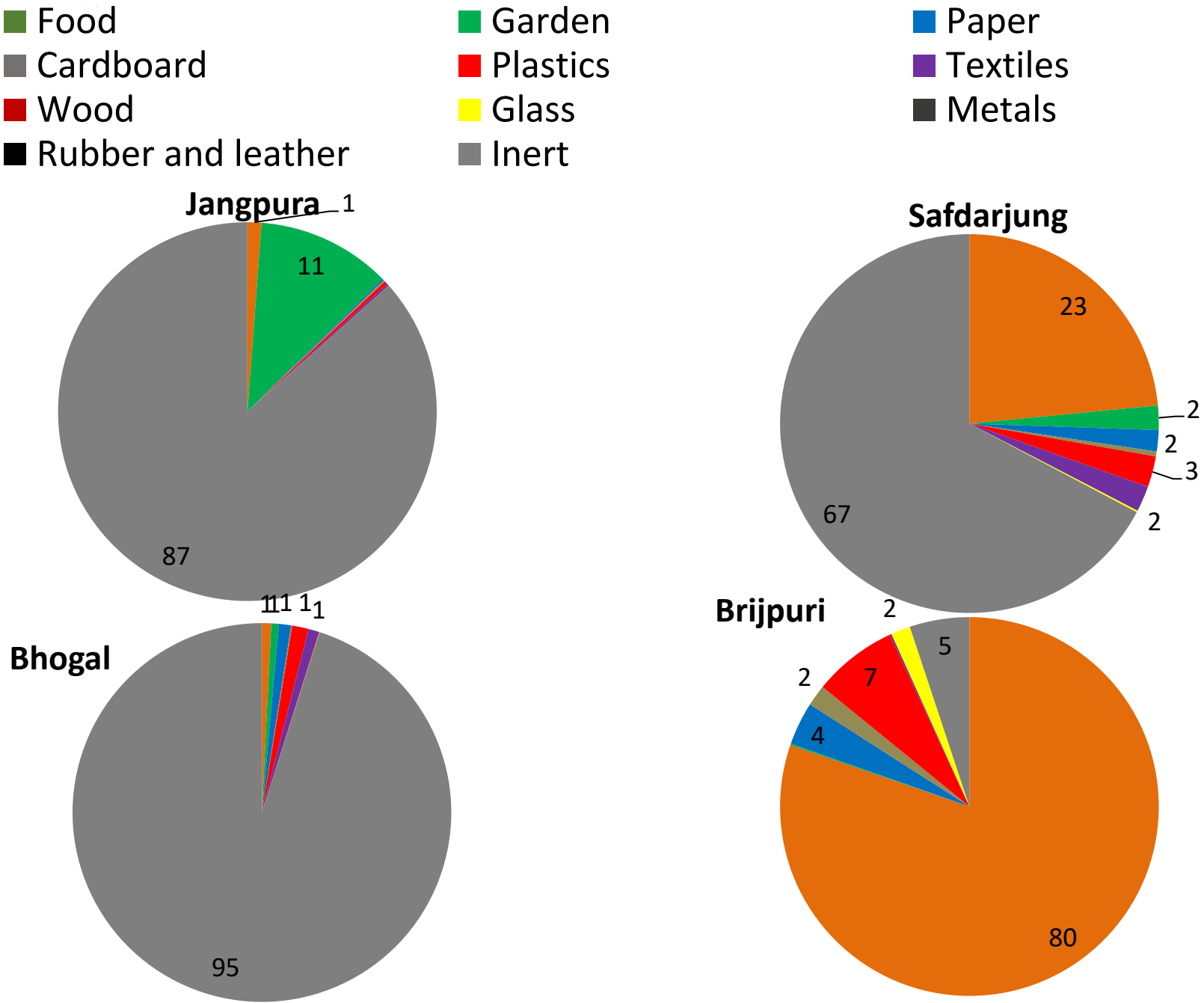




Composition (>25 kg piles)



Composition (all piles)



MSW Management

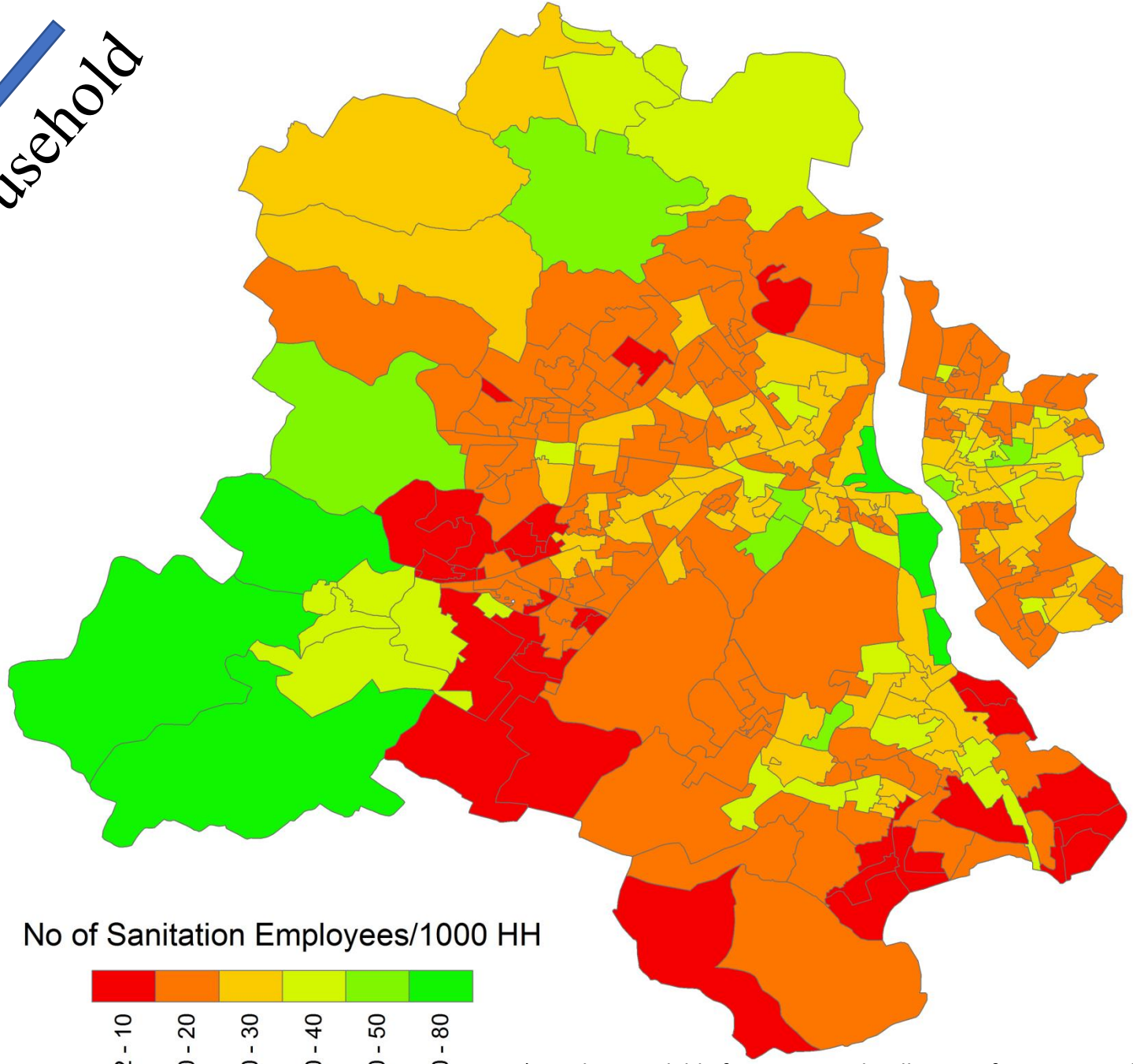
	Jangpura	Safdarjung	Bhogal	Brijpuri
Population Density (Population/km2)	20193	14663	34105	86950
Generation-kg	7774	5807	13130	14955
Waste on street (0-25 kg)-kg	1317	1479	3332	8157
Waste on the neighborhood (>25kg)-kg	51805	46100	133744	5327905
Total Waste on the area (Average)-kg	39083	51114	137076	5336061
Efficiency (%)	83	75	75	45
Per Capita				
Generation (kg)	0.39	0.40	0.39	0.17
Waste on street (0-25 kg) -kg	0.07	0.10	0.10	0.09
Waste on the neighborhood (>25kg)-kg	2.57	3.14	3.92	61.28
Total Waste on the area (Average)-kg	1.94	3.49	4.02	61.37
Waste Management				
Neighborhood Association (NHA) Available	Yes	Yes	Yes	Yes
Role of NHA in MSW Management	Yes	No	No	No
MCD Collection	Yes	Yes	Yes	Yes
Collection by Private waste handlers	Yes	Yes	Yes	No
Waste Collection Center/1000 HH (Based on Ward Data from MCD)	2.72	2.26	1.19	0.15
Number of Sanitation Employees/1000 HH	30	21	20	13

Scale up at city level

Per Capita waste on the street and neighborhoods characteristics

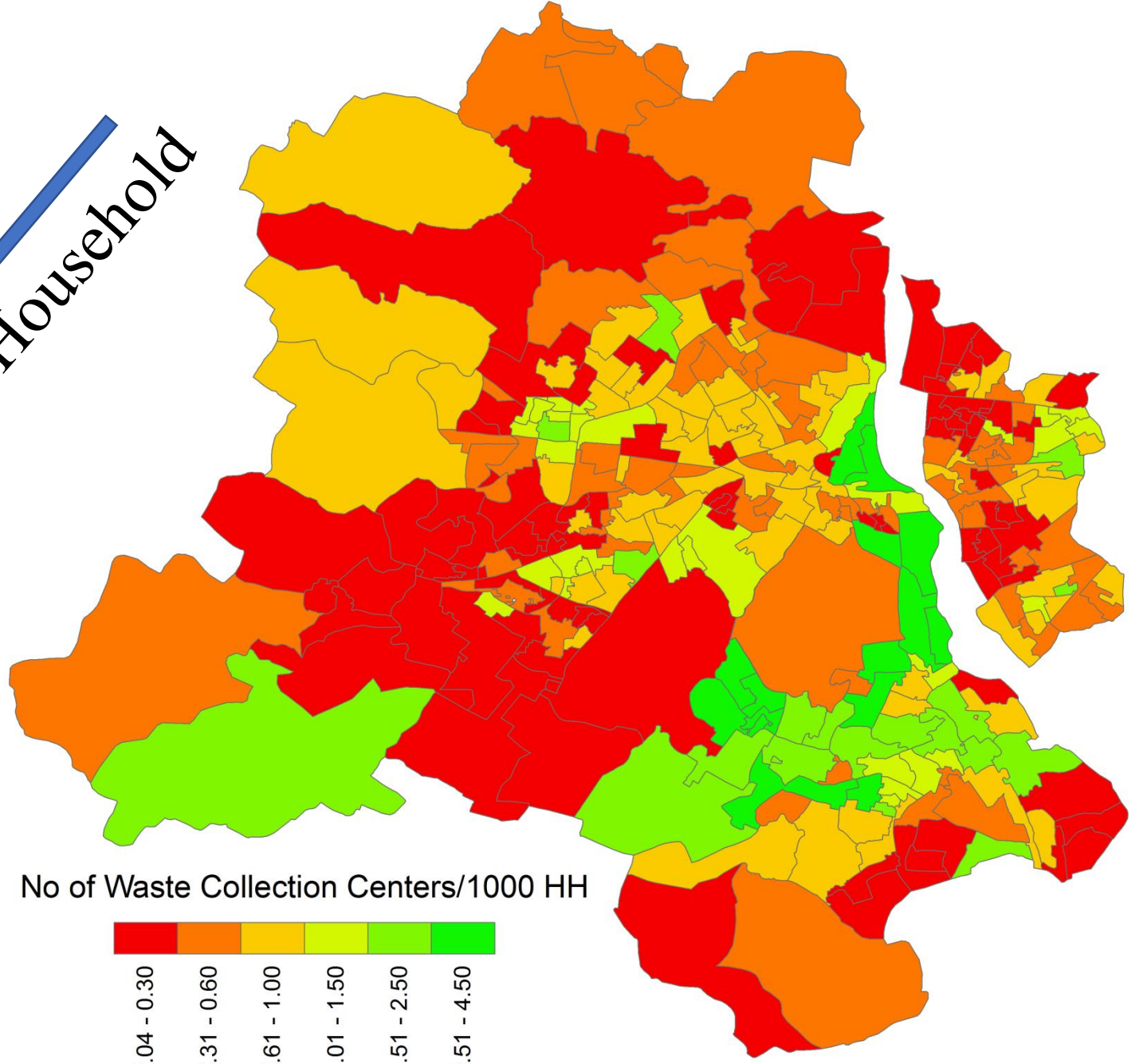
	Brijpuri	Bhogal	Safdarjung Enclave	Jangpura	R2 with waste on the street
Ward No	269	156	163	157	
Waste on the street (Kg/Capita)	61	4	3	2	
Santation Employee (1000/HH)	13	20	21	30	0.61
Waste Collection Center (1000/HH)	0.15	1.19	2.26	2.72	0.71
Average Colony Cat weight	25	58	75	61	0.87
Literates Population Male (%)	70	85	88	87	0.97
Literates Population Female (%)	60	78	85	79	0.92
Total Worker Population Male (%)	47	55	57	56	0.94
Total Worker Population Female (%)	5	13	22	17	0.76
Households with Good condition (%)	49	80	84	73	0.91
Material of Roof (Concrete) (%)	38	71	89	86	0.89
Drinking Water from treated source (%)	58	95	99	97	0.99
Waste water outlet connected to Closed drainage (%)	5	94	98	93	0.99
Type of Fuel used for Cooking LPG/PNG (%)	89	93	96	94	0.82

1000 Household



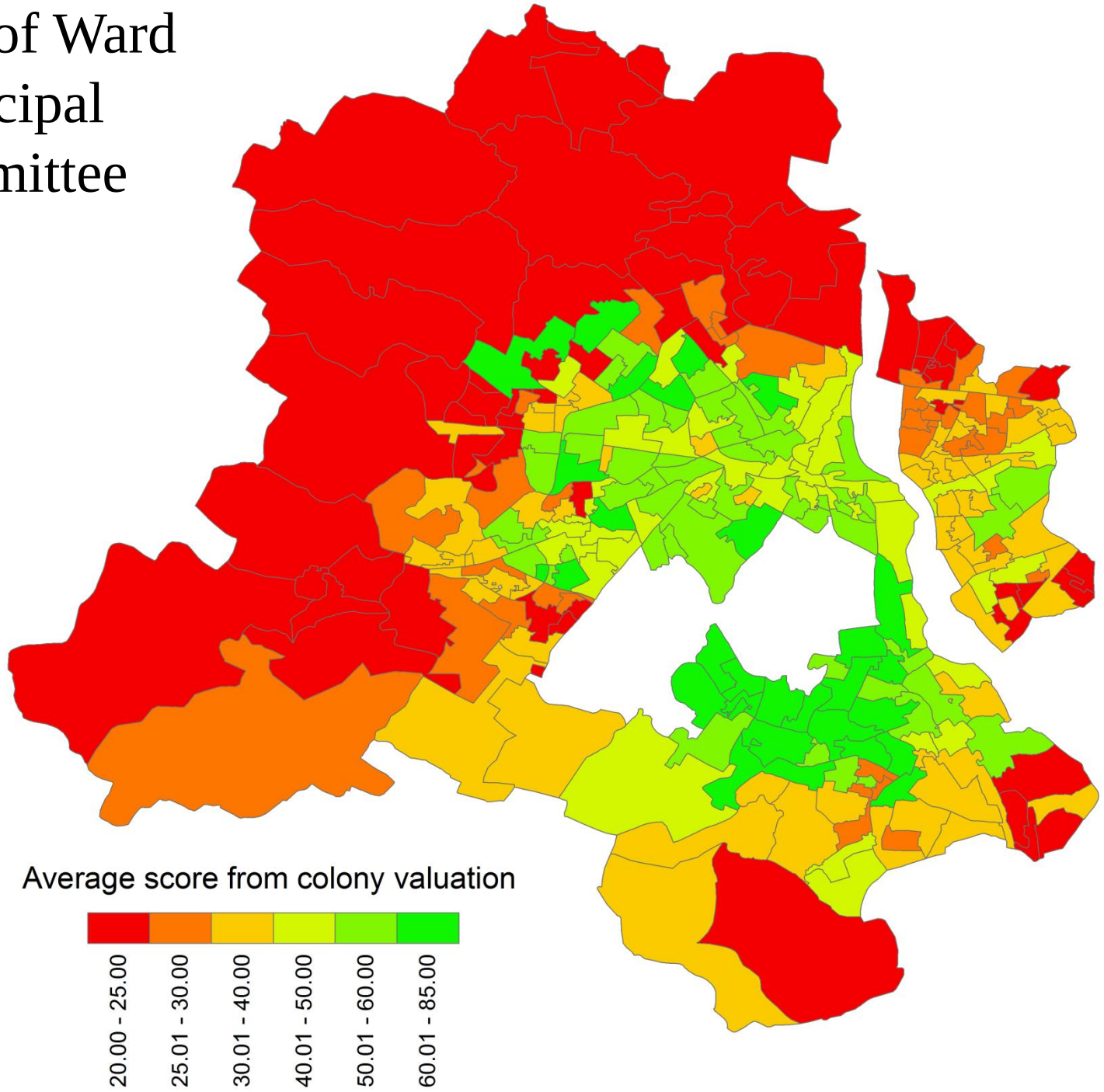
* No data available for NDMC and Delhi Cant, for NDMC and Delhi cant data from similar ward have been taken

1000 Household



* No data available for NDMC and Delhi Cant, for NDMC and Delhi cant data from similar ward have been taken

Average score of Ward based on Municipal Valuation committee colony score

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Proposed Interventions

Proposed Policy or Criteria	Implementation Duration	Implementing Agency/Stakeholder
Organic waste converter for prominent societies, colonies, etc.	2021-2030	SMC (with support from NGOs, SHGs, RWAs, ragpickers)
Decentralized waste to compost plant	2021-2030	SMC (with support from NGOs, SHGs, RWAs, ragpickers)
Recovery facility	2021-2030	SMC (with support from NGOs, SHGs, RWAs, rag pickers, and private sector)
Awareness program	2021-2023	SMC (with the help of NGO's and SHG)
Monitoring of open burning of MSW	2021 -2030	SMC
Prevention of textile or thread burning (gasification plant)	2021-2030	Industries' Association, GPCB, GIDC, SMC
Closure of old dumping site Bhatar	2021-2025	SMC, GPCB