Network Literacy

Network Question:

Documentation of a Mumbai city in India. Looking at how the transport infrastructure is growing across the city.

Why this Question:

To know how the city is growing and is there any pattern of growth.

Research Question:

Does city forms the pattern while it's growing in terms of transport infrastructure?

Does transport infrastructure contribute to change of cityscape?

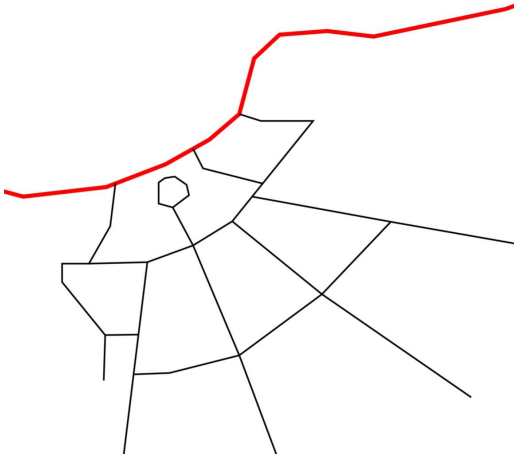
Objective / Method:

Try to quantify measures of growth of city by measuring surface area, try to characterise growth of spatial networks locally (e.g. zooming in to the network).

Quantitatively characterise growth: is it in grid like or tree like networks?

Bharvi & Paras

Bharvi & Paras



Bharvi & Paras

Nagpur,Maharashtra. How the growth of transport infrastructure developed from tree network to grid network.

Bharvi & Paras

How has the recent infrastructure changed the transport routes in Mumbai?

These major infra projects include the Mumbai Trans Harbour Link, Navi Mumbai International Airport, Mumbai Coastal Road, Delhi Mumbai Industrial Corridor, Mumbai Ahmedabad High-Speed Rail, Goregaon-Mulund Link Road, and the planned underground tunnel between Borivali and Thane.

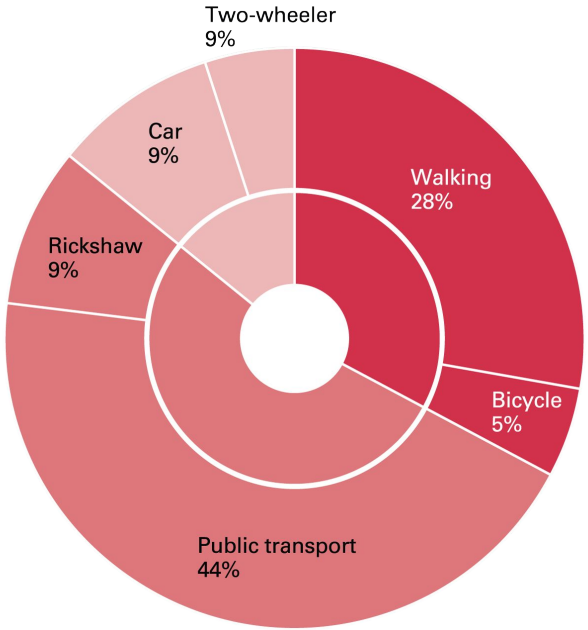
The modes of transportation in mumbai : Railways (Mumbai Suburb Rail)The Mumbai Suburban Railway comprises a major 6 line – Western Line, Central Line, Harbour Line, Trans-Harbour Line, Nerul–Uran line and Vasai Road–Roha line. Each of these corridors may consist of additional lines that may intersect with each other, Buses BEST (Brihanmumbai Electric Supply & Transport), Private vehicles , Metro , Monorail ,Electric buses and some virtual taxi , bus and auto apps like OLA , Uber, Meru, Easy cab, Taxi for sure , Tab cab, Rbus, Cityflo etc.

Methods:

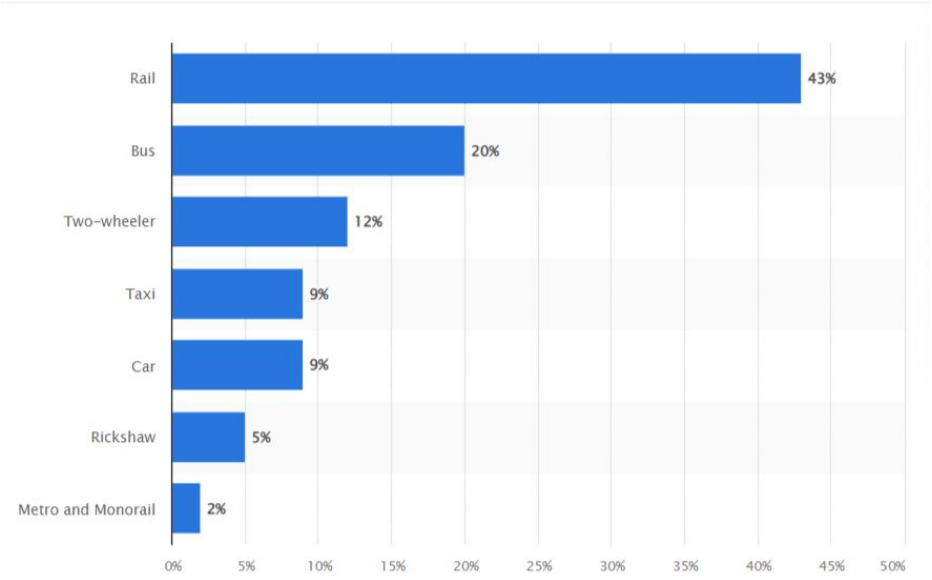
Reference links: https://trift.io/mumbai/public-transport-information/

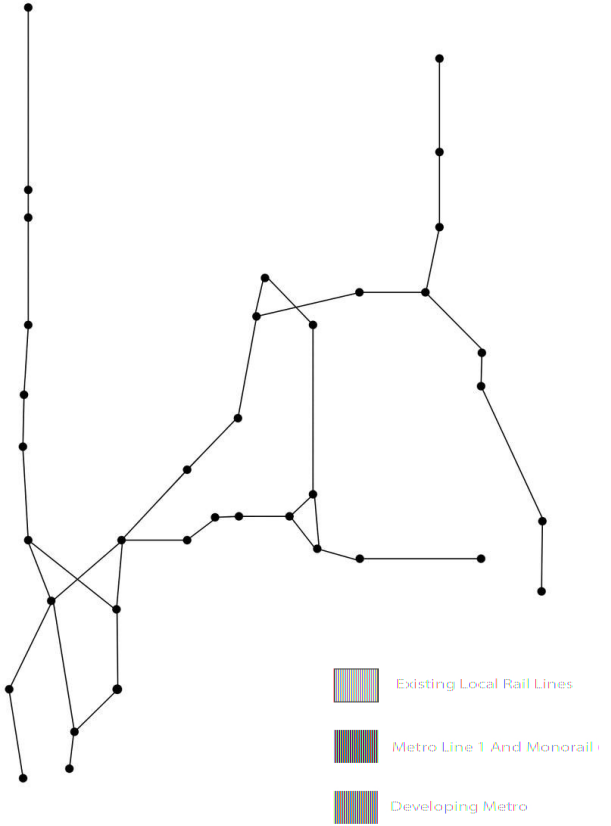
https://www.freepressjournal.in/headlines/6-infrastructure-developments-that-changed-the-face-of-mumbai

https://iglus.org/mumbai-transportation-system-transformation/



Developing Local/Metro Lines in Mumbai:

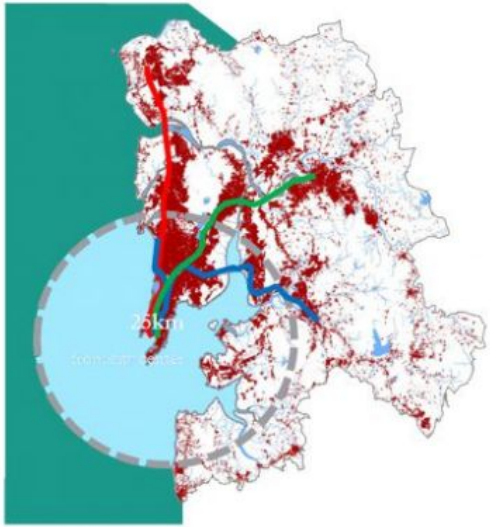




EVOLUTION of the City

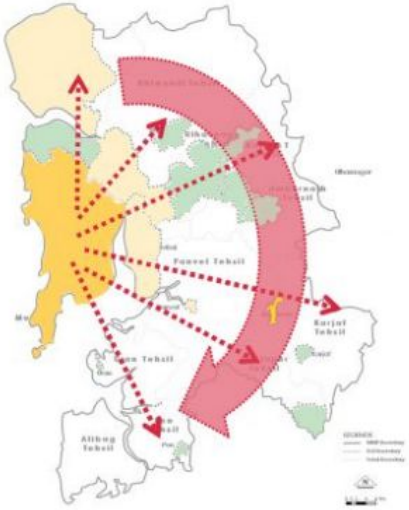
MUMBAI METROPOLITAN REGION

urbanization trends
expansion of boundary???



The urban sprawl and densification has taken place along the direction of the WESTERN, CENTRAL, HARBOUR suburban rail lines.
Sea and water bodies occupies 66% of the total area of the circle
The land area accessible at less than 25 km from the CBD is only 230 km2.

The most number of trips are from Panvel, Ambernath and Vasai. This is due to the suburban lines that have linked them to the island city.
However, the transport strategies over the years have been focussed less into inter connecting the periphery.



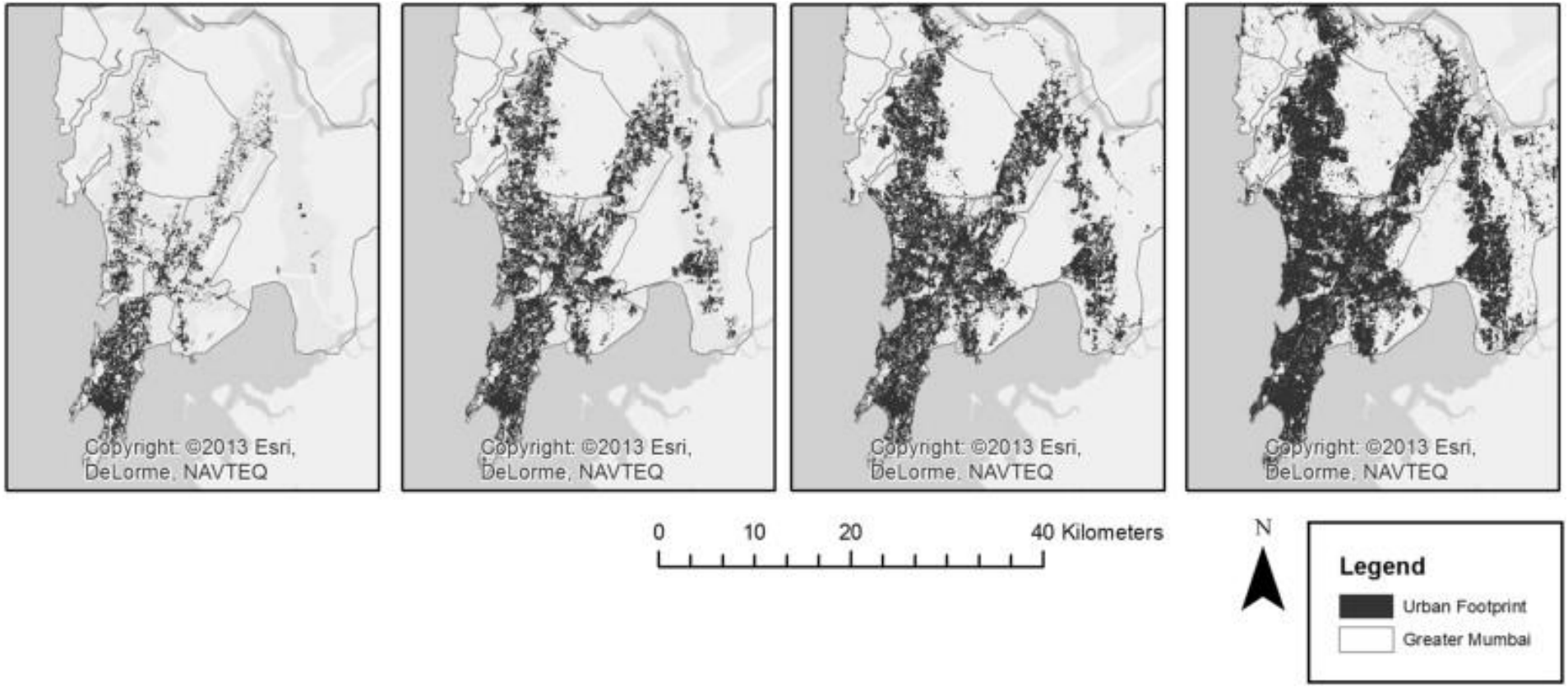
AN INCREASE IN THE SIZE OF THE REGION WILL ONLY INCREASE THE COMPLEXITIES.

BUT RATHER:
NEED FOR MANAGEMENT AND ORGANIZATION OF THE EXISTING ISSUES INTERCONNECTING THE AREAS WITHIN

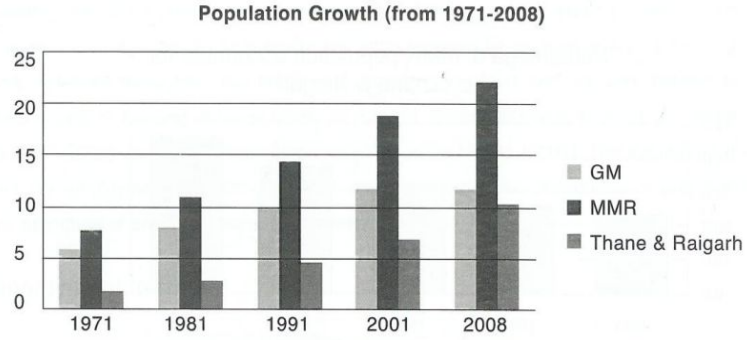
the MMR boundary was fixed 32 years ago, but has never been revised. It was fixed based on the transit line avaible i.e the suburban network

WILL EXPANDING THE MMR BOUNDARY HELP IN ITS FUTURE GROWTH?

Sarah Lukhadia



Sarah Lukhadia



Year	1971	1981	1991	2001	2008
Greater Mumbai	5.9	8.2	9.9	11.9	11.9
Thane & Raigarh	1.8	2.8	4.6	6.9	10.3
MMR	7.7	11.0	14.5	18.8	22.3

Figure 1.1: Population Growth in Greater Mumbai, MMR and Thane/Raigad
Source: 2008-2009 Economic Survey of Maharashtra, Population and Employment Profile of Mumbai Metropolitan Region, MMRDA

Table 1.1: Population, Annual Rates of Growth of Greater Mumbai, 1951–01

	Population in '000s	Rate of Growth (% p.a.)	Decade Increase ('000s)	Natural Increase ('000s)	Net Migration ('000s)	Share of Migration (%)
1951	2994	5.1	1193	243	950	79.6
1961	4152	3.3	1158	558	600	51.8
1971	5971	3.6	1819	934	885	48.7
1981	8243	3.2	2272	1204	1068	47.0
1991	9926	1.9	1683	1387	296	17.6
2001	11914	1.8	1989	1257	732	36.8

Table2: Population growth in Greater Mumbai

Year	Island City	Suburbs	Total	BMR Urban	Mumbai's share in urban Population on Maharashtra
1901	7,75,968	1,51,988	9,27,956	n/a	25.3
1911	9,79,445	1,69,312	11,48,757	n/a	31.3
1921	11,75,914	2,04,534	13,80,448	-	32.3
1931	11,61,383	2,36,429	13,97,812	-	28.4
1941	14,89,383	3,11,473	18,01,356	18,10,000	28.9
1951	23,29,020	6,65,424	29,94,444	33,10,000	32.2
1961	27,77,933	13,80,123	41,52,056	46,60,000	37.2
1971	30,70,378	28,99,617	59,70,575	68,30,000	0.38
1981	32,85,040	49,58,365	82,43,405	96,50,000	37.3
1991	31,74,889	67,51,002	99,25,891	134,50,000	32.5
2001	33,26,837	85,87,561	119,14,398	163,60,000	-

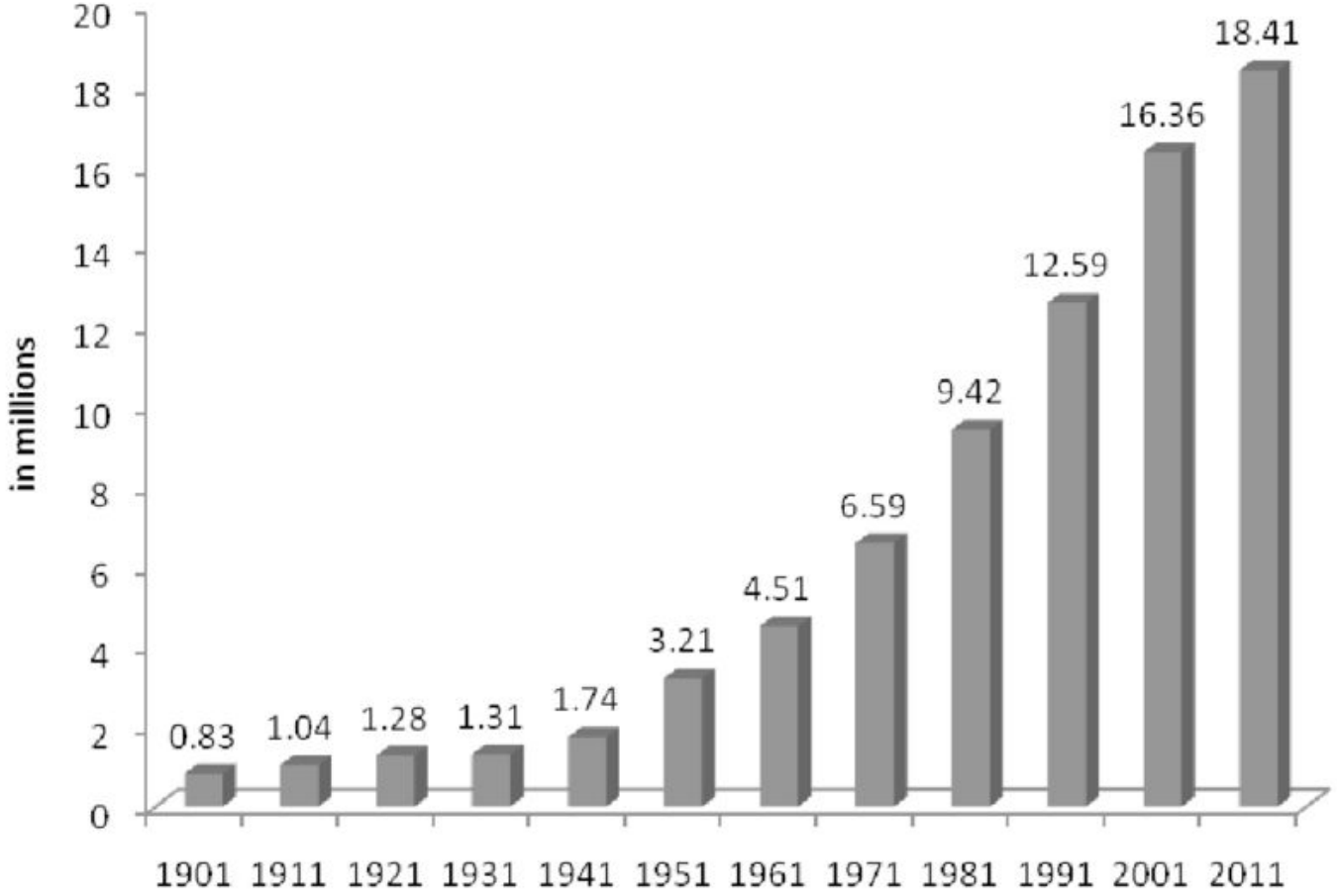
Source: BMRDA, 1994 and Census of India, 2001

Table 3: Household Income Distribution in Mumbai, 1993

Average Annual Income in US$				
Quintile I	**Quintile II**	**Quintile III**	**Quintile IV**	**Quintile V**
373.84	619.97	938.53	1552.92	2496.55

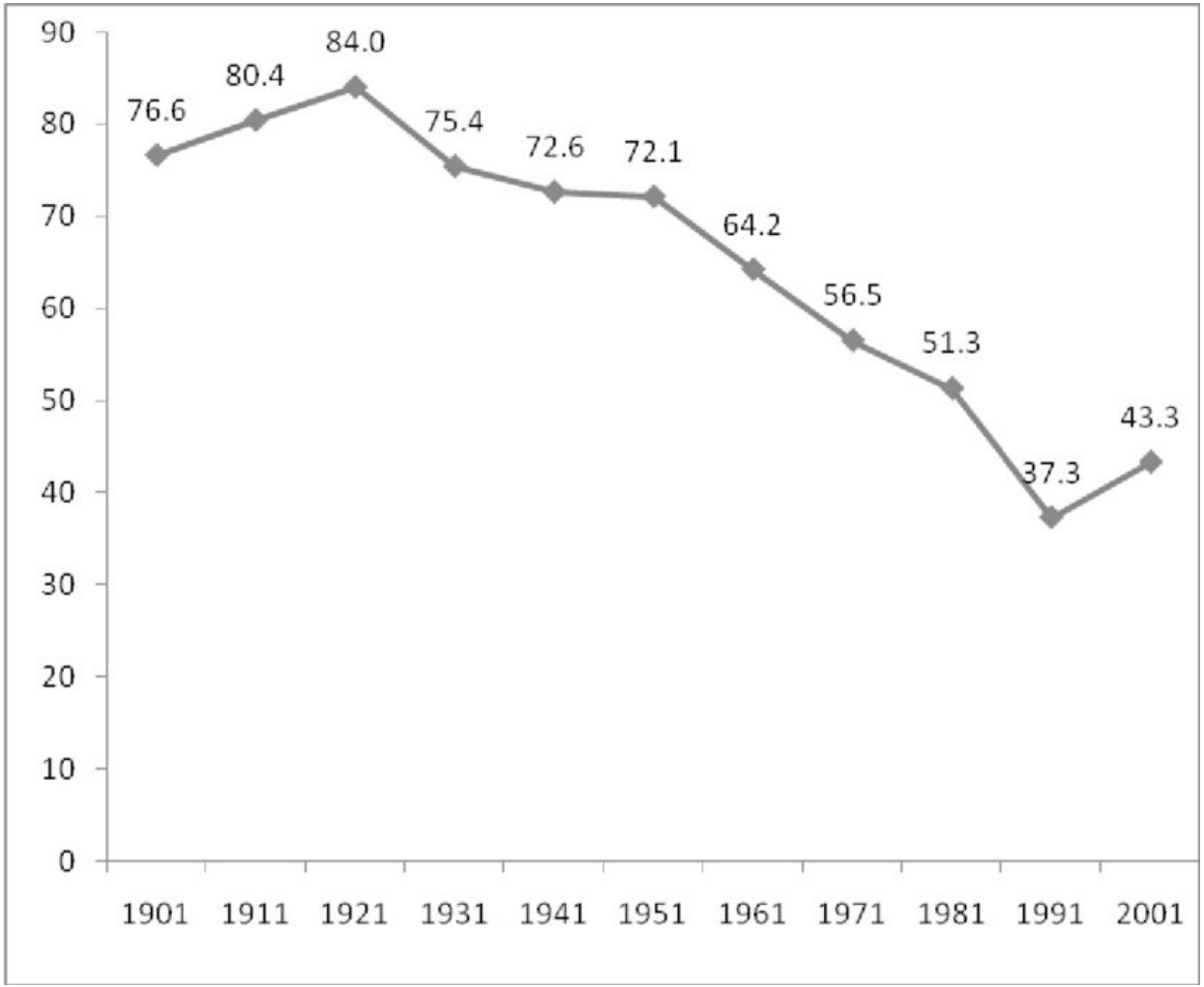
Source: India National Report, Habitat II, (Government of India,1996)

Population growth



Sarah Lukhadia

Migration graph



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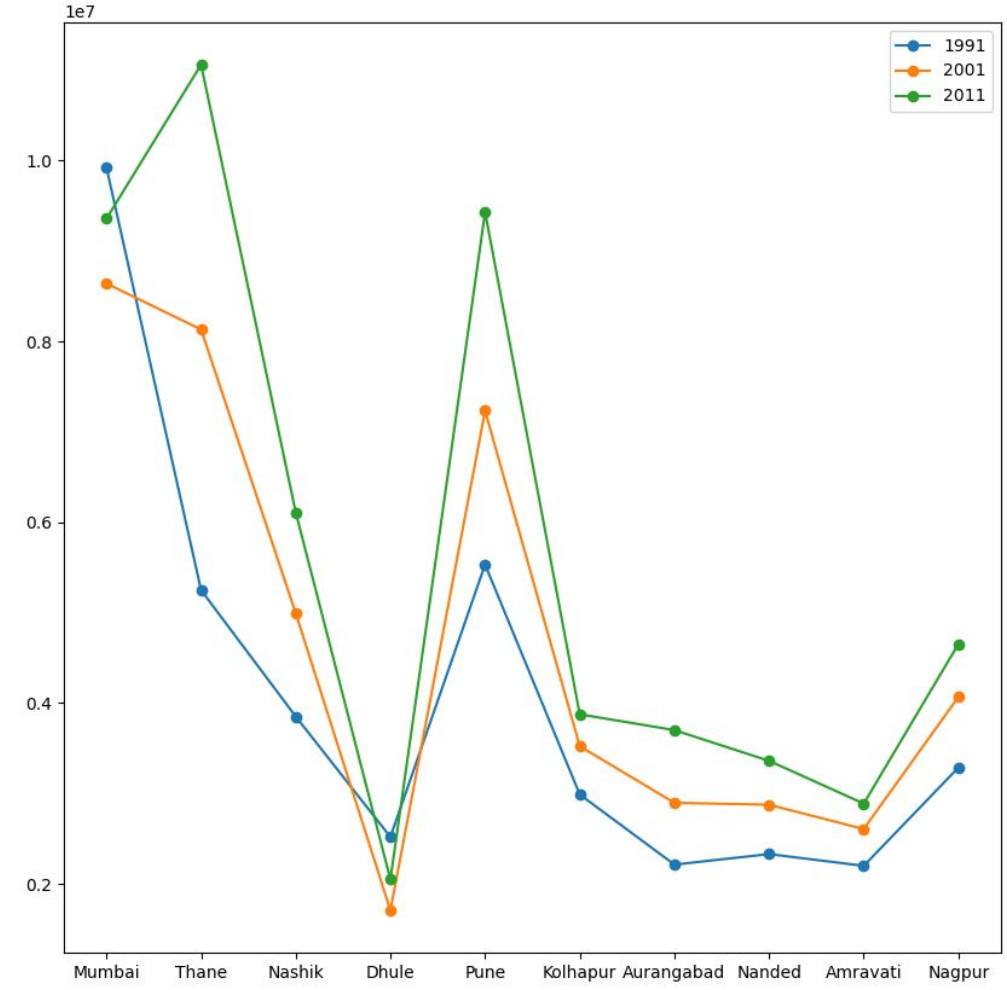


Population growth

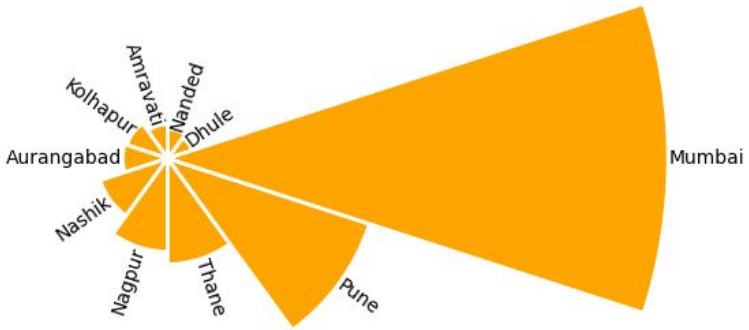
```
# Libraries
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd

# Set figure default figure size
plt.rcParams["figure.figsize"] = (10, 6)

# Get some random points!
w = np.array([ "Mumbai", "Thane", "Nashik", "Dhule", "Pune",
"Kolhapur", "Aurangabad", "Nanded", "Amravati", "Nagpur"])
x = np.array([
9925891,5249126,3851352,2519663,5532532,2989507,22137
79,2330374,2200057,3287139])
y = np.array([
8640419,8131849,4993796,1707947,7232555,3523162,28970
13,2876259,2607160,4067637])
z = np.array([
9356962,11060148,6107187,2050862,9429408,3876001,3701
282,3361292,2888445,4653570])
plt.plot( w,x, linestyle="-", marker="o", label="1991")
plt.plot( w,y, linestyle="-", marker="o", label="2001")
plt.plot( w,z, linestyle="-", marker="o", label="2011")
plt.legend()
plt.show()
np.array(range(10))
```

Sarah Lukhadia

Migration growth in Maharashtra



Year 1991

```
# import pandas for data wrangling
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np

# Build a dataset
df = pd.DataFrame(
        {
            'Name': [ "Mumbai", "Thane", "Nashik", "Dhule", "Pune", "Kolhapur",
"Aurangabad", "Nanded", "Amravati", "Nagpur"],
            '1991': [
591967,125105,83997,30223,250915,50881,53353,34676,40231,110362],
            '2001': [
1797831,860569,1154394,361453,1668510,836303,578167,34676,40231,110362],
            '2011': [
1819424,2105228,1152601,361453,1668510,836303,577729,494870,473774,706375]
        })
```

591967,125105,83997,30223,250915,50881,53353,34676,40231,110362

```
# Reorder the dataframe
df1 = df.sort_values(by=['1991'])

# initialize the figure
plt.figure(figsize=(10,10))
ax = plt.subplot(111, polar=True)
plt.axis('off')

# Constants = parameters controling the plot layout:
upperLimit = 100
lowerLimit = 30
labelPadding = 4

# Compute max and min in the dataset
max = df1['1991'].max()

# Let's compute heights: they are a conversion of each item value in those new
coordinates
# In our example, 0 in the dataset will be converted to the lowerLimit (10)
# The maximum will be converted to the upperLimit (100)
slope = (max - lowerLimit) / max
heights = slope * df1["1991"] + lowerLimit

# Compute the width of each bar. In total we have 2*Pi = 360°
width = 2*np.pi / len(df1.index)

# Compute the angle each bar is centered on:
indexes = list(range(1, len(df1.index)+1))
angles = [element * width for element in indexes]
angles
```

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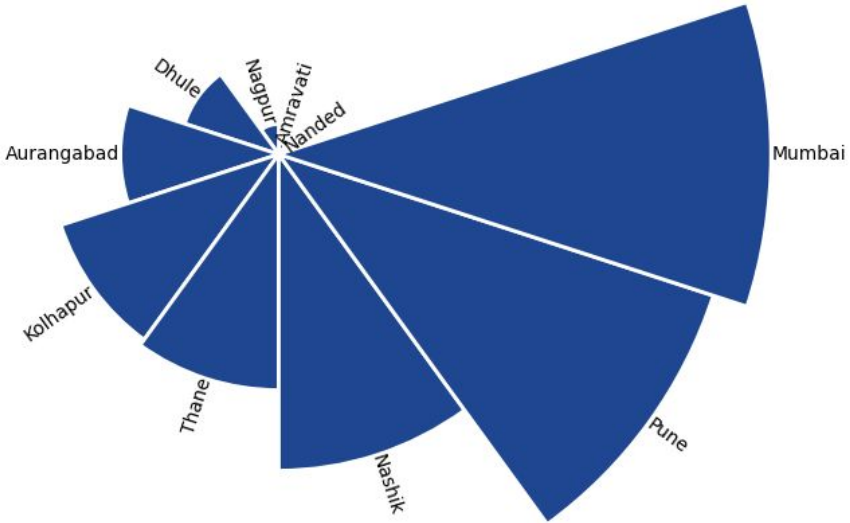

Year 2001

```
# Reorder the dataframe
df2 = df.sort_values(by=['2001'])

# initialize the figure
plt.figure(figsize=(10,10))
ax = plt.subplot(111, polar=True)
plt.axis('off')

# Constants = parameters controling the plot layout:
upperLimit = 100
lowerLimit = 30
labelPadding = 4

# Compute max and min in the dataset
max = df2['2001'].max()

# Let's compute heights: they are a conversion of each item value in those new
coordinates
# In our example, 0 in the dataset will be converted to the lowerLimit (10)
# The maximum will be converted to the upperLimit (100)
slope = (max - lowerLimit) / max
heights = slope * df2["2001"] + lowerLimit

# Compute the width of each bar. In total we have 2*Pi = 360°
width = 2*np.pi / len(df2.index)

# Compute the angle each bar is centered on:
indexes = list(range(1, len(df2.index)+1))
angles = [element * width for element in indexes]
angles

# Draw bars
bars = ax.bar(
    x=angles,
    height=heights,
    width=width,
    bottom=lowerLimit,
    linewidth=2,
    edgecolor="white",
    color="#1F4690",
)

# Add labels
for bar, angle, height, label in zip(bars,angles, heights, df2["Name"]):

    # Labels are rotated. Rotation must be specified in degrees :(
    rotation = np.rad2deg(angle)

    # Flip some labels upside down
    alignment = ""
    if angle >= np.pi/2 and angle < 3*np.pi/2:
        alignment = "right"
        rotation = rotation + 180
    else:
        alignment = "left"
```

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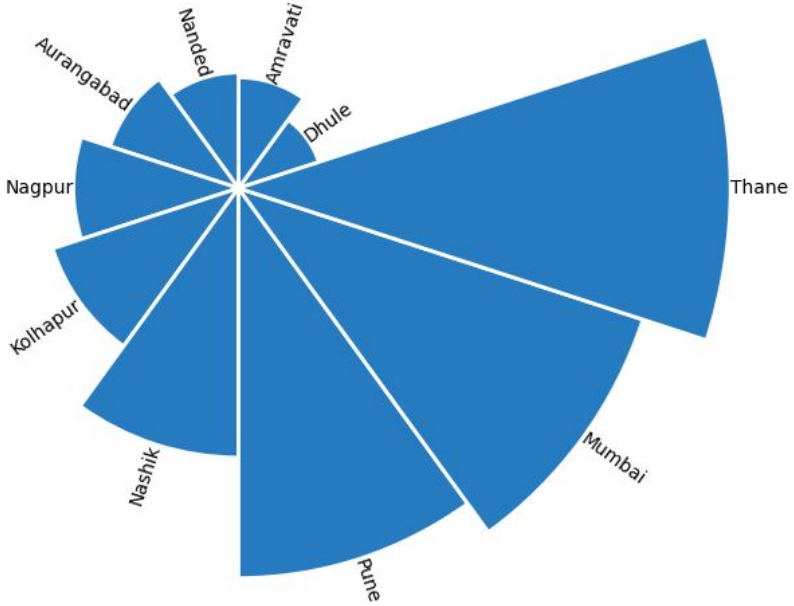

Year 2011

```
df3 = df.sort_values(by=['2011'])

# initialize the figure
plt.figure(figsize=(10,10))
ax = plt.subplot(111, polar=True)
plt.axis('off')

# Constants = parameters controling the plot layout:
upperLimit = 100
lowerLimit = 30
labelPadding = 4

# Compute max and min in the dataset
max = df3['2011'].max()

# Let's compute heights: they are a conversion of each item value in those new
coordinates
# In our example, 0 in the dataset will be converted to the lowerLimit (10)
# The maximum will be converted to the upperLimit (100)
slope = (max - lowerLimit) / max
heights = slope * df3["2011"] + lowerLimit

# Compute the width of each bar. In total we have 2*Pi = 360°
width = 2*np.pi / len(df3.index)

# Compute the angle each bar is centered on:
indexes = list(range(1, len(df3.index)+1))
angles = [element * width for element in indexes]
angles

# Draw bars
bars = ax.bar(
    x=angles,
    height=heights,
    width=width,
    bottom=lowerLimit,
    linewidth=2,
    edgecolor="white",
    color="#277BC0",
)

# Add labels
for bar, angle, height, label in zip(bars,angles, heights, df3["Name"]):

    # Labels are rotated. Rotation must be specified in degrees :(
    rotation = np.rad2deg(angle)

    # Flip some labels upside down
    alignment = ""
    if angle >= np.pi/2 and angle < 3*np.pi/2:
        alignment = "right"
        rotation = rotation + 180
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        alignment = "left"
```
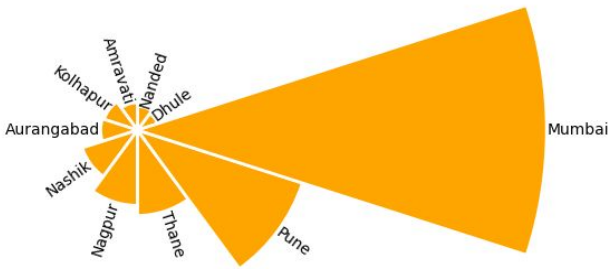
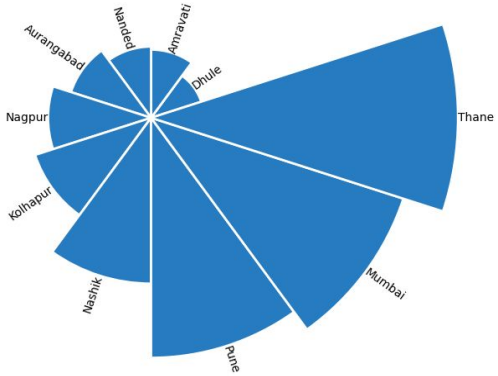
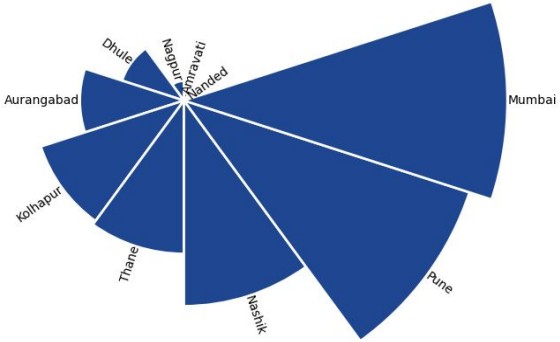

Sarah Lukhadia



1991



2001



2011

Data Sources :
Government census table
https://censusindia.gov.in/census.website/data/census-tables

1. D1 Population Classified By Place Of Birth
2. Migrants By Place Of Last Residence To Cities By Reason For Migration

https://www.python-graph-gallery.com/density-plot/

REFERENCE CODE 1 - Population
Connected Scatterplot

Connected Scatterplot (python-graph-gallery.com)

REFERENCE CODE 2 - Migration
Basic circular barplot with Python and Matplotlib

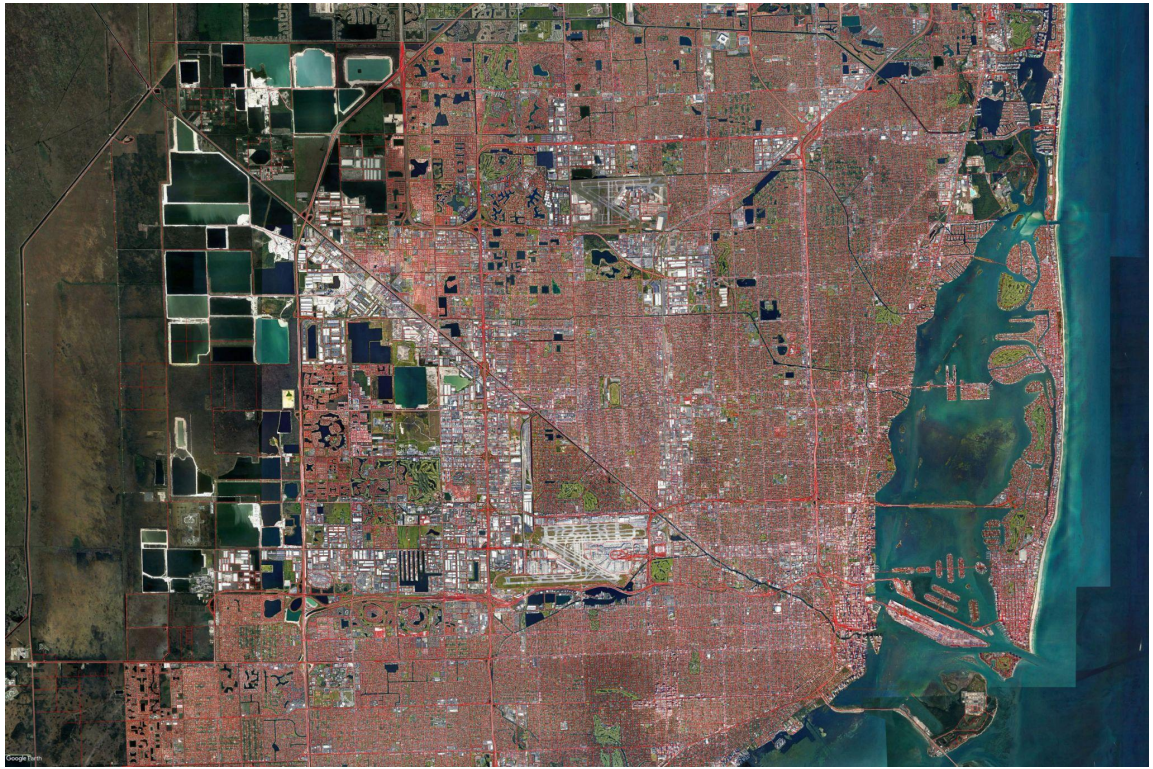
Most basic circular barplot with Python and Matplotlib (python-graph-gallery.com)

Sarah Lukhadia

Document City Evolution of Miami, Florida

Research Question/Statement-

Our aim was to evaluate Miami's city evolution and growth in terms of roadworks, street and highways networks, with respect to land acquisition. From 1984, Miami has been growing at a very fast pace, acquiring land, and building on it. The transport network, then too, has to grow rapidly to cater to the new infrastructure, making it accessible. Thus, we mapped the ever-growing road network, with respect to the land increase to evaluate the speed at which Miami is growing, and also, when will too much improvement will result in slowing down the development of the city, all in all, making it unaffordable to live there.

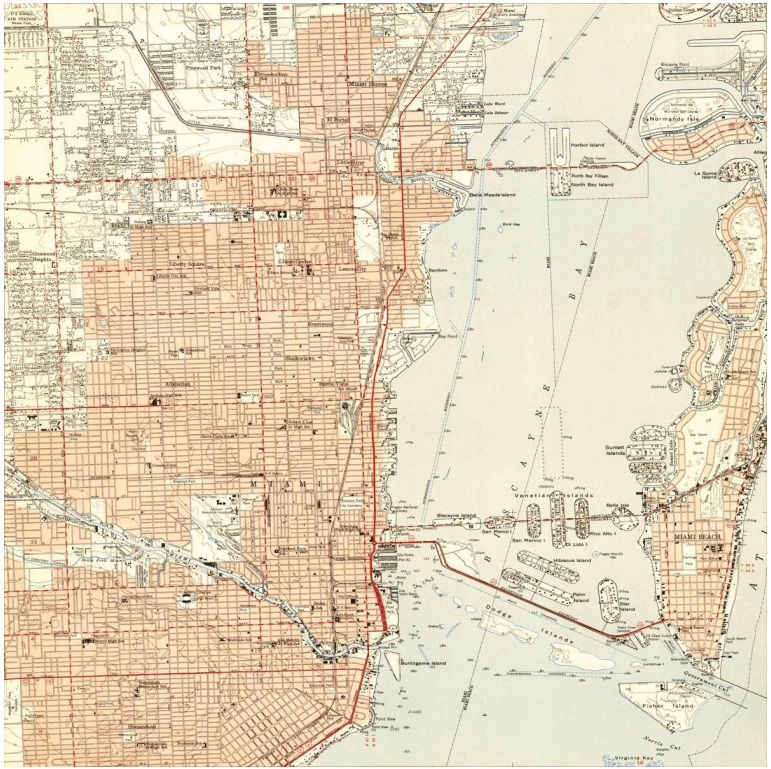


Miami Street, US Roads and Highway Network

Shreeraj N. & Aditi G.

Methods in play

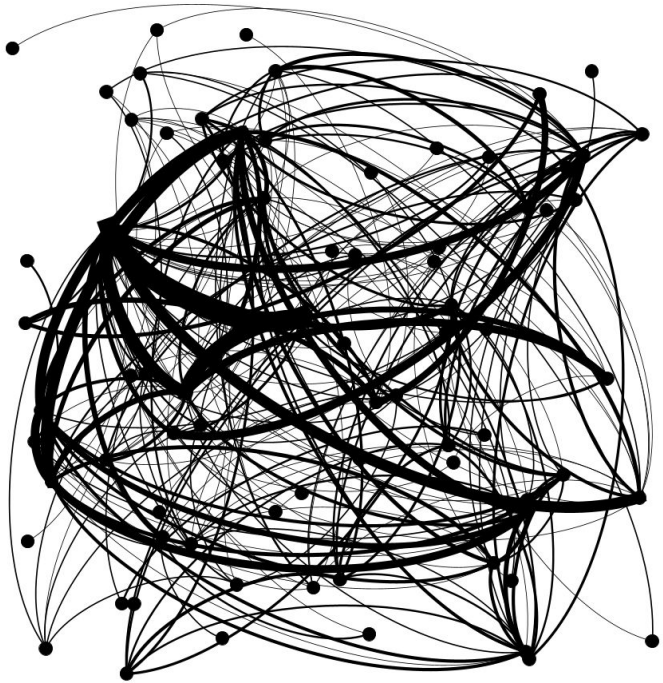
1. Google Timelapse Capture-
   For a map timelapse showing us a growth in infrastructure.
2. Open Street Map-
   For the present street map along with street networks.
3. Miami Open Data Hub-
   For Street networks, US Roads networks, Highway networks.
4. Old World Maps-
   For analysing the growth in new infrastructure as seen on the maps.



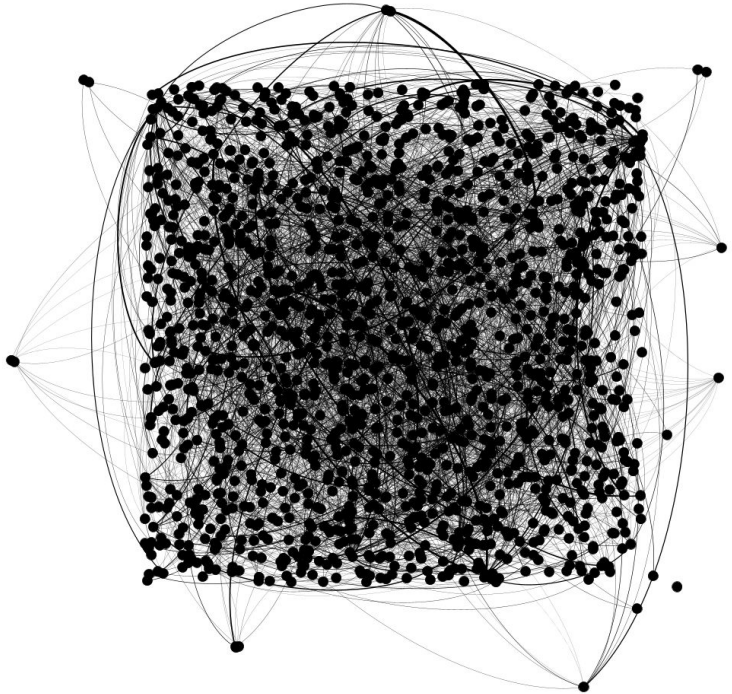
Shreeraj N. & Aditi G.

Timelapse- 1984-2022

Network’s Layout



US Roads Network, Miami

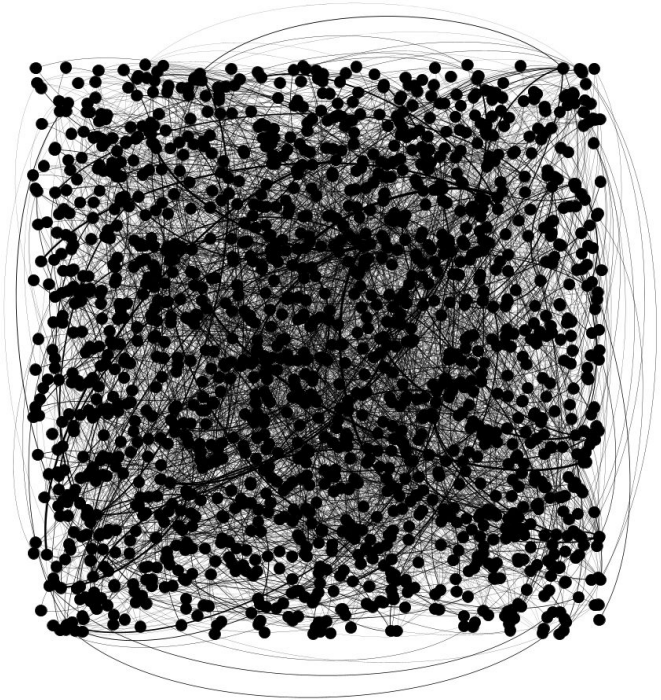


Street Network, Miami

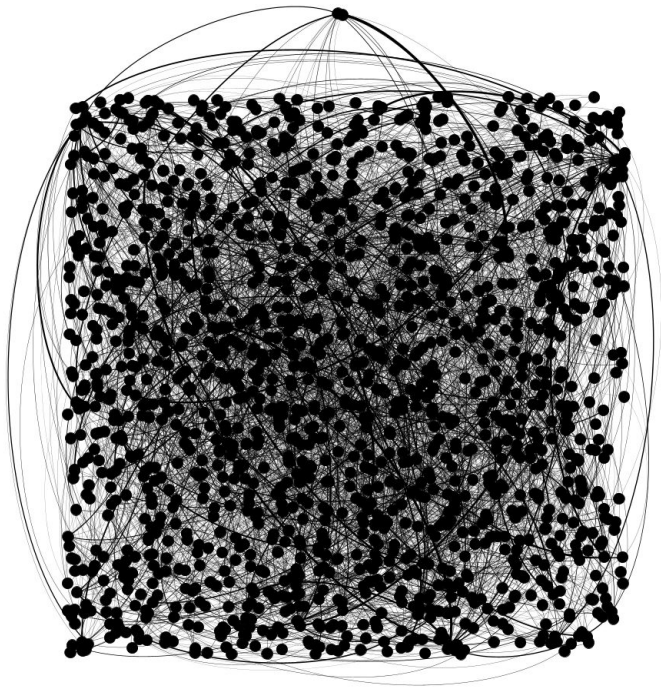
The nodes represent road intersections and the number of connections represent the number of intersections.

Shreeraj N. & Aditi G.

Network's Layout



Socio-Transport Network, Miami



Public Transport Network, Miami

The nodes represent road intersections and the number of connections represent the number of intersections.

Shreeraj N. & Aditi G.

References-

1. https://developers.google.com/earth-engine/timelapse/videos
2. https://gis-mdc.opendata.arcgis.com
3. https://www.openstreetmap.org/#map=12/25.8276/-80.3162&layers=T
4. https://www.oldmapsonline.org/en/Miami#bbox=-80.34441375732422,25.774735839401245,-80.21941375732422,25.899709739188253&q=&date_from=0&date_to=9999&scale_from=&scale_to=
5. https://networkrepository.com/index.php

OSMNX Network, Miami

RESEARCH QUESTION

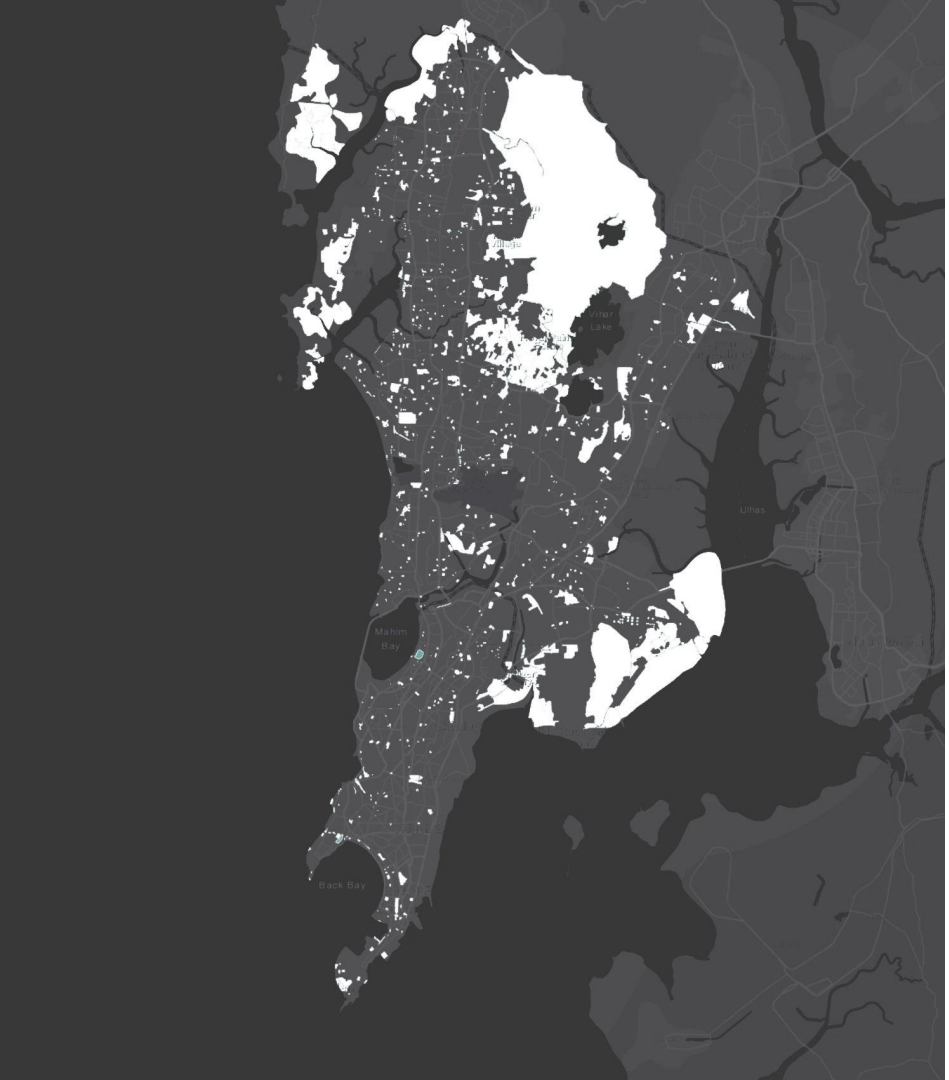
Mapping of public amenities (recreational, streets, tourists, public toilets) spaces and private spaces in Mumbai and thereby studying the proportions (public vs. private)

What is the percentage of open spaces in mumbai?

How much of the open public space is actually accessible to public?

Studying the street networks of public spaces in southern part of mumbai.

Akanksha Thakur & Neha shah



OPEN SPACES IN MUMBAI

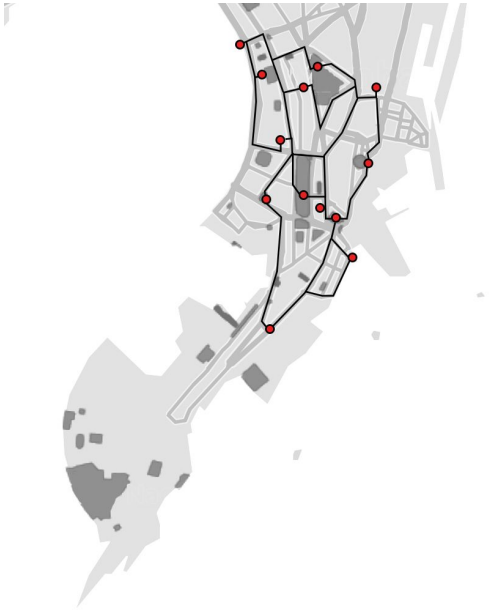
Total area - 603.4 km²
Open space - approx. 150 km² (25% of total area)
Street network area - approx. 17 km² (2.8% of total area)

Akanksha Thakur & Neha shah

OPEN PUBLIC AND AMENITIES SPACES IN SOUTHERN PART OF MUMBAI

Total area - 9,597,709 sq.m.

Area actually accessible to public - 44,1760 sq.m.



Street network of public amenities spaces

Open spaces include parks, stadiums, playgrounds, gardens, national parks, beaches.
Public Amenities include markets, library, museums, toilets.

Akanksha Thakur & Neha shah

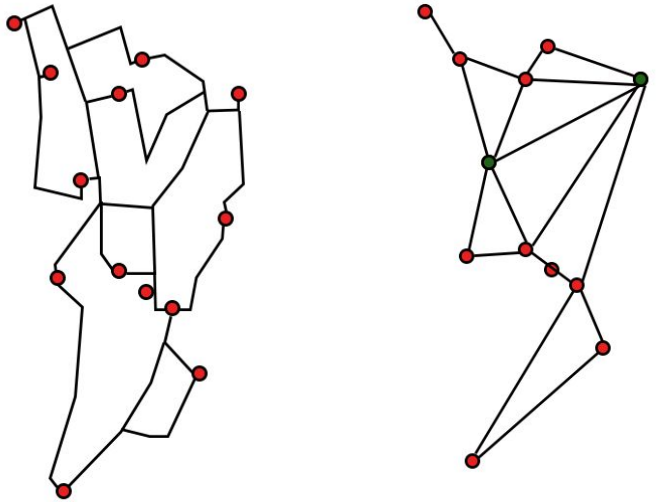
RESULT / CONCLUSIONS

FOR MUMBAI

- 25% of the total area of mumbai are open spaces (parks, stadiums, playgrounds, gardens, national parks, beaches).

FOR SOUTHERN PART OF MUMBAI

- Total area (southern part of mumbai) is 9,597,709 sq.m. out of which 44,1760 sq.m. area is occupied by open public and amenities spaces which is 4.6% of the total area is actually accessible (public/ amenities).
- The amenities network is distributed network.
- Average degree distribution for amenities network is 2, 4.



Street network of public amenities spaces

Reference links:

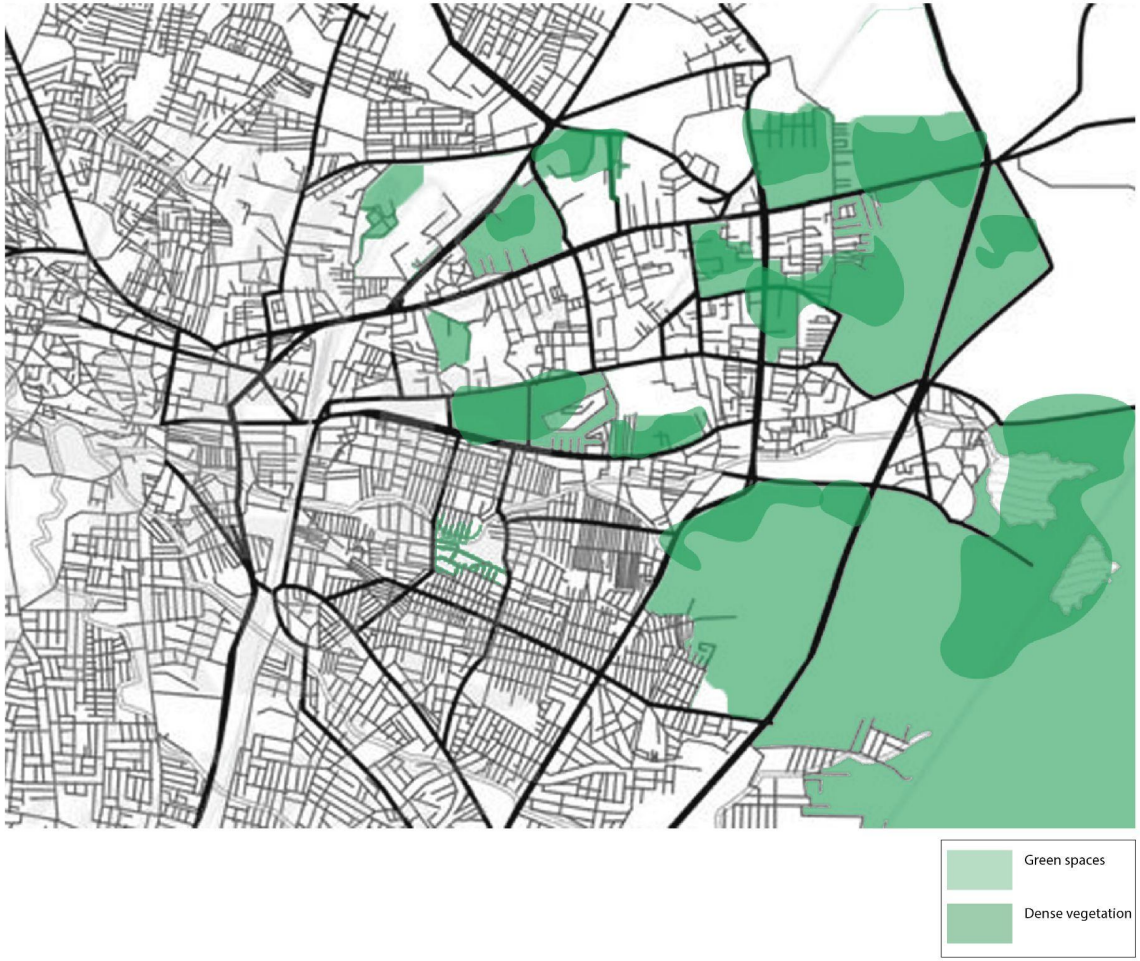
https://www.arcgis.com/index.html
https://data.unhabitat.org/pages/open-spaces-and-green-areas
Google Earth
Openstreetmaps

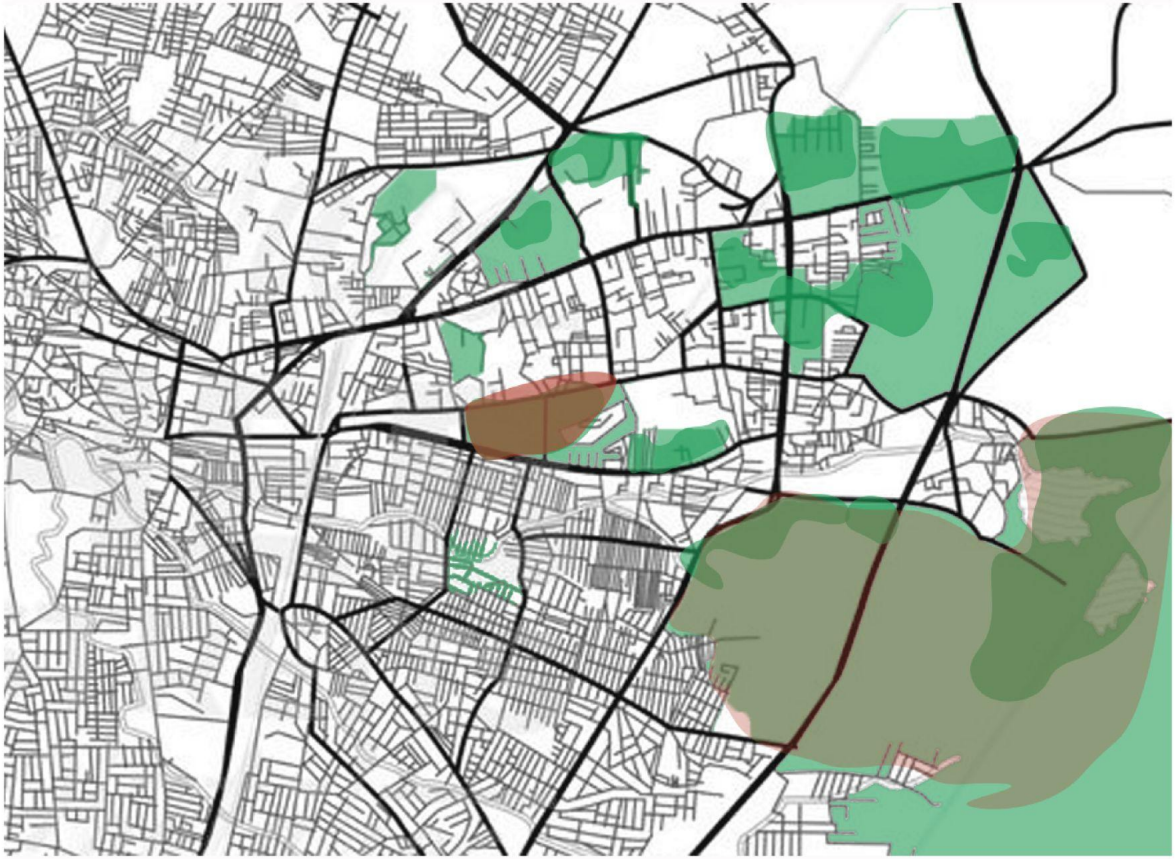
Research Question

While looking at the actively participation of public throughout the week, how are open street networks connected to green spaces simultaneously creating public and private spaces?

1] How green spaces are active ?
2] People occupying the space.
3] Connectivity between built and green spaces.

Mrunmai Bailke and Gauri Shinde


Green spaces
Dense vegetation



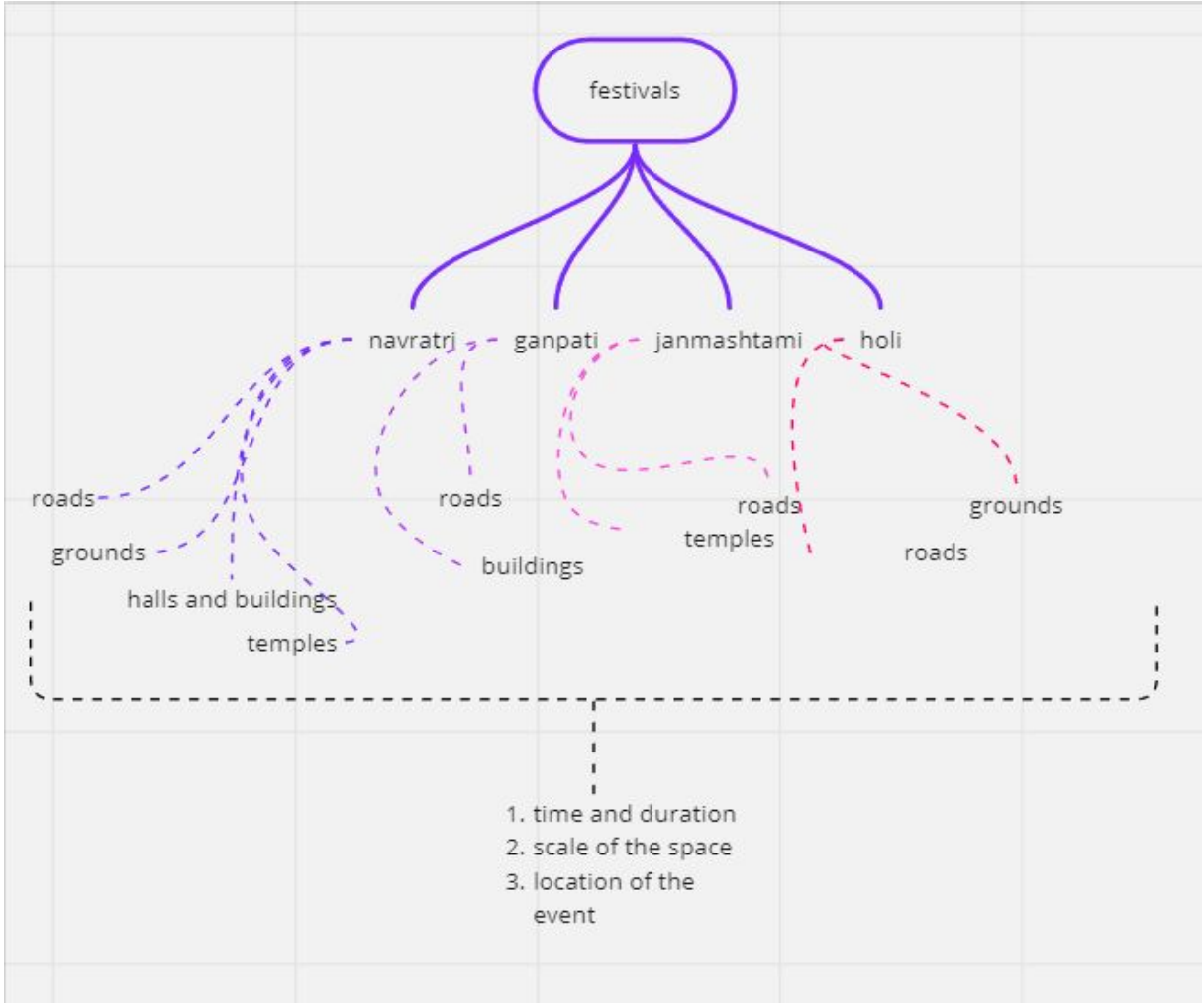
Public participation in green spaces throughout time periods.
During weekdays green patch within the city is more active while the green spaces on the outskirts are more active on weekends

https://www.openstreetmap.org/export#map=15/20.9259/77.7666&layers=H

In India festivals play a major part in people's life but also in the way the city is shaped and the public infrastructure of the society since most of the festivals happen in public realms. After the two years of the covid-19 pandemic this is the first year when all the festivals are being celebrated normally again.

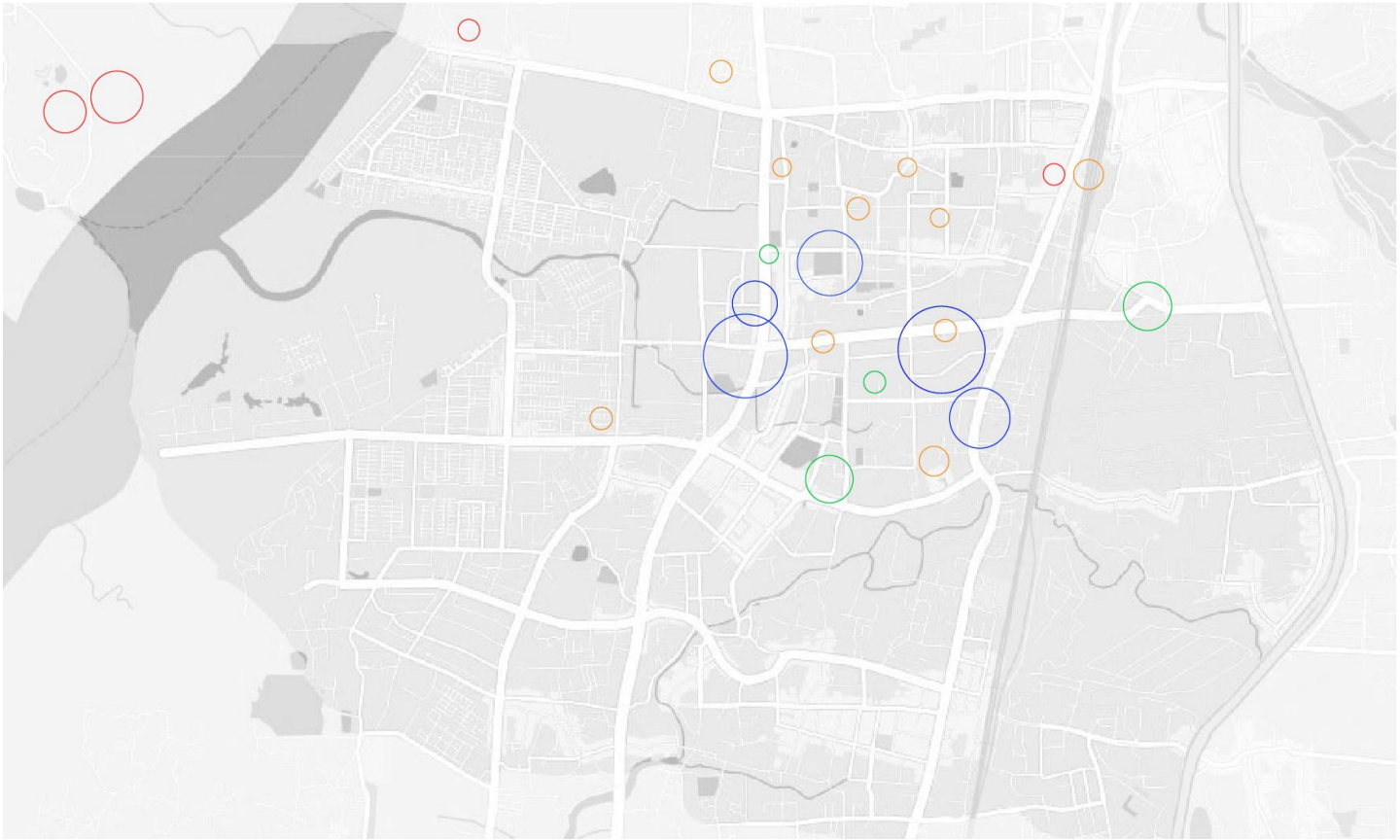
The idea is to map the festivals(Ganpati, Navratri, Janmashtami, Holi) that happen throughout the year that use public infrastructure like roads ,chowks open grounds etc. Mapping these events in relation to the time duration and scale of the space required wrt the people participating in these festivals will be helpful to understand the culture and document movement of people and vehicles and maybe provide basic infrastructure for festivals like these. How festivals and social spaces responds to existing infrastructure can be observed as well.

However since this a totally experience based and qualitative information based question it was impossible to get data from any open source networks but are through our own experiences and reading about the places a bit.

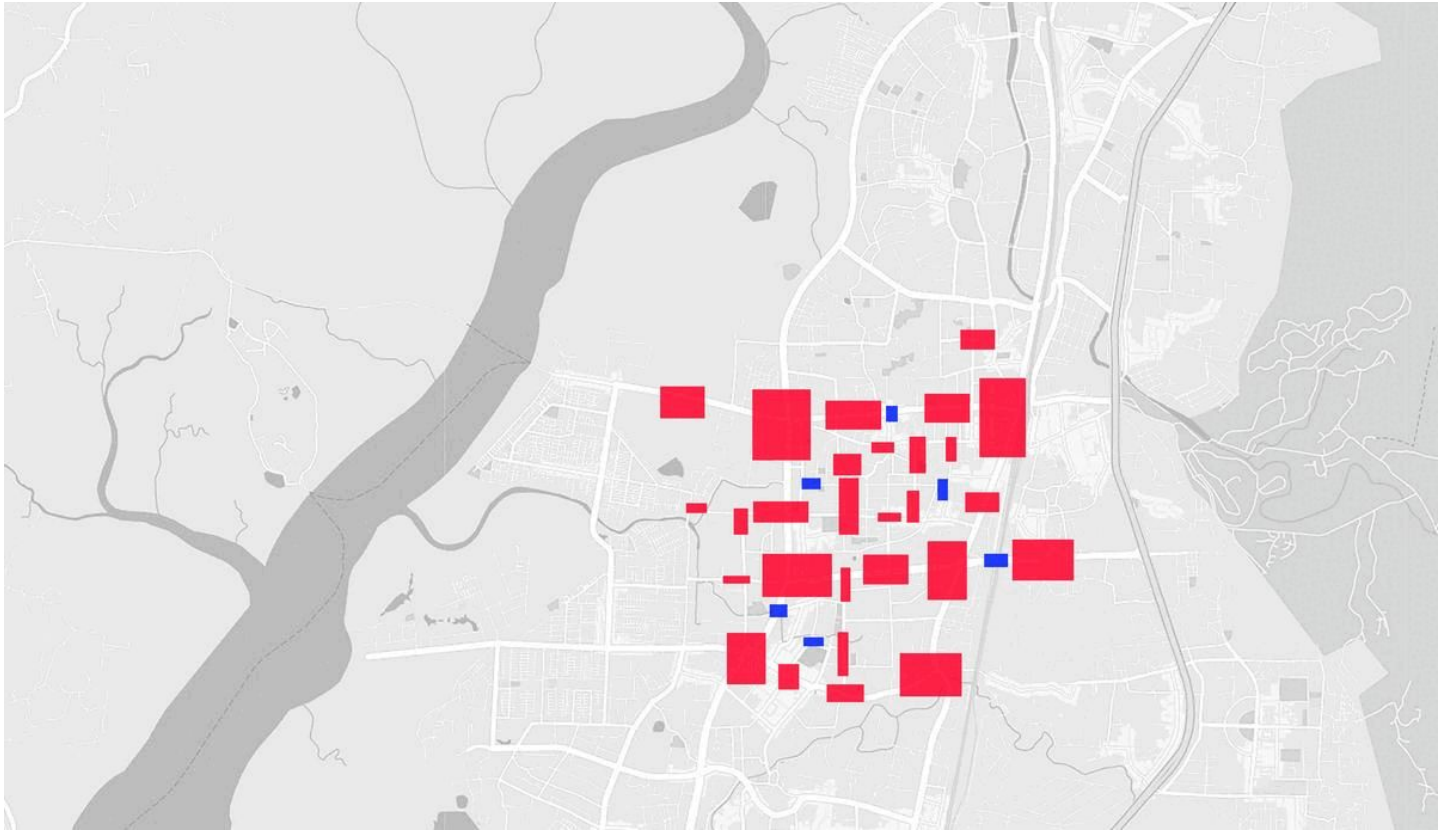


Place/Ground/Road(nodes)	Private/Public(connectors)	Number of people(scale of nodes)	Festival(colours)
Pushpanjali Gardens	Public	4000	Navratri
Kora Kendra Ground	Public	3000	Navratri
Late Shri Pramod Mahajan Sports Cor	Public	2000	Navratri
Kutchi Ground	Public	2000	Navratri
Water Kingdom	Public	1000	Holi
The Bay Banquet	Private	900	Holi
Dattapada Road	Public	800	Janmashtami
Mahavir Nagar BMC Ground	Private	700	Janmashtami
Vazira Koliwada Holi Maidan	Public	600	Holi
Essel World	Public	600	Holi
Poisar	Public	400	Janmashtami
Mahavir Banquet Halls	Private	200	Navratri
Indraprasth	Private	200	Ganpati
Hall 2 of sun beach resort	Private	150	Holi
Raghuleela	Private	150	Ganpati
Eskay Resorts	Public	100	Holi
Bombay Eatery	Private	100	Holi
Saibaba Nagar	Public	100	Janmashtami
Juni MHB	Public	100	Ganpati
Vasant Complex	Public	100	Ganpati
RM Bhattad Road	Public	90	Ganpati
Mhatre Wadi	Public	90	Ganpati
Korakendra	Public	90	Ganpati
Babai Naka	Public	90	Ganpati
Shimpoli	Public	70	Janmashtami
TPS 3	Public	70	Ganpati
Vazira	Public	70	Ganpati
LT Road	Public	70	Ganpati
Chikoowadi	Public	50	Ganpati
Kerkar	Public	50	Ganpati
Mulji Nagar-Bhatt Lane	Public	50	Ganpati
Ram Mandir	Public	50	Ganpati

So we started by quantifying the data we knew and putting it together in an organised form. Also dividing festivals into categories to understand them better and deciding parameters for an overall study.

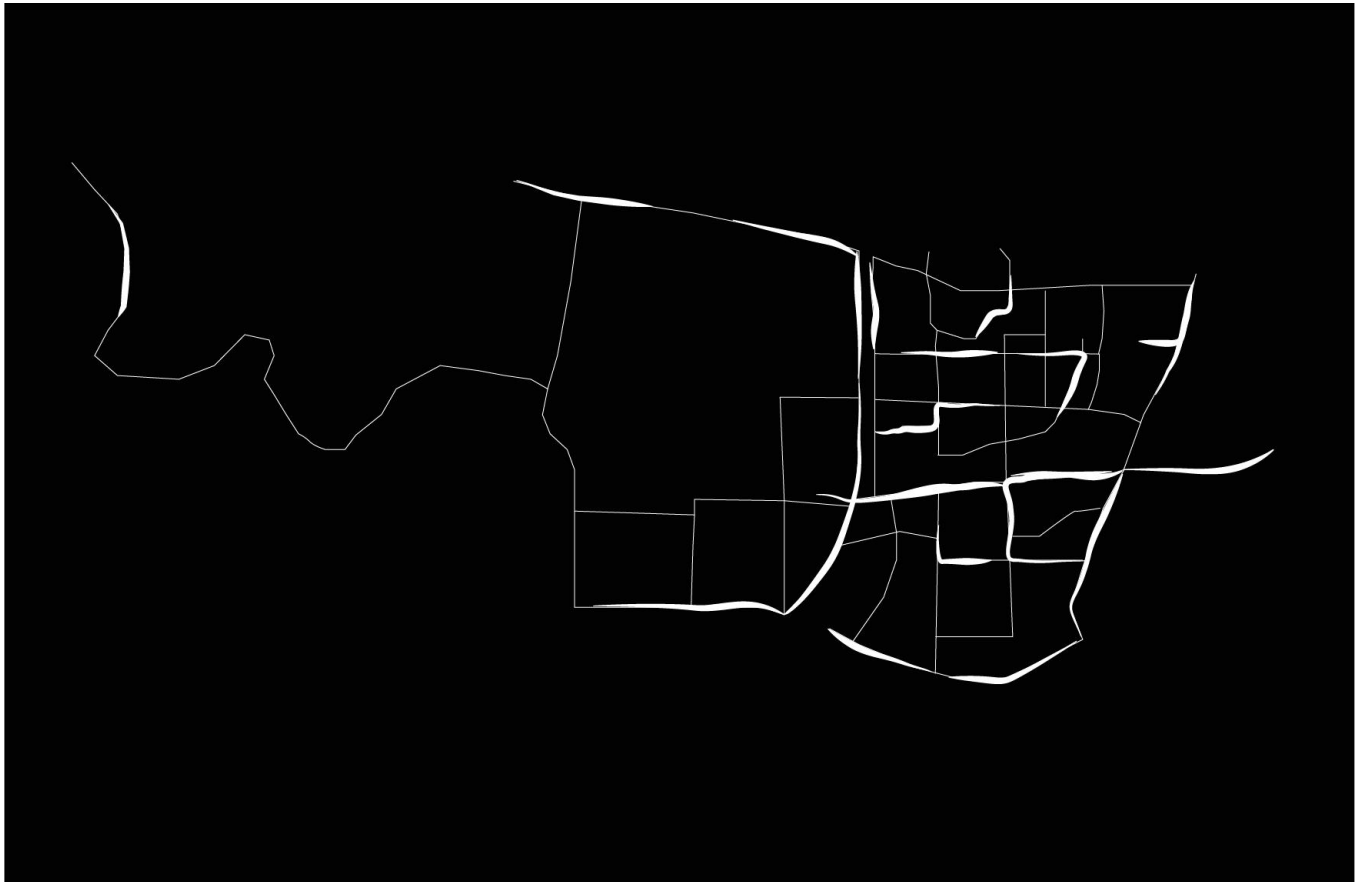


By coding different festivals as different colours we started mapping out the spread of the festivals on the adjoining streets and seeing how much they affected the neighbourhood.



However that did not show the change in the private and public sectors that took place over time. Blue are the private events that have increased recently after covid because it causes less crowding. Thus the number of places have increased but the scale is reduced.

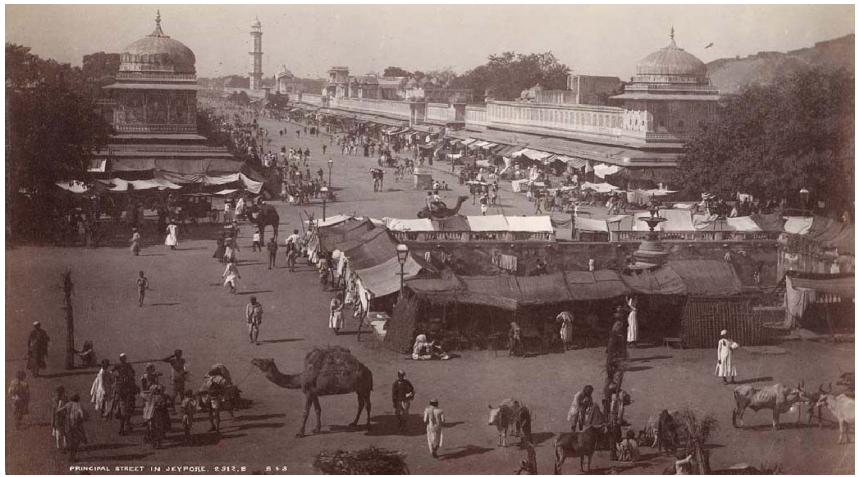
The road and pathways defined by the festivals.



The actual spread of the festivals.

NETWORK/RESEARCH QUESTION:

Understanding the accessibility and connectivity of the City Palace from the 8 gates of the Pink City of Jaipur. This resulted in asking the question that what is the complexity in the spatial configuration of the Pink City. Also understanding whether is there a hierarchy in the way space is organised or no?



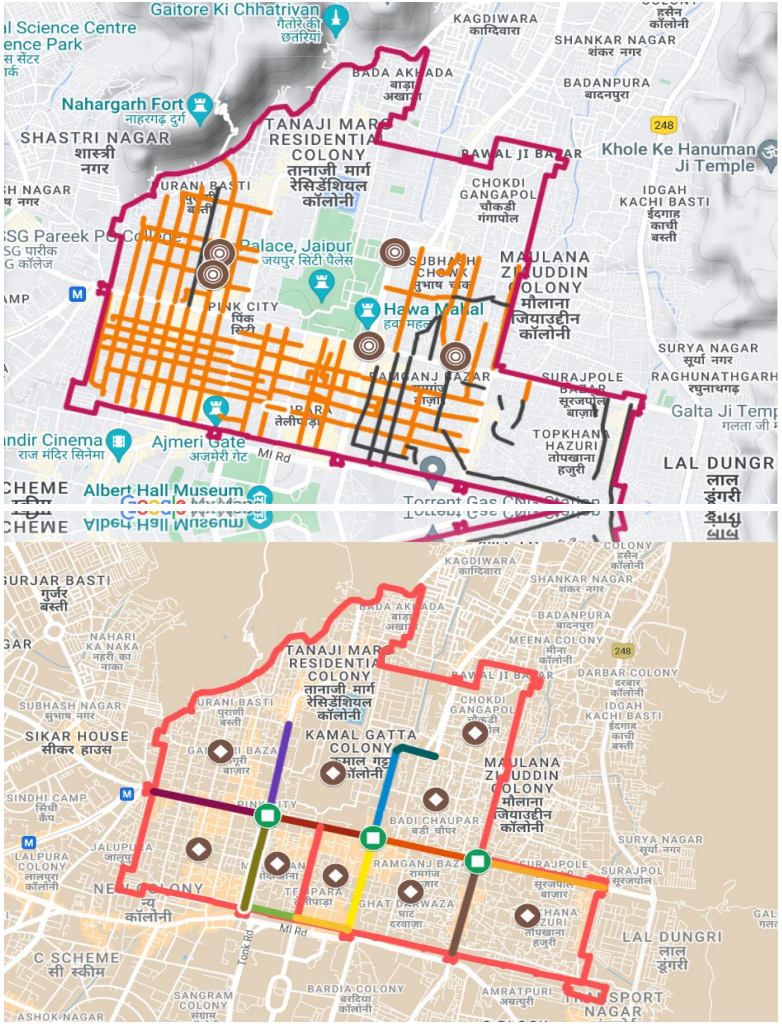
PROCESS AND DATA SOURCES:

Open street maps:To understand the overall geography of Pink City.

Jaipur Heritage:Data of the occupation and streets including bazaars.

Unesco Heritage: Understanding the gates and chaupars of Pink City.

https://jaipurworldheritage.com/chaupars-and-bazars/
https://jaipurworldheritage.com/street-stories/
https://en.unesco.org/creative-cities/sites/default/files/jaipur_uccn_monitoring_report_2019.pdf



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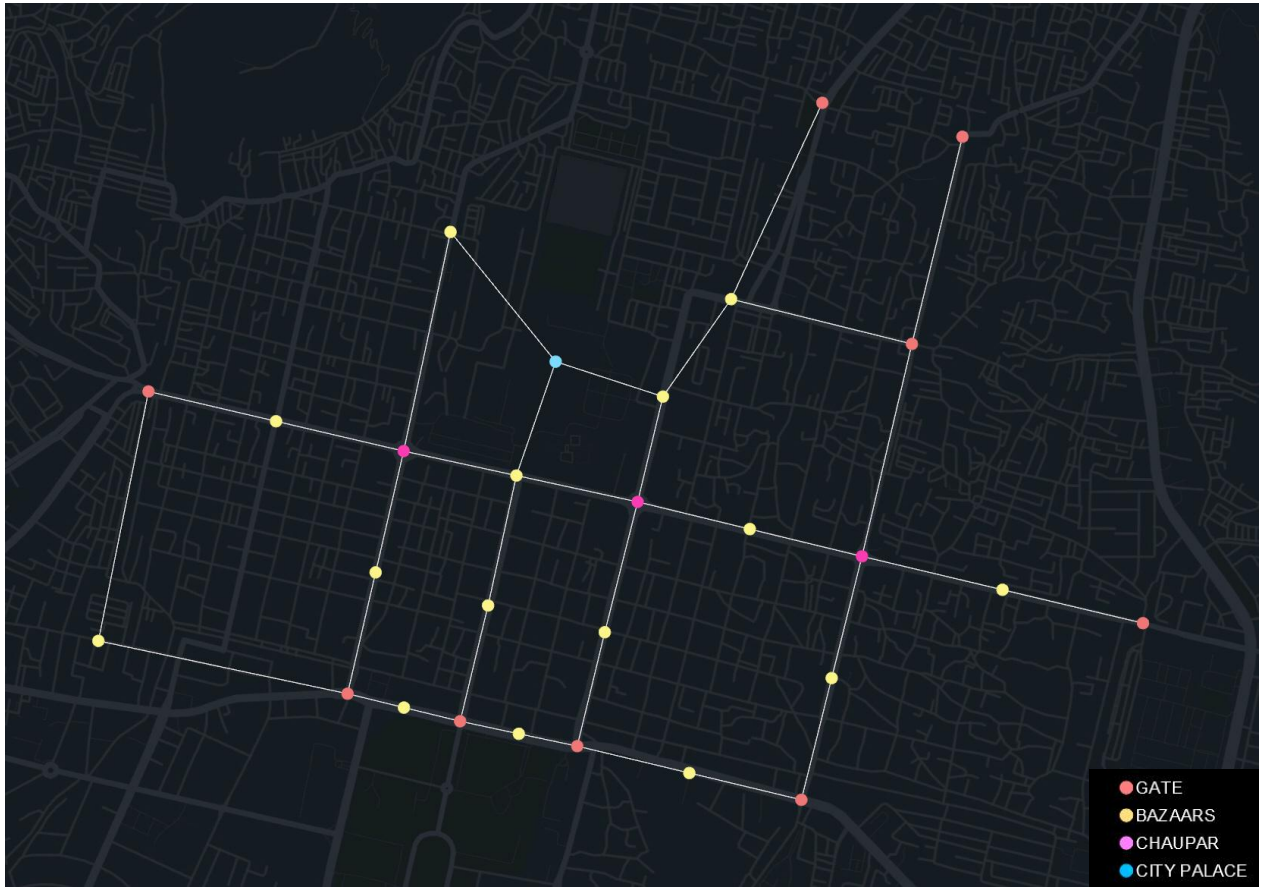
DATASET :

Chaupar	Gate	Chaukri	Bazaar	Raasta(Occupation)	Raasta(Occupation)
Choti Chaupar	Chandpol	Modikhana	Chandpol Bazar	Topkhane ka Rasta	Gopalji ka Rasta
Badi Chaupar	Ajmeri Gate	Vishveshwarji	Tripolia Bazar	Nindar Rao Ji ka Rasta	Jhadiyon ka Rasta
Ramganj Chaupar	New Gate	Sarhad	Ramganj Bazar	Kalyan Ji ka Rasta	Sonthaliwalon ka Rasta
	Sanganeri Gate	Ramchandraji	Surajpol Bazar	Bhindo ka Rasta	Teli Pada ka Rasta
	Ghat Gate	Gangapol	Kishanpol Bazar	Khazane Waalon ka Rasta	Vidyadhar Ji ka Rasta
	Suraj Pol Gate	Purani Basti	Chaura Rasta	Khejron ka Rasta	Hanuman Ji ka Rasta
	Char Darwaza	Ghat Darwaza	Johari Bazar	Mishra Ji ka Rasta	Mana Ram Ji ka Rasta
	Dhruv Pol	Topkhana Desh	Ghat Darwaza Bazar	Jhalaniyon ka Rasta	Thakur Pachewar ka Rasta
		Topkhana Huzuri	Nehru Bazar	Tikadmal Ka Rasta	Mahero ka Rasta
			Bapu Bazar	Sonkhiyon ka Rasta	Niwai Mahant ka Rasta
			Gangouri Bazar	Khuteton ka Rasta	Haldiyon ka Rasta
			Sireh Deori Bazar	Tikkiwalon ka Rasta	Gheewalon ka Rasta
			Subhash Chowk Bazar	Chandpol Road	Moti Singh Bhomion ka Rasta
				Indira Bazar Road	Kundighar Bheruji ka Rasta
				Godhon ka Rasta	Langar ke Balaji ka Rasta
				Laalji Saand ka Rasta	Shailon ki Gali
				Churukon ka Rasta	Raja Shivdas Ji ka Rasta
				Thatheron ka Rasta	Bordi ke Kuwe ka Rasta
				Maniharon ka Rasta	Dhabai Ji ka Rasta
				Natanion ka Rasta	Musavviron ki Gali
					Panigharon ka Rasta
					Bandri ka Nasik Rasta
					Ghoda Nikas Road

Dataset of the Pink City

Harsh+ Anika

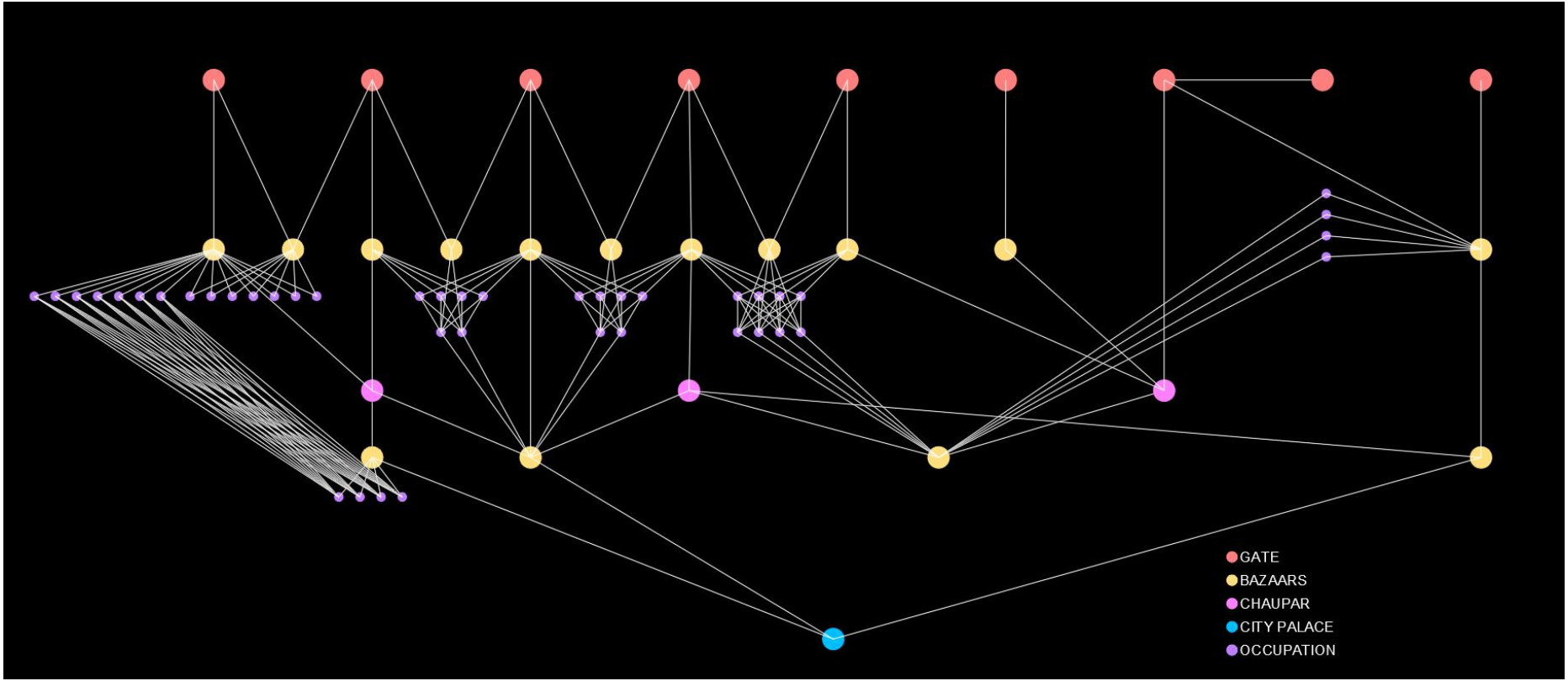
NETWORKS:



Connectivity and geo-locating the nodes to understand how spaces are linked

Harsh+ Anika

NETWORKS:



The accessibility of the fort bringing out the hierarchy in the spatial configuration.

Harsh+ Anika

CONCLUSION:

We looked at the planned area of Jaipur- (Pink City) and mapped it using network science in the abstract form.Based on the analysis, we identified :

- The nodes with high number of walks and a **greater degree centrality** are primarily the 'Bazaars'.
- When one has to go from the Gate to the City palace,he has to pass through the
  1.Baazar
  2.Chaupar
  3.Raasta
  Degree of city palace is not so high while bazaars have very high centrality Measure(you need to go through bazars in order to get to the other nodes of the city)
  This means that the **Bazaar** has really **high 'Betweenness centrality'**.
- **Bipartite network** form between Bazaar and other locations of the gates, chaupars and the palace because the baazar is not connected to other bazaar's(exception of one bazaar) but are connected to other classes(where nodes in one group are connected only with nodes from other types).

Hence, an abstract representation of the landscape helped us identify the hierarchy and hence one identifies the level of importance of the different nodes.

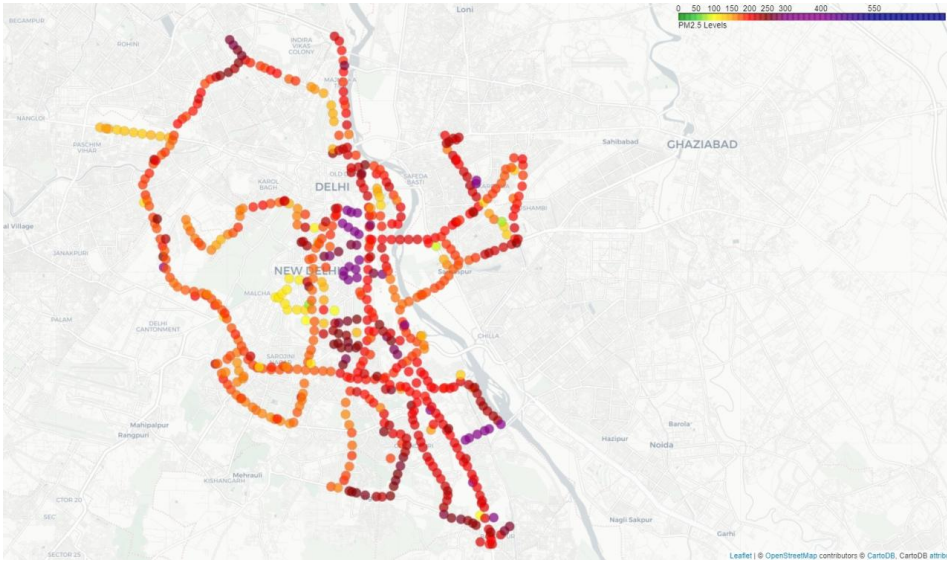
How has urbanisation affected Delhi's pollution?

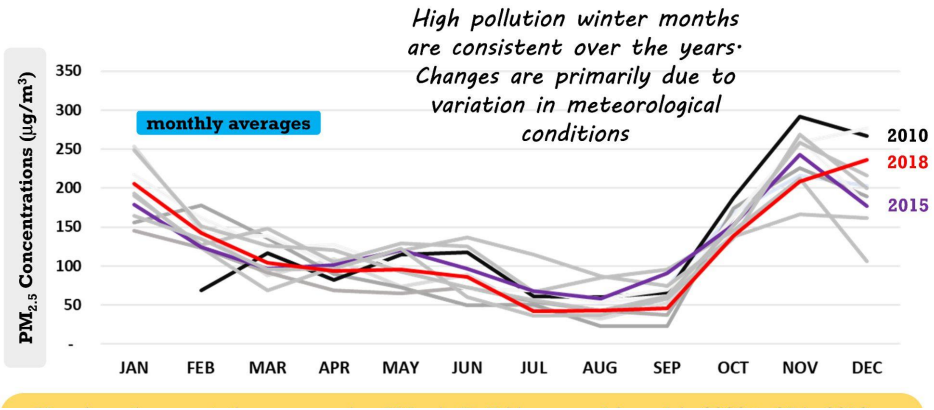
Urbanisation has exacerbated air pollution levels, shrunk water bodies, increased temperature and heat emissions

“More the construction, lower is the moisture content and more is heat in the environment,”

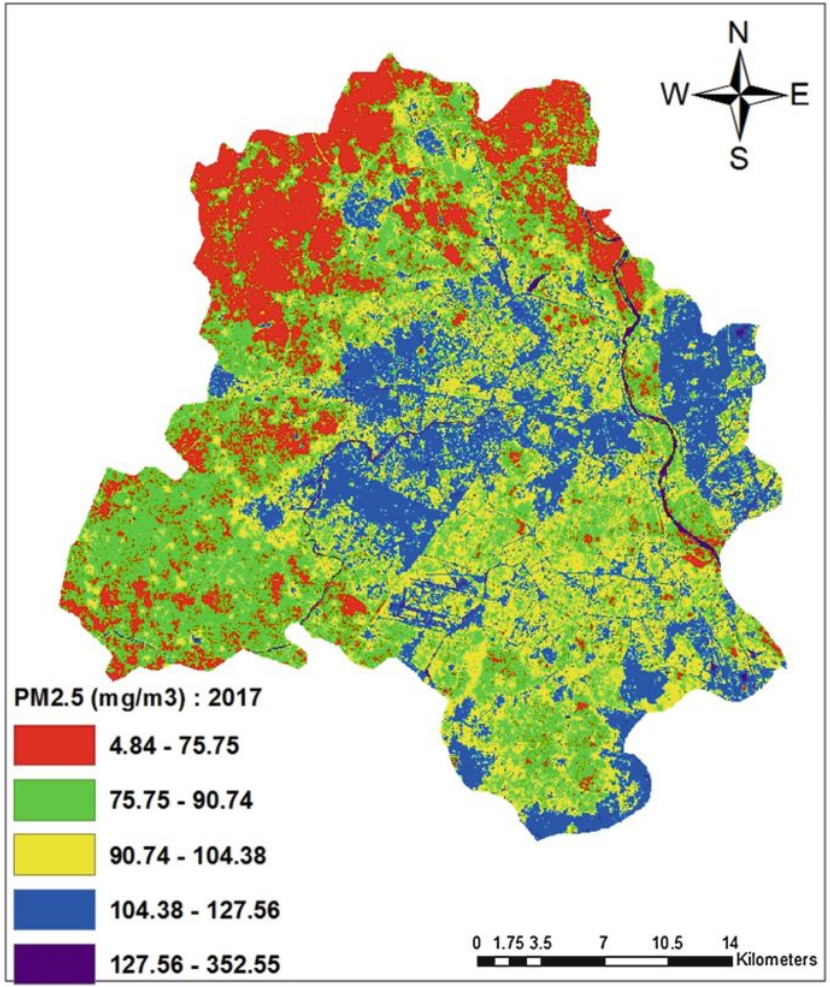
High temperature reduced the wind speed, which, in turn, decreased the ‘heat and pollutant flushing capacity’ of the region.

Bhavit Patil

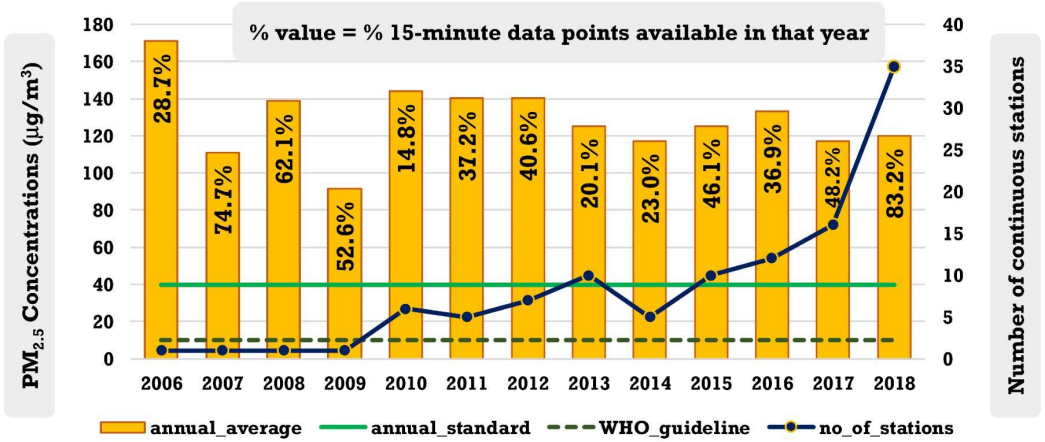


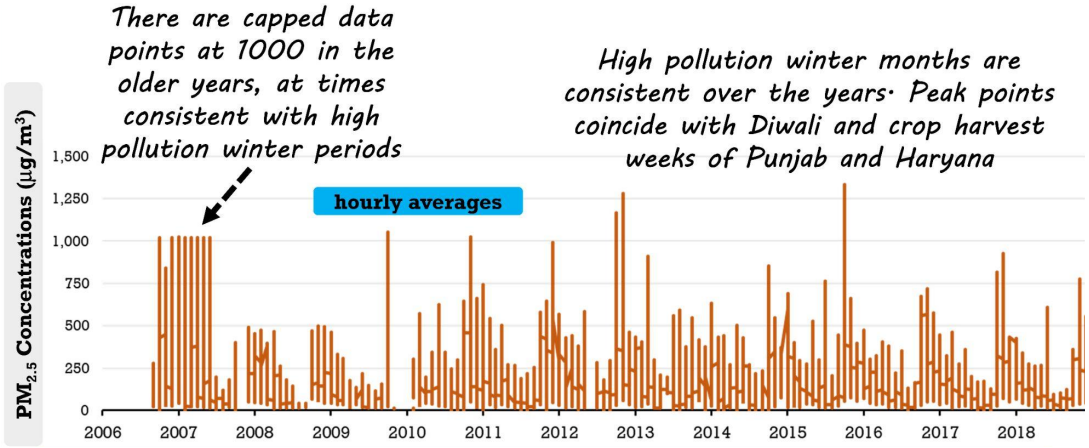


Average Monthly Pollution Graph



Delhi Pollution Map





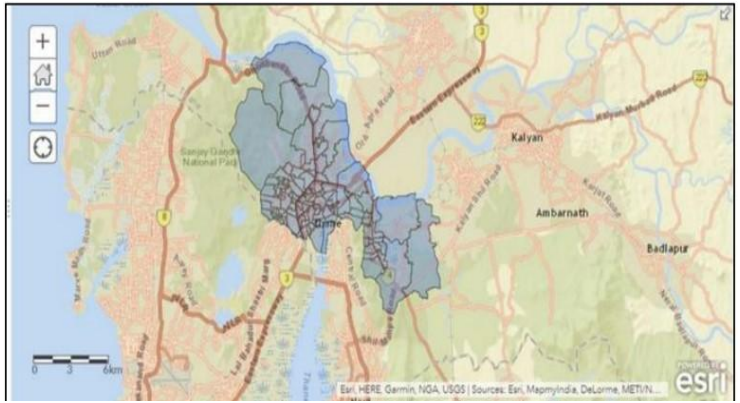
Pollution Graphs
2006-2018

Due to the dominance of stagnation conditions (more than 90 per cent) over Delhi, the climatic conditions favour high atmospheric pollution potential over the region. In a region like Delhi, the reduction in wind speed due to increasing urbanisation should be analysed and its impact on air quality should be considered while planning city development or expansion,

How can we prepare the phenolic database of all species of trees present in the study area ? (Thane)

Tree census, in general, gives the exact picture of the diversity of trees and density of the region where the survey is carried out. The data further help to calculate the amount of oxygen generated and the carbon sequestered in that area. Further analysis of the data; help us understand the quality in the tree species diversity in terms of the ecosystem services they offer.

Ecosystem of trees in city refers to the shade they provide, temperature management, aesthetic values, medicinal value, recreational value, flowers and fruits they offer to mankind and variety of fauna, refuge and nesting to the fauna.



The specific objectives includes

Preparing the phenolic database of all trees species present in the study area.

Preparing database to access the importance of tree species found across the city.

QUALITATIVE ANALYSIS

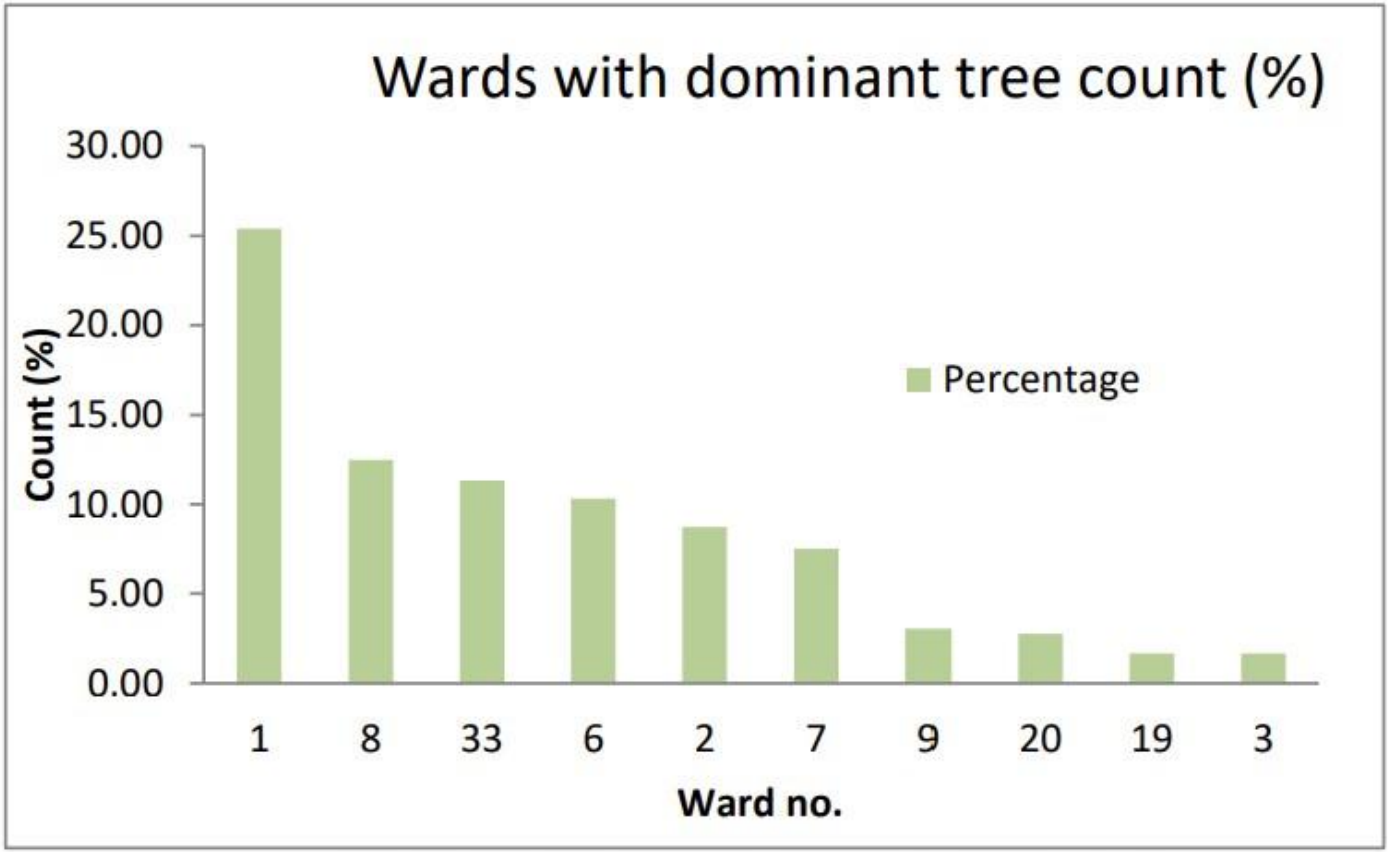
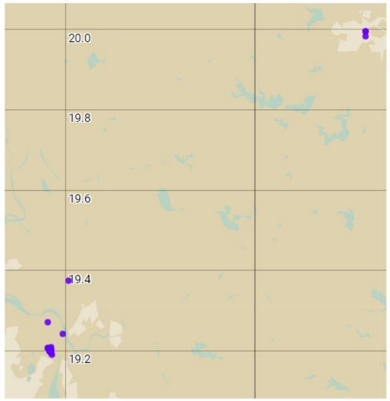
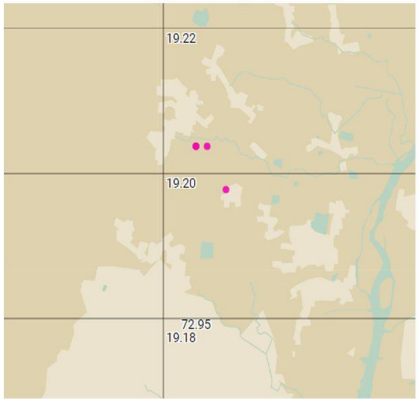


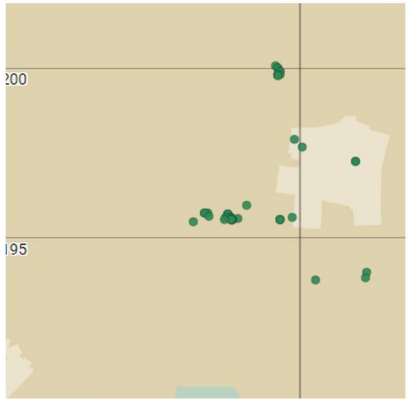
Figure 15: Ward with dominant Tree count



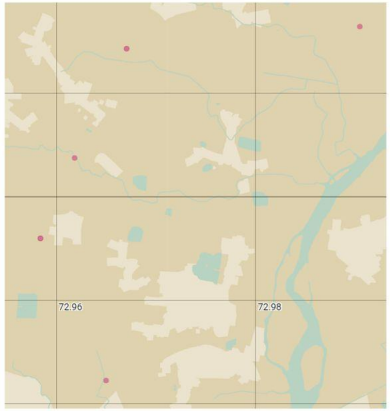
Wild Almond



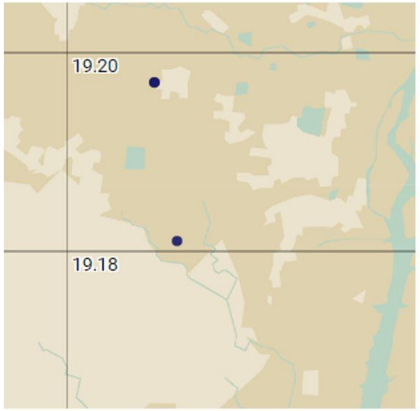
Kadamb



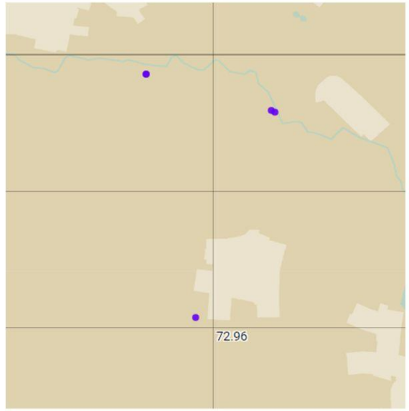
Asupalav



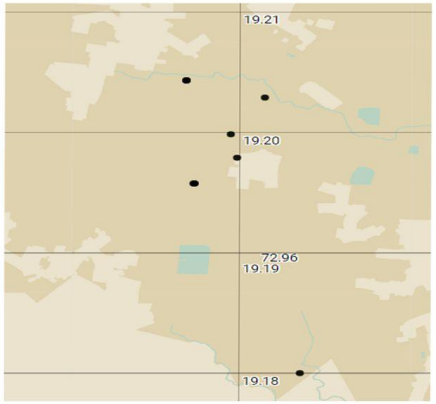
Bhend and Charcoal



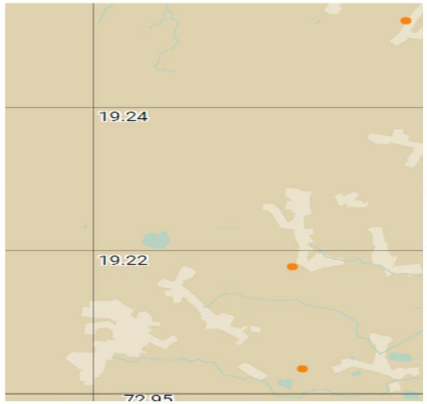
Karanj and Sitasok



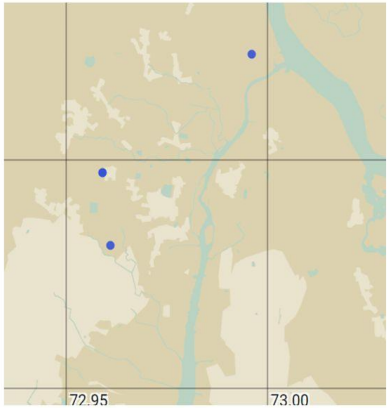
Bhend and wild Almond



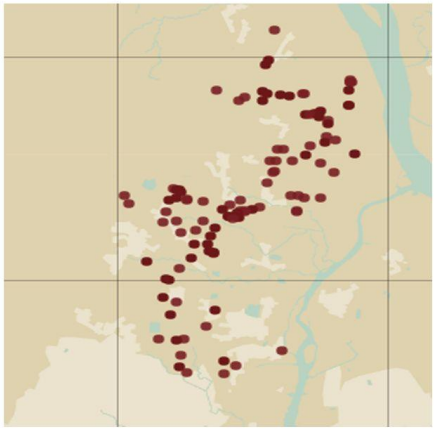
Sag

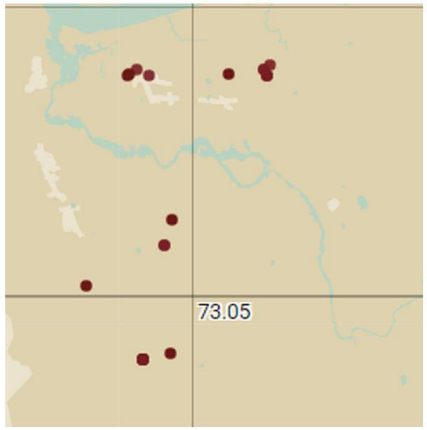


Bhokar



Bhokar


Vad



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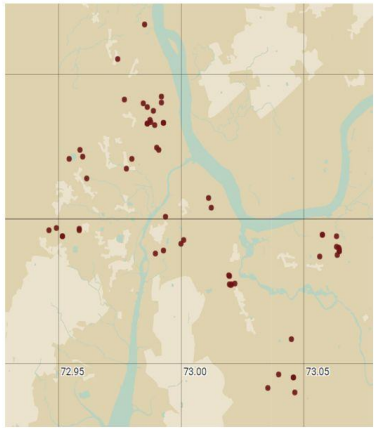
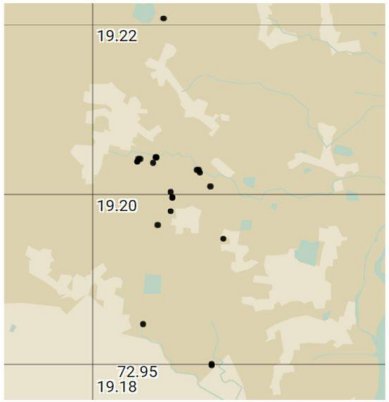
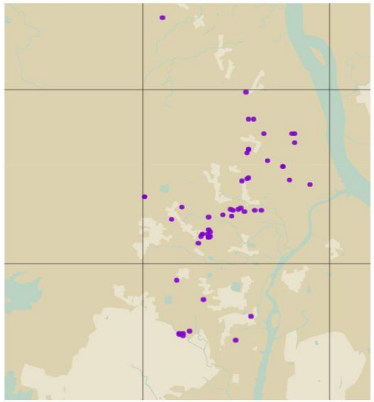


Vad

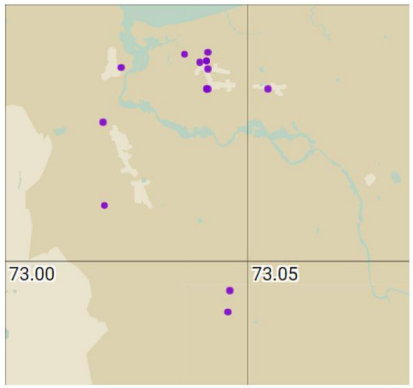
Sag and desi Almond



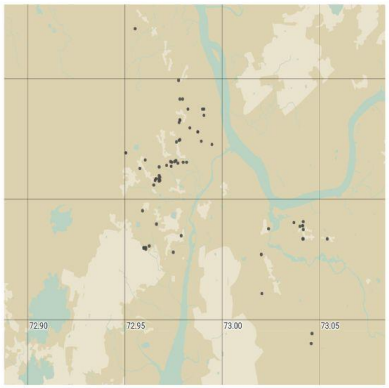
Nandaruk and Anjir



Pimpal



Pimpal



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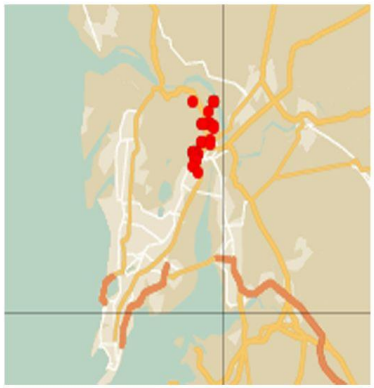
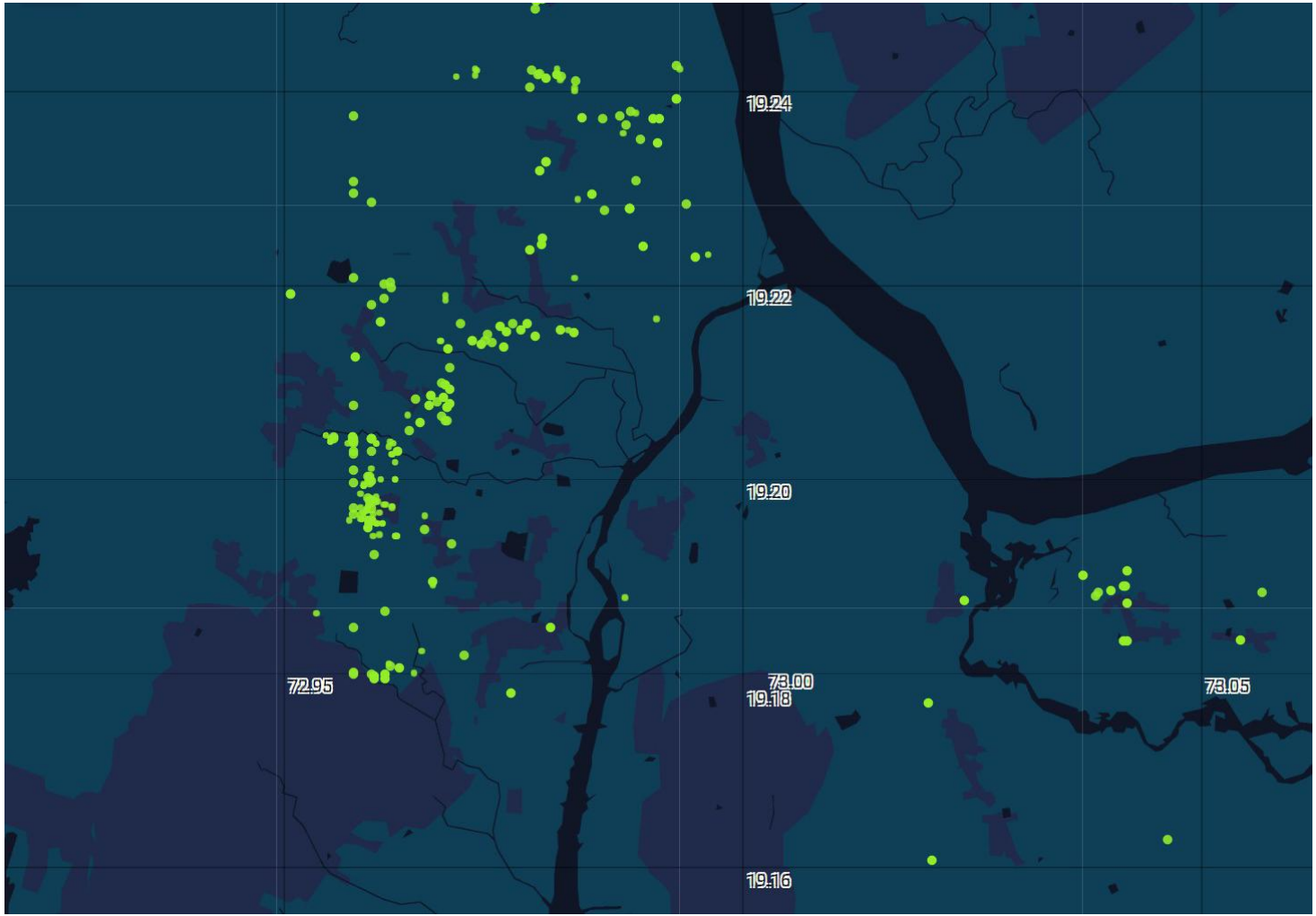


Amba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