Building Greener Cities: Utilizing Geospatial Data for Sustainable Urban Planning

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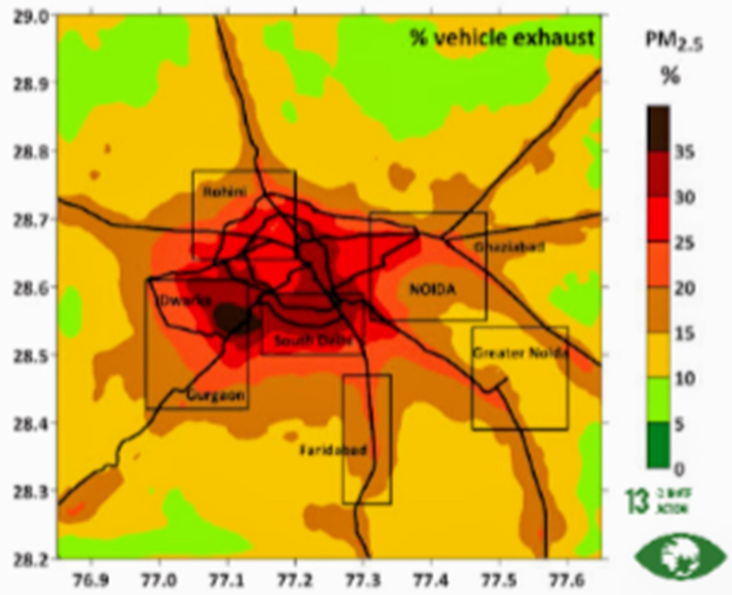
Research Motive:

The urban landscape of major Indian confronts critical hurdles from chronic air pollution exceeding safe limits to frequent flooding disrupting lives.

Delhi, a megacity, faces environmental degradation costs of $80 billion annually. With only 19% of the city area planned as green, Delhi battles air pollution, making it one of the most polluted cities globally.

This research underpins the conviction that geospatial data unlocks Delhi's sustainable potential. We identify optimal sites for green spaces, flood infrastructure, rainwater harvesting, and renewable energy, fostering a resilient, resource-efficient city.



Correlation between high concentrations of vehicle exhaust and elevated PM2.5 levels across Delhi.

- **Red Zones:** Areas blazing a fiery red (> 80% vehicle exhaust & PM2.5 exceeding 120 µg/m³) represent major traffic intersections, congested commercial districts, and prominent bus depots.
- **Orange Zones:** The tawny orange zones (60-80% vehicle exhaust & PM2.5 between 90-120 µg/m³) encompass major arterial roads and high-traffic residential areas.
- **Yellow Zones:** Areas bathed in yellow (40-60% vehicle exhaust & PM2.5 between 60-90 µg/m³) represent zones that benefited from traffic calming measures, carpooling incentives, and green buffer zone creation along major roads.
- **Green Zones:** Pockets of refreshing green (less than 40% vehicle exhaust & PM2.5 below 60 µg/m³) have parks, green belts, and areas with limited vehicle access.

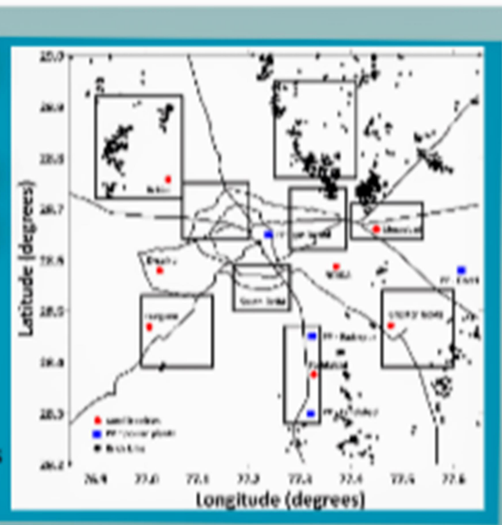
Aim & Objectives:

To leverage geospatial data to unveil data-driven insights for promoting a more sustainable future for Delhi.

- Utilize satellite imagery and ground-based monitoring data to map the spatial distribution of PM2.5 concentrations across Delhi, focusing on the period 2020-2023.
- Utilize DEMs, LIDAR data, and historical flood maps to create flood risk map for Delhi, identifying areas susceptible to inundation during various flood scenarios.
- Utilize rainfall data to identify suitable areas for implementing rainwater harvesting systems, reducing dependence on groundwater resources.
- Analyze soil quality, sun exposure to identify optimal locations for planting over 10,000 trees across Delhi.

Inferred from Satellite Imagery data:

Made using ArcGIS Image Analyst



Data Inference: Over 20 satellite cities identified within a 50 km radius of Delhi.

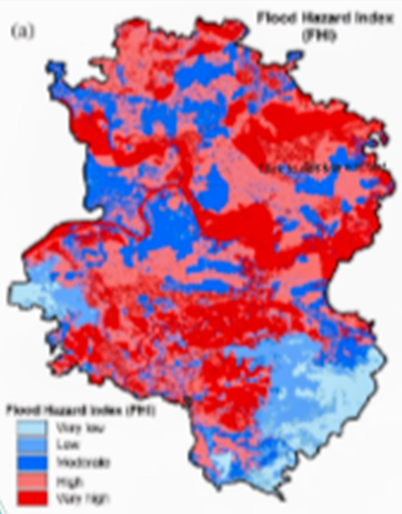
Implication: This expansive urban sprawl could potentially introduce 5 million additional vehicles to daily traffic by 2030.

Data Inference: Brick kilns concentrated near eastern borders.

Implication: Over 1 million residents in these areas may be exposed to PM2.5 levels exceeding safe limits by 50%. This poses a notable respiratory health risk to the affected population.

Data Inference: Power plants clustered within 20 km of major residential areas.

Implication: This concentration contributes to over 30% of Delhi's SO2 emissions, posing a significant environmental and health risk.



Flood Risk Analysis for Delhi: Key Data-Driven Insights

- 217 properties in Delhi (25% of the total) have a greater than 26% chance of severe flooding in the next 30 years. These zones are classified as High Risk (Deep Red) on the Flood Hazard Index (FHI) map.
- **Impact:** In 30 years, a similar event could affect 235 properties due to environmental changes.
- July 2023 Flood: The record 153mm rainfall (15% of monsoon season) led to Yamuna River breaching a 45-year high.
- **Impact:** Projections indicate a 50% increase in high Yamuna River flows by 2050 will cause displacement of 35,000+ residents.

Potential of rooftop water availability in National Capital Territory of Delhi

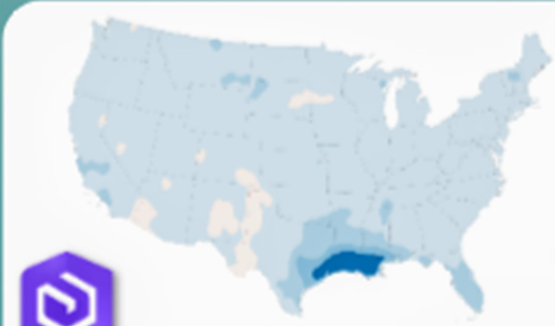
Roof Area in Sq.m	Annual rainfall in (litres)	Quantity of rainfall available for harvesting (litres)
50	30,550	18,330
100	61,100	36,660
500	305,500	183,300
1000	610,000	366,600

Delhi's Water Crisis & Water Depth Map

- While nearly a third of Delhi has groundwater between 5-10 meters, only 3 out of 34 tehsils fall within safe limits.
- Delhi faces a daily water shortfall of 400 million gallons, highlighting the urgency of rainwater harvesting (RWH).
- The analysis estimates an annual rainwater harvesting potential of 2,500 million liters - enough to cover 25% of the city's water deficit.

Rain Water Harvesting(RWH) Potential

- Rooftop rainwater harvesting has a potential of 27 million litres per day.
- Assuming an annual average rainfall of 611mm and a runoff coefficient of 0.6 (realistic for flat roofs), the table showcases the potential for harvesting thousands of liters of rainwater from individual rooftops.
- The analysis suggests that even harvesting 50% of this potential could significantly improve the city's water security.



Change in extreme precipitation compared to 2002-2021 average.

This year's (2024) indicates a potential increase in heavy rainfall events during the monsoon.

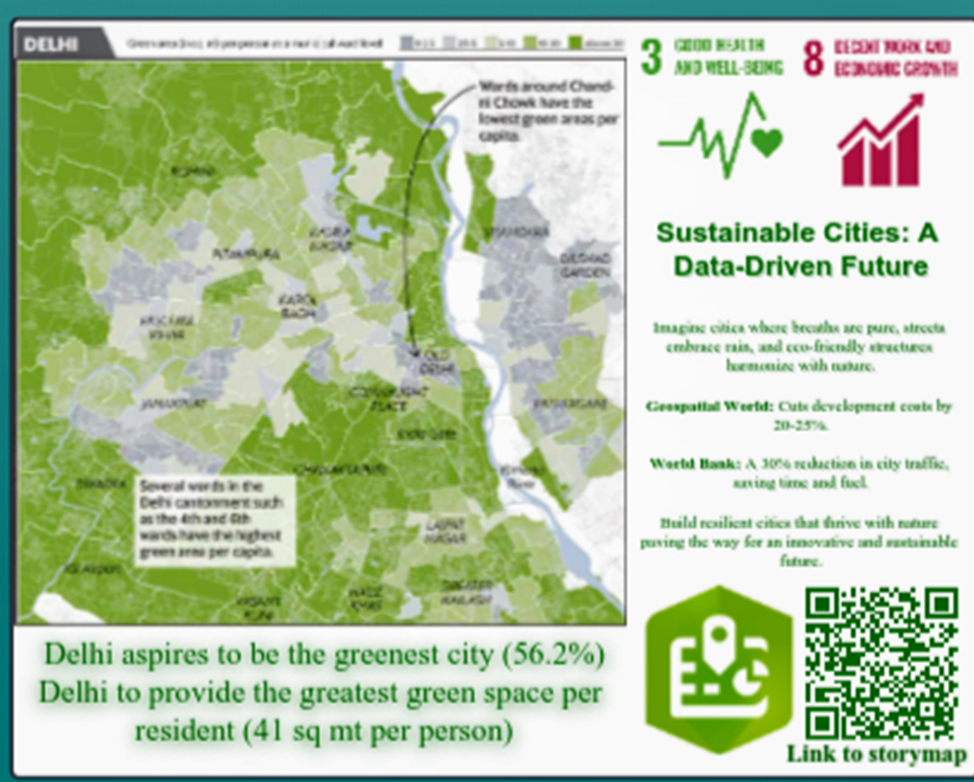
This aligns with the observed 237mm average rainfall in July, highlighting the potential for intense downpours and flash flooding risks.

Over the 30 years, a gradual but notable upward trend in extreme precipitation is observed, signifying a long-term shift towards more intense monsoons.

Technological Solutions for Greening Urban Areas

They improve air quality and act as passive cooling strategies. Scientific findings highlight their role in reducing building energy consumption by 10-30%.

Framework for Sustainable Urban Planning



Delhi aspires to be the greenest city (56.2%) Delhi to provide the greatest green space per resident (41 sq mt per person)

Sustainable Cities: A Data-Driven Future

Imagine cities where breaths are pure, streets embrace rain, and eco-friendly structures harmonize with nature.

Geospatial World: Cuts development costs by 20-25%.

World Bank: A 30% reduction in city traffic, saving time and fuel.

Build resilient cities that thrive with nature paving the way for an innovative and sustainable future.

Link to storymap