PLANNING INTERVENTION TO DEVELOP BLUE GREEN INFRASTRUCTURE

Thesis Submitted in Partial Fulfilment of the requirements
for the award of the degree of

M. PLANNING (Urban Planning)

By
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1220152004

Under The Guidance of
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2023-2024

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(Praveen Kumar)

UNDERTAKING

I Mr. **Praveen Kumar**, the author of the thesis titled " : **Planning Intervention to Develop Blue Green Infrastructure "** hereby declare that this is an independent work of mine, carried out towards fulfillment of the requirements for the award of the Masters in Urban & Planning at the Department of Architecture and Planning, BBDU, Lucknow. The work has not been submitted to any other organization / institution for the award of any Degree/Diploma.

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Date: June,2024

TABLE OF CONTENT :-

TABLE OF CONTENT :-

INTRODUCTION BACKGROUND AND VISION

Blue-Green Infrastructure can be defined as an umbrella of nature-based solutions that have a direct impact on climate change, urban resilience, and health and wellness' '

Blue-green infrastructure manages the risk of flooding in urban environments by introducing a more natural water cycle and multi-functional land use to generate benefits for the environment, society and the economy. Blue and green infrastructure are integrated into urban spaces, and linked up to control rainwater and excess surface water and combat increasing development and hard surfaces.

Using green space to manage surface water and implement a more natural approach to urban drainage enables water to be controlled closer to the source. More water is retained in blue-green infrastructure which reduces the chances of traditional drainage systems becoming overwhelmed.

BGI (BLUE GREEN INFRASTRUCTURE)

GREEN INFRASTRUCTURE **BLUE INFRASTRUCTURE**

Aim of the study

The aim is to analyze the need of integration of blue green infrastructure with urban development to make cities future proof or hazard resilient.

Objective

a.) Understand the requirement and importanceof BGI in urban context of Ayodhya.
b.) Integration of Blue Green Infrastructure approach with respect to latest government policies.
c.) Find the public opinion and adaptive scale for to cater the environment concerns using Blue Green Infrastructure strategies.
d.)To plan and deliver at a local level while recognizing that this will inevitably extend at times across administrative boundaries.

Scope of the study

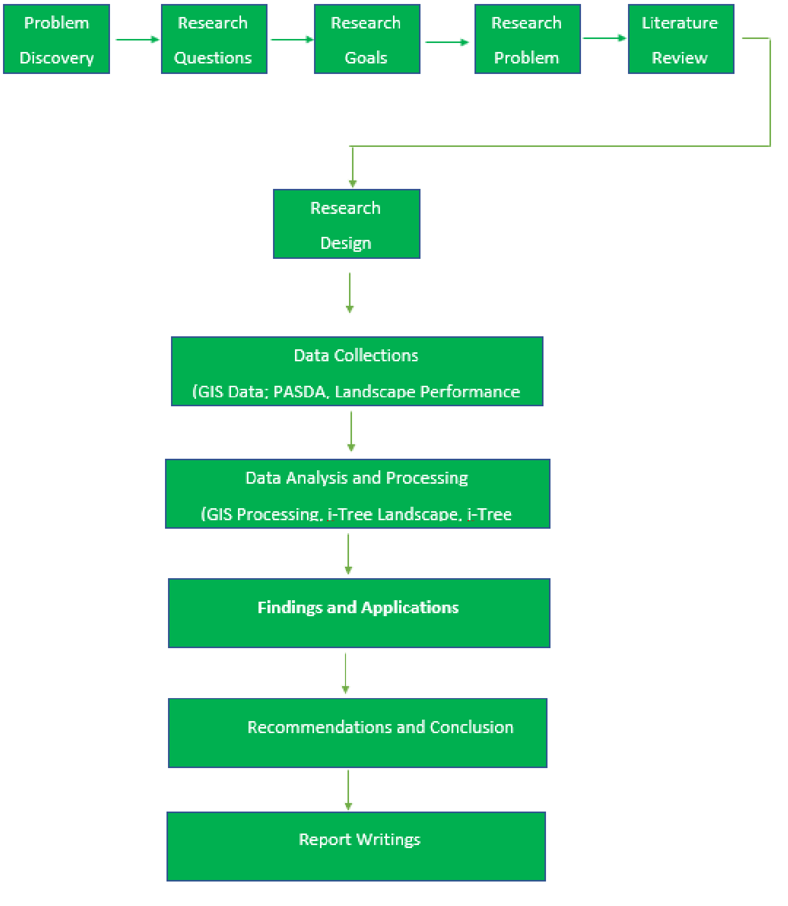
- Enhance urban resilience and sustainability
- Integrate natural elements like water bodies and green spaces into the built environment
- Efficiently manage water resources and reduce flooding
- Mitigate the impacts of climate change
- Improve biodiversity and ecosystem services
- Foster healthier and more livable urban spaces
- Balance human development with environmental conservation
- Promote long-term sustainability and quality of life.

Need of study:-

The study on blue-green infrastructure is vital for tackling urban challenges, promoting sustainability, and building resilience to climate change. It focuses on improving water management, fostering biodiversity, and enhancing overall urban quality of life. Additionally, by addressing heat island effects and air pollution, the study contributes to public health. Its findings offer essential evidence for making informed decisions in urban planning and policy

Aspects

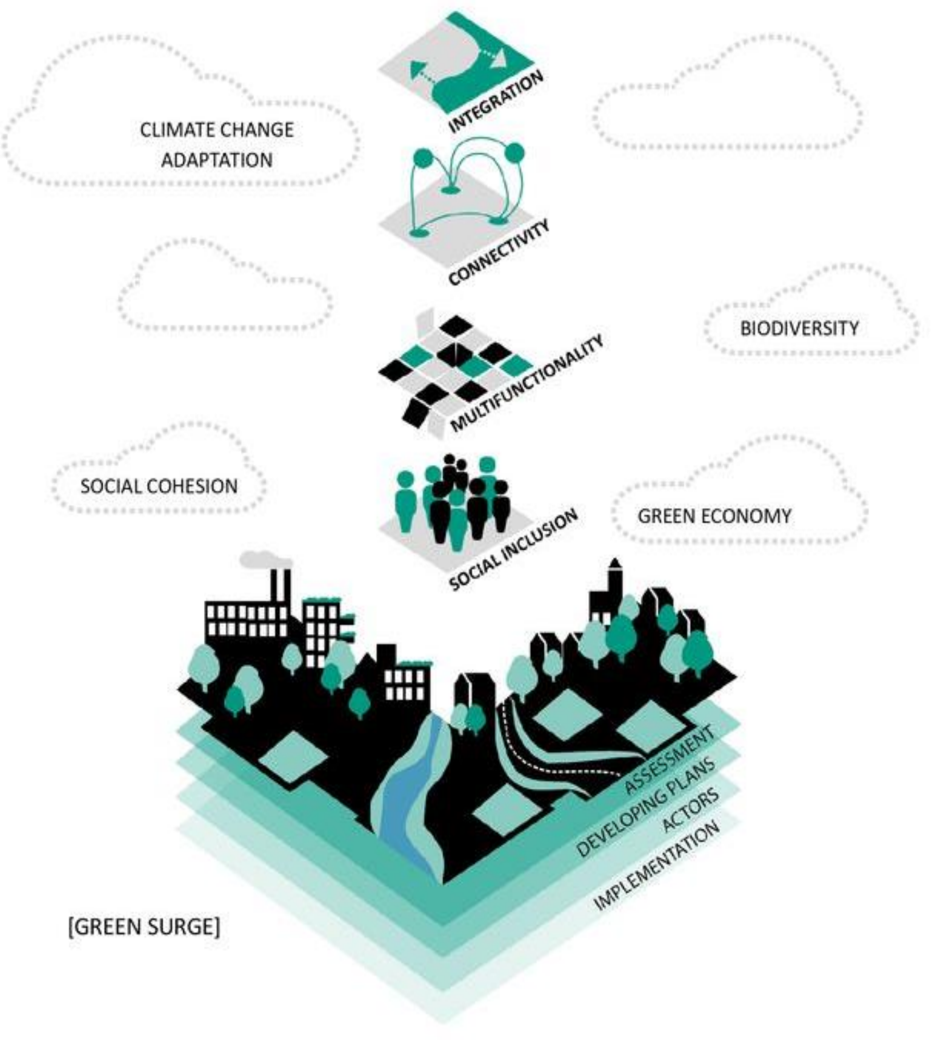
Methodology and Framework:-



Influence on SDGs

GOAL 1: Good Health and Well-being.
GOAL 2: Clean Water and Sanitation.
GOAL 3: Industry, Innovation and Infrastructure.
GOAL 4: Sustainable Cities and Communities.
GOAL 5: Climate Action.
GOAL 6: Life Below Water.
GOAL 7: Life on Land.
GOAL 8: Partnerships to achieve the Goal.

Approach



LITERATURE STUDY -1

LITERATURE STUDY OF SPONGE CITY PROGRAMME (WUHAN, CHINA

- Using Nature to Reshape Cities and Live with Water: An Overview of the Chinese Sponge City Program and Its Implementation in Wuhan.
- Wuhan, located in central China, is well-known as the “city of one hundred lakes” and has abundant water resources and extensive water systems. However, water management and waterlogging prevention in Wuhan is challenging. Wuhan has suffered from waterlogging for years mainly due to the low-lying built-up area and the uneven distribution of precipitation. Rapid urbanization has exacerbated waterlogging. The sharply shrinking size of natural lakes caused by land expansion reduces the regulation and storage capacity of the lakes. As sewage pipes and storm water pipes are mixed and misconnected, the sewage water is discharged into urban water channels, resulting in water pollution that deteriorates the water management system. It is urgently needed to develop an effective system for water management and waterlogging prevention.

Several key points lead to the success of the Wuhan Sponge City Programme:

1 Applying whole-process management in waterlogging prevention;
2 Integrating sponge projects in Wuhan Comprehensive Planning with the collaboration of different city departments;
3 Developing localized strategies and technical standards;
4 Establishing a fund-raising mechanism and attracting social participation for risk- and benefit-sharing.

Schedule of funding:-

To support the construction of sponge cities, the national government offers funds for pilot cities to start the program in the initial three years: CNY 400 million (EUR 51 million) per year for each city, CNY 500 million (EUR 63 million) for each provincial capital, and CNY 600 million (EUR 76 million) for each municipality directly under the central government. In general, the national fund equals 15-20% of the total cost of sponge city construction. A 10% incentive subsidy is given to the local municipal government if social investment from other sources funded a certain proportion of remaining costs

Figure 1.2 Pilot Cities in Chinese Sponge City Programme

List of pilot cities:

2015 (16 cities): Qianan, Baicheng, Zhenjiang, Jiaxing, Chizhou, Xiamen, Pingxiang, Jinan, Hebi, Wuhan, Changde, Nanning, Chongqing, Suining, Guian New Area and Xixian New Area.

2016 (14 cities): Beijing, Tianjin, Dalian, Shanghai, Ningbo, Fuzhou, Qingdao, Zhuhai, Shenzhen, Sanya, Yuxi, Qingyang, Xining and Guyuan.

APPROACH & STRATEGY

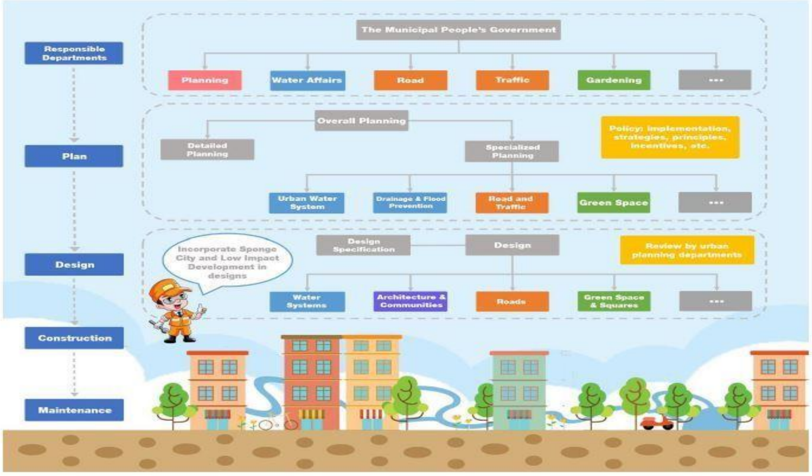


Figure 1.3 Coordinating Different Departments in the Municipal Sponge City Programmes

APPROACH & STRATEGY

- The organizations or responsible departments undertaking the sponge city plans should be qualified in urban and rural planning and should engage in the planning work within the scope permitted by the qualification.
- Content :
- Analyze urban location, geography, economic and social status, rainfall, soil, groundwater, underlying surface, drainage systems and hydrological situation before urban development to identify existing problems in water resources, water environment, water ecology, water security and other aspects.
- Determine the objective of sponge city construction and specific indexes: the objective is mainly the volume capture ratio of annual rainfall, defining the short and long-term sponge city Construction Performance Evaluation and Assessment Method.
- Propose the overall idea of sponge city construction .
- Propose guidelines on the zoning of sponge cities: identify background conditions of ecosystems, such as mountain, water, forests, croplands and lakes, address the natural ecological space pattern of the sponge city, and define the protection and restoration requirements.
- Implement the sponge city construction control requirements: divide the objective and indicators of the rainfall capture into four categories — water ecology, water environment, water safety and water resources.
- Address suggestions on linking planning measures with relevant specialized plans.
- Clearly define the priorities the short-term: put forward the construction requirements in different stages.

CONCEPT & IDEA

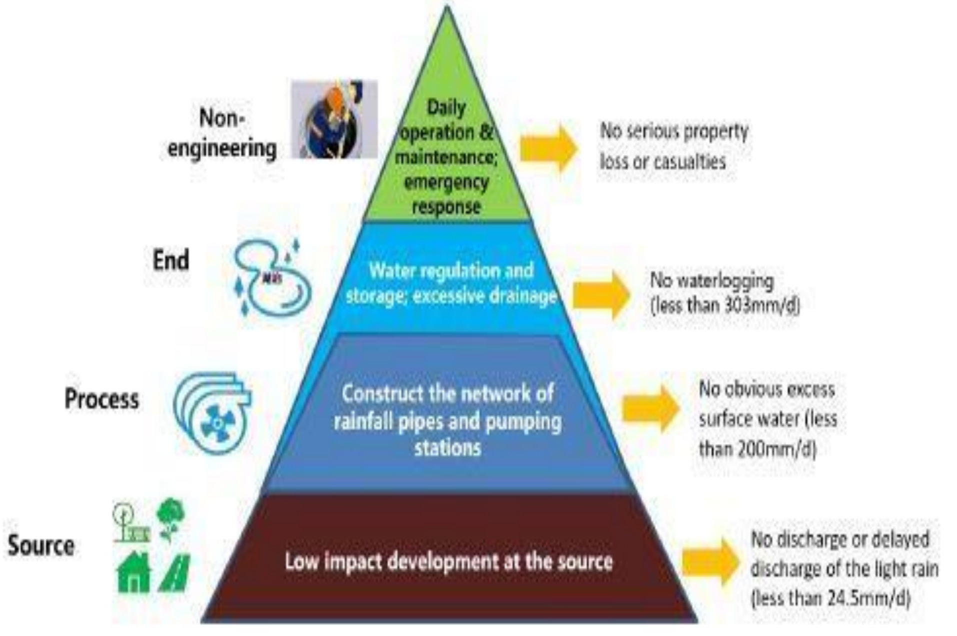


Figure 2.3 The management ideas of sponge city construction (adapted from KANG Dan 2020[15], permissions from the Wuhan Urban and Rural Construction Bureau)

- "1+6" pattern refers to 1 central urban district and 6 new urban districts within the urban development are
- Two axes: mountains and rivers (the Yangtze River and Han River)
- Two rings: an inner ring formulated by the protected forest belt connecting 6 large parks, 27 small and medium parks and 5 low-density construction areas and an outer circle located outside of the central urban district within the urban development area.
- Six wedges: 6 lake districts, consisting of parks, lakes, wetlands, forests, agricultural fields, recreational areas, etc.
- Multiple corridors: multiple ecological corridor connected with the six wedges

PROJECT DEMONSTRATION

Figure 2.7 Before and after sponge construction of demonstration project – the Gangcheng No.2 Middle School in Qingshan district, Wuhan (Kang Dan, permissions from the Wuhan Urban and Rural Construction Bureau)

RESULT : SPONGE INDEXES OF WUHAN SPONGE PROJECTS

Project			Case 1	Case 2	Case 3	Case 4
			Nangan Channel	Qingshan Port Wetland	Gangcheng No.2 Middle School	South Lake Area
Sponge Indexes	Water Ecology	Volume capture ratio of annual rainfall	70%	85%	80%	65%
		Ecological shoreline	NA	NA	NA	NA
	Water Environment	TSS[1]	50%	70%	70%	60%
		Others	NA	Diversion rate of rainfall and sewage water: 100% Water quality standard: standard III	Sewage collection rate: 100%	NA
	Water Safety	Flood control	Achieve a capacity to resist 50-year storm	50-year storm	50-year storm	NA
		P[2]	3 years	2-3 years	5 years	New rainwater pipes: 2-3 years; Renovated rainwater pipes: 1 year
		Runoff coefficient	≤0.6	≤0.6	≤0.6	≤0.6
	Water Resources	Rainfall utilization rate[3]	25%	≥25%	≥25%	NA
	Others		NA	NA	NA	The proportion of permeable pavements: 40%

Note:

TSS[1]: The reduction rate of non-point source pollution

P[2]: The recurrence interval for storm sewer design

Rainfall utilization rate[3]: The utilization rate of recycled stormwater in greening irrigation, road flushing and other ecological purposes

CASE STUDY -1

MADURAI ACTION PLAN FOR BLUE-GREEN INFRASTRUCTURE

Introduction background and vision:-In March 2013, Atkins, supported by the Development Planning Unit of University College London and the Indian Institute of Human Settlements, were commissioned by the Climate Development Knowledge Network (CDKN) to undertake action planning with the city authorities of Bangalore and Madurai, focussed on developing future proofed urban strategies in the cities. In Madurai, we have been working closely with Madurai Municipal Corporation who has been the client for the project as well as Dhan Foundation who are delivery partners for the project.

Over all approach to the project:-The project has been undertaken over two key stages at the city level, which is consistent with the future proofing approach developed by Atkins and UCL, with later stages disseminating the lessons learned.

This report is the final action plan for Madurai which provides a basis to address the climate risks and development needs of the city.

At the conclusion of the urban diagnostic stage, stakeholders in the city converged on the view that the plan should focus on future proofing Madurai's blue-green infrastructure to build resilience to climate change impacts facing the city. This

Purpose of the plan:-The purpose of the action plan is to provide a mechanism for building the city's current and future resilience, as well as the capacity to act among communities, institutions, and government. The aim is to foster collaboration between sectors and communities, in order to arrive at an integrated approach and to generate momentum for early action around the priority issue of blue-green infrastructure.

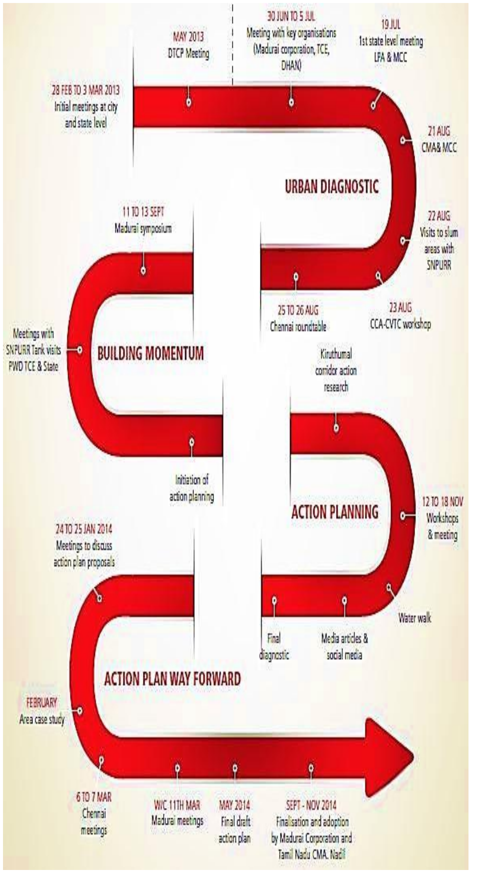
The aim of the action plan is to:

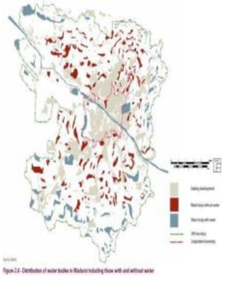
- **-**mobilise action, target specific vulnerabilities and deliver change on the ground that will benefit a wide range of stakeholders, including those in multidimensional poverty
- address identified risks, including multiple risks to generate 'win-win' and 'triple win' environmental benefits
- catalyse economic development.
- make the case for the mobilisation of resources to address issues and infrastructure gaps in Madurai
- define a programme of interrelated actions to help unlock currently stalled projects in Madurai

- contribute to the forthcoming revision to the CDP and master plan
- link to and reinforce other planning interventions and existing policies
- be implementable, in the context of other existing plans, capacities and incentives
- to identify those organisations, departments and institutions who have the responsibility for implementing each element of the action plan
- to identify potential sources of investment, funding, and delivery vehicles for key interventions and projects.

Action Planning

- Building platforms for engagement.
- Reviewing the current position and creating an urban diagnostic.
- Using the action planning process to clarify and examine the implications of the existing situation for vulnerable communities.
- Bringing together stakeholders to engage and consider the priority issues.





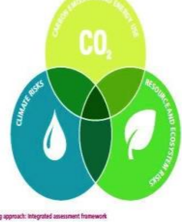



Figure 2.1 - Future proofing approach: integrated assessment framework

Figure 2.3 - An example of one of the water bodies which has fallen into disuse from sand mining which is disrupted the flow of water which would replenish the tank. The tank has then been encroached upon by development which is at high risk of flooding

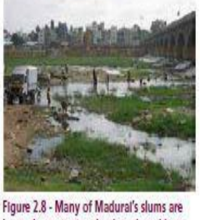


Figure 2.8 - Many of Madurai's slums are located near to river banks vulnerable to flooding

The Future Proofing Strategy For Madurai

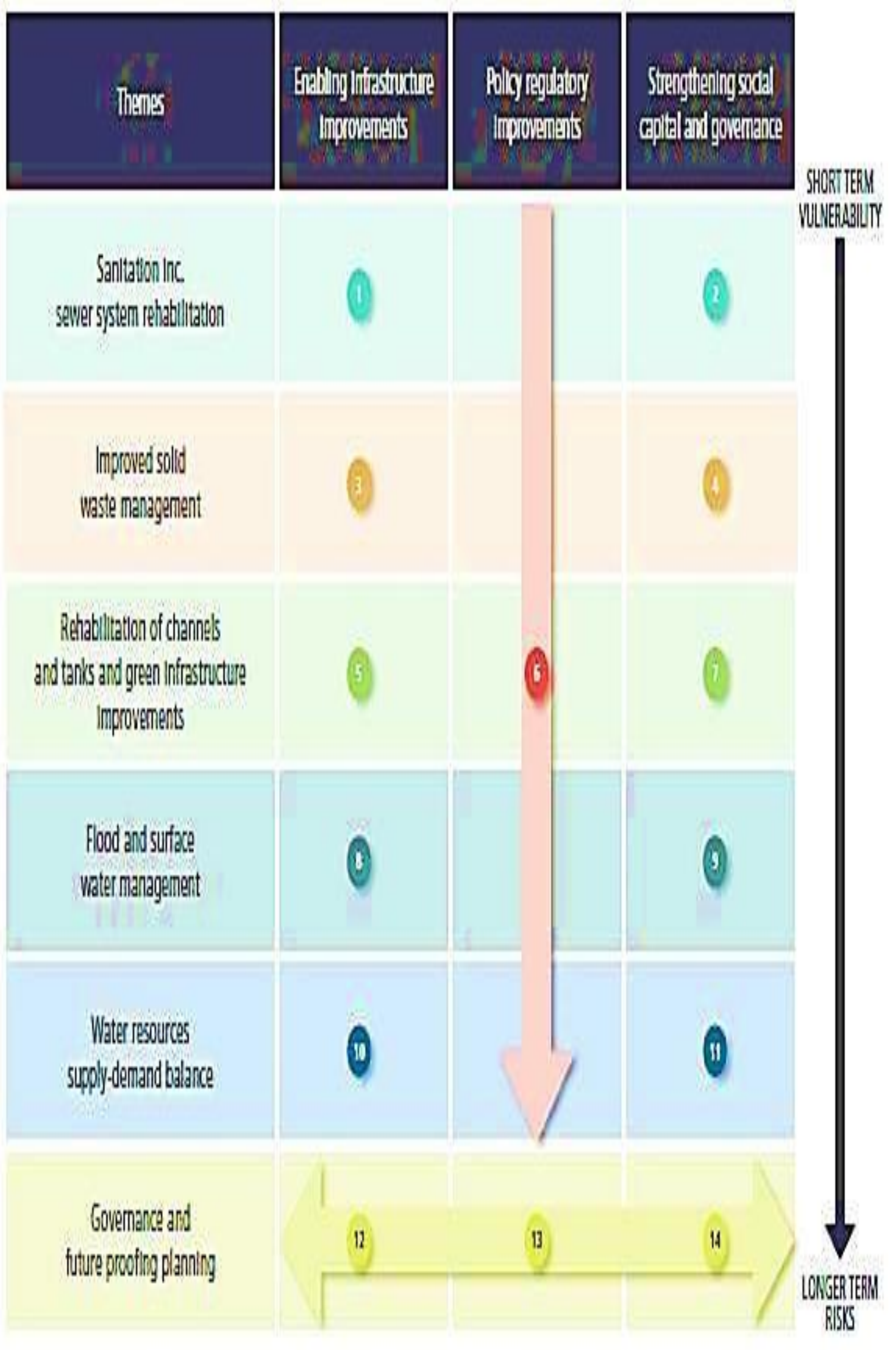


Figure 3.1 - Tackling risk and vulnerability together in Madurai
Tacking risk and vulnerability together in Madurai requires integration action across sectors (see project key on page 32)

The Future Proofing Strategy For Madurai

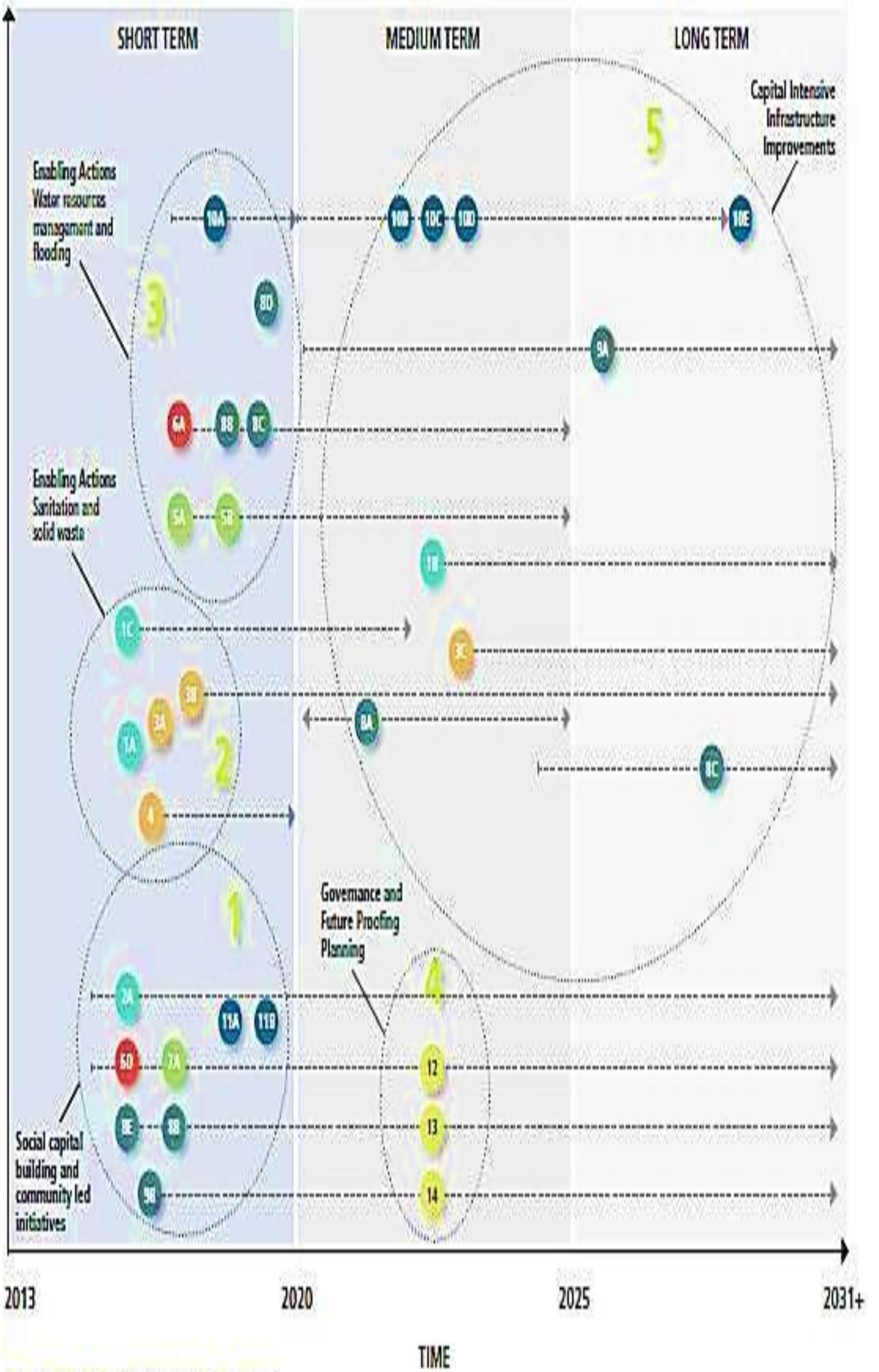


Figure 3.2 - Indicative schedule of actions

Benefit/Impact Scorecard

- A benefit / impact scorecard was developed to provide a preliminary assessment of how each project would address the range of future proofing dimensions defined as follows.
- Climate risk: Initial assessment on whether the measure would be effective in addressing climate risk along one or more dimensions. Effects of increased temperatures, variability in monsoons, extreme precipitation events/flooding; 5 = very high, 4 = high, 3 = medium, 2 = low, 1 = very low / no impact.

  Community needs: Initial assessment of how the measure would reduce vulnerability of communities and reduce multidimensional poverty e.g through provision of basic services,health improvements etc.. 1 - 5 scale.

  Resource efficiency: Initial assessment of whether the project would address resource efficiency along one or more dimensions water scarcity,food security, natural habitat, 1 - 5 scale.
- Prioritization: An initial assessment was made for the prioritisation which should be given to each policy to help inform the approach to phasing and sequencing within the overall strategy.

Conclusion

- In conclusion, the study and understanding of the requirement and importance of Blue-Green Infrastructure (BGI) in the urban context reveal its significant role in creating sustainable and resilient cities. BGI refers to the integration of natural elements, such as green spaces, water bodies, and vegetation, into urban landscapes to provide multiple benefits to both the environment and society.
- BGI contributes to biodiversity conservation and ecological sustainability. By incorporating green corridors and habitat networks, BGI supports wildlife habitats, promotes biodiversity, and enhances ecological connectivity within urban environments. It provides opportunities for urban residents to interact with nature, improving their mental and physical well-being.
- Secondly, BGI offers social and economic benefits. Access to green spaces and natural environments has been linked to improved mental health, reduced stress levels, and increased social cohesion within communities. BGI projects also create job opportunities in fields such as urban planning, landscape design, and environmental management. Moreover, the aesthetic value of well-designed BGI can enhance property values and attract investments.
- Overall, the requirement and importance of BGI in the urban context underscore its potential to create more sustainable and resilient cities. By integrating nature into urban environments, BGI addresses environmental, social, and economic challenges, fostering a better quality of life for urban residents and promoting a healthier planet. Continued research, planning, and implementation of BGI are essential for building greener and more sustainable cities for future generations.

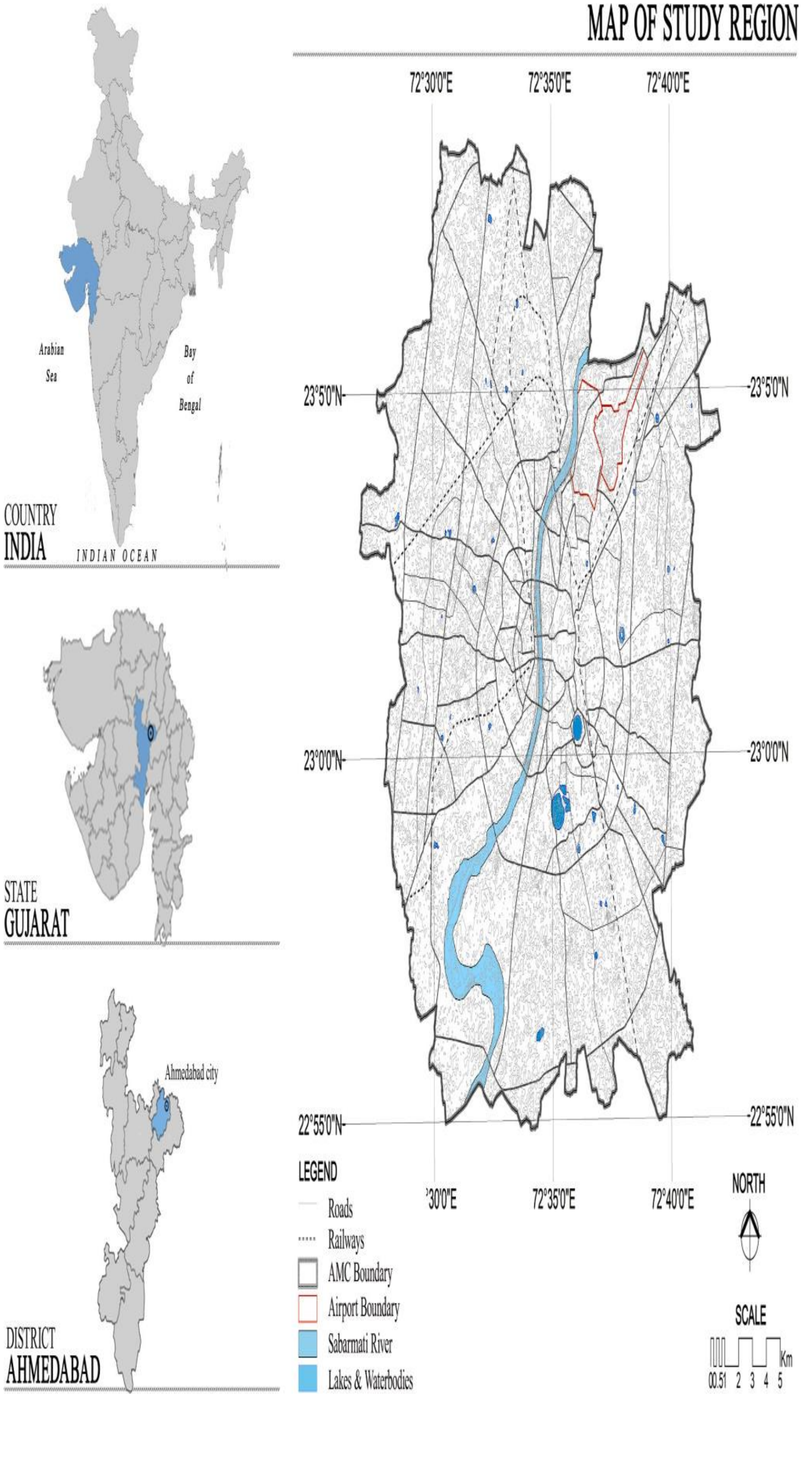
CASE STUDY -2

AHMEDABAD ACTION PLAN FOR BLUE-GREEN INFRASTRUCTURE

Introduction:-55% of the world's population resides in an urban setting and it is projected by United Nations that this proportion is going to increase to 68% by 2050 . The physical expansion of urban areas as a result of urbanization often comes at the expense of natural landscapes . Loss of city's blue and green spaces and increase in the impervious surfaces considerably reduces its capacity to absorb water in the event of a rainfall and hence entirely dependent on grey infrastructure to collect storm water and transport it out of the city . Compounding these challenges, even a moderate rainfall event generally leads to a major flooding situation in the cities . Hence, it becomes imperative to explore alternative approaches to urban storm water management as in most cases the traditional disposal systems fails to address the hydro climatic problems induced by urbanization and impervious land cover . For an effective water and storm water management, it is important to manage the water above the ground where it falls by utilizing a network of blue and green spaces as supplementary to traditional piped (grey) infrastructure, generally termed as Blue-Green Infrastructure (BGI). BGI can be defined as an integrated network of natural, adapted or man-made blue and green spaces in an urban context to mimic natural hydrological processes (such as flow control, detention, retention, filtration, infiltration and different forms of water treatment like reuse and recycling) for sustainable water and storm water management in cities

Ahmedabad Urban Development Authority Development Plan (AUDA DP). National Bureau of Soil Survey and Land Use Planning (NBSS&LUP). Bhaskaracharya National Institute for Space Applications and Geoinformatics (BISAG-N).

Soil has a natural tendency to slowly allow water to pass through it and different soil types have varied drainage capacities. The United States Department of Agriculture (USDA) Natural Resource Conserva- tion Service have classified soils into four hydrologic soil groups based on the infiltration rates; A, B, C and D. Group A soils have the highest infiltration rates and the lowest run off potential, and Group D soils have the lowest infiltration rate and highest run off potential. BGI practices such as rain gardens, permeable pavement and bio-swales generally require soils with high infiltration rate to function effec- tively


MAP OF STUDY REGION
72°30'0"E
72°35'0"E
72°40'0"E
23°5'0"N
23°0'0"N
22°55'0"N
Arabian Sea
Bay of Bengal
INDIAN OCEAN
COUNTRY
INDIA
STATE
GUJARAT
Ahmedabad city
DISTRICT
AHMEDABAD
LEGEND
Roads
Railways
AMC Boundary
Airport Boundary
Sabarmati River
Lakes & Waterbodies
NORTH
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Km
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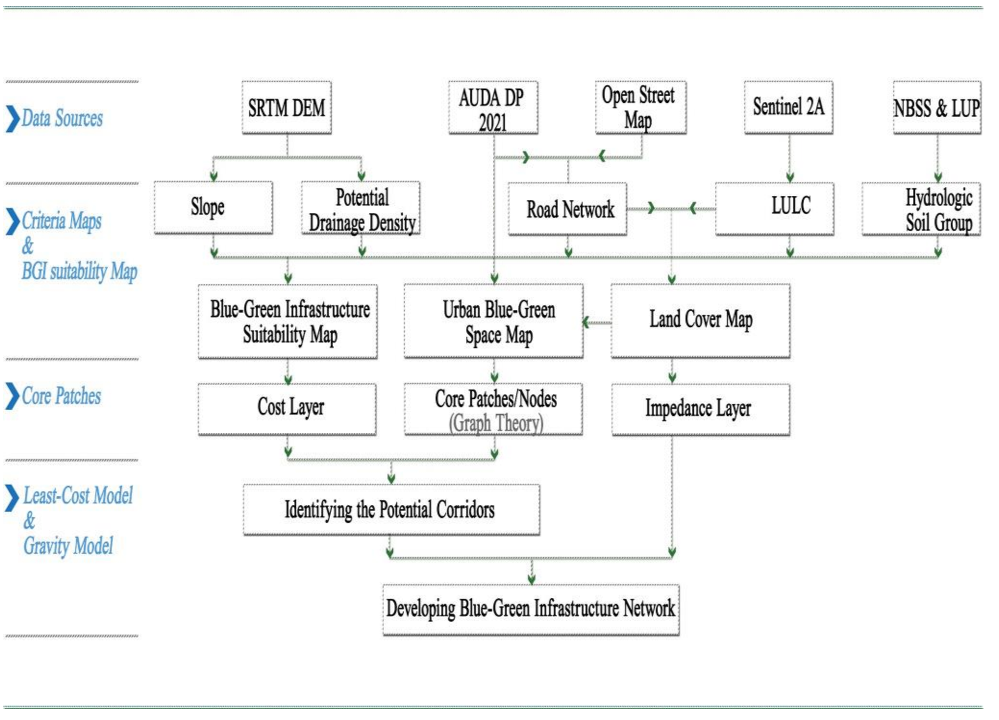

Fig. 2. BGI methodology flowchart used to identify potential corridors and develop an urban blue-green space network.

Therefore, Group-A soils are most effective for BGI implementation. The soil map for Ahmedabad has been obtained from National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) and BISAG. The soil types within the AMC boundary are classified into two types: coarse loamy and fine loamy, belonging to hydrologic group A and C respectively.

Management of BGI network and accessibility is also very important for long term success of identified BGI network and for this study, public owned lands were considered more appropriate over private lands. The roads and transportation Right-of-Ways (ROW) provide easier access for implementing and maintaining varied BGI practices . Therefore, in this study all the major roads /streets and an average of 30 m right of way along the transportation networks has been considered most suit- able for the implementation of BGI. The existing and proposed streets dataset is obtained from AUDA DP . Open street map is used to add the rest of the road network

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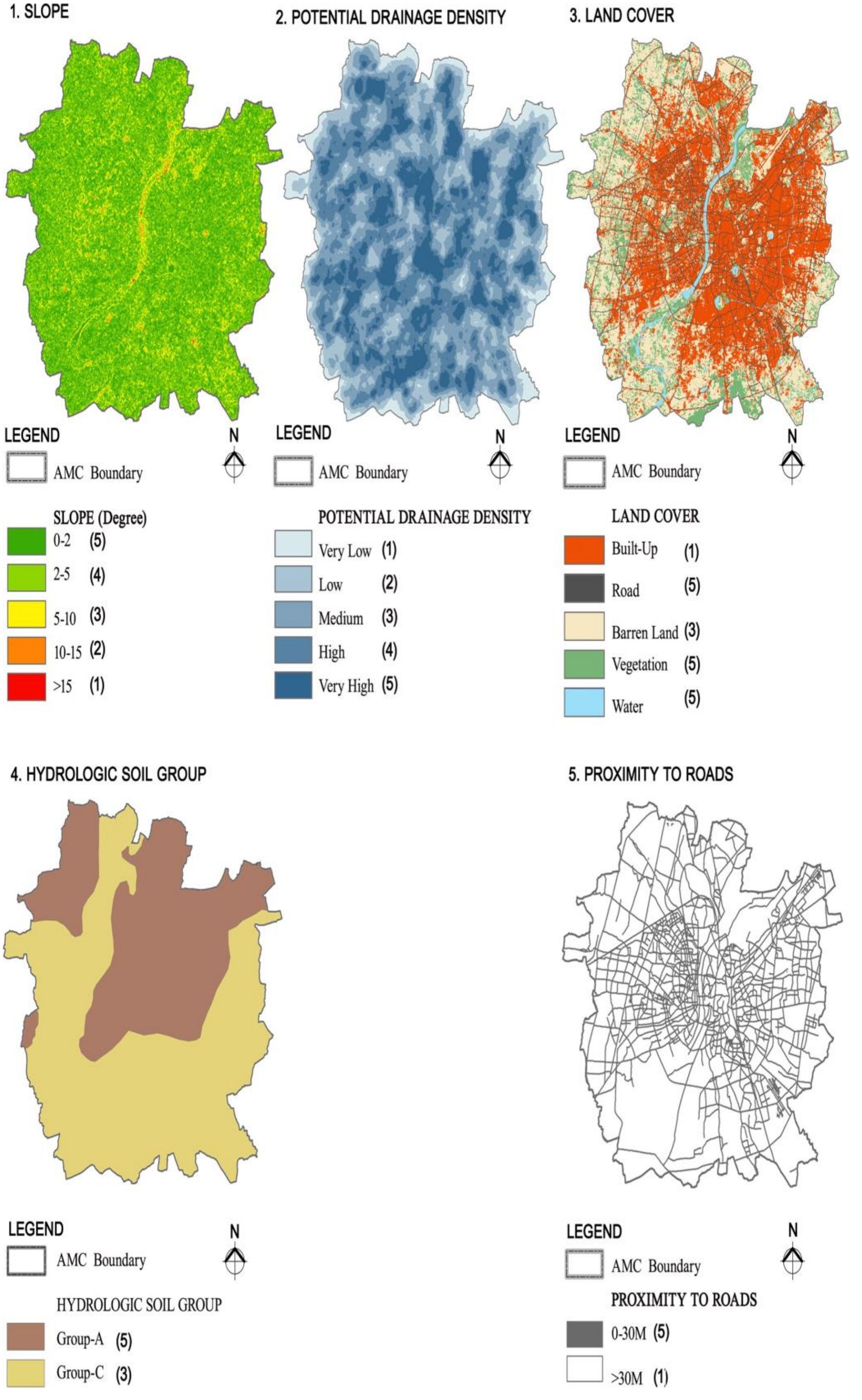
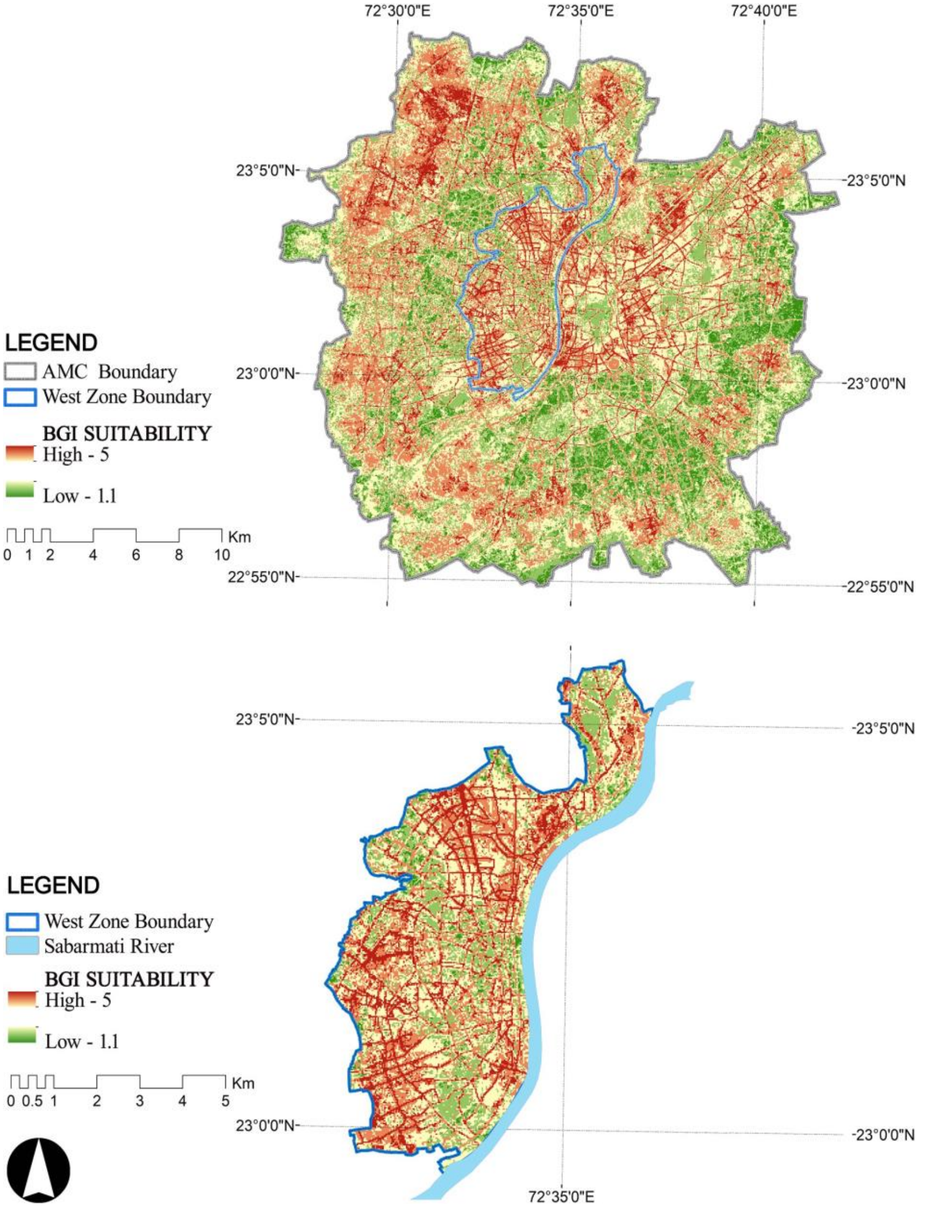


Fig. 3. The five criteria used to identify the areas suitable for blue-green infrastructure implementation in Ahmedabad (1) Slope Degree (2) Potential Drainage Density (3) Land cover (4) Hydrologic Soil Group (5) Proximity to Roads.

BLUE-GREEN INFRASTRUCTURE SUITABILITY MAP



. 4. The map above shows BGI suitability map of the study region within the AMC boundary and the map below shows the enlarged BGI Suitability map of the west zone of the study region.

As discussed earlier, five layers are identified (Slope, Hydrologic Soil Group, Potential Drainage Density, Land Cover, and Proximity to Roads), ranked and weighed to determine most suitable sites for implementation of BGI in the city of Ahmedabad.
The final suitability map, which integrates all the five criteria, shows overall suitability for blue-green infrastructure implementation in the study region .

The suitability is represented by colors, ranging from green (low) through yellow (medium) to red (high). The result shows that out of total study area of 450 km^2, an area of about 145 km^2 (32%) has low suitability, around 157 km^2 area (35 %) has moderate suitability and 148 km^2 area (33 %) has the highest suitability for the implementation of BGI. According to graph theory, landscape can be conceptualized as a network of points and lines. The points in a landscape represent the patches(nodes) of blue and green spaces and the lines (corridors) represent the connectivity between these patches

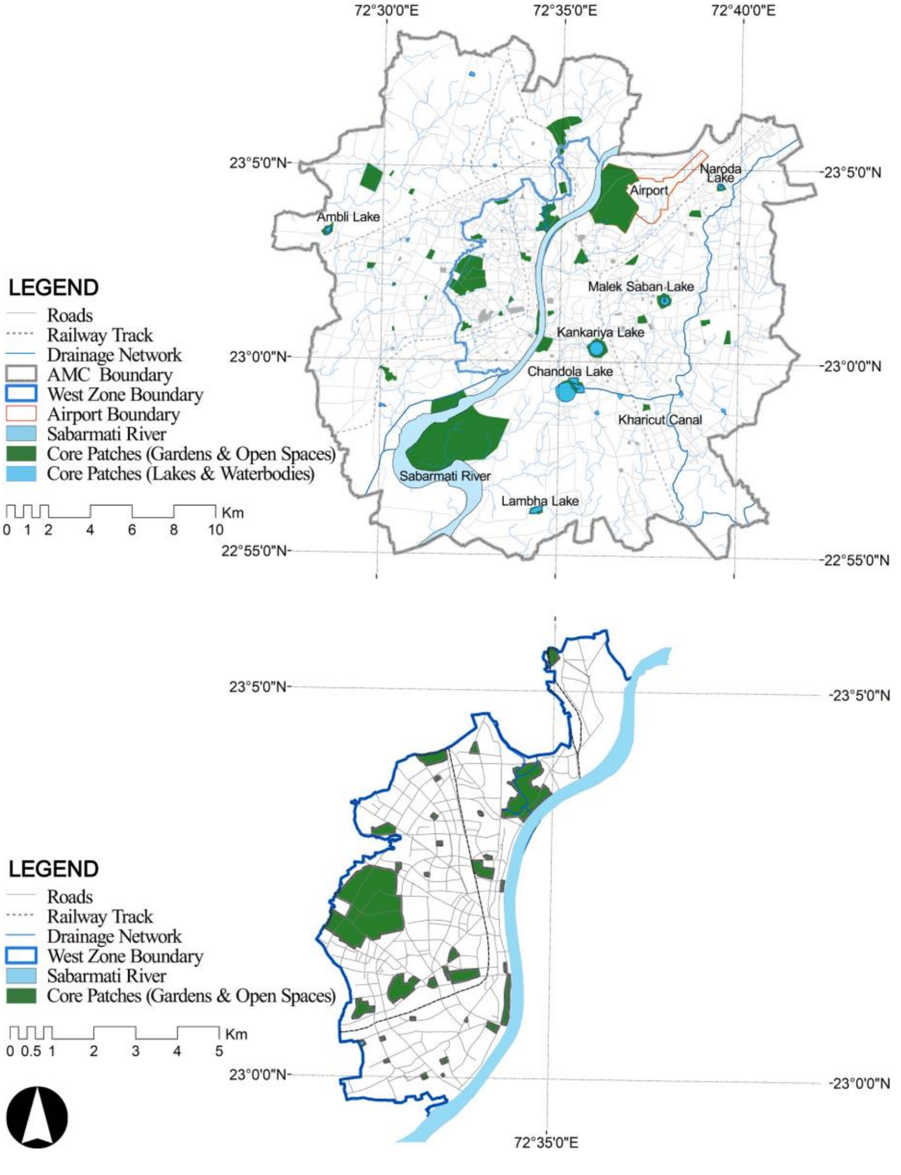


Fig. 5. The map above shows the Core patches (Nodes) > 2 ha of the study area within the AMC boundary and the map below shows the enlarged Core patches (Nodes) of the west zone of the study region.

Establishing node-corridor matrix by least-cost path analysis

In a GIS environment, cost path tool determines the least cost path i. e., high suitability to develop blue-green corridors between the established nodes. Substituting BGI suitability map as a cost surface resulted in a network of 561 potential corridors connecting 48 nodes on either side of river Sabarmati

5. Conclusion

The proposed geospatial based approach for BGI network identification presents a pragmatic approach which is easy to implement with openly accessible datasets. The presented landscape conservation approach promotes idea of blue-green over grey infrastructure for water sensitive urban design and planning in the city of Ahmedabad. However, the study has applicability in the any city of the world especially in the context of developing region which are generally has dearth of datasets and poor landscape conservation practices. The study has also demon-strated the utilization of open source and freely available RS datasets successfully to implement developed methodology. Widespread avail- ability of open-source datasets has strong potential for number of planning studies as these datasets provide updated and synoptic infor-mation with no cost. RS datasets provide updated information on landscape characteristics and integration of various tools in GIS assisted in enhanced capabilities with ease and timeliness in analysis, which would not have been possible with traditional approach of data analysis. This landscape design and urban planning approach presents an inno-vative approach, an approach which requires further validation and verification on its practical site-based application. Besides, in future integration of spatially variable high-resolution criteria such as land use; land ownership and climatic factors may further improve the suitability map and the final BGI network map.

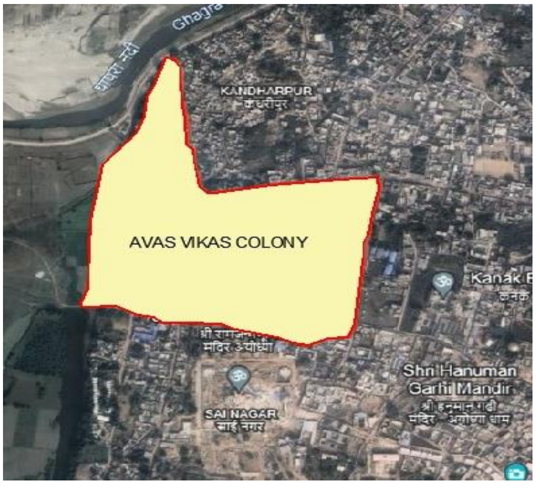
The locations most appropriate for the implementation of BGI within the city of Ahmedabad have been determined with Suitability Analysis by integrating five identified criteria in GIS environment. Further analysis identified critical core habitat patches for storm water man- agement and modeled a network of green and blue spaces using the suitability map as base reference map. The resulting blue- green infra- structure corridors may reduce the water logging conditions and enhance the groundwater potential in the study region.

ABOUT THE AYODHYA

Introduction:- Ayodhya, a city in the northern Indian state of Uttar Pradesh, is steeped in history and mythology. Revered by millions around the world, Ayodhya holds a significant place in Hinduism as the birthplace of Lord Rama, a central figure in the epic Ramayana. The city is situated on the banks of the sacred Sarayu River and is believed to have existed for thousands of years.

Historically, Ayodhya was the capital of the ancient Kosala Kingdom, ruled by the illustrious King Dasharatha, father of Lord Rama. The city flourished during various periods of Indian history, witnessing the rise and fall of different dynasties, including the Mauryas, Guptas, and Mughals. Its rich cultural heritage is evident in its magnificent temples, vibrant festivals, and intricate architecture

ABOUT THE SITE

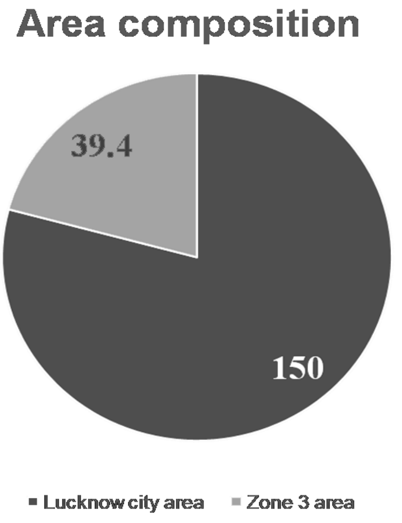


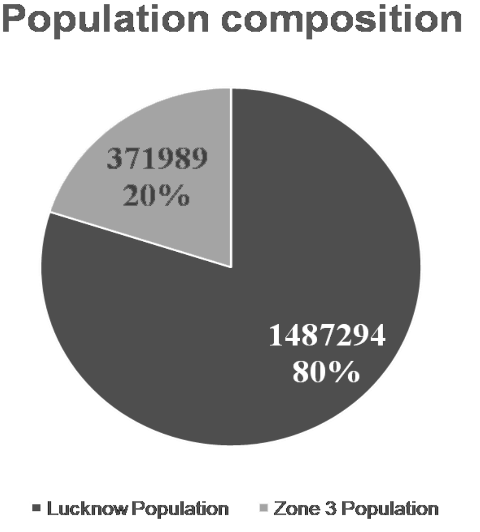
- Ayodhya is the capital city of UttarPradesh and it has always been a multicultural city.
- Ayodhya is known for its rich Culture and Heritage.
- Ayodhya is also known birth place of Lord RAMA .
- The avas vikas colony is away 2km. From the temple.
- The colony is also connetwd the sarayu river
- Area of the colony 14 sqkm.

DEMOGHAPHY

Population studies help us to know how far the growth rate of the economy is keeping pace with the growth rate of population. If the population is increasing at a fast rate, the pace of development of the economy will be slow.

To achieve knowledge about the size, composition, organization and distribution of the population. To study the trend of population growth which describes the past evolution present distribution and future changes in the population of an area.-





POPULATION DISTRIBUTION OF AYODHYA

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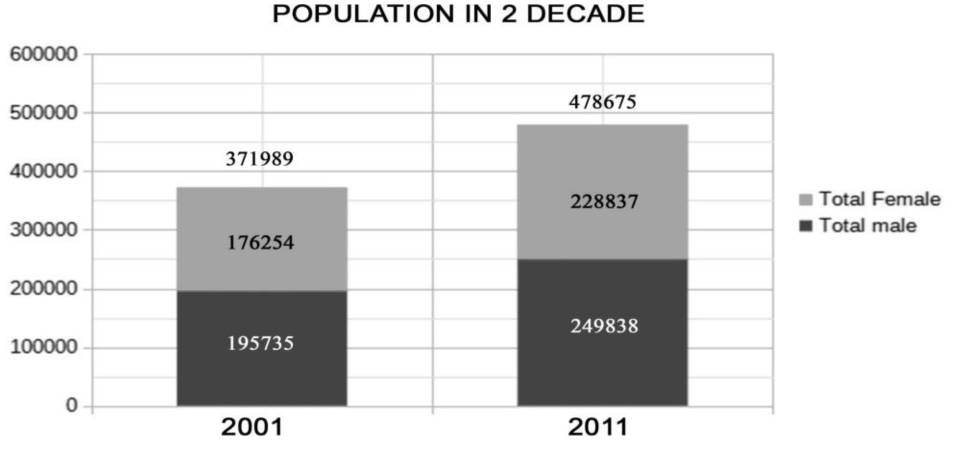


CLIMATE CONDITION

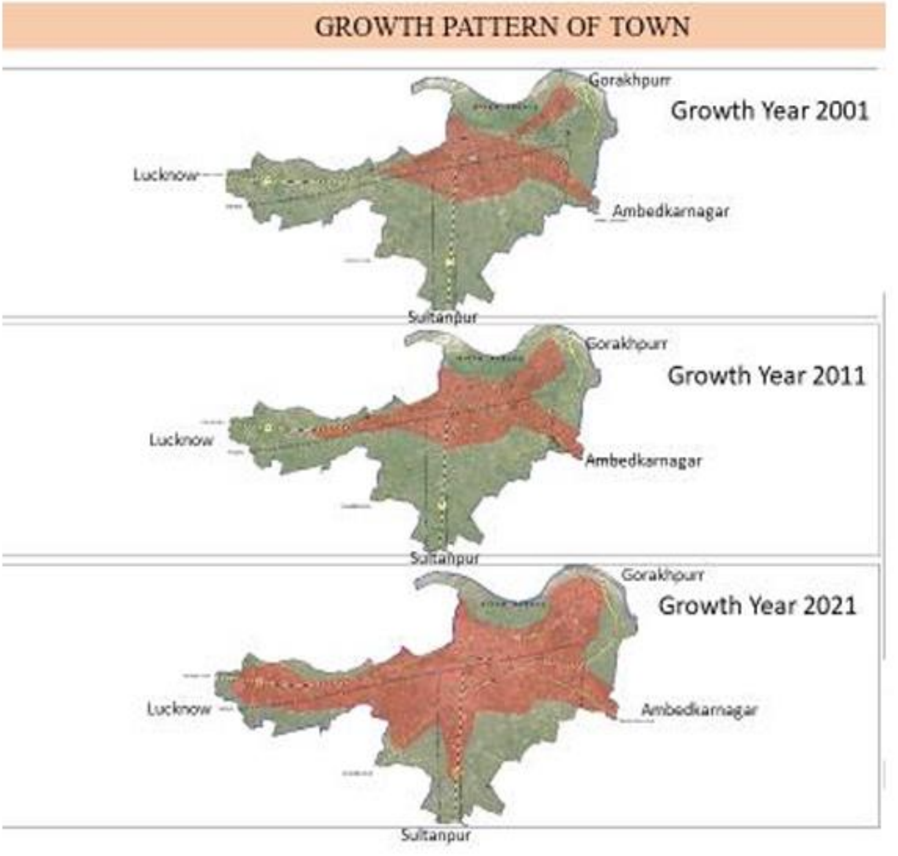
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Nov	Oct	Dec	Year
Record high °C (°F)	29.0 (84.2)	37.0 (98.6)	45.0 (113.0)	48.0 (118.4)	51.0 (123.8)	50.0 (122.0)	43.0 (109.4)	40.0 (104.0)	39.0 (102.2)	40.0 (104.0)	34.0 (93.2)	32.0 (89.6)	51.0 (123.8)
Average high °C (°F)	23.38 (74.08)	27.12 (80.82)	33.99 (93.18)	39.93 (103.87)	42.97 (109.35)	41.25 (106.25)	35.31 (95.56)	34.53 (94.15)	33.75 (92.75)	33.11 (91.6)	30.01 (86.02)	25.56 (78.01)	33.41 (92.14)
Daily mean °C (°F)	18.63 (65.53)	22.33 (72.19)	29.38 (84.88)	36.07 (96.93)	39.45 (103.01)	38.62 (101.52)	33.23 (91.81)	32.22 (90.0)	31.2 (88.16)	29.7 (85.46)	26.18 (79.12)	21.23 (70.21)	29.85 (85.73)
Average low °C (°F)	11.83 (53.29)	14.37 (57.87)	19.87 (67.77)	26.45 (79.61)	30.66 (87.19)	31.88 (89.38)	28.8 (83.84)	27.47 (81.45)	26.08 (78.94)	23.51 (74.32)	19.72 (67.5)	14.77 (58.59)	22.95 (73.31)
Record low °C (°F)	6.0 (42.8)	6.0 (42.8)	12.0 (53.6)	20.0 (68.0)	21.0 (69.8)	18.0 (64.4)	23.0 (73.4)	25.0 (77.0)	20.0 (68.0)	16.0 (60.8)	13.0 (55.4)	7.0 (44.6)	6.0 (42.8)
Average precipitation mm (inches)	23.37 (0.92)	18.05 (0.71)	10.94 (0.43)	7.84 (0.31)	14.21 (0.56)	113.17 (4.46)	438.1 (17.25)	315.59 (12.42)	219.28 (8.63)	48.98 (1.93)	0.4 (0.02)	2.1 (0.08)	101.0 (3.98)
Average precipitation days (≥ 1.0 mm)	2.82	3.18	1.91	2.09	3.55	9.27	22.45	20.91	15.73	4.0	0.09	0.45	7.2
Average relative humidity (%)	57.26	53.12	32.88	23.06	25.49	38.13	65.26	70.65	70.0	56.12	43.03	44.02	48.25
Mean monthly sunshine hours	8.52	8.95	11.72	12.82	13.26	13.16	12.48	12.48	11.75	9.9	8.66	8.64	11.03

TOPOGRAPHYOF SITE

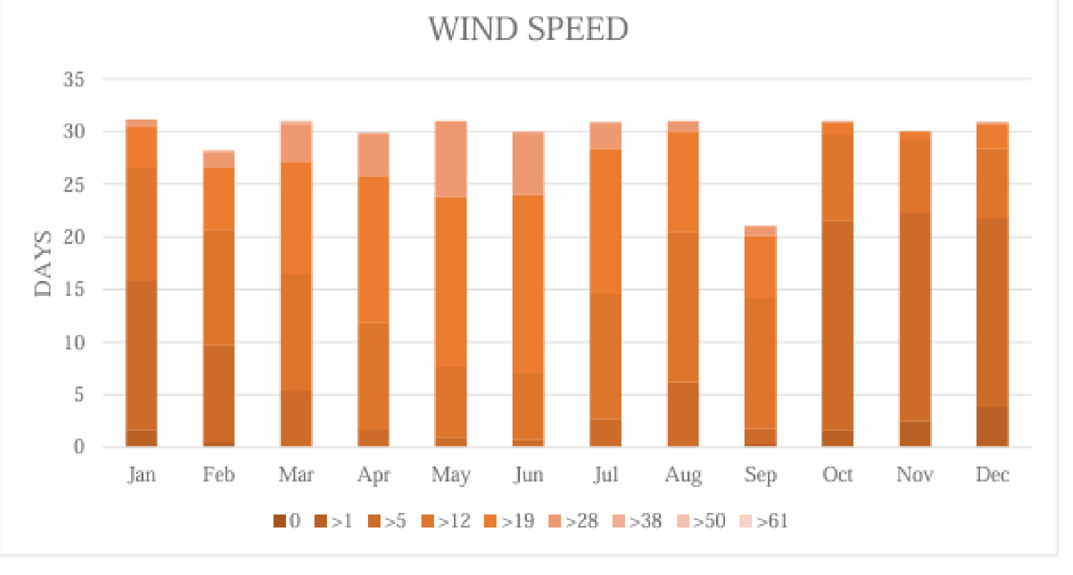
The topography of Ayodhya is comprise of alluvial soil, sand, gravels. The mountain, plateau and other geographical reliefs are missing as it belongs to Gangetic plain. The general slope of relief is west to east and stretch is about 130 KM. The major river is Saryu passing on north Ayodhya is at an elevation of 93 m. Almost plain terrain having low lying area near river frequently flooded. Bund are constructed to prevent floods in low lying areas. Water table varies from 3.75.mt to 7.75 mt below ground. Potable water is available 30 mt depth. Good soil available at 1.5 mt to 2.0 mt depth having SBC around 19 t/Sqmt. Three water bodies in the city accumulates rain water. Water logging issue is not observed in the city as it is on the bank of river. The Saryu river changes its course every decade, due to which submergence area increases. The river is perennial, sufficient water is available throughout the year.

GROWTH DIRECTION OF THE CITY

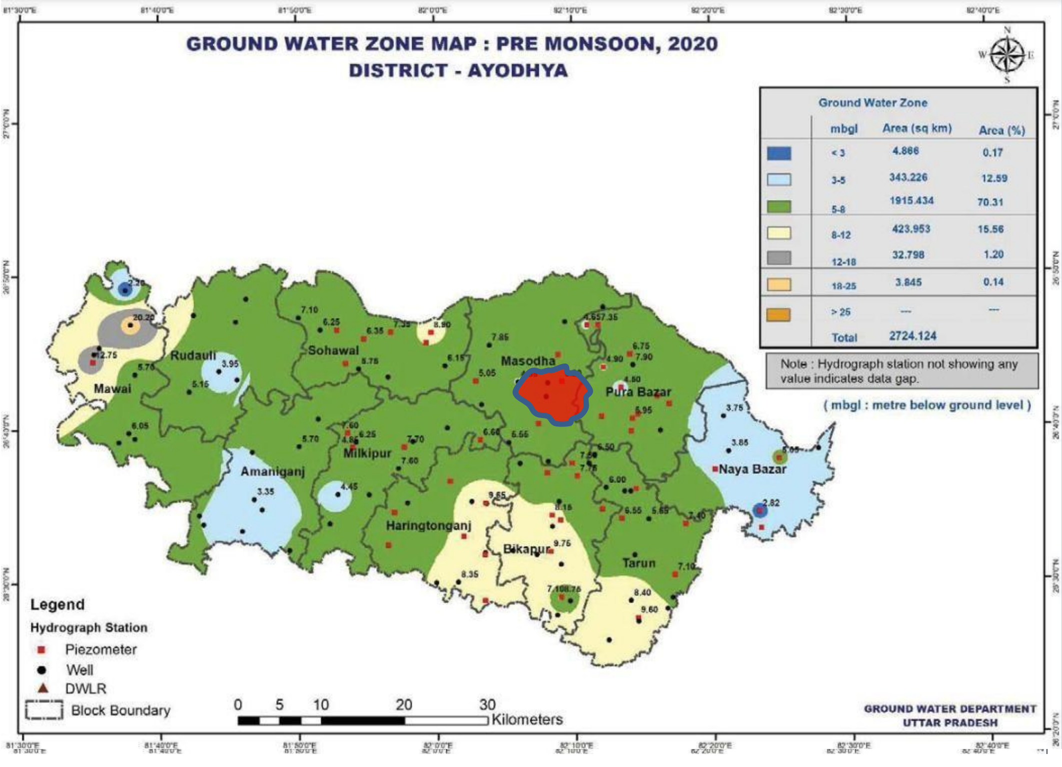
The possible growth pattern is observed in the southern side of the city. The growth of the city is mostly seen along the roads such as Ayodhya-Azamgadh, Ayodhya -Prayagraj, Ayodhya Raibareli and Ayodhya -Lucknow. Ayodhya Municipal Corporation is growing at faster rate. The highways passing through city is joining Lucknow and Gorakhpur. Linear development is taking place towards Lucknow road. The development at faster rate is observed on Sultanpur road. Linear development is also observed on Faizabad to Ambedkar nagar road. On Sultanpur and Raibareli main roads commercial development and interior area is developed for residential use. Industrial development is developed on Lucknow road. Institutional development is developed on Lucknow road, Ram Manohar university is developed on Sultanpur road. K.S.Sanket Mahavidhyala and ITI are developed between Ayodhya and Faizabad. Mix land use is observed towards the National highway and state highway

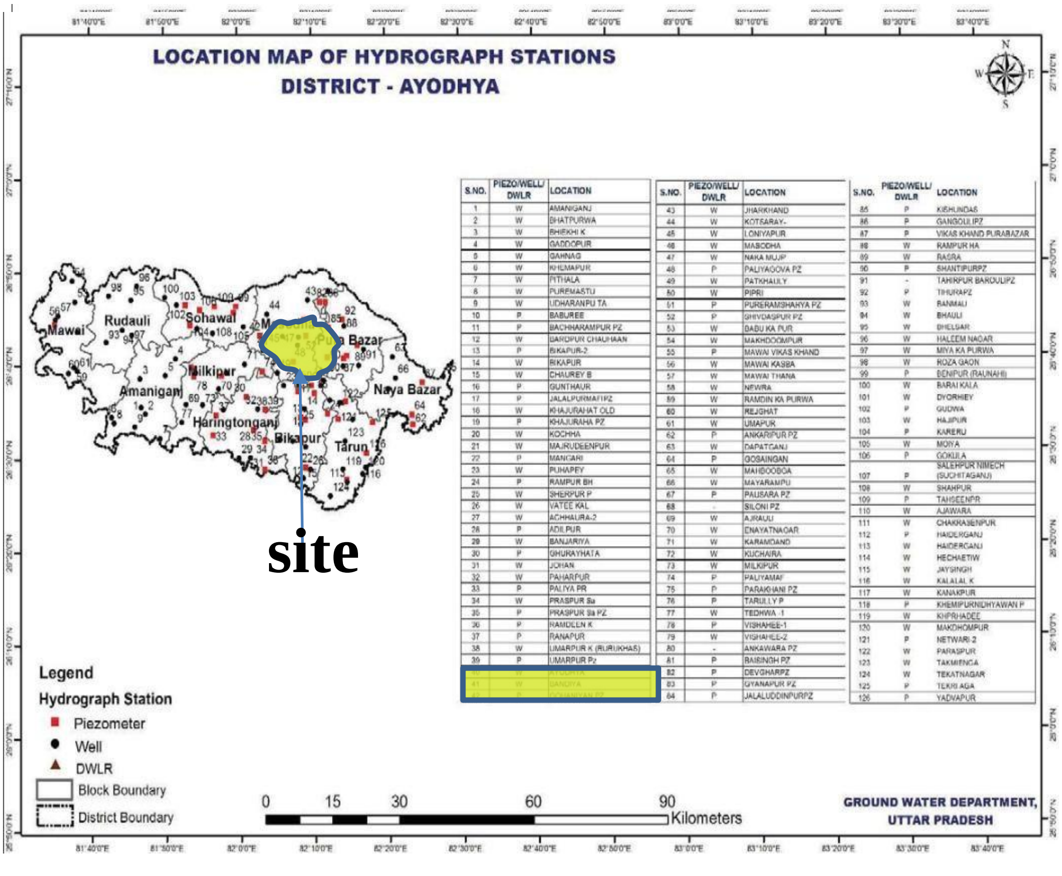


WIND SPEED



The graph shows the days per month, during which the wind reaches a certain speed. Where the monsoon creates steady strong winds from December to April, and calm winds from June to October.





S.NO.	PIEZO/WELL/ DWLR	LOCATION
1	W	AMANIGANJ
2	W	BHATPURWA
3	W	BHEKHI K
4	W	GADDOPUR
5	W	GAHNAG
6	W	KHEMAPUR
7	W	PITHALA
8	W	PUREMASTU
9	W	UDHARANPU TA
10	P	BABUREE
11	P	BACHHARAMPUR PZ
12	W	BARDPUR CHAUHAN
13	P	BIKAPUR-2
14	W	BIKAPUR
15	W	CHAUREY B
16	P	GUNTHAUR
17	P	JALALPURMAFIPZ
18	W	KHAJURAHAT OLD
19	P	KHAJURAHA PZ
20	W	KOCHHA
21	W	MAJRUDEENPUR
22	P	MANGARI
23	W	PUHAPEY
24	P	RAMPUR BH
25	W	SHERPUR P
26	W	VATEE KAL
27	W	ACHHAURA-2
28	P	ADILPUR
29	W	BANJARIYA
30	P	GHURAYHATA
31	W	JOHAN
32	W	PAHARPUR
33	P	PALIYA PR
34	W	PRASPUR Sa
35	P	PRASPUR Sa PZ
36	P	RAMDEEN K
37	P	RANAPUR
38	W	UMARPUR K (RURUKHAS)
39	P	UMARPUR Pz
40	W	AYODHYA
41	W	DANDIYA
42	P	DOHANIYAN PZ
43	W	JHARKHAND
44	W	KOTSARAY-
45	W	LONIYAPUR
46	W	MASODHA
47	W	NAKA MUJP
48	P	PALIYAGOVA PZ
49	W	PATKHAULY
50	W	PIPRI
51	P	PURERAMSHAHYA PZ
52	P	SHIVDASPUR PZ
53	W	DABU KA PUR
54	W	MAKHDOOMPUR
55	P	MAWAI VIKAS KHAND
56	W	MAWAI KASBA
57	W	MAWAI THANA
58	W	NEWRA
59	W	RAMDIN KA PURWA
60	W	REJGHAT
61	W	UMAPUR
62	P	ANKARIPUR PZ
63	W	DAPATGANJ
64	P	GOSAINGAN
65	W	MAHBOOBGA
66	W	MAYARAMPU
67	P	PAUSARA PZ
68	-	SILONI PZ
69	W	AJRAULI
70	W	ENAYATNAGAR
71	W	KARAMDAND
72	W	KUCHAIRA
73	W	MILKIPUR
74	P	PALIYAMAF
75	P	PARAKHANI PZ
76	P	TARULLY P
77	W	TEDHWA -1
78	P	VISHAHEE-1
79	W	VISHAHEE-2
80	-	ANKAWARA PZ
81	P	BAISINGH PZ
82	P	DEVGHARPZ
83	P	GYANAPUR PZ
84	P	JALALUDDINPURPZ
85	P	KISHUNDAS
86	P	GANGOULIPZ
87	P	VIKAS KHAND PURABAZAR
88	W	RAMPUR HA
89	W	RASRA
90	P	SHANTIPURPZ
91	-	TAHIRPUR BAROULIPZ
92	P	TIHURAPZ
93	W	BANMALI
94	W	BHAULI
95	W	BHELSAR
96	W	HALEEM NAGAR
97	W	MIYA KA PURWA
98	W	ROZA GAON
99	P	BENIPUR (RAUNAHI)
100	W	BARAI KALA
101	W	DYORHIEY
102	P	GUDWA
103	W	HAJIPUR
104	P	KARERU
105	W	MOIYA
106	P	GOKULA
107	P	SALEHPUR NIMECH (SUCHITAGANJ)
108	W	SHAHPUR
109	P	TAHSEENPR
110	W	AJAWARA
111	W	CHAKRASENPUR
112	P	HAIDERGANJ
113	W	HAIDERGANJ
114	W	HECHAETIW
115	W	JAYSINGH
116	W	KALALAL K
117	W	KANAKPUR
118	P	KHEMIPURNIDHYAWAN P
119	W	KHPRHADEE
120	W	MAKDHOMPUR
121	P	NETWARI-2
122	W	PARASPUR
123	W	TAKMIENGA
124	W	TEKATNAGAR
125	P	TEKRI AGA
126	P	YADVAPUR

ISSUES ON THE SITE

1.Overflow and Blockages: Aging sewer systems can lead to blockages caused by debris, grease buildup, or tree roots invading pipes. This can cause sewage to overflow into streets or back up into homes and businesses.

2.Infrastructure Issues: This colony have outdated sewage infrastructure that struggles to handle the volume of waste generated by growing populations. This can lead to leaks, bursts, or collapses in sewage pipes.

3.Pollution: Improperly treated sewage can pollute water bodies, harming aquatic life and posing risks to human health if contaminated water is used for drinking or recreation.

4.Health Risks: Exposure to untreated sewage can lead to the spread of diseases like cholera, typhoid, and hepatitis, especially in densely populated urban areas.

5.Environmental Impact: Sewage contamination affects ecosystems by introducing excess nutrients like nitrogen and phosphorus into water bodies, leading to algae blooms and oxygen depletion.

Addressing sewage problems requires investment in modernizing infrastructure, regular maintenance, and implementing effective sewage treatment and disposal systems. Public awareness and responsible waste disposal practices also play crucial roles in mitigating sewage-related issues in cities

ISSUES ON THE SITE

•**Congestion**: Narrow roads can lead to congestion, especially in urban areas with high traffic volumes. Limited space reduces the number of lanes available for vehicles, causing delays and frustration among drivers.

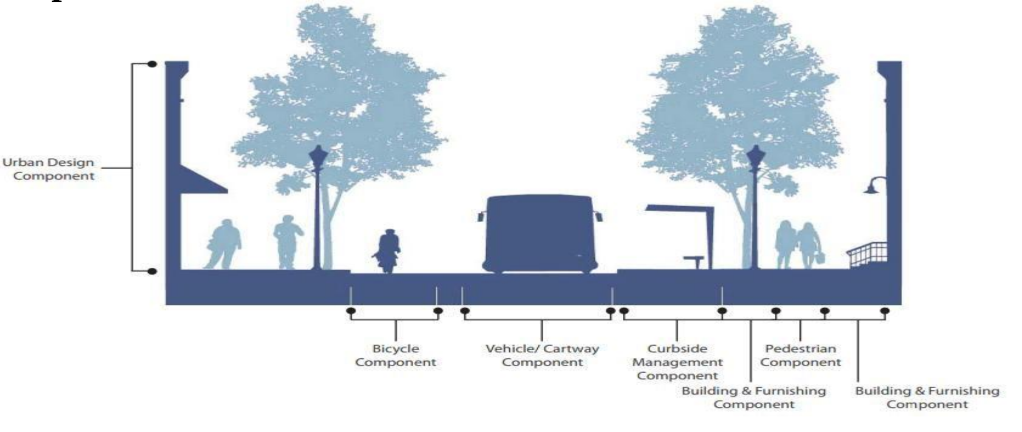
•**Safety Concerns**: Narrow roads may pose safety hazards, especially when vehicles attempt to pass each other or when there is insufficient space for pedestrians and cyclists. This can increase the risk of accidents and injuries.

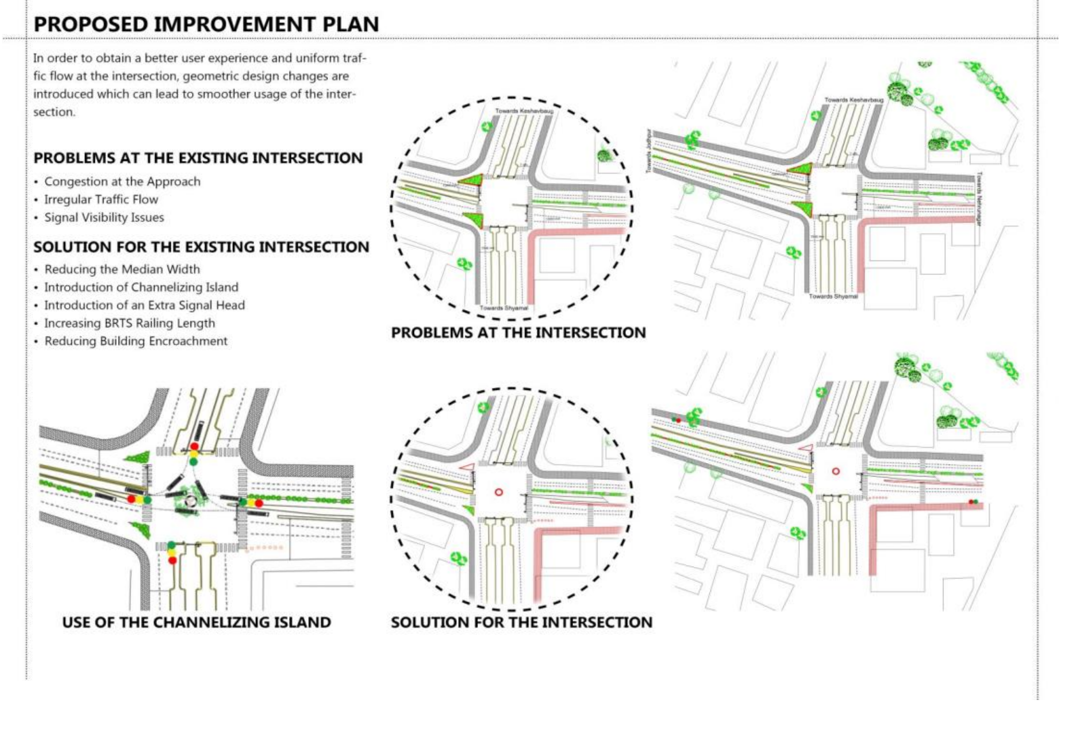
•**Accessibility**: Narrow roads may not accommodate larger vehicles, emergency vehicles, or public transport effectively. This can hinder accessibility for essential services and transportation options for residents.

•**Pedestrian and Cyclist Issues**: Narrow roads often lack dedicated space for pedestrians and cyclists, forcing them to share limited space with vehicles. This can lead to conflicts and compromise safety for vulnerable road users

Existing road road

Proposal road section





RECOMMENDATIONS & PROPOSALS

1. Comprehensive Planning and Design:

- Conduct a thorough assessment of the local hydrological conditions, including rainfall patterns, flood areas, and drainage systems.
- Employ green infrastructure solutions such aspermeabl pavements, green roofs, rain gardens, and retention ponds to enhance water absorption and retention capacities.
- Develop a comprehensive plan that integrates sponge city principles into urban development, considering land use, building design, and infrastructure layout .

2. Integrated Water Management:

- Implement a decentralized approach to water management that combines natural and engineered capture, store, and treat rainwater.
- Adopt innovative techniques like rainwater harvesting, storm water reuse, and groundwater recharge to reduce the demand for freshwater resources and alleviate flooding.
- Foster collaboration among different stakeholders, including government agencies, urban planners,engineers, and local communities, to ensure coordinated water management efforts.

3. Green Space Enhancement:

- Increase the amount of green spacein urban areas to enhance bio diversity,improve airquality, and provide additional water absorption capacity.
- Establish green corridors and urban forests to connect natural areas and facilitate ecological connectivity.
- Promote community involvement in the maintenance and management of green spaces, fostering

4. PublicAwareness and Education:

- Launch public awareness campaigns to educate residents about the benefits of sponge city initiatives, such as flood reduction, water conservation, and improved urban livability.
- Conduct workshops, seminars, and educational programs to promote sustainable water practices and encourage community participation in sponge city projects.
- Foster a culture of water stewardship and responsible water use among residents, businesses, and institutions.

RECOMMENDATIONS & PROPOSALS

5.Monitoring and Evaluation:

- Implement a robust monitoring and evaluation system to assess the performance and effectiveness of city measures.
- Regularly collect data on rainfall, flood events, water quality, and the performance of green infrastructure elements.
- Use the collected data to fine-tune and optimize the sponge city design,identify reasfo improvement, and share best practices with other cities.
-

- **6. Policy and Institutional Support**
- Develop and enforce supportive policies, regulations, and standards that encourage the implementation of sponge city principles.
- Provide financial incentives, grants, and subsidies to promote the adoption of sponge city practices by individuals, businesses, and institutions.
- Establish dedicated departments or agencies responsible for overseeing and coordinating sponge city initiatives, ensuring long-term commitment and collaboration among stakeholders.