URBAN SPATIAL DATA FRAMEWORK FOR SMALL AND MEDIUM TOWNS

ANNEXURES

RESEARCH STUDY

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Authors

CRDF, CEPT University

Dr Saswat Bandyopadhyay, Research Lead, Project Director, CUPP, CRDF
Mr Avanish Pendharkar, Center Executive Director, CUPP, CRDF
Dr Shaily Gandhi, Manager Informatics, CRDF
Mr Mohit Kapoor, Urban Planning Specialist, CUPP, CRDF
Mr Rohit Raina, Senior Research Fellow, CUPP, CRDF
Ms Dhwani Chawla, Research Intern, CUPP, CRDF

External Contributors

Shri Paresh L. Sharma, Chief Town Planner (Retd.), TPVD, Gujarat

Virtual Expert Group Meeting September 9 & 15, 2021

Shri Mohd. Monis Khan, Town and Country Planner, TCPO, MoHUA
Shri Jaswant Singh, Senior Town Planner (Retd.), TCP, Haryana
Shri Suryakant Verma, Deputy Town Planner, T.P Department, Rajasthan
Shri M. Shivashanmugam, Chief Planner, CMDA, Tamil Nadu

Virtual Stakeholder Consultations

July 6, 2021 : Ms Shashi Tindwani, Junior Town Planner (Research), Head office, TPVD
July7, 2021 : Ms Dipti J. Parikh, Town Planning Officer, Mehsana Collectorate office
July 11, 2021 : Mr Prasoon Chaturvedi, Deputy Town Planner, T. P. Department, Rajasthan
Sept 27, 2021 : Mr Ramesh Kumar, Assistant Director, Member Secretary, Dindigul Local Planning Authority

Design and Layout

Tarun Vataliya. Senior Graphic Designer, CUPP, CRDF

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ANNEXURE

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ANNEXURE 1: DEFINING SMALL AND MEDIUM TOWNS FOR THE STUDY

What are small and medium towns in Indian context?

There is no definite way to distinguish small and medium sized urban areas. Nevertheless, various countries adopt multiple criteria to identify 'Degree of Urbanization' and classify urban areas into cities, towns and semi-dense areas (DIJKSTRA, HAMILTON, LALL, & WAHBA, 2020). These criteria may include indicators such as minimum population size, type of local administration, type of economic activities, level of infrastructure and services etc. The census of India identifies urban areas or "Census Towns" as towns with:

a. A Minimum population of 5000 people;
b. At least 75 percent of the male main working population engaged in non-agricultural pursuits; and
c. A population density of at least 400 persons per sq. km (Census, 2011).

It further classifies these urban areas into various categories of towns based on their population to establish a preliminary degree of their urbanization. (Refer table 1 below)

Table 1: Classification of towns and urban areas (Census, 2011)

Urban Area Classification	Population
Class 1	1,00,000 and above
Class 2	50,000 to 99,999
Class 3	20,000 to 49,999
Class 4	10,000 to 19,999
Class 5	5000 to 9,999
Class 6	less than 5000

The Ministry of Housing and Urban Affairs (MoHUA) in 2015, identified a set of criteria for Classification of Urban Settlements in the "Urban and Regional Development Plan Formulation and Implementation (URDPFI) Guidelines". The URDPFI guidelines suggest that urban areas can be classified into small, medium, large, metropolitan and megalopolis areas based on both the population and as well as the type of governing local body existing in the area. These guidelines also identify the criteria for classifying small and medium towns as areas with populations ranging between 5000 to 5,00,000 people and with a governing urban local body with a status not higher than a Municipal council (Nagar Palika or Municipality). This is detailed out by further categorizing the small and medium towns into sub categories as explained in table 'b' below.

Table 2: classification of urban settlements as per URDPFI Guidelines (TCPO, 2014)

Sr.No	Classification	Sub-Category	Population Range	Governing Local Body (ULB)
1	**Small Town**	Small Town I	5,000 - 20,000	Municipal Board (Nagar Panchayat)
		Small Town II	20,000 - 50,000	Municipal Board (Nagar Panchayat) / Municipal council (Nagar Palika)
2	**Medium Town**	Medium Town I	50,000 - 1,00,000	Municipal council (Nagar Palika)
		Medium Town II	1,00,000 - 5,00,000	Municipal council (Nagar Palika)
3	**Large city**	-	5,00,000 - 10,00,000	Municipal Corporation (Nagar Nigam)
4	**Metropolitan City**	Metropolitan City I	10,00,000 - 50,00,000	Municipal Corporation (Nagar Nigam) / Metropolitan Planning Committee
		Metropolitan City II	50,00,000 - 1,00,00,000	Nagar Municipal Corporation/ Metropolitan Planning Committee
5	**Megalopolis**	-	More than 1,00,00,000	Municipal Corporation / Metropolitan Planning Committee

ANNEXURE 2: DETAILED METHODOLOGY FOR SELECTION OF TOWNS FOR THE STUDY

As part of the study, a few small and medium towns from the states of Haryana, Rajasthan, Gujarat and Tamil Nadu will be studied in detail to understand their overall spatial data infrastructure. For shortlisting the towns from each selected state, the following methodology is adopted.

a. **Step 1:** Identify the criteria and define what small and medium towns will be for this study.
b. **Step 2:** Identify all towns in the selected states based on the criteria selected for defining small and medium towns in step 1.
c. **Step 3:** Identify various indicators of growth in small and medium towns in India.
d. **Step 4:** shortlist small and medium towns from the identified cities in the selected states based on the various indicators identified in step 3 through a method of elimination.

1 Identification of a comprehensive criteria for defining what small and medium towns will be for this study

2 Identifying all towns in the selected states based on the criteria adopted above for defining small and medium towns

3 Identifying various indicators of growth in small and medium towns in India

4 Shortlisting a town from the selected states based on the indicators identified in step 3 through a method of elimination.

Figure 1: Methodology for selection of small and medium towns for the study

Step 1: Identifying criteria to define small and medium towns for the study

The central investigation through this study intends to identify the urban spatial data framework in small and medium towns in India. The Government of India in recent years has undertaken multiple initiatives such as preparing policies, undertaking missions, setting up dedicated informatics centres etc. to boost up the data infrastructure in the country. One such initiative by the MoHUA was preparing a sub-scheme under the AMRUT mission for "Formulation of GIS based master plan" for all Amrut cities. These identified AMRUT cities include those urban areas which have a population

of over one lakh and have a notified municipality (TCPO, 2015). This initiative by the government outlines the eminent need for having a robust spatial data infrastructure in the identified AMRUT cities. Furthermore, these cities are also anticipated to receive significant investments in the future. Hence, the towns selected under the AMRUT mission are uniquely positioned to upgrade their data infrastructure framework in the immediate future.

For the purpose of defining small and medium towns for this study, a comprehensive criterion encompassing all aforementioned definitions and classifications of small and medium towns in India is adopted. Therefore, all AMRUT cities with a population ranging between 1 lakh to 5 lakhs and having a ULB with the status at least of a Municipal Council (Nagar Palika) as the governing local body shall be considered as the Small and Medium Towns for this study (refer table 3 below).

Table 3: Comprehensive criteria for defining small and medium towns for the study

Sr.No	Population Range	Classification of Town (As per census of India)	Classification of small and medium towns (Sub categories as per URDPFI guidelines)	Governing Local Body (As per URDPFI guidelines)	AMRUT cities selection criteria
1	5,000 - 20,000	Class 4, 5	Small Town I	Municipal Board (Nagar Panchayat)	✗
2	20,000 - 50,000	Class 3	Small Town II	Municipal Board (Nagar Panchayat) / Municipal council (Nagar Palika)	✗
3	50,000 - 1,00,000	Class 2	Medium Town I	Municipal council (Nagar Palika)	✗
4	1,00,000 - 5,00,000	Class 1	Medium Town II	Municipal council (Nagar Palika)	✓

Step 2: Identifying all potential small and medium towns in the selected states

Based on the criteria identified for defining small and medium towns (refer table 3), a preliminary list identifying all potential small and medium towns is prepared for each of these states in table d below. It must be duly noted that official figures from the census 2011 have been considered for identifying all potential cities due to the limitations in availability of homogenous data across all small and medium towns post census survey of 2011.

Table 4: Potential list of small and medium towns in the selected states based on the comprehensive criteria for small and medium towns (as identified in table 3)

Sr.No	Name of the Towns	Population (As per census 2011)	Type of Governing Local Body (As per census 2011)
Haryana			
1	Palwal	1,31,926	Municipal council (Nagar Palika)
2	Rewari	1,43,021	Municipal council (Nagar Palika)
3	Kaithal	1,44,915	Municipal council (Nagar Palika)
4	Thanesar	1,55,152	Municipal council (Nagar Palika)
5	Jind	1,67,592	Municipal council (Nagar Palika)
6	Bahadurgarh	1,70,767	Municipal council (Nagar Palika)
7	Sirsa	1,82,534	Municipal council (Nagar Palika)
8	Bhiwani	1,96,057	Municipal council (Nagar Palika)
Rajasthan			
1	Sujangarh	1,01,523	Municipal council (Nagar Palika)
2	Bhiwadi	1,04,921	Municipal council (Nagar Palika)
3	Bundi	1,04,919	Municipal council (Nagar Palika)
4	Hindaun	1,05,452	Municipal council (Nagar Palika)
5	Nagaur	1,05,218	Municipal council (Nagar Palika)
6	Chittorgadh	1,15,406	Municipal council (Nagar Palika)
7	Baran	1,17,992	Municipal council (Nagar Palika)
8	Jhunjhunun	1,18,473	Municipal council (Nagar Palika)
9	Gangapur city	1,19,090	Municipal council (Nagar Palika)
10	Churu	1,20,157	Municipal council (Nagar Palika)
11	Sawai Madhopur	1,21,106	Municipal council (Nagar Palika)
12	Dhaulpur	1,25,989	Municipal council (Nagar Palika)
13	Beawar	1,45,504	Municipal council (Nagar Palika)
14	Hanumangarh	1,50,958	Municipal council (Nagar Palika)
15	Kishangarh	1,54,886	Municipal council (Nagar Palika)
16	Tonk	1,65,294	Municipal council (Nagar Palika)
17	Pali	2,30,075	Municipal council (Nagar Palika)
18	Ganganagar	2,37,780	Municipal council (Nagar Palika)
19	Sikar	2,44,497	Municipal council (Nagar Palika)
20	Alwar	3,22,568	Municipal council (Nagar Palika)
21	Bhilwara	3,59,483	Municipal council (Nagar Palika)

Sr.No	Name of the Towns	Population (As per census 2011)	Type of Governing Local Body (As per census 2011)
Gujarat			
1.	Amreli	1,05,573	Municipal council (Nagar Palika)
2.	Deesa	1,11,160	Municipal council (Nagar Palika)
3.	Gondal	1,12,197	Municipal council (Nagar Palika)
4.	Valsad	1,14,636	Municipal council (Nagar Palika)
5.	Jetpur	1,18,302	Municipal council (Nagar Palika)
6.	Palanpur	1,22,344	Municipal council (Nagar Palika)
7.	Patan	1,25,497	Municipal council (Nagar Palika)
8.	Botad	1,30,327	Municipal council (Nagar Palika)
9.	Godhara	1,43,644	Municipal council (Nagar Palika)
10.	Bhuj	1,48,834	Municipal council (Nagar Palika)
11.	Porbandar	1,51,770	Municipal council (Nagar Palika)
12.	Veraval	1,54,636	Municipal council (Nagar Palika)
13.	Navsari	1,60,941	Municipal council (Nagar Palika)
14.	Vapi	1,63,630	Municipal council (Nagar Palika)
15.	Bharuch	1,69,007	Municipal council (Nagar Palika)
16.	Surendranagar	1,77,851	Municipal council (Nagar Palika)
17.	Mahesana	1,84,991	Municipal council (Nagar Palika)
18.	Morvi	1,94,947	Municipal council (Nagar Palika)
19.	Anand	1,98,282	Municipal council (Nagar Palika)
20.	Nadiad	2,18,095	Municipal council (Nagar Palika)
21	Gandhidham	2,47,992	Municipal council (Nagar Palika)
Tamil Nadu			
1.	Karaikudi	1,06,704	Municipal council (Nagar Palika)
2.	Rajapalayam	1,30,442	Municipal council (Nagar Palika)
3.	Dindigul	2,07,327	Municipal council (Nagar Palika)
4.	Nagercoil	2,24,849	Municipal council (Nagar Palika)

Step 3: Identifying various "indicators of growth" in small and medium towns in India

For further shortlisting of small and medium towns from the comprehensive list identified in table d above, some common **'indicators of growth'** in small and medium towns needs to be identified. From a broader perspective these indicators may be categorically understood to be demographic, social and economic in nature (Miranda). However, for the purpose of this study, a nuanced approach is adopted for identification of these indicators as explained below (refer image 2):

Figure 2: Indicator of growth for small and medium towns identified for the study

Figure 3: Major states, districts and cities forming the part of the Metropolitan area of Delhi NCR

a. **Indicator 1: Presence of Small and medium towns within an economically dominant region such as a Metropolitan area:** It is highly recorded that urbanization in India in the last decade has started to disperse into small and medium towns from the major urban centers. These trends are even more prominent in dominant economic regions such as metropolitan areas (NCRPB, 2015). Now these towns may play a major role in the development of the manufacturing sector and providing linkages to both cities as well as rural areas (Saitluanga, 2019). Additionally, it is well understood that these towns are important in overall growth of the region (Tacoli, Why small towns matter: urbanisation, rural transformations and food security, 2017). Therefore, the role of these small and medium towns within a metropolitan region (refer image 3) is greatly important especially to counter the increasing pressure on urbanization on the metropolitan city and to distribute the resources within the metropolitan region. All towns falling within the boundary of an identified Metropolitan area are shortlisted first from the potential list of towns.

b. **Indicator 2: Proposals for Industrial growth such as Freight corridors, Industrial development and Investment Regions in close proximity to the towns:** The secondary sector economy is an important trigger for growth of small and medium towns. These towns play an important role in the development of the regions as a whole especially through growth in the secondary sector economy (Miranda, Silva, & da Costa, 2020). Therefore, proposed industrial corridors, industrial units as well as special investment regions are important triggers to identify potential growth of the certain small and medium towns in the future. The government of India had recently initiated the National Industrial Corridor Development Program aiming to develop various Industrial Corridors across the country (refer image 4). The program aims at developing futuristic industrial cities in India which can create employment opportunities and economic growth leading to overall socio-economic development in different

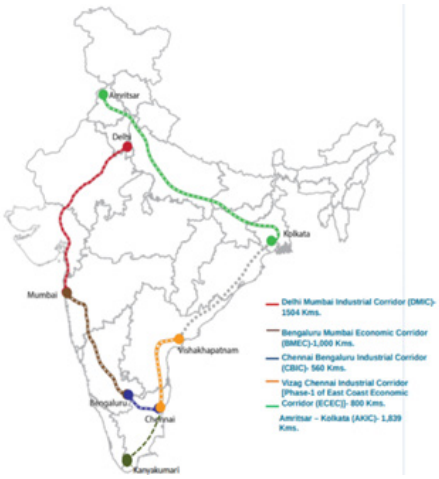

Figure 4: Major proposed industrial corridors in India

regions of the country (NICDC, 2020). Irrespective of their regional relevance, all towns proposed as important nodes in these industrial corridors are expected to experience significant growth in the future and must be shortlisted for detailed study.

c. **Indicator 3: An immediate need for planning in the towns:** small and medium towns for the study can be prioritized based on an immediate need for planning. Such a strategic need helps identify the town specific requirements based on the unique characteristics and challenges in these towns. Such strategic need is further asserted based on significant growth rates and the type of activities in these towns.

d. **Indicator 4: Delineated Development Area boundary outside the municipal limits by the state government:** The state government from time to time delineates a Development Area Boundary outside the municipal limits for the purpose of enabling planned growth and development through preparation of Spatial plans. The towns where such a delineation of the Development Area boundary has been done by the state government signify expected growth in the future.

Step 4: Selecting one town in each of the selected states for detailed study based on the indicators identified in step 3

The final step is to select the most appropriate town out of the potential list of towns after careful consideration of all the indicators identified in step 3. Based on these considerations, the towns of Rewari in Haryana, Alwar in Rajasthan, Mehsana in Gujarat and Dindigul in Tamil Nadu are selected for detailed investigation of their spatial data framework. The brief of the selected small and medium towns is explained in 'table 5' below:

Table 5: Brief of selected small & medium towns for the study

Sr. No	Town	State	Indicators of Growth		
			Regional Dominance	Industrial Growth	Strategic Need for planning
1	Rewari	Haryana	Part of the NCR metropolitan area	Proposed DMIC freight corridor. Proposed Rewari Manesar Bawal investment region (node 6).	High dec. growth rate (42.05%) b/w. 2001 and 2011. Major growth centre and district headquarter. Existing industrial activities related to brass and metalworks and upcoming automobile & auto-Ancillary industries. Need for Planned Industrial development and related infrastructural requirements along with ensuring growth for accommodation of newer population.
2	Alwar	Rajasthan	Part of the NCR metropolitan area	Proposed DMIC corridor Proposed khushkhera bhiwadi neemrana investment region (node 7)	Significant dec. growth rate (21.17%) b/w 2001 and 2011. Major growth centre and district headquarter. Major Tourism Hub. Tourist attractions include forts, palaces, temples, reserve forests etc. Upcoming auto and auto-ancillary industries in close proximity to the city. Need for planned Tourism and allied Infrastructure centric development along with ensuring growth for accommodation of newer population.

Sr. No	Town	State	Indicators of Growth		
			Regional Dominance	Industrial Growth	Strategic Need for planning
3	Mehsana	Gujarat	N.A.	Proposed DMIC corridor Mandal bechraji SIR is proposed in the region.	High dec. growth rate (34.85%) b/w 2001 and 2011. Major growth centre and district headquarter. Existing Industrial activities related to Food-Agro, Engineering, Petro-chemical, pharmacy, textile. Upcoming auto industries and allied industrial activities in the proximity. Need for Planned Industrial development and related infrastructural requirements along with ensuring growth for accommodation of newer population.
4	Dindigul	Tamil Nadu	LPA	Proposed CKIC. corridor proposed development in Phase 1 to focus on the region including Madurai, Dindigul, Virudhunagar & Theni	Moderate growth rate (13.22%) b/w 2001 and 2011. District Headquarters with agglomeration in nearby villages and towns. Surrounded by natural & environmentally sensitive areas in the vicinity. Existing commercial activities related to textile, silk, wholesale markets, production of Iron locks and safes. Upcoming major node in the CKIC. Need for holistic development of the town along with the agglomerations (LPA). Ensuring growth for accommodation of newer population through provision of affordable housing and slum improvement. Ensuring environment sensitive development

ANNEXURE 3: WHAT IS USDI?

Urban Spatial Data Infrastructure (USDI) is a framework of creating, applying and using information and communication technology for spatial data collection and dissemination in the context of cities and urban environments. Spatial data infrastructure is leveraged to implement a trans-disciplinary research and practices that has a crosscutting impact on three broad domains: people, place and technology. The concept of Spatial Data Infrastructure (SDI) was coined back in 1993 by the US National Research Council to denote a framework of technologies, policies and institutional arrangements that facilitate the creation, exchange and use of geospatial data and related information resources across information sharing communities (GSDI, 2009).

The major components of USDI includes collection of Policies, Technologies, Data frameworks, Standards an Institutional arrangements (refer image 5). It adopts a distributed data storage method to host physical and non-physical spatial data, along with its metadata. This helps to discover, visualize and evaluate the data using catalogues and web portals which further provide access to spatial information. USDI affirms to be useful for various organizations to make quick and timely decisions. It also enables higher cooperation between various government departments to tackle various environmental issues, economic downturns, disasters risks, social challenges and resources management etc. USDI in turn is of utmost importance for smooth running of the cities and making them resilient. Integrated maps and documents of the region helps to create a structure for managing knowledge to better plan the cities. Undoubtedly, from large countries to small nations, everyone benefits from documented public works and utilities, protected environments and biodiversity, correctly assessed resources, and completed strategic planning.

USDI can be understood as a multi-levelled, scalable, and adaptable collection of technical and human services, which are interconnected across system, organizational, and administrative boundaries via standardized interfaces. Here, interoperability is the most essential component of USDI as it facilitates information sharing and allows users to find information, services and applications when needed, independent of physical location. It provides a vital solution to eliminate the problem of data redundancy, providing a central database platform for accessing spatial data and other digital resources. It also has a cost benefit perspective, which allows geospatial data to be collected once and reused multiple times in myriad applications. The application of SDI could be used for various purposes including administration of land and urban

planning; documenting ownership, land use, informal settlements etc.; utility management; agriculture sector; disaster management and risk assessment; Climate change impact assessment and mitigation; Socio economic activities management; and much more.

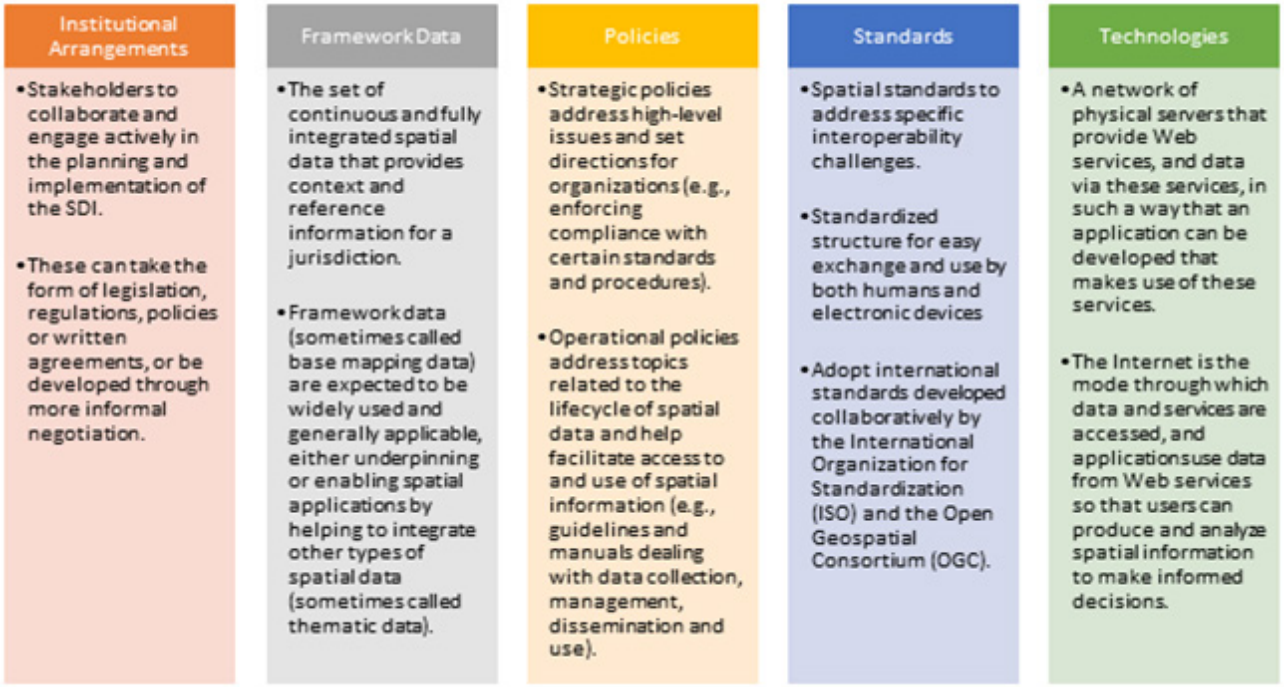

Figure 5: Components of an SDI

Cities, states, nations and the world are largely built on spatial layers with physical and non-physical attributes of data. This spatial information plays an integral part in planning of both urban and rural areas. Recent times have seen significant advancements in use of technology such as use of satellite images, drones, high resolution cameras and IOT sensors for spatial data capturing. These geographically referenced data sets helps in building a common language for planning sustainable and resilient cities. Therefore, in this context, spatial attributes of data play a major role in planning cities, which in turn emphasizes the relevance of Geographical Information systems (GIS). The applications of GIS vary according to the different stages, levels, sectors and functions of urban planning. A key function of planning is to derive future scenarios and predict the future needs of the city based on existing trends. Data driven solutions using spatial modelling of the spatial distribution makes it possible to estimate the widest range of impact to predict and project the future requirements for the city. For example; land suitability analysis and maps are in turn extremely useful in identifying the non-developable spaces and directing future development direction for the city (refer image 6). Hence, location based information helps in building correlation and relevance of the nearby evens which shows trends of the changing dynamics of the city. SDI is developed, to address the need for

this large scale data collection, policies to distribute the data and institutional arrangements that simplify the availability of and access to spatial data. Availability of quality USDI has the potential to serve as a centralized database for preparing sustainable plans, especially for urban areas.

Urban planning is a process which requires accurate information in terms of space and time which include maps, data, geospatial services and tools. Thus the collection of spatial data from various sources becomes a crucial step. Hence, a framework to narrowly enable the sharing of geospatial information within an organization or more broadly for use at a national, regional, or global level is a way forward. In this context, USDI provides an institutionally sanctioned, automated means for posting, discovering, evaluating, and exchanging geospatial information by participation of both the information producers and users. It extends the access of accurate and reliable spatial data by ensuring geospatial data and standards are used to create authoritative datasets and policies that support the process of planning. Moreover, USDI intends to create an environment that enables a wide variety of users to access the data in the most cost effective way to better achieve the objectives at the appropriate political and administrative level. Therefore, it acts as an umbrella of policies, standards and procedures under which organizations and technologies interact to foster more efficient use, management and production of geospatial data for urban planning.

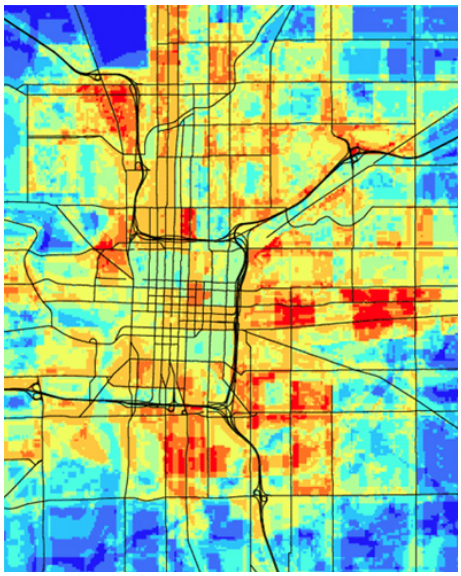

Figure 6: An illustrative example of land suitability analysis through data modelling tools

Source: (GISlounge, n.d.)

Status of USDI globally

Globally, Urban Spatial Data Infrastructure (USDI) is established and used at various geographical levels. USDI projects are often initiated at National level and further established at regional and city level as each city has its unique context and requirements. There are multiple examples of such SDI projects and initiatives across the globe. The Global Earth observation system (GEOSS) shares environmental data of more than 70 countries. It also offers coordinated, independent Earth observation, information and processing systems that interact and provide access to diverse information for a broad range of users in both public and private sectors (GEO, 2019). Infrastructure for Spatial Information in the European Community (INSPIRE) is a continental level SDI, which enables the spatial data sharing among public organizations across Europe. The United States (US) has a national level SDI called the Data.gov providing access to government open data at the national level. The US also has a second SDI project established by the United States Geological Survey (USGS) called the USGS earth explorer. It provides access and downloading of topographic information regarding elevation, geographic names, hydrology boundaries,

transportation etc. Similarly many countries such as Australia, China, and Japan have also invested in developing National level SDIs (refer image 7). The developing countries around the globe

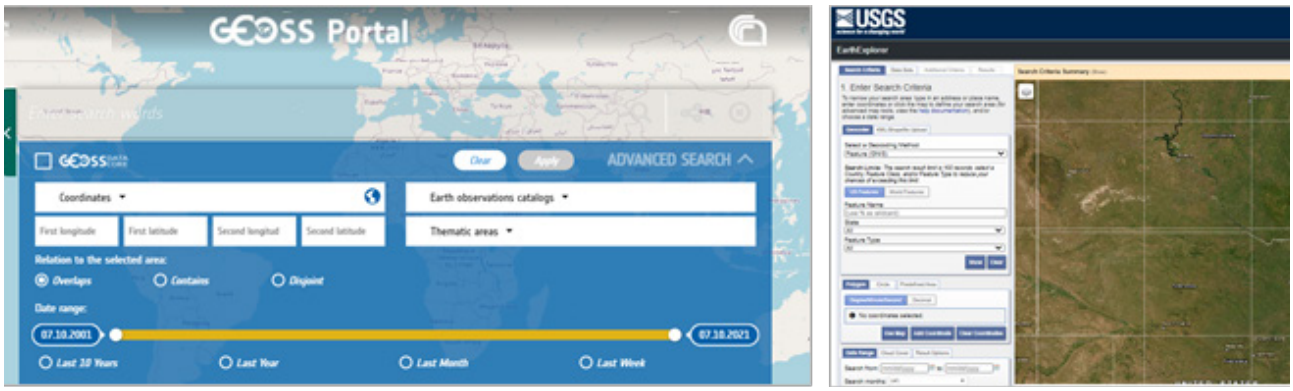

Figure 7: GIS enabled web portals: GEOSS portal and USGS. source: (GEO, 2019), (USGS)

are gradually realizing the need for institutionalizing SDI at the National level. They are often presented with major challenges in managing growth and providing urban infrastructure. Moreover, the experiences of cities from the developed nations have usually proved inappropriate in solving issues of developing countries. Hence there is a persistent need for exploring alternative innovative solutions for solving issues of the cities in the global south. It is also observed that GIS and the underlying spatial data infrastructures appear to offer significant potential to assist in managing human settlements in developing countries (Bishop, Escobar, Suwarnarat, & Yaqub, 2000). SDI plays a key role in avoiding unnecessary duplication of data collection. Moreover, it helps in assisting and promoting the harmonization, dissemination, and use of data. Comprehensively, SDI improves quality, reduces costs, makes geographic data more accessible, and establishes partnerships between key entities, thereby increasing data availability. The ultimate objective of SDI is to promote economic development, stimulate better governance and foster environmental sustainability (Masser, 1998). Although the institutionalizing of USDI is at a relatively nascent stage in the developing countries, multiple evidences suggests that a robust SDI promises to be a viable tool for dealing with the challenges presented as a result of urbanization in developing nations.

The Republic of Korea's National Spatial Data Infrastructure (NSDI) program been the country's landmark initiative. It has played a tremendous role in transforming the country's largely aid dependent economy to a self-reliant developed nation in a significantly short duration. South Korea's rapid economic growth and development could be attributed to the national level NSDI strategy which involves combining strategic efforts and advanced IT infrastructure (Kim, 2010). This NSDI program showcases the importance of adopting

a hybrid model with both the top-down and bottom-up approaches for Institutionalizing SDI. The government of the Republic of Korea played a major role in running the SDI initiative and establishing the infrastructure and relevant policies. Subsequently, a paradigmatic shift in GIS technology from GIS to geo-spatial information resulted in a change of policy from top-down approach to a more bottom-up approach (refer image 8). This in turn has enabled a harmonization of both of these approaches, with organizational arrangements for future direction for the National NSDI initiative. This approach emphasizes the importance of integrating four major strategies including strategies for geospatial data collection and assimilation; Geo-info capacity building; Geo-info portals enabling access platforms, and cost-effective management of Geo-Info with partnerships (Kim, 2010).

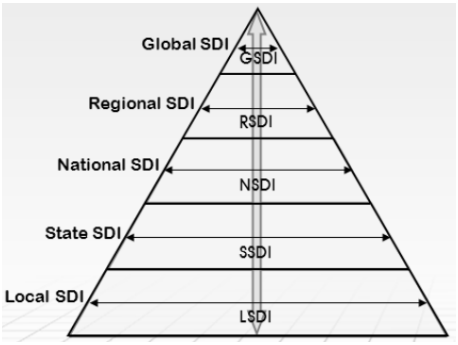

Figure 8: Republic of Korea's SSDI hierarchy
Source: (Kim, 2010)

The city of Ganzhou, in china has established SDI for the city under its "Digital Ganzhou" initiative (refer image 9). The construction of Urban Spatial data Infrastructure for the city involves three major elements: a) Establishing an Institutional framework for USDI for the city; b) preparing the regulations/ policy for standardizing the production and sharing of data through use of technology; c) integration of Geo Information Systems (GIS) with office automation (OA) Systems to draw mutual relations amongst various types of data such as official business flow database, multimedia database and spatial information database (liu, Chen, & Weng, 2005). The construction of this robust USDI for the city of Ganzhou has helped in serving various purposes in addition to its core Urban Planning and management functions.

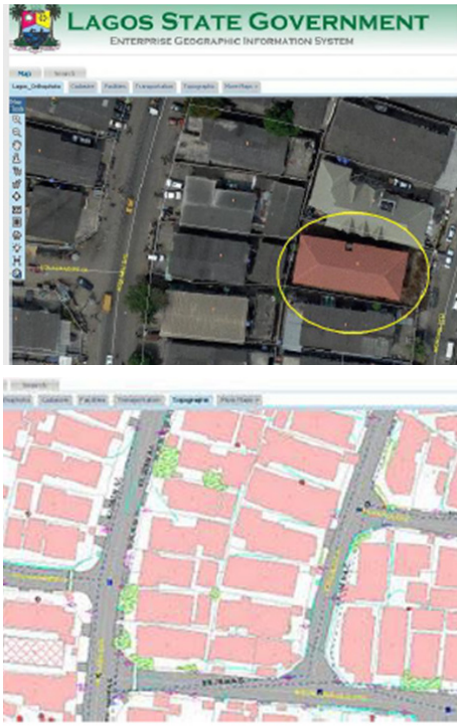

Figure 9: Illustrative example of LAGIS enterprise GIS portal for the Nigeria showing a) Ortho-photo layer; b) Cadastral Map Layer
Source: (Dekolo & Oduwaye, 2014)

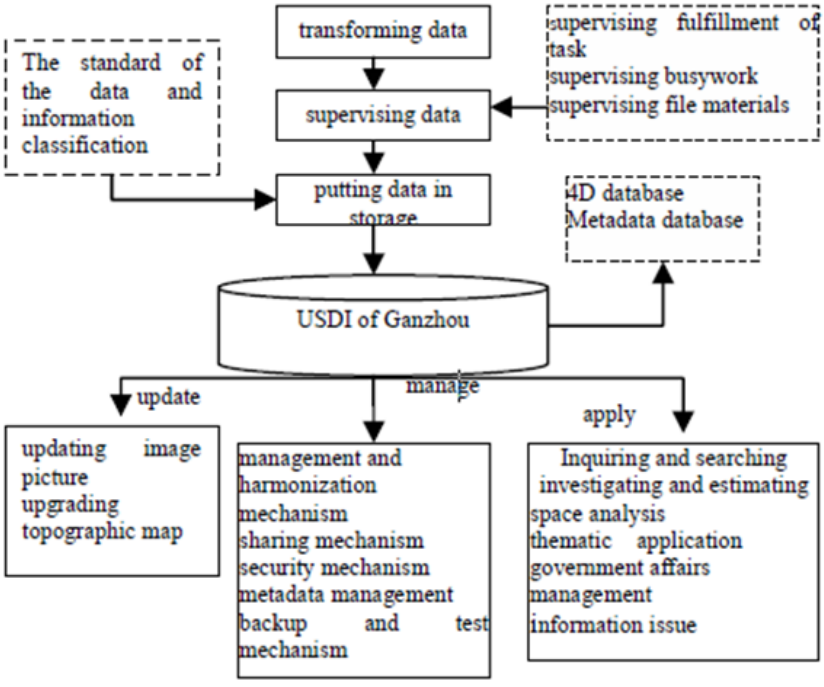

Figure 10: Overall structure chart of the USDI of Ganzhou
Source: (liu, Chen, & Weng, 2005)

The city of Lagos in Nigeria is one of the fastest growing agglomerations in the world with its population expected to double between 2000 and 2025. The city has faced challenges of urbanization with sporadic growth of slums and unplanned settlements accounting for over 60% of the city (Dekolo & Oduwaye, 2014). To deal with these issues, the Nigerian government has invested heavily on SDI at the national level with initiatives such as the LAGIS Enterprise GIS project. This project provides both public and private users access to various typology of spatial data such as ortho-photo and cadastral maps, administrative boundaries, land use, road network, Water bodies, etc. (refer image 10). However, the available data has not been used optimally by the planners from both the public and private side in the planning process. The access to the web portals of LAGIS often requires high speed Internet and an advanced operation system to access and use the data which often was unavailable within the government departments. The existing geospatial portal was not being used to its full potential due to the lack of a robust Spatial Data Infrastructure, especially at the local level. The local governments and planners preparing plans at local level require access to quality infrastructure to make use of the centrally available database and portal such as LAGIS. Therefore, the SDI initiatives and approach in Lagos and other rapidly urbanizing cities require a long term vision, investment and a self-sustaining financing model (Dekolo & Oduwaye, 2014).

One of the most integral element to the success of any USDI is its ability to collect and regularly update its databases. Traditionally the responsibility of collecting and updating reliable and demonstrable data has been understood primarily as the government's responsibility, especially in developing nations. However, more recently there have been various innovative approaches to data collection and collating such as Community driven data collection and Participatory GIS.

The Slum Dweller International (SDI) is a network of community based organizations of the urban poor in 32 countries and hundreds of cities and towns across Africa, Asia and Latin America. It deploys a 100% community driven data collection on slums around the world, where the slum dwellers collect city wide data and information on informal settlements. (Refer image 11). This work creates alternative systems of knowledge that are owned by the communities and have become the basis of a unique social and political argument that supports an informed and united voice of the urban poor. SDI's databases are becoming the largest repositories of informal settlement data globally.

In addition to the community driven data collection, the participatory GIS (P-GIS) is another sustainable initiative undertaken for strengthening the current data collection process. It is the bottom-

up approach which engages the residents to survey and map their own communities. Self-enumerations allows the urban poor and indigenous communities to generate and control their own information in better position to negotiate with the government. P-GIS techniques are widely used for urban community neighbourhood identification; problem prioritization; participatory planning; natural resources identification and management (forest resources) and environmental hazard mapping etc. The Dene mapping project in was undertaken in Northern Canadian regions to designate land use and occupancy up till 1975. The project involved the use of P-GIS methods for mapping and designating boundaries between federal government, provincial governments and the neighbouring indigenous community to reduce conflicts (McCall, 2004). Similar examples of use of P-GIS methods for solving land and administrative boundaries related problems in the Philippines, Indonesia and Cameroon (Refer image 12).

Figure 12: An example of urban Participatory 3-D Modelling (P3DM) [source: (Verbrugge, 2018)] urban Participatory 3-D Modelling (P3DM) by residents of the Barangay Commonwealth assisted by Philippine Disaster Resilience Foundation as part of the USAID-funded project "Strengthening Public-Private Partnership on Disaster Risk Reduction to Build Resilient Communities"

Figure 11: Slum Dwellers International (SDI) community driven data collection and mapping initiatives in Kampala, Uganda

Source: (SDI, 2014)

The concept of SDI is therefore different within various contexts of political, social, administrative and technical environments. No two national level SDIs are identical anywhere in the world. Therefore, it is key that each country develop its own strategy at the national level, based on the experiences of countries with an advanced National Spatial Data Infrastructure (NSDI) program. For the creation of such an NSDI, four key conditions are important from an organizational perspective: leadership, vision, communication channels, and coordination (Tonchovska, Stanley, & De Martino, 2012).

USDI Initiatives in India

Over the past years, various organizations at both the central and state levels have produced comprehensive and rich data base of spatial information in the form of 2-dimensional maps. These maps traditionally have been produced systematically through various surveys such as topographic surveys, geological surveys, soil surveys, cadastral surveys, Land use surveys, various natural resources inventory programs and the use of the remote sensing images. However, up till very recently, this map data was widely used as softcopies in the form of paper which has been a mainstay for a wide variety of applications and decision-making in most towns and cities in the country (Ministry of Science and Technology, 2021).

The preparation and use of these integral spatial data sets is constantly improving as more spatially referenced data on wider thematic layers are being documented by many towns and cities. The thematic layers of data sets (such as land use, demography, economics and employment, Physiography, Topography, climate, hydrology, agriculture, etc.) are being produced, stored, transferred, operated, and analysed in digital form by various organizations and government departments. Further, the advancements in technology such as the use of Geographical Information System (GIS) and the Global Positioning System (GPS) has provided significant advancement in this process. It has enabled access to precision, high-resolution satellite images, which has enhanced the accuracy and dynamics of these spatial datasets or maps.

India is rapidly transitioning into an information and knowledge society through use of Information Technology and “transparent” e-governance. The ability to consciously use and share this rich information with the country’s citizens, society, private enterprises and government organizations is being considered of paramount importance. Various organizations at central and state level have traditionally undertaken the collection of various types of data sets (refer table 6). The emphasis now is to streamline the collection of data and enable a National Spatial Data Infrastructure (NSDI) through common conventions and technical agreements, standards, metadata definitions, network and access protocols. The recent amendments made in the IT Act in February 2021 has now further emphasizes the government’s attempt to enable ease in data sharing in addition to the collection and documentation (Ministry of Science and Technology, 2021). The act recognizes the importance of spatial data in making sound decisions for planning and implementation at local, regional, state and central levels.

Table 6: Agencies and organizations collecting data for various projects in India [Source: (singh, 2009)]

Name of Agencies	Key projects/ Data contents
Survey of India (SOI)	Base maps and topographical maps
Indian Space Research Organization (ISRO)	NRDB (Natural Resource Database) initiative, which is pulling data from NRIS (Natural Resource Information System- over 25 GIS layers relating to bio-physical and demographic features for 17 states; FASAL (Forecasting Agricultural output using Space, Agro-meteorology and Land-based observations); Nationwide wasteland mapping; Nationwide wetlands mapping; Nationwide natural resource census; Village Resource Centre (VRC) for remote areas etc.
National Remote sensing Centre (NRSC)	Acquisition, processing, and supply of areal and satellite remote sensing data
Ministry of Housing and Urban Affairs (MoHUA)	One stop resource for urban mapping and management under various schemes such as NUIS and AMRUT GIS based Master Plans
Census of India (COI)	Nationwide demographic and socio-economic data-based survey every 10 years
Forest Survey of India (FSI)	Biennial monitoring of forest resources in India
Geological Survey of India (GSI)	Geo-scientific database developed over a period of 150 years
Central Ground Water Board (CGWB)	Ground water occurrence in different terrains
National Atlas and Thematic Mapping Organization (NATMO)	Large number of atlases and thematic maps on environment and associated aspects
Ministry of Agriculture	Crop Acreage and Production Estimation (CAPE)/ FASAL
Indian Meteorological Department (IMD)	Meteorological information
National Bureau of Soil survey and Land Use Mapping (NBSSLUP)	Nationwide soil survey and mapping
Natural Resource Data Management System (NRDMS)	Micro planning data on experimental basis

The GoI. has already taken huge leaps towards establishing Spatial data Infrastructure in the country. The GoI. had constituted a taskforce in to suggest ways and means to create a Spatial Data Infrastructure (SDI) in India in the year 2000. The taskforce recommended 'NSDI: Strategy and Action Plan' which provided a blueprint for National spatial data infrastructure (NSDI) in India (singh, 2009). The NSDI enables the establishment of a national repository of a digital warehouse of the national map data holdings and to facilitate sharing and access to digital spatial information to multiple stakeholders. NSDI in India has been implemented as a network of spatial data nodes established in various data providing agencies in central and state governments towards improving access to geospatial data by all stakeholders. A set of geospatial data and process standard specifications from Open Geospatial Consortium (OGC) and International Standardization Organization (ISO) have been adopted to facilitate interoperable sharing of and

access to data amongst organizational data nodes and end-users. National Data Registry (NDR) to support registration, search and discovery of data services; application development on a cloud-based processing platform; development of ontologies for ensuring semantic interoperability amongst data nodes; and deployment of advanced cybersecurity tools for preventing cyberattacks; and R&D in geospatial ontologies, 3D SDI and geo-analytics constitute a part of the NSDI's strategy for the future.

The implementation and utilization of NSDI comprehensively in India has faced multiple challenges due to various impediments. These include delays in data cleaning and reengineering; inefficient data/metadata update; absence of registry and catalogue service to support search and discovery; non-availability of a common application development platform; delays in on boarding of data services/applications; insecurity of the cyberspace; lack of technical capacity amongst end-users; and absence of skilled personnel for building and maintaining data nodes.

Based on the outline provided by NSDI, multiple state governments have undertaken attempts to establish a state level spatial data infrastructure. States such as Kerala, Karnataka, Uttrakhand, Delhi, West Bengal, Haryana and Odisha have institutionalized internet based geoportals having multiple thematic datasets such as political and administrative boundaries, natural resources, transportation, demography, agro and socio-economy etc. (Choudhary , 2017). Although this initiatives have addressed the aspect of data collection and storage, it overlooks usage of data for decision making, sharing of data between coordinating agencies, updating, human resource, technical and financial capacity etc. It is evident that the state governments accept the need for a State level SDI, but face multiple hurdles in successful implementing and institutionalizing it. Amongst multiple challenges, the lack of 'Data procurement' and 'standardization' is the most critical (Choudhary , 2017).

The GoI. over the years has formulated various schemes, policies and programs for enabling smooth collection and documentation of key spatial data and information. These initiatives have been enabled at varied timelines and for varied purposes such as Base Map preparation, data bank creation, agricultural data collection, mapping of revenue records etc. A few of these initiatives are listed below:

i. **Urban Mapping Scheme, 1991**

   The Urban Mapping Scheme was conceived in 1991 within the 8th Five year Plan for primarily preparing Base maps in 53 selected towns and cities in India. At the time of its inception about 25% of India's urban population resided in 4615

towns and cities (TCPO, 1991). Moreover, only 1200 towns were able to prepare their masterplans and development plans. The GoI. had identified the urgent requirement of preparing accurate and reliable base maps for planning and monitoring of development and management of towns. It is also a prerequisite for carrying out multiple planning exercises by various departments (such as Town Planning Departments, Local Bodies, Public Works Departments, Services and Utilities Agencies, Taxation Department, Directorate of Survey and Land Records etc.).

The Scheme was conceptualized to move away from the hand drawn base maps to a digital platform on computers. For the selected towns, the scheme proposed to adopt modern technique of aerial photography and remote sensing for preparation and updating of existing base maps by adopting computer based Geographic Information Systems (GIS) and the techniques of remote sensing for urban planning and development (TCPO, 1991). The National Remote sensing Centre (NRSC) provided the support in Aerial photography, remote sensing and mapping at a scale of 1:2500 within this scheme.

The Base maps were broadly classified into 5 land use classes namely :

a. Built-up Structure
b. Contours
c. Open Space/Forest
d. River/Canal;
e. Road/Rail.

These were further subdivided into 107 feature classes corresponding to the broad land use classes. The feature classes were recorded as Computer Aided Drawings (CAD) files in .dwg format and stored as point, polyline or polygon features besides labels as text layer depending on the type of geographical feature (TCPO, 1991).

ii. National Urban Information System (NUIS), 2006

The National Urban Information System (NUIS) scheme was launched by the Ministry of Housing and Urban Affairs (MoHUA) in 2006 with the aim to develop spatial database for 152 selected towns and cities. The collection and documentation of Spatial and attribute data sets on digital platforms was acknowledged to be extremely useful in preparing Master plans and various development schemes. Furthermore, the spatial data sets were considered important for providing local governments with decision support. The scheme had two major components:

a. Urban Spatial Information System (USIS): The USIS component of this scheme includes the mapping of approximately 16 spatial layers with corresponding 99 classes and 203 sub-classes approximately (refer table 7). These feature classes were typically recorded at two scales; 1:10,000 for mapping data layers for Masterplans & 1:2000 for mapping data layers for zonal plans (TCPO, 2006). It also incorporated utility mapping at a scale of 1:1000.

   The collection and mapping of spatial data sets included use of both Remote sensing imagery/Topography Maps and subsequent ground-truthing by the local authorities. These data sets includes 12 major layers:

   i). Urban land use / land cover
   ii). Physiography
   iii). Geomorphology (outside city area)
   iv). Geological structures (outside city area)
   v). Lithology (outside city area)
   vi). Drainage
   vii). Soil (outside city area)
   viii). Surface water bodies
   ix). Road
   x). Rail
   xi). Canal
   xii). Transportation nodes

   In addition to these data layers, this scheme requires incorporated maps to be collected from the local bodies, authorities and other appropriate bodies for the following:

   i). Administrative Boundaries (Metro. Region / DP Areas, Municipal / Corporation / Cantt. / Planning Zones) etc.
   ii). Locational details of Slums, Heritage Buildings / Sites, Industries, Infrastructure maps etc.
   iii). Details of MP / DP proposal maps etc.
   iv). Details on new layouts / plotted areas and land use regulation and controls etc.

   The USIS component also requires the local governments, authority or appropriate bodies to collect about 61 thematic attributes as non-spatial data. These attributes are broadly grouped within the following major heads:

   i). Administrative Boundaries
   ii). Regional Setting
   iii). Demography

iv). Socio-Economic Development
v). Industry
vi). Land Use
vii). Housing and Slums
viii). Traffic & Transportation
ix). Facilities and Utilities
x). Environment
xi). Governance (Proposals & Policies)

b. National Urban Data Bank and Indicators (NUDBI): The NUDBI component of the NUIS was idealized to be designed and established as a comprehensive data bank. Additionally, the databank was also conceptualized for monitoring the health of urban settlements based on the 23 indicators identified by United Nations commission on human settlement's (UNCHS). These indicators were classified within major heads: i) shelter; ii) social development and Eradication of Poverty; iii) Environmental Management; iv) Economic development; v) Governance; vi) International Cooperation

Table 7: Major Spatial and Non-spatial data sets requirements under NUIS

National Urban Informatics System (NUIS), 2006		
Sr. No	**Spatial Layers**	**Source of Generation**
1	**Urban land use / land cover** (from Level 1- 5) (Total: 47 classes, 85 Sub classes)	From Remote Sensing Imagery & Topomaps for classes (Level I, II and III); Ground Truth by ULB's for Sub classes (Level IV, V)
2	**Physiography** (5 classes)	From Remote Sensing Imagery & Topomaps for Level I, II and III;
3	**Geomorphology** (outside city area) (5 classes, 27 sub, classes)	
4	**Geological structures** (outside city area) (10 classes)	
5	**Lithology** (outside city area) (7 classes, 37 sub classes)	
6	**Drainage** (5 classes)	
7	**Soil** (outside city area) (3 classes, 27 sub classes)	
8	**Surface water bodies** (7 classes)	
9	**Road** (3 classes, 11 sub classes)	
10	**Rail** (1 class, 3 sub classes)	
11	**Canal** (1 class, 3 sub classes)	
12	**Transportation nodes** (1 class, 4 sub classes)	
13	**Boundaries**	UDA / ULB / TP / SNA and Others:
14	**Locational details of various point data**	
15	**Details of MP / DP proposal maps etc.**	
16	**Details on new layouts / plotted areas and land use regulation and controls etc.**	

iii. AMRUT: Formulation of GIS-Based Masterplan

The formulation of GIS based Masterplans is one of the important sub-scheme launched in 2015 by the MoHUA under the Atal Mission for Rejuvenation and Urban Transformation Mission (AMRUT). The sub-scheme is envisaged as a State-driven program with funding from the Central Government. Additionally, NRSC was tasked with providing the support the state governments in creation of their geo-spatial database (TCPO, 2015).

The key objectives of the sub- scheme were:

a.To develop common digital geo-referenced base maps and thematic land use maps using GIS.

b.Master Plan Formulation for 500 cities that are selected as AMRUT Cities.

The scheme identifies Utilization of Very High-Resolution Satellite (VHRS) Data for preparing 8 major spatial layers to be mapped by the local authorities with support from the state government (refer table 8). The 8 major layers identified for mapping includes:

i). Base layers ((5 classes, 46 Sub classes)
ii). Urban Land use / Land Cover (28 classes, 220 sub classes)
iii). Building Footprints (22 classes, 144 sub classes)
iv). Utilities (5 classes, 36 sub classes)
v). Hypsography (3 classes, 4 sub classes)
vi). Cadastral layer (1 class, sub classes as per state records)
vii). Boundaries (4 classes, 22 sub classes)
viii). Hazard Prone Areas (1 class, 3 sub classes)

These 8 spatial layers encompass corresponding 69 major classes and 475 sub- classes. These scheme further identifies clear design standards as a prerequisite for mapping all thematic maps and data sets at a scale of 1:4000. This scheme also requires local governments, authority or appropriate bodies to collect about 92 thematic attributes as non-spatial data.

For formulating their masterplans, the cities would adopt the process required under the various state legislation. The typical process includes sector-wise data analysis, demand assessment, identification of issues, projected requirements, development strategy and draft proposals on the GIS base maps. Furthermore, the scheme also proposes capacity building amongst the Town planning, line departments and other concerned personnel at state and local levels. This is

envisioned with the aim to create a cadre of professionals proficient in the use of Remote Sensing and GIS technology for use and updating of databases in urban planning and management within the state.

iv. AMRUT Formulation of Drone-based Masterplans for small and medium towns

The MoHUA has recently introduced the sub-scheme of Formulation of drone-based masterplans for small and medium towns in 2019. The scheme was conceptualized especially for small and medium towns after observing their struggle in implementing the GIS based Master plan following the AMRUT guidelines due to lack of data availability and capacity to process such data. Tech. advancements like UAS/Drone have made it possible to obtain quality geospatial data of high accuracy and better spectral and spatial resolution at low cost and fast turn-around time. Since these towns have limited extent, therefore exploring accurate and cost effective technologies such as Drone/ Unmanned Aerial Vehicle (UAV) was envisioned to be more beneficial and cost effective.

The scheme encompasses mapping of the same 8 major spatial layers and 69 classes that were proposed under the GIS-based masterplan sub scheme. However, this sub-scheme proposed mapping of 540 sub classes corresponding to the spatial layers as compared to the 475 sub- classes that were proposed under the AMRUT GIS-based masterplans (refer table 8).

Table 8: Spatial layers, classes and sub classes to be mapped under the Drone-based masterplans sub-scheme

AMRUT GIS Based Masterplan, 2016			GIS based MP for SMT (Drone /UAV), 2020	
Sr.	**Spatial Layers**	**Source of Generation**	**Spatial Layers**	**Source of Generation**
1	**Base layers** (5 classes, 46 Sub classes)	Very high Resolution satellite data	**Base layers** (5 classes, 50 Sub classes)	Drone / UAS data
2	**Urban Land use / Land Cover** (28 classes, 220 sub classes)	Very high Resolution satellite data	**Urban Land use / Land Cover** (28 classes, 251sub classes)	Drone / UAS data
3	**Building Footprints** (22 classes, 144 sub classes)	Very high Resolution satellite data	**Building Footprints** (22 classes, 170 sub classes)	Drone / UAS data
4	**Utilities** (5 classes, 36 sub classes)	Urban Local Body	**Utilities** (5 classes, 38 sub classes)	Urban Local Body
5	**Hypsography** (3 classes, 4 sub classes)	Topographic Survey; Exisiting DEMs or Countour maps	**Hypsography** (3 classes, 4 sub classes)	Topographic Survey; Exisiting DEMs or Countour maps

AMRUT GIS Based Masterplan, 2016			GIS based MP for SMT (Drone /UAV), 2020	
Sr.	Spatial Layers	Source of Generation	Spatial Layers	Source of Generation
6	**Cadastral layer** (1 class, sub classes as per state records)	Urban Local Bodies / State Revenue Department	**Cadastral layer** (1 class, sub classes as per state records)	Urban Local Bodies / State Revenue Department
7	**Boundaries** (4 classes, 22 sub classes)	State Revenue Department / Urban Local Bodies	**Boundaries** (4 classes, 23 sub classes)	State Revenue Department / Urban Local Bodies
8	**Hazard Prone Areas** (1 class, 3 sub classes)	Information from NRSC, ISRO, GSI, NDMA, Other State and Central Government Dept.	**Hazard Prone Areas** (1 class, 4 sub classes)	Information from NRSC, ISRO, GSI, NDMA, Other State and Central Government Dept.

Critical lessons

The following critical points are established from the review of urban spatial data framework (SDI) globally and in India:

1. A successful SDI requires technology, policy and institutional arrangements that enable easy data collection, documentation, storage, standardization, and sharing amongst various stakeholders.
2. Acceptance in use of GIS, GPS and web based geo portals have initiated he attempt to establish SDI globally and in India. However, the main constraints in the use of GIS in urban planning today is not technical issues, but the availability of the data, data collection and sharing policy, organizational structure and skills to work with spatial data.
3. It is extremely important to have an USDI framework in place to ensure access to up - to - date data and to move towards a sustainable planning approach. It will lead to enabling interoperable data sharing between organizations and across applications and departments, which results in the generation and sharing of more useful information seamlessly. Urban Spatial Data Infrastructure would interconnect GIS nodes across the World Wide Web to enhance the process of information sharing and access.
4. In India, over the years many initiatives have been started for data collection and documentation under various policies and schemes by the government. However, for successful implementation of these schemes and policies, it becomes essential to have communication networks, software and hardware technology, distributed databases, policy, standards, institutional arrangements) and functional parts (e.g., discovery, evaluation and application mechanisms) which together typically facilitate the access to spatial data in place.

5. Planning process is data hungry and cumbersome, which leads to situations where small and medium towns find it difficult to cope up with extensive requirements of the schemes with the limited resources available. There is a significant difference between master plan preparations for mega cities, small and medium towns. Hence, it is imperative to identify some key layers that are imperative for preparing a master plan for small and medium town.

ANNEXURE 4: STATE SPATIAL DATA INFRASTRUCTURE

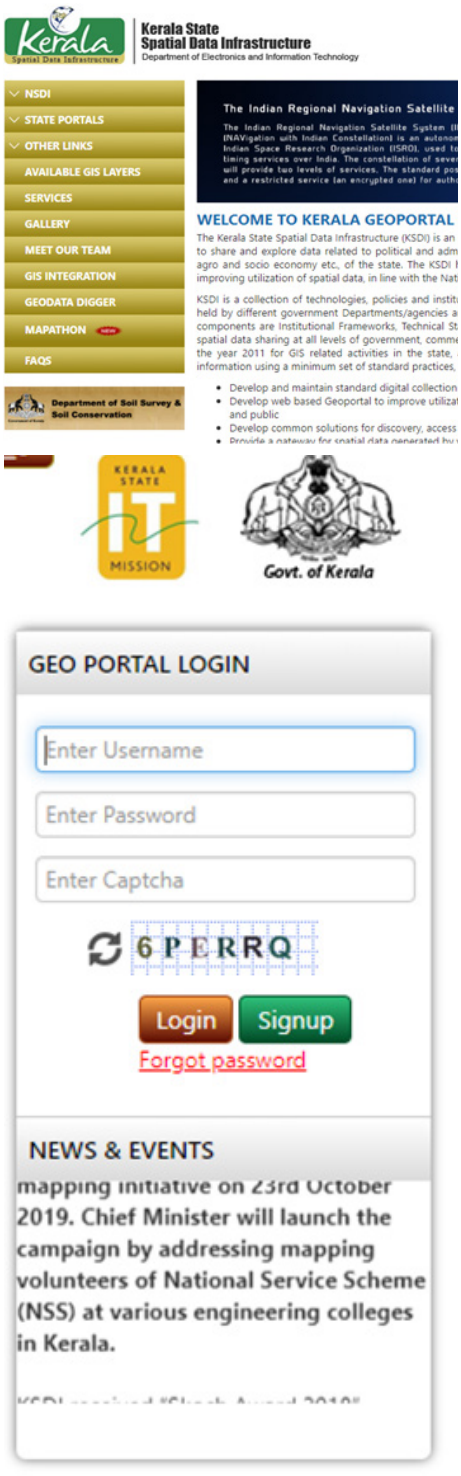

Figure 13: Kerala state SDI (KSDI) geoportal

The Natural Resources Data Management System (NRDM), a division of National Spatial Data Infrastructure has been proactive in promoting the institutionalization of spatial data Infrastructure (SDI) at state level. In 2017, NRDM along with the Karnataka State Council for Science and Technology co-organized a workshop to technically review and demonstrate the advantages of standardization and improved access to map data towards promotion of the SDI concept and prepare a strategy for the coming years. The following states demonstrated their attempts towards institutionalizing SDI initiatives.

1. **Kerala SDI:** Kerala established the Kerala State Spatial Data Infrastructure (KSDI) and its supporting Geoportal on January 18, 2013 on similar lines as National Spatial Data Infrastructure (NSDI). KSDI is an Internet-based Geospatial Data Directory for the state of Kerala that facilitates users of the system to share and explore data related to political and administrative boundaries, natural resources, transportation, demography, agro and socio-economy, etc. The state geoportal is currently being upgraded using Hexagon Geospatial's Erdas Apollo 2016. It is also integrated with Bhuvan, Open Street Maps and Google Maps, and the geoportal has key features like Map Catalogue search, Geoprocessing on Web, navigation and measurements, spatial and non-spatial query builder, Web Editing etc. It also allows users to view and download online map services. The state is on a mission to develop public utility mapping mobile app.
2. **Karnataka SDI:** Karnataka State Spatial Data Infrastructure (KSSDI) project has developed state's Web-accessible spatial database for use in developmental planning activities and has been in operation for use and demonstration since 2009. The KSSDI portal has been supporting data update and application development for the state-level Line Departments and the Zilla Panchayaths (District Councils of India) at the districts over the past few years. The NRDMS program is continuously updating its datasets in diverse fields with an increasing set of application requirements emerging from the end users in the Line Departments of the Zilla Panchayaths. Karnataka appears to be the only state to institutionalize usage of spatial data in decision-making at the district level for Panchayati Raj Institutions (PRIs).
3. **Uttarakhand SDI:** Uttarakhand Geoportal Server has been installed at the Uttarakhand State Council for Science and Technology (UCOST), Dehradun (Capital of Uttarakhand). However, testing of the portal is still under way. At present,

Uttarakhand Web Geoportal is enabled, where around 192 Layers of different line departments at state and district levels have been uploaded to Central RDBMS. For regular updating of GIS, District GIS Cells have been established in 9 different districts.

4. **Haryana SDI:** Haryana has developed geoportal with the involvement of BISAG. The state aims to develop a Web-based infrastructure (geoportal) to acquire, catalogue, process, store, value adds, distribute and enhance the use of geospatial data.
5. **Odisha SDI:** The Odisha government is planning to adopt the Odisha State Data Policy (OSDP), in the line of National Data Sharing and Accessibility Policy (NDSAP) soon. The main aim is to facilitate easy access and sharing of government-owned data for supporting sustainable and inclusive governance and effective planning, implementation and monitoring of developmental programs, including managing and mitigating disasters, and scientific research that aids to informed decisions for public good. The state has signed MoU with NRSC and ISRO so that it can effectively use Remote Sensing, GIS, and IT technologies and create Web-based geospatial applications on Bhuvan platform for supporting governance. ORSAC is to host all its datasets in Bhuvan geoportal for public use. That will provide better geospatial governance support to various departments of the state and decision making for planning and development.
6. **West Bengal SDI:** In West Bengal, the State S&T wing and other departments like Forest, P&RD, Fisheries, PHED, I&WD, WRDD, Development & Planning, KMDA, etc. have already generated substantial geospatial data in various fields like natural resources management, spatial environmental planning, natural disasters, etc. The government of West Bengal aims to reach Panchayats and municipalities for local level planning for a better resource management.

Challenges in implementing State SDIs in India

Looking at the present scenario, it is amply clear that states in India are digitally enabled and accept the need of "State SDI". But to achieve their goals they have many hurdles in between. The main challenges that every state is facing are:

- Lack of awareness about the importance of geospatial data and its applications
- Lack of collaboration ultimately resulting in data duplicity
- Lack of 'data procurement' and 'standardization'.
- Lack of technical know-how for developing an State SDI
- Tendering process for vendor selection is very slow
- Fund constraints and lack of basic infrastructure

ANNEXURE 5: BEST PRACTICES IN SPATIAL DATA CAPTURING IN INDIA

The following is a collection of initiatives by various organisations in India deploying innovating data capturing methodology for various types of data sets. A few innovative innitiatives have been explained briefly below:

Data Maturity assessment framework (DMAF) (India)	
Organization: NIUA, MoHUA	**Year : 2019 onwards**

Purpose

To realize the vision of empowering cities through data, the ministry has undertaken various data initiatives. DMAF was conceptualised in 2019 to understand the readiness of cities on data. The first cycle of the same was concluded in December 2019. The second cycle was launched in November 2020

Source: http://dmaf.mohua.gov.in/

Smart cities open data portal (India)	
Organization: NIUA, MoHUA	**Year : 2019 onwards**

Purpose

Smart cities continuously strive towards making the right data available to the right people at the right time to help build solutions to complex urban challenges. With the deployment of IoT devices and other methods to 'sense' the city, real-time data is increasing every day, offering cities the chance to address these challenges in smarter ways.

Method

The Smart Cities Mission-Ministry of Housing & Urban Affairs intends to harness this potential through its 'DataSmart' Cities Strategy. The Smart Cities Mission Directorate intends to initially implement the DataSmart Cities strategy for the existing 100 Smart Cities through their Urban Local Bodies (ULB). These cities will become the lighthouses for all other cities and towns across the country that aspire to emulate a paradigm of data-driven governance.

Source: https://smartcities.data.gov.in/

India urban observatory (India)

Organization: NIUA, MoHUA	Year: The IUO website was launched on 9th March 2020 (https://iuo.mohua.gov.in)

Purpose

The IUO website acts as a repository of insights, visual resources and use cases aimed at instilling data culture in the urban ecosystem. The Observatory is at the heart of all the technology initiatives and plug into the different sources of data from the cities, both from real-time and archival sources. The website will also act as a repository of visual resources and urban data collected through multiple sources. It will also enable users to plot data on GIS map and generate insights.

Method

As cities begin to implement 'smart' solutions, data is becoming a significant asset and an enabler for data driven governance, leading to urban transformation. The Observatory will plug into various sources of data from cities both from real-time and archival sources for generating insights through analytics for cities, academia, industry and governments. The Mission has set up the IUO at the Ministry office in New Delhi.
The Observatory is designed to provide an interactive showcase of collective insights on cities over various parameters using data through various sensors, devices, third party sources including citizens and social media. The Ministry aims to disseminate knowledge in the form of insights / trends generated at the IUO as well as provide a platform for citizen engagement in the urban ecosystem.

Source: https://smartcities.gov.in/India_Urban_Observatory

City innovation exchange (India)

Organization: NIUA, MoHUA	Year: 2020

Purpose

The City Innovation Exchange (CiX) will connect cities to innovators across the national ecosystem to design innovative solutions for their pressing challenges. The platform will ease the discovery, design& validation of solutions through a robust, transparent and user centric process that will reduce barriers for innovators and cities to discover fitting solutions.

Method

Built on the concept of 'open innovation', the platform will help in the flow of ideas 'outside in and inside out', enhancing the skills and capacity required to deliver smart urban governance. Through interaction with the Academia and Businesses/Start-ups, the platform will benefit cities in the transfer of ideas from 'labs' to real environment. Similarly, by helping urban governments interact with citizens, the platform will ensure adoption of tested solutions that will be impactful and sustainable. The platform in due time will help our cities in adopting solutions that will enhance the quality of life for its residents and significantly improve the Ease of Doing Business.

Source: https://cityinx.niua.org/

India urban data exchange (Surat, Varanasi, Pune - India)	
Organization: NIUA, MoHUA	**Year : 2021 onwards**

Purpose

IUDX was born out of the need to enable data exchange between various city departments, government agencies, citizens and private sector. IUDX helps the cities in using the data intelligently to address complex urban challenges, establish integrated development across various aspects of the urban sector and catapult them to the next stage of innovation. IUDX is an open-source software platform that will facilitate secure and authenticated exchange of data amongst various data platforms, 3rd party applications, data producers and consumers, both within a city to begin with, and scaled up across cities eventually at a national level, in a uniform & seamless way.

Method

IUDX is completely open source, based on an underlying framework of open standard APIs, data models, and the security, privacy and accounting mechanisms that will facilitate its easy adoption across the digital ecosystem. The platform will provide full control to the data owners as to what data to expose and to whom. Built-in accounting mechanisms will enable it to connect with payment gateways which will form the foundation for a data marketplace. The whole platform will be developer friendly, via definitions of open APIs and data schema templates (formats for interpreting data), so that a whole new application ecosystem gets created.

Source: https://iudx.org.in/

UDRI (Mumbai, Maharashtra, India)	
Organization: NIUA, MoHUA	**Year: 2020**

Purpose

Through research and multi-stakeholder interactions, UDRI aims to improve the quality of life for all its citizens, and works towards making the City and Region inclusive and humane, while balancing the cultural heritage and social fabric with equitable growth and efficient infrastructure.

Method

UDRI's core urban planning policy and design interventions revolve around social and urban issues such as effective affordable housing efficient public transport, heritage conservation, environment and adequate standards for the provision of social amenities and infrastructure.

Source: http://www.udri.org/

Hyderabad Urban Lab (Hyderabad, India)

Organization: Hyderabad Urban Lab	**Year : Established in 2012**

Purpose

Hyderabad Urban Lab (HUL) Foundation is an interdisciplinary research and action initiative based in Hyderabad. Founded by a group of academics and development professionals, HUL has been conducting urban research and community engagement activities on a range of themes related to life in the "Urban." The idea is to produce enabling knowledges about the city that lead to a reasonable understanding of the issues and challenges inherent in urban coexistence.

Method

Hyderabad Urban Lab produces knowledge about the city to enable durable responses to challenges of urban coexistence. This is done through pure research, pedagogic programme, engagements with communities and mixed groups of people, collaborations with other organisations and frequent un-ticketed unsponsored public events in the city. The coordinates, both human and ecological, are the main resources. Outputs of the work are available in multiple formats and designed to facilitate further action. Public repository with lists of old business houses in the city, their global connections and also public sector undertakings - Hyderabad Urban Lab (HUL). It would help promote transparency in governance and provide information to the public which was one of the many key takeaways from the event. Data collection, analysis and usage, mapping of urban issues, infrastructure and designing inputs with history of localities of Hyderabad and change in the socio-cultural practices during the past four decades.

Source: https://hydlab.in/the-organisation

Slum Data: Rapid Household Survey (Maharashtra, India)

Organization: Shelter Associates	**Year : Ongoing**

Purpose

Pune-based NGO Shelter Associates, founded by Pratima Joshi, has partnered with Google and UNICEF to bring a unique solution -`Plus Codes'. Plus, Codes are like street addresses for people or places that don't have one. Shelter Associate's with the help of the government mapped 313 slums in Pune consisting of 4.9 lakh people. The spatial data helped them identify health, safety, convenience, and maintenance issues spread across the slums. Future policies were made in coherence with the data collected. SA is engaged in a process of collecting, organizing and publishing slum data gathered through surveys and mapping efforts. The slum data is collected by members of the community, spatially organised using GIS software and presented as an overlay on Google Earth remote sensing imagery.

Method

The housing projects implemented are:
(1) based on accurate data which has been spatially organised;
(2) generated from a city-wide approach which considers housing as an integral part of the city along with areas of employment, healthcare, education, and convenience; and
(3) Implemented in partnership with beneficiary communities.
In a unique project, as many as 9,000 families living in slums across Pune, Thane, Navi Mumbai and Kolhapur now have an independent digital address. The address is based on their latitude and longitude, and displayed as numbers and letters.

Source: https://www.shelter-associates.org/dattawadi.php

Research and Poverty Mapping in Maharashtra (Maharashtra, India)	
Organization: Shelter Associates	**Year : Ongoing**

Purpose

Resulting from extensive research and poverty mapping which enable analysis of the situation of informal settlements in a more inclusive manner. The findings are available to authorities for policy formation. This data-driven approach towards planning for the urban poor has been widely appreciated and awarded.

Method

The findings of the research initiatives are used in projects and are publicly available to help local government bodies form policies that will enable needs-based, effective, replicable and scalable interventions. The research data is also available to support the efforts of other CSOs and concerned citizens. Outputs of the research and documentation work includes articles, films, photographs, flyers, blogs and tweets, providing life stories and in-depth analysis of land use and socio-economic factors. Examples of the research and documentation outputs which have influenced interventions include the Sangli Sanitation Project and Thane Poverty-Mapping and Redevelopment Project.
Comprehensive settlement and household level data are methodically collected and linked with accurate maps using geographic information systems (GIS) technology in combination with remote sensing technology (Google Earth). The data is collected by community members, who have been trained to gather household level socio-economic data and upload it to the system through mobile phones. The data is arranged spatially across cities which are being worked on and used to generate targeted interventions. This unique, data-led approach is a key component of inclusive planning, and is central to the philosophy of acknowledging informal communities as integral parts of any city. This approach earned us the title of Google Earth Hero (2009).

Source: https://www.shelter-associates.org/dattawadi.php

Sanitation (Maharashtra, India)	
Organization: Shelter Associates	**Year : 2001-15**

Method

SA facilitate access to sanitation in informal settlements by:
(1) setting up a very robust spatial data platform to pinpoint families who lack access to basic sanitation,
(2) facilitating the construction of individual toilets,
(3) conducting workshops to increase awareness within the community of environmental issues,
(4) providing a forum for sanitation issues to be discussed and
(5) Establishing solid waste collection systems.

Source: https://www.shelter-associates.org/dattawadi.php

Low-cost community-based approach by Ar. Pratima Joshi in Pune - Dattawadi project (Pune, Maharashtra, India)

Organization: Shelter Associates	Year : 1996-98

Purpose

Our first project was initiated in Pune, during the first rains of the monsoon, with the sudden demolition of an informal settlement known as Rajendra Nagar by the city administration. We worked with the community to ensure that 50 families were resettled into formal housing within a kilometre of the existing slum. Through the implication of participatory methods in both building and design, they impacted lifestyle and ensured safety and hygiene in the new building, which in turn resulted in socio-economic upliftment. WWe documented the construction of the project in a flyer called Moving Mountains, and in May 2012, 13 years after the community first occupied their new homes, we carried out a study to ascertain the outcome of the new environment on their lives. The study was uploaded as blog called 13 years after completion.

Implemented with the help of the community, this project was executed in just two years from May 1996 to September 1998. This was a unique experiment in Pune where the beneficiary families assisted with the design, monitoring and construction of their own homes.

Source: https://www.shelter-associates.org/dattawadi.php

Use of Global Positioning System (GPS) devices to map informal settlements in Cuttack, India (Cuttack, India)

Organization: SPARC, NSDF, Mahila Milan, UDRC	Year: Case Study 2012

Purpose

Ways that enhance and support residents' participation in the data collection and planning process. Rather than relying on remote sensing to identify informal settlement locations, each settlement is visited individually by a mapping team composed of community leaders and NGO staff. The mapping team meets with settlement residents to develop a detailed settlement profile and map the settlement boundary using a GPS device. This process has helped to open and sustain a dialogue between the residents of informal settlements and city government around "slum" upgrading, and has influenced the use of a central government fund to support local upgrading plans.

Source: Enabling participatory planning with GIS: a case study of settlement mapping in Cuttack, India Avery Livengood, Keya Kunte (https://journals.sagepub.com/doi/full/10.1177/0956247811434360)

EnteKochi (Chennai, India)

Organization: Kochi Municipal Corporation, C-HED	Year: 2008

Purpose

The competition is a national level Urban Design Competition, aiming to jointly 'design the future city' of Kochi. It is envisaged to plan and then facilitate the implementation of an integrated civic project. The Kochi Municipal Corporation encouraged multiple stakeholders to participate.

Source: https://www.c-hed.org/wp-content/uploads/2020/07/EnteKochi-Report_Online-version-2020.pdf

ANNEXURE 6: KEY QUESTIONS FOR STAKEHOLDER CONSULTATIONS

A. Questions related to Master Plan/ Development Plan Preparation:

1. Does your town currently have a sanctioned Development plan/ Master Plan?
   - Yes
   - No

   If yes,
   i. When was it prepared? _____
   ii. When will it be revised? _____
   iii. Which department is responsible for preparing the DP/ MP?
   iv. Is the plan prepared in-house or outsourced to a consultant?

2. What is the process followed for preparation of development plan/ master plan in your town? Is it in accordance with the statutory provisions in the Act? (For e.g.: such as Base map preparation, data collection, existing situation analysis, proposals etc.)

3. Why is/ was there a need to carry out a master plan/ development plan exercise for your town/jurisdiction? (Major issues/ challenges faced by the town wrt. to urban planning)?

4. Has the master planning exercise met the expectations? Has it helped address the concerns that were identified?

B. Questions related to Data Collection for Preparation of DPs/ MPs:

5. What kind of data was collected for preparing the master plan/ development plan? (For e.g. existing data sets? such as survey plot boundaries, transportation, physical and social infrastructure, amenities, open spaces, economic activities, others.) **(refer Appendix 1 for an indicative list of data)*

6. How are the various data sets collected? At what frequency? Have you undertaken a data gathering exercise before? If yes, how is it different now? (for eg: collection through primary survey, secondary sources, government and private sources etc.)

7. How are the various data sets documented? (for e.g. medium of data input like Hand drawn documentation, Use of Microsoft office tools such as Word and Excel, AutoCAD , GIS etc.)

8. How are the various data sets stored? (for eg: Stored as Hard copy documents, stored on computer as soft copy documents, other)

9. Other than the relevant planning department or revenue department, who else has gathered data for this planning exercise? (important departments collecting data used for preparing plans?)

10. Is the collected data shared between various departments of the state and town? What is the process to avail data from state / central / other organizations?

    - Yes
    - No

    If yes, who is the final custodian of the collected data? (is it a single department or is it kept separately with multiple departments?)

11. What in your view are the most crucial data layers that need to be collected for preparing master plans in your town?

12. What in your view are the key data layers that are overlooked/ not completely addressed in the DPs/ MPs? (for eg: informal settlements, vendors, parking, others)

C. related to AMRUT GIS-based Masterplans:

13. Is AMRUT GIS-based master plan preparation being implemented for your city?
    - Yes
    - No

    If yes,
    - How different or similar is this from the traditional statutory plan preparation process? (i.e major differences in tools such as use of satellite imagery in base map preparation, undertaking existing situation mapping and analysis etc.)

    - Are these plans adopted as statutory plans under the planning act of the state govt.?

    - What major data layers are prepared as part of the GIS based master plan mapping process *(refer Appendix 2 for an indicative list of data layers)

14. In your view, is the AMRUT GIS based master plan more adept at solving the identified urban problems of the town?
    - Yes
    - No

    Reason:

15. What kind of resources are required by the department to undertake and implement AMRUT GIS based master plan mapping exercise? (is it possible to undertake the exercise in-house or through outsourcing?)

    Explain:

16. In your view, is it viable for your town to also have more implementable alternative plans (other than MP/DP/ GIS-based plan) to address the immediate needs of the town in a shorter time duration? (eg: strategic plans, etc)

    Explain:

Table 9: Template for list of data sets collected by planning authorities

List of data for Statutory planning process	Collection status (Yes/No)	Collection (Org. responsible for collecting, collating and validating)	Use and storage (Org. using and storing the data)
1. Historical Background (Growth of the town over the years)			
2. Location and Regional Setting (including connectivity and regional linkages, economic and social linkages)			
3. Physiography such as			
3.1 Climate			
3.2 Soil			
3.3 Geographical features such as (topography, watersheds, contours etc)			
3.4 Others			
4. Demographic profile (Past trends and future population projections)			
4.1 Population and Growth Rates (past decades)			
4.2 Primary Census Abstract past years and latest			
4.3 Population projections			
4.4 Other			
5. Economic Characteristics			
5.1 Major economic activities and sectors			
5.2 Push and pull factors for economy			
5.3 Others			
6. Existing Situation data such as			
6.1 Administrative boundaries (state boundary, village boundary, municipal limit, other administrative boundaries)			
6.2 Revenue plots			
6.3 Revenue roads			
6.4 Railway lines			
6.5 Natural and man made drainage (Green and Blue infra)			
6.6 Existing town/village abadi areas,			
6.7 Existing Housing Scenario (including, demand supply, deficit etc)			

List of data for Statutory planning process	Collection status (Yes/No)	Collection (Org. responsible for collecting, collating and validating)	Use and storage (Org. using and storing the data)
6.8 Existing Informal settlements and slums			
6.9 Existing Transportation and traffic scenario			
6.10 Existing Environment and pollution scenario			
6.11 Existing public amenities (such as health and medical, education, parks, gardens, fire, police, community centers etc.)			
6.12 Existing Public utilities and facilities such as (Water supply and storage infrastructure, sewerage infrastructure, solid waste management infrastructure,, electrical infrastructure, telecom infrastructure,)			
6.13 Land ownership and land Prices			
6.14 others			
7. Existing land use/ zoning such as			
7.1 Transportation (including roads, bus stops, bus/truck depots, railway station, airports etc)			
7.2 Residential			
7.3 Commercial			
7.4 Industrial			
7.5 Institutional			
7.6 Green/ eco sensitive areas			
7.7 Public utilities (ETP, STP, OHT, etc)			
7.8 Public amenities (schools, hospitals, police station, gardens, parks, firefighting etc.)			
7.9 EWS (informal settlements and slums)			
7.10 Agricultural			
7.11 Others			
8. Other data sets (non-spatial)			
8.1 Law and Order - • CRIMES REPORTED-Year wise for Last Five Years • No. of CCTVs installed			

List of data for Statutory planning process	Collection status (Yes/No)	Collection (Org. responsible for collecting, collating and validating)	Use and storage (Org. using and storing the data)
8.2 Disasters • Are there any structures which have been damaged by disaster during last ten years? • Type of Disaster • Year of disaster • No. of Houses damaged Persons affected Property Loss (Rs. Lakhs) • Action Taken. • Earthquake Floods Cyclone Landslides Tsunami Fire Others (specify)			
8.3 Animal Husbandry Details • No. of Veterinary Hospital or dispensary or clinic, • No. of Dairy outlets & collection centres (Milk Co - Operative Societies) (MILMA), • No. of Dairy Farm, • No. of Poultry Farm, • No. of Slaughter Houses, • No. of Hatcheries, • No. of Broiler Farm, • Others			
8.4 Travel, Tourism & Heritage • Tourism Destination Centers, • Tourism Information Centers, • Tourism Season, • Average No. of Foreign Tourist, • Average No. of Domestic Tourist, • No. of Star hotels, No. of House boats, • No. of Travel Agencies, • No. of Tourism Promotion Councils, • Other institutions promoting Tourism			
8.6 Plan Implementation • Institutional framework • Staffing and budgetary requirements • Projects and capital costs • Project Financing • PPP			

Table 10: Template for List of data sets collected for AMRUT masterplan prepration by appropriate authorities

List of data for Statutory planning process	Collection status (Yes/No)	Collection (Org. responsible for collecting, collating and validating)	Use and storage (Org. using and storing the data)
1. Base Layers			
1.1 Road			
1.2 Rail			
1.3 Bridges			
1.4 Flyovers			
2. Urban Land use/Land cover			
3. Building Footprints			
4. Utilities			
4.1 Water supply network			
4.2 Stormwater drainage network			
4.3 Sewerage network			
4.4 Power supply network			
4.5 Gas distribution network			
5. Hypsography			
5.1 Digital elevation model (DEM) type: Digital terrain model (DTM)			
5.2 Contour			
5.3 Ground control points			
6. Cadastral layers			
7. Boundaries			
7.1 Administrative boundaries			
7.2 Planning boundaries			
7.3 Municipal boundaries			
7.4 Other boundaries: Enumeration block (EB), Urban framework survey (UFS) and mining area			
8. Hazard Prone areas			

ANNEXURE 7: KEY THEMATIC LAYERS PRESCRIBED FOR VARIOUS PLANS UNDER THE UDRPFI GUIDELINES

Table 11: key thematic layers prescribed for various plans under the UDRPFI guidelines

Sr. No	Types of Plans	Key Thematic layers & Major Contents of the Plans				
		Existing situation assessment	Projections/ projected requirements	Development vision and proposals	Implementation plans & projects	Plan monitoring
1	Perspective Plan	• Existing Scenario in overall terms. • Specific planning studies • Economy and employment levels • Shelter requirements • Transportation analysis based on detailed OD surveys • Institutional uses (Amenities)	• Projected requirements for the horizon year • Population projection for the horizon year	• Infrastructure with vision including an overview of new technologies and the way to develop and implement a) water, b) underground sewerage, c) drainage, and d) solid waste management. e) Use of alternate sources of energy f) others	• Resource base • Manpower resources both existing and proposed as per requirement.	
2	Regional Plan	• Introduction of the Region • Physical setting • Geography of the Region • Demography (Region and Sub region wise) • Settlement pattern • Transportation • Social Infrastructure • Physical Infrastructure • Heritage & Tourism • Economic activity and Fiscal policy • Shelter • Environment	• Major Proposals & Projects a) Regional policy & Development strategy b) Regional land use and Development Controls: c) Regional infrastructure d) Disaster Risk Mitigation measures: e) Tourism f) others	• Implementation Plan New and Modified Policies		
3	Development Plan	• Background • Demographic Profile • Land Profile • Economic Profile • Transportation • Social Infrastructure & Facilities • Physical Infrastructure (benchmarks) • Environmental Profile • Shelter (both formal and informal) • Administrative profile • Existing situation thematic Maps & Plans • Gap analysis:	• Population • Economic base and employment • Shelter • Transportation • Social Infrastructure • Physical Infrastructure • Land use requirement for various purposes • Disaster management • infrastructure assessment	• Vision formulation • Proposed Land use Plan • Comprehensive Mobility Plan • Infrastructure Plan/ Utility Plan: • Special Area Planning: • Development Promotion Rules / regulations	• Priorities • Phasing • Proposal for land resource mobilization • Investment Strategy	• Institutional Setup
4	Local Area Plan	• Introduction • Site Background & Analysis		• Conceptual Framework • Proposals and development strategy • Conservation and Improvement of Environment • Compliance of Government Policies • Zoning Regulations • Development Regulations	• Resource Mobilization and Implementation • Implementation framework • Detailed maps	
5	Special Purpose Plan					

Sr. No	Types of Plans	Key Thematic layers & Major Contents of the Plans				
		Existing situation assessment	Projections/ projected requirements	Development vision and proposals	Implementation plans & projects	Plan monitoring
5.1	Comprehensive Development plans (CDP)	• Introduction • City Profile • City vision and development of goals and strategies • Demographic Profile • Land Management and Urban Growth • Inner city scenario • Economic Profile • Financial Profile • Infrastructure • Environment Profile • Disaster Management • Urban Poor and Slum • Conservation and Heritage Management • Governance and Institutional Arrangement		• Community Consultation • SWOT Analysis • Investment Framework • City Investment Plan • Institutional Reforms		
5.2	Comprehensive mobility Plans (CMP)	• Introduction • City Profile • Review of Land Use System • Existing Transport Systems • Analysis of Existing Traffic Pattern /Transport Situation		• Development of Visions and Goals • Development of Alternative Urban Growth Scenarios • Future Transport Network Scenarios • Development of Urban Land Use and Transport Strategy • Public Transport Improvement Plan • Road Network Development Plan • NMV Facility Improvement Plan • Intermodal Facilities • Regulatory and Institutional Measures • Fiscal Measures • Mobility Improvement Measures • Social and environmental considerations	• Implementation Programs	
5.3	Comprehensive Sanitation Plan (CSP)	• Introduction • Profile of the City • Sanitation Situation Analysis • Storm Water Drainage System • Solid Waste Management • Water Supply • Institutional Capacity and Finance • Sanitation Situation with respect to • National Ranking Parameter		• Vision and City Wide Sanitation Planning • Sub sector Strategies	• Enabling and Sustaining strategies	• Monitoring and Evaluation
5.4	Slum Redevelopment Plan (SRP)	• Assessment of present status of slums		• Formulation of Slum Intervention Strategies • Estimating Urban Poor Housing Shortage & Identifying Supply and Demand constraints • Identifying Supply and Demand Side Reforms and Framing Future Supply Strategy • Framing Institutional arrangements	• Finalization of Plan of Action	
5.5	Disaster Management plan (DMP)					

Sr. No	Types of Plans	Key Thematic layers & Major Contents of the Plans				
		Existing situation assessment	Projections/ projected requirements	Development vision and proposals	Implementation plans & projects	Plan monitoring
5.6	Tourism master Plan (TMP)					
5.7	Heritage Conservation Plan (HCP)					
6	Annual Plans					• Review of last year's performance • Component wise Performance review • Aims & objectives • Fiscal requirements and Physical targets • Fiscal resource mobilization plan • Land Assembly • Capacity building and skill upgradation
7	SCHEMES/ PROJECTS / RESEARCH			• Location • Site Planning • Detailed Drawings • Environmental Impact Assessment (EIA) • Spatial Impact Assessment (SIA) • Financing Plan • Project administration • Legal Support (if any)		

ANNEXURE 8: KEY DATA LAYERS AND DATA SETS CONSIDERED WHILE PREPARING MASTERPLANS / DEVELOPMENT PLANS IN REWARI, ALWAR, MEHSANA AND DINDIGUL TOWNS

Table 12: key data layers and data sets considered while preparing Masterplans / Development Plans in Rewari, Alwar, Mehsana and Dindigul towns

Sr. No	Key Data Layers	Key Data Sets	Status of data collection for MP/DP			
			Mehsana DP 2031	Alwar MP 2031	Rewari DP 2031	Dindigul MP (2001)
1	**Historical Background**	1.1 Growth of the town over the years	For Collecting, collating by Consultant & Validating by Authority	TCPD Rajasthan	State government (Haryana)	Housing & UD Department, TCP Madurai region, TCP Chennai
2	**Location and Regional Setting**	2.1 connectivity and regional linkages, economic and social linkages	Consultant	TCPD Rajasthan	State government (Haryana)	Housing & UD Department, TCP Madurai region, TCP Chennai
3	**Physiography such as**	3.1 climate	Consultant	District Gazetter	Indian Meteorological Department	Indian Meteorological Departmen
		3.2 soil	Consultant	District Gazetter	-	Dept. of Environment
		3.3 geographical features such as (topography, watersheds, contours etc)	Consultant	Consultants	consultant	Consultants
4	**Demographic profile (Past trends and future population projections)**	4.1 Population and Growth Rates (past decades)	Consultant	Census	Census	Census
		4.2Primary Census Abstract past years and latest	Consultant	NSD / Not Collected	Census	NSD / Not Collected
		4.3Population projections	Consultant	Census	Census	Dindigul LPA
5	**Economic Characteristics**	5.1 Major economic activities and sectors	Consultant	Census	NSD / Not Collected	Census
		5.2 Push and pull factors for economy	Consultant	Census	NSD / Not Collected	DCHB
		5.3 Others(Hawkers)	Consultant	NSD / Not Collected	NSD / Not Collected	NSD / Not Collected
6	**Existing Situation data such as**	6.1 Administrative boundaries (state boundary, village boundary, municipal limit, other administrative boundaries)	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Government of Tamil Nadu
		6.2 Revenue plots	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Government of Tamil Nadu
		6.3 Revenue roads	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Government of Tamil Nadu
		6.4 Railway lines	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Government of Tamil Nadu
		6.5 Airport	Municipality	TCPD Rajasthan	NSD / Not Collected	Government of Tamil Nadu
		6.6 Natural and man made drainage (Green and Blue infra)	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Government of Tamil Nadu
		6.7 Existing town/village abadi areas,	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Housing & UD Department, TCP Madurai region, TCP Chennai
		6.8 Existing Housing Scenario (including, demand supply, deficit etc)	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Dindigul Municipality/ Dindigul Local planning Authority
		6.9 Existing Informal settlements and slums	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Dindigul Municipality/ Dindigul Local planning Authority
		6.10 Existing Transportation and traffic scenario	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Highways Department
		6.11 Existing Environment and pollution scenario	Municipality	TCPD Rajasthan	NSD / Not Collected	NSD / Not Collected
		6.12 Existing public amenities (such as health and medical, education, parks, gardens, fire, police, community centers etc.)	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Assistant Director of Statistics, Dindigul, District Statistical Handbook
		6.13 Existing Public utilities and facilities such as (Water supply and storage infrastructure, sewerage infrastructure, solid waste management infrastructure,, electrical infrastructure, telecom infrastructure,)	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Dindigul Municipality/ Dindigul Local planning Authority
		6.14 Land ownership and land Prices	Municipality	NSD / Not Collected	State government (Haryana)/ ULB Department	NSD / Not Collected
		6.15 others (Building Typology/Condition. Informal Sector Settlement etc.)	Municipality		State government (Haryana)/ ULB Department	NSD / Not Collected

Data sets collected Data sets not collected

Sr. No	Key Data Layers	Key Data Sets	Status of data collection for MP/DP			
			Mehsana DP 2031	Alwar MP 2031	Rewari DP 2031	Dindigul MP (2001)
7	**Existing land use/ zoning such as**	7.1 Transportation (including roads, bus stops, bus/truck depots, railway station, airports etc)	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Dindigul Municipality/ Dindigul Local planning Authority
		7.2 Residential	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Housing & UD Department, TCP Madurai region, TCP Chennai
		7.3 Commercial	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Housing & UD Department, TCP Madurai region, TCP Chennai
		7.4 Industrial	Municipality	District Industries Authority	State government (Haryana)/ ULB Department	DIC Action Plan, Factory Inspector Dindigul, Secretary, Tanners Association, Dindigul.
		7.5 Institutional	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Housing & UD Department, TCP Madurai region, TCP Chennai
		7.6 Green/ eco sensitive areas	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	NSD / Not Collected
		7.7 Public utilities (ETP, STP, OHT, etc)	Municipality		State government (Haryana)/ ULB Department	Dindigul Municipality/ Dindigul Local planning Authority
		7.8 Public amenities (schools, hospitals, police station, gardens,	Municipality	District education office, District health office	State government (Haryana)/ ULB Department	Dindigul Municipality/ Dindigul Local planning Authority
		7.9 EWS (informal settlements and slums)	Municipality		State government (Haryana)/ ULB Department	Dindigul Municipality/ Dindigul Local planning Authority
		7.10 Agricultural	Municipality	TCPD Rajasthan	State government (Haryana)/ ULB Department	Secretary Chamber of Commerce, Dindigul
8	**Other data sets (non-spatial)**	8.1 Law and Order	NSD / Not Collected	NSD / Not Collected	State government (Haryana)/ ULB Department	Secretary Chamber of Commerce, Dindigul
		8.2 Disasters	NSD / Not Collected	NSD / Not Collected	NSD / Not Collected	NSD / Not Collected
		8.3 Animal Husbandry Details	NSD / Not Collected		NSD / Not Collected	Housing & UD Department, TCP Madurai region, TCP Chennai
		8.4 Travel, Tourism & Heritage	NSD / Not Collected	Tourism office, Alwar	NSD / Not Collected	NSD / Not Collected
		8.5 Plan Implementation	Municipality		NSD / Not Collected	NSD / Not Collected

Data sets collected Data sets not collected

ANNEXURE 9: DATA REQUIREMENTS UNDER A TYPICAL STATUTORY MASTER PLAN VS THE SUB SCHEME FOR 'FORMULATION OF GIS-BASED MASTERPLAN' UNDER AMRUT

Table 13: Data requirements under a typical statutory Master Plan vs the sub scheme for 'formulation of GIS-based Masterplan' under AMRUT

Sr. No	Statutory Spatial Plans (MP/ DP)		AMRUT GIS Based-Master Plan	
	Key Thematic Layers (statutory plans)	Key Thematic data sets (statutory plans)	Spatial layers	Classes
1	**Historical Background**	1.1 Growth of the town over the years	N.A	N.A.
2	**Location and Regional Setting**	2.1 including connectivity and regional linkages, economic and social linkages	Physical aspects and locational particulars	Name of City/Town
				Civic Status
				Name of Tehsil/ Mandal/ Block
				Name of District
				Name of State/UT
				Area of City/Town
				Distance from Town
				Nearness/Distance of Major River/Canal/coastline from Town
3	**Physiography**	3.1 Climate		N.A
		3.2 soil		N.A
		3.3 geographical features such as (topography, watersheds, contours etc)	Hypsography (3 classes, 4 sub classes)	N.A
				Digital Elevation Model (DEM) Digital Terrain Model (DTM)
		3.4 Others		Contour
				Ground Control Points
4	**Demographic profile (Past trends and future population projections)**	4.1 Population and Growth Rates (past decades)	Demographic and Basic Socio-Economic Data	Population and Growth Rates
		4.2 Primary Census Abstract past years and latest		Primary Census Abstract 2011
		4.3 Population projections		Housing Data (For Ward/Town)
		4.4 Other		Vital Statistics (Town wise)
				Persons below Poverty Line
5	**Economic Characteristics**	5.1 Major economic activities and sectors	Occupational Classification	Workforce 2001 - 2011
		5.2 Push and pull factors for economy		Occupational classification of Main workers 2001
		5.3 Others (Hawkers)		
6	**Existing Situation data / Base Layer data**	6.1 Administrative boundaries (state boundary, village boundary, municipal limit, other administrative boundaries)		Administrative boundary
				Planning Boundaries
				Municipal Boundaries
				Other Boundaries such as Enumeration Block (EB), Urban Framework survey (UFS), andMining Area
		6.2 Revenue plots	Cadastral layer (1 class, sub classes as per state records)	Cadastral layer
		6.3 Revenue roads	Base layers (5 classes, 46 Sub classes)	Road
		6.4 Railway lines		Rail
				Bridges
				Flyovers

Sr. No	Statutory Spatial Plans (MP/ DP)		AMRUT GIS Based-Master Plan	
	Key Thematic Layers (statutory plans)	Key Thematic data sets (statutory plans)	Spatial layers	Classes
6	Existing Situation data / Base Layer data	6.5 Natural and man-made drainage (Green and Blue infra)		Water bodies
		6.6 Existing town/village abadi areas,	N.A	N.A.
		6.7 Existing Housing Scenario (including, demand supply, deficit etc)	Housing	Distribution of House Holds (HHs.), No. of persons and Tenure
				Categories of Houses
		6.8 Existing Informal settlements and slums	Slums	Slum concentration, (Nos, population, Area)
				Availability of Basic Amenities in Slums Ward wise
				Houseless Population
				Bridges
				Flyovers
		6.9 Existing Transportation and traffic scenario	Traffic & Transportation	Registered Vehicles
				Work Trips Undertaken from Residence to Work Place
				Road length and Footpath (in kms.)
				Railway (nos, platforms, yards etc.)
				Inland Water ways
		6.10 Airport		Air
		6.11 Existing Environment and pollution scenario	Environment	Air Pollution Concentration (µg/m3) (SO2, NO, SPM, CO)
				Level of Noise Pollution (Db)
				Water Pollution (Mg/l)
		6.12 Existing public amenities (such as health and medical, education, parks, gardens, fire, police, community centers etc.)	Educational Facilities	Number of various types of educational facilities
			Medical Facilities	Number of hospitals, dispensaries, etc., doctors, nurses, paramedical staff and total number of beds available therein
				Epidemiological Details
			Availability of Recreational, Cultural, Banking and Credit Facilities	Community and other Facilities
				Number of banks and credit societies
				Details of Self Help Groups(SHG) and NGOs Year
		6.13 Existing Public utilities and facilities such as (Water supply and storage infrastructure, sewerage infrastructure, solid waste management infrastructure,, electrical infrastructure, telecom infrastructure,)	Availability Of Drinking Water	Important sources of drinking water
				Water Supply Details
				Supply Infrastructure:
			Electricity	Type of connections and consumption
				Water Supply Details
				Supply Infrastructure:
			Electricity	Type of connections and consumption

Sr. No	Statutory Spatial Plans (MP/ DP)		AMRUT GIS Based-Master Plan	
	Key Thematic Layers (statutory plans)	Key Thematic data sets (statutory plans)	Spatial layers	Classes
6	Existing Situation data / Base Layer data		Post and Telecommunications	Number of various types of telecom infra
			Availability of Sanitary Facilities	Household Sanitary Facilities
				Network Details
				Estimated quantity of sewage generated (MLD)
				Quantity treated (MLD)
				No. of sewage treatment plants (with capacity)
				Disposal of treated sewage (river, nala, open land)
				Disposal of untreated sewage (river, nala, open land
				Disposal Industrial wastewater (treated/untreated) (river, nala, open land
				Public Toilets
				Major Storm Water Drains
			Solid Waste Management	Solid waste generation
				Disposal method of solid waste (
				Vehicles deployed for Collection and Disposal of Solid waste,
				Employees details
				system of segregation of solid waste
				Details of ongoing and committed projects under solid waste disposal management
		6.14 SOLID WASTE MANAGEMENT		Solid Waste Management
				Land Prices
7	Existing land use/ zoning such as	7.1 Residential	Urban Land use / Land Cover (28 classes, 220 sub classes)	Residential
		7.2 Commercial		Commercial
		7.3 Industrial		Industrial
				Mixed
		7.4 Public amenities (schools, hospitals, police station, gardens, parks, firefighting etc.)		Educational
				Health Services
				Central Govt. prop
				State Govt. prop
		7.5 Transportation (including roads, bus stops, bus/truck depots, railway station, airports etc)		Railway
		7.6 Institutional		Public & Semi public
				Religious
		7.7 Public amenities (schools, hospitals, police station, gardens, parks, firefighting etc.)		Recreational

Sr. No	Statutory Spatial Plans (MP/ DP)		AMRUT GIS Based-Master Plan	
	Key Thematic Layers (statutory plans)	Key Thematic data sets (statutory plans)	Spatial layers	Classes
7	Existing land use/ zoning such as	7.8 Public utilities (ETP, STP, OHT, etc)		Public utilities
				Solid Waste Management
				communication
				Heritage
		7.9 EWS (informal settlements and slums)		Slum
				Vacant Land
		7.10 Transportation (including roads, bus stops, bus/truck depots, railway station, airports etc)		Transportation
				Traffic related
				Rural
		7.11 Green/ eco sensitive areas		Green Areas
		7.12 Agricultural		Agricultural lands
		7. 13 Green/ eco sensitive areas		Wetlands
				Waste lands
				specific land use
		7.14 Green/ eco sensitive areas		Eco sensitive Areas
		7.15 Others(water body/like River,Talav, Canal etc.)		others
			Building Footprints (22 classes, 144 sub classes)	Residential
				commercial
				Industrial
				Mixed
				Educational
				Health Services
				Central Govt. Property
				State Govt. Property
				Railway
				Public & Semi public
				Religious
				Recreational
				public utilities
				Solid Waste Management
				communication
				Heritage
				Transportation
				Traffic related

Sr. No	Statutory Spatial Plans (MP/ DP)		AMRUT GIS Based-Master Plan	
	Key Thematic Layers (statutory plans)	Key Thematic data sets (statutory plans)	Spatial layers	Classes
7	Existing land use/ zoning such as			Rural
				Specific land use
				Eco-Sensitive Areas
				Others
		7.16 Public utilities (ETP, STP, OHT, etc)	Utilities (5 classes, 36 sub classes)	Water supply network
				Storm Water Drainage network
				Sewerage network
				Power supply network
				Gas distribution network
8	Other data sets (non-spatial)	8.1 LAW AND ORDER –	Law and order	CRIMES REPORTED
		8.2 DISASTERS	Disasters	Types of and its effect
		8.3 ANIMAL HUSBANDRY DETAILS	Animal Husbandry Details	Nos. of various facilities and infra
		8.4 TRAVEL, TOURISM & HERITAGE	Travel and Tourism	Tourism Destination Centers
				Tourism Information Centers
				Tourism Season
				Average No. of Foreign Tourist
				Average No. of Domestic Tourist
				No. of Star hotels
				No. of House boats
				No. of Homestay facilities
				No. of Travel Agencies
				No. of Tourism Promotion Councils
				Other institutions promoting Tourism
		8.5 PLAN IMPLEMENTATION & FINANCE	Revenue and Receipt of Local Body	Revenue Receipt, Revenue Expenditure, Revenue less expenditure, Resource Mobilization, Debt service charges, Revenue and Receipt of Local Body or Department of state Government, Detailed Revenue Receipt heads
				Proposed Large Projects
			Public Private Partnership Projects Implemented in the town	Relevant Details
			Industrial Aspects (Town Level)	Industries details
				TRADITIONAL INDUSTRIES
				Most important commodities imported
				Most important commodities manufactured
				Most important commodities exported
				Most Important agricultural produce
			Land Use (in Hectares)	Area under each land use from 199, 2001, 2011, proposed ...

Sr. No	Statutory Spatial Plans (MP/ DP)		AMRUT GIS Based-Master Plan	
	Key Thematic Layers (statutory plans)	Key Thematic data sets (statutory plans)	Spatial layers	Classes
8	Other data sets (non-spatial)		Governance	Civic Status of the Town:
				Size and Class of the Town:
				Status of Master Plan/Development Plan
				Name and Address (with Phone, Fax and e-mail) of Commissioner/Executive Officer of ULB:
				Name and Address (with Phone, Fax and e-mail) of Mayor/Chairperson of ULB:
				Total Staff Strength of ULB
				Division-wise breakup of Staff Strength
				year of last election
				Functions entrusted to local bodies as per 12th Schedule appended to 74th Constitutional Amendment
				List of Government Offices

Physical attributes mapping Non- physical attribute collection

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ENDNOTE

i. Potential list of small and medium towns for Tami Nadu is shortlisted from a limited set of AMRUT towns as per the scope of this study

ii. Then known as National Remote Sensing Agency (NRSA), an autonomous society under Department of Space (DOS). It was converted into a full-fledged Government organization called National Remote Sensing Centre (NRSC) on 1st September 2008s.

iii. Then known as the Ministry of Urban Development (MoUD).

CUPP CENTER FOR URBAN PLANNING AND POLICY CRDF CEPT RESEARCH AND DEVELOPMENT FOUNDATION CEPT UNIVERSITY

CENTER FOR URBAN PLANNING AND POLICY

Near AES Boys Hostel Campus, University Ground, Navrangpura,

Ahmedabad - 380 009