GIS Steering Smart Future for Smart Indian Cities

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Abstract- A Smart City is the integration of technology into a strategic approach to sustainability. 21st Century has brought with it a new global trend of "sustainable urban development" and this concept adds new dimensions to urbanization which require a quick need to upgrade existing cities. The concept of a smart city is a relatively new one. Throughout the years, with the significant contribution from various technologies like computer science, information technology, remote sensing, advance multimedia world etc, GIS evolved from traditional geographer's or cartographer's tool for surveying and planning to a rapidly expanding primary technology for understanding our planet and related geospatial opportunities to foster a sustainable world. This paper describes smart city projects in India and thoroughly explores the existing and extended capability of GIS to include modeling and visualization in order that decision makers will be able to see the state of the resources separately in three pillar of smart development model with the impacts of their decisions and the future state of resources.

Index Terms- GIS, Smart City, Urbanization, Three Pillar Smart City Model, Sustainability, Urban Development

I. INTRODUCTION

A city is an economy of agglomeration; it provides various advantages and opportunities. That is why we all flock to the cities in search of a better future. Upcoming decades are going to witness a major population density in urban India. Industrialization will bring about a rapid pace in urbanization and by 2050, India's urbanization levels will increase to 70 per cent from 30 per cent in 2011. In a global context, the scale of India's urbanization will be immense. India will have 68 cities with population 1 million or more than 1 million, 13 cities with more than 4 million people, and 6 megacities with populations of 10 million or more, at least two of which (Mumbai and Delhi) will be among the five largest cities in the world by 2030 (Source: Indian Urbanization Econometric Model, McKinsey Global Institute Analysis Report). As urbanization increases, adverse effects also increase. Swelling populations will only exacerbate the numerous problems in urban areas. Problems include slums, air pollution, water shortages, energy shortages, traffic congestion, inadequate capacity for treating waste water and sewage, and inadequate capacity for disposing of urban and industrial waste [2]. Most cities can barely cope with the crush of steadily increasing population, and many are stretched to breaking point trying to meet the energy, water and transport and communication demands of its residents.

21st Century has brought with it a new global trend of "sustainable urban development" and this concept adds new dimensions to urbanization which require a quick need to upgrade existing cities. The concept of a smart city is a relatively new one. A Smart City is the integration of technology into a strategic approach to sustainability. Although there is no clear definition to define Smart City but broadly "a city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens is known as Smart City" [3]. Cities are our fundamental building blocks. Throughout the history, they have served as centers of innovation, advancement, civilization, and as facilitators of the social interaction necessary for the progress of humankind [4]. It is only fitting that the next evolution of how we live, work, play, and interact is emerging as new dimension within Smart Cities.

Smart city is a "booming" international phenomenon. There are smart cities projects across the globe. The statistics show that over 2000 Smart City projects have been started or going on in Asia, Europe, the Americas and Africa: there have been more than 1500 by 2013, with an annual compounded growth rate of 20%. Among the stakeholders, there are Governments, Municipalities, Property Developers, Utilities, IT Companies, Engineering Companies, Architectural Firms, Telecommunications Companies, Infrastructure Providers, Grid Providers, Building Systems Suppliers, and even Automakers [7].

Already, several new cities have been master-planned from scratch, on green field sites, as Putrajaya (Malaysia), Songdo and Incheon (Korea), King Abdullah Economic City (Saudi Arabia), GIFT, Lavasa, and Nano City (India), Wuxi Huishan and Dongtan and Meixi (China), Dubai Waterfront, Dubai Central, Masdar (UAE), Living PlanIT Valley (Portugal), Neapolis (Cyprus), and Skolkovo (Russia).

II. GIS & SMART CITIES

Throughout the years, with the significant contribution from various technologies like computer science, information technology, remote sensing, advance multimedia world etc, GIS evolved from traditional geographer's or cartographer's tool for surveying and planning to a rapidly expanding primary technology for understanding our planet and related geospatial opportunities to foster a sustainable world. GIS technology bridges the gap between different sectors and acts as an integrated cross sectoral platform to collect, manage, compile, analyze and visualize geospatial, temporal information for sustainable urban planning, development and management. Nowadays, immense value and broad

applicability of GIS is obviously a major driving force of some significant changes happening around us. GIS was basically developed as a system for capturing, storing, querying, analyzing and displaying geographically referenced data [5] but with the advancement in web, mobile technology, GIS emerged as a broad term and a complete package, which can refer to a number of modern technologies and advance processes and become more mainstream that expands knowledge of the urbanization and connections among people [6]. As an indispensable decision making tool GIS is now finding its place among decision makers for assessing and creating sustainable urban policies and smart place to live, learn, experience, socialize and grow.

III. SMART CITIES IN INDIA

The smart city concept is still quite new in India, although it has received a lot of attention in the last few years. India has witnessed massive urban transformation. According to a study [By consulting firm Booz & Company], in search of jobs, opportunities to improve their lives and create a better future for their children, every minute 30 people leaving rural India and at this rate, by 2050; to house 700 million more city dwellers the country will need some 500 new cities. With this rampant urbanization in India, government, urban planning agencies are looking for innovative technologies and solutions to manage the growing demands on city infrastructures that provide vital services. So, what exactly is the answer? Simply, it will be an upgraded city whose core is spatial technology-based infrastructure and services that enhance city's intelligence, quality of life and other attributes (i.e., environment, entrepreneurship, education, culture, transportation etc.), as opposed to the conventional definition of roads, bridges, water and power supplies and buildings. India's economy is expanding rapidly. By 2030 it is expected to have grown by five times, beyond largely by the country's urban centers. During the same period, the country's labour force is expected to grow by 270 million, with urban jobs accounting for 70% of that growth.

A. LAVASA (India): SMART HILL CITY

Lavasa a modern "hill town" in harmony with nature is master planned with the objective of striking a balance between cosmopolitan architecture and environmentally friendly surroundings. This India's first planned hill city is located on the backwaters of Warasgaon dam on the Western Ghats between Pune and Mumbai. Based on new urbanism principles and to undertake a large-scale lifestyle development private infrastructure companies in India building integrated township at a cost of Rs 1,400 billion that offer smart living and working, over a sprawling area of approximately 10,000 rolling acres.

City: Lavasa in the Mose valley of the Western Ghats.

Towns: Dasve, Mugaon, Dhamanohol, Sakhari-Wadavali and Central Business District (CBD)

Coordinates: 18.40528°N 73.50627°E **Altitude:** 640 m (2,100 ft) **Area:** 100 square Km (40 square mile)

Taluka: Mulshi **District:** Pune   **State:** Maharashtra **Country:** India

Anticipated annual tourist flow: 2 million tourists every year, **Size:** 22,000 properties, 0.3 million permanent residents

Employment base: approximately 97,000.
Captive water body: 15-km long lake
          Target completion date: 2021.

Figure 1. Lavasa in the Mose valley of the Western Ghats

Lavasa offers a vibrant, self-contained world with an extensive master plan drawing inspiration from traditional patterns of Indian town planning as well as vernacular forms of building. It emulates principles that are culturally based and that have proven sustainable for centuries.

B. GIFT (India): GUJARAT INTERNATIONAL FINANCE TEC-CITY

Gujarat International Finance Tec-City or GIFT is a central business district in the Indian state of Gujarat. Its main purpose is to provide high quality physical infrastructure (electricity, water, gas, district cooling, roads, telecoms and broadband), so that finance and tech firms can relocate their operations there from Mumbai, Bangalore, Gurgaon etc. where infrastructure is either inadequate or very expensive. It will have special economic zone, international education zone, integrated townships, an entertainment zone, hotels, convention center, an international techno park, Software Technology Parks of India units, shopping malls, stock exchanges and service units. The city is under construction. It will be built on 986 acres (3.99 km^2) of land. This project is located on the bank of the river and is around 12 km from Ahmadabad International Airport External Transport.

City: Gujarat International Finance Tec-City or GIFT

Coordinate: 23.159626°N 72.684512°E

Altitude: 640 m (2,100 ft)

Area: 3.99 square Km (1.54 square mile)

District: Gandhinagar **State:** Gujrat **Country:** India

Employment base: approximately 600000.

Captive water body: Sabarmati River

Target completion date: 2020.

Figure 2. Gujarat International Finance Tec-City or GIFT

Basic parameters for Green Ecological Environment

- High-energy evolving fusion of Nature and Technology, enhancing zest for work & life
- Reduced use/waste of energy thus Reduced energy bills.
- Sky Gardens/Roof-top gardens,
- Non-conventional energy resources such as solar water heating, rain water harvesting,
- Planning and Design consideration according to micro-climatology.
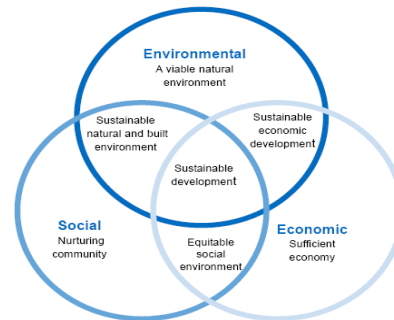
IV. THREE PILLAR BASIC SMART CITY MODEL

This is one of the most well-known models created using the three dimensions -Economy, Environment and Society. (Doran et al, 2012). (Figure): The diagram shows three interlocking circles with the triangle of environmental (conservation), economic (growth), and social (equity) dimensions. Sustainable Smart City Development is modeled on these three pillars. This model is called 'three pillars' or 'three circles model' that the smart city system aims to integrate.

1. Economic component includes public administration and economic factors. It covers governance models, urban regeneration, open data, big data, bandwidth, mobility, cloud computing, security, business intelligence, etc.

2. Environmental component includes resources and managerial infrastructures. It covers water, air, energy and waste management, public and alternative transportation, geographical information, green buildings, green spaces, smart growth, climate change measurement, etc.

3. Social component includes citizens. It covers community life, urban mediation, participatory democracy, social innovation, human-scale cities, civic participation, proximity services, etc.

The three components of the proposed Model are needed in order to create an innovative, prosperous, civic and sustainable Smart City.
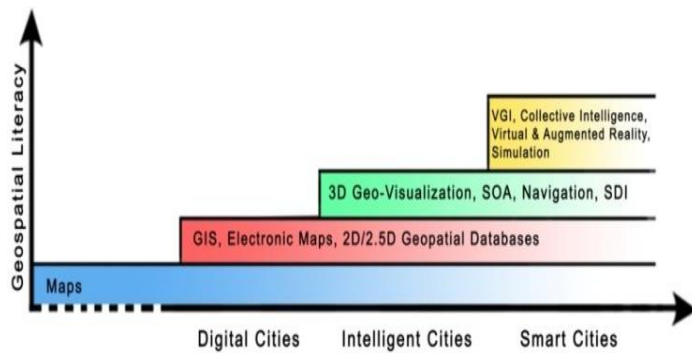

Figure 3. Three Pillar Basic Smart City Model

V. GIS ENABLED SMART CITY SOLUTION

Geographic Information Systems (GIS) is more than just map displays. In many aspects, GIS is pivotal to collect and integrate data, reveal where the problem is, how the surrounding context is, which solutions can be designed and which ones are optimal at different scenarios in a dynamic environment [9]. In this way GIS grown as systems of systems that integrate cartography, statistical analysis, and database technology. Countless applications and precise decision support capability prove this technology a useful to link and analyze spatially resolved data. Further for urban development and its sustainability, GIS technology has the potential and ability to be used to "drive planning support systems, decision-making frameworks incorporating a combination of computer and information technology, urban growth models, and computer-based visualization techniques to support community-based planning"[11]. Visualization is an integral component in GIS technology and application. New sustainable urban development demands comprehensive urban visualization and 3D city models providing extended urban visualization with new techniques for data query. Following figure depicts the growing of typical geospatial literacy over advancements of intertwining development stages of cities.

Three pillar smart city model represents divergent interest, and therefore leads to three fundamental viewpoints for smart development.

People concerned about smart development suggest that meeting the needs of the future depends on how well we balance social, economic, and environmental objectives--or needs--when making decisions today. 80% of global city indicators have a spatial component. These issues of smart development are spatial in nature and require spatial tools and spatial thinking. Creating and applying GIS tools and knowledge allow us to execute geographic intelligence for better decision making.

Figure 4. Geosptial Literacy growth in modern version of cities

The integration of GIS and 3D city model can better explain the interaction and the variation with time of the sustainable indicators for residential development. Hence it's able to support the Decision Maker to view the sustainable level of urban residential areas more comprehensively.

Figure 5. Comprehensive GIS solution for Smart City

VI. GIS SMART CITY SERVICES

GIS solutions for smart city are capable to help policy makers to manage and deliver spatial data by geographic location, and integrate this data with existing applications. This can help to visualize scenarios, extend intelligence, make more informed decisions and address complex issues such as:

- Asset management—gather and summarize data across geographic locations, track movement of assets over time, and identify trends and predict future events with greater accuracy by analyzing and visualizing asset use patterns.
- Water management—use sophisticated sensor networks, and apply advanced computing and analytics to support better-informed water policy and management decisions.
- Crime prevention—integrate data collected through GPS into a new repository of consistent, accurate information, which is then presented in multiple

business views, including offenses or incidents, dispatch history and arrests.
- Emergency response—integrates existing systems based on GPS and RFID sensors to provide seamless communications, incident response management, desktop mapping and real-time collaboration.

VII. CONCLUSION

GIS has emerged from the scientific laboratories, conventional cartographer table into the heart of urban and regional planners, policy makers. This paper examines how GIS can improve collaboration in decision making among the three basic components of proposed '3-piller smart city model' and needed in order to create an innovative, prosperous, civic and sustainable Smart Cities. GIS technology is currently converging with several other technologies to provide new levels of accessibility and functionality. Along with GIS the use and integration of these various technologies to simulate and interpret the sustainability problems leads to a deeper understanding on

sustainable smart development especially in economics, society, environment and housing. The current study presents two smart city projects that justify the potential of sustainable development in India. This development enables new principles that are proven sustainable for self contained world. And ultimately the paper helps to understand the use of GIS and its integration with various approaches to formulate, simulate, interpret and validate the sustainable development of urban areas, steering a smart and sustainable future for smart cities.

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