G- Journal of Environmental Science and Technology

(An International Peer Reviewed Research Journal)

Available online at http://www.gjestenv.com

Role of Geographical Information System (GIS) for Eco-city Planning: A Review

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ARTICLE INFO

ABSTRACT

The rapid expansion of cities expected to rise within population and global economic growth is increasing additional demand on natural resource that leads to land-use changes in particularly cities. In the present scenario, cities are becoming the center of human activities. Cities in developing countries become over-populated and over-crowded as a result of the migration of population from rural to urban due to job opportunities, educational facilities, availability of health facilities etc. This has resulted in ever-growing size of cities, informal settlements environmental pollution, destruction of ecological structure and scarcity of natural resources and also leads to traffic congestion, housing shortage, unaffordable housing prices, crowded streets, degraded ecosystem, increasing demands for waste disposal and many others.. Eco-cities have a strong potential to solve the urban challenges and derive to manage the environment and natural resources. This review article presents the brief on innovative uses of GIS techniques for eco-city planning. The purpose of this article is to provide information about GIS tool for planners, engineers and others to think about the impact of urban sprawl and to develop eco-city for sustainable development.

1) INTRODUCTION

The escalation in population is witnessing a growth in industrialization, urbanization and depletion of the nation's resources. India has been fast urbanization considering 1970, having its urban population increasing from 109 million throughout 1971 and 377 million throughout 2011, a percentage raise by 19.9 to 31.6 more than a number of decades. The numbers of million-plus cities in the country, meanwhile has steadily increased from 23 in 1991 and 35 in 2001 to 53 in 2011 [1, 2]. India, the second most populous country on the planet with a population of 1.2 billion, has observed a population growth of 31.8% over the last decade [3]. The uncontrolled urbanization in India has prohibited the town and cities to manage up. In the most developed nations more than 80 % of the inhabitants are now living in cities, and as a result of urbanization it's expected that 70% of the world's populace is going to be surviving in cities by 2030 [4]. Some 1.1 billion people are anticipated to move into Asian cities in coming decades [5]. This includes 11 megacities, each with a population exceeding 10 million, eg., Beijing, Shanghai, Kolkata (Calcutta), Delhi, Jakarta. Such expanding urban population will increase the demand of a whole range of infrastructure, services, housing, and jobs including land. The rapidly growing population has reduced per capita urban and green area (table. 1).

Table.1. Major Indian cities with population (in million) and green area (per capita)

City	Geographical Area (Sq. km.)	Population (in million)	Forest and Tree Cover	Per Capita Green Area
Delhi	435	16.31	90.74	5.5
Mumbai	735	18.48	122	2.01
Chennai	174	8.69	9	1.03
Kolkata	186.23	14.11	0	0

Source: Census of India [1], Forest Survey of India report [6] and www.urbanindia.nic.in.

These trends are very unsustainable for the country and the rest of the planet. In the recent time, mostly Asian cities are characterized by following five unsustainable trends [7].
1) Larger number of old parts of the city, which need regeneration with mature housing estates desperate for rejuvenation.
2) An existing building stock which is out-dated and not energy-efficient.
3) Structural problems, e.g. expansion of large shopping malls, but lack of non-commercial, catalytic, socially sustainable city projects;
4.) High carbon energy supply due to use of conventional burning fossil fuels for generating energy.

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5) Inefficient safe drinking water, waste disposal and transport operations accompanied by population growth. They also lack basic amenities like a proper land use planning, sewage system, drainage system, solid waste management system, etc. [8].

A way to take care of these raising difficulties and to minimize the power use in urban environments, governments and companies are developing and utilizing new systems and methods with the objectives to make a sustainable future. Thus, there is an urgent need to come up with an environmentally, economically and socially planning with eco-cities which are communities in balance with nature representing a new way of considering cities. Eco-cities are the answer for eco-friendly and sustainable planning. According to Zhou and Williams [9], there are no existing indicator systems to measure how sustainability can be applied to Eco-Cities. It is, therefore, useful to isolate different significant eco-city dimensions relating to landuse management, environment quality improvement, energy management, transportation planning, economic and health development. Eco-city has a strong potential to solve the urban challenges and derive to manage the environment and natural resources. The Eco-City notion implies an optimization of accessible and new resources and seeks to make a whole system solution. The answer views several features such as sustained power supply, community protection, well-being, heat and chilling techniques, water supply, wastes administration and mobility for eco-city. The eco-cities growth has been facilitated by data exchange and network growth that fosters eco-innovation [10]. In the recent years we have seen the extraordinary use of the eco-city concept and an accelerated interpretation of the some ideas and thoughts which are actually using many practical initiatives [11]. These initiatives contain, however, not limited to in India, the government picked pilot eco-city program in 2002 directed at retro-fitting six pilgrim cities i.e. (Kottayam, Puri, Thanjavur, Tirupati, Ujjain, and Vrindavan). This was followed in 2010 by plans for four new-build eco-cities (Changodar, Dahej, Manesar Bawal, and Shendra) over the Delhi–Mumbai Corridor and in 2011 by the selection of 36 pilot programs beneath the national 'solar cities' initiatives [12]. Arguably the most ambitious eco-city programme happens to be getting devote China, where a projected 100 or so eco-city projects are under progress and some 259 cities have declared the intention of getting an eco-city or low-carbon town [13].

In India, eco-city planning is altogether new approach to human settlement development [14]. In the recent time, many techniques like, co-engineering design and development, eco-scope planning and legislation and ecosystem monitoring and management can be used for the promotion of eco-city planning approaches. The eco-city planning approaches are beneficial to the ecological, environmental and social systems. Hence, co-city is a sustainable city that links the human beings with natural environments. Besides, eco-city provides good housing, good environment and minimize input of natural resources and energy and leads to least output of waste [15] by using modern technologies such as eco engineering, system engineering and information technology. It must be stated that concepts of eco-city planning and design are not new in the planning literature, but sustainable eco-cities planning and redesigning with remote sensing and GIS is a new concept for the sustainable development [16].

2) IDEA OF ECO-CITIES

The idea of Eco-cities was initially discussed in 1970s as a part of sustainable urban development agenda [17]. The urbanization and increasing awareness of this idea initiated to the scholars to find a new way of building and developing eco-cities which are sustainable for the future. The original "Eco-City" idea is introduced by Richard Register, one of the early advocates for linking ecological principles to the redesign of cities and it was first coined in his book, Eco-City Berkeley: building cities for a healthy future [18, 19]. Especially, the recent years have seen the dramatic take up of the eco-city concept and an accelerated translation of the ideas and visions are now taking place in many practical initiatives [11]. Ecocities provide solar, wind and recycling technologies, in green buildings and green businesses, in urban environmental restoration projects. Simply, an eco-city is ecologically healthy and eco-friendly established city. Eco-city full fills the basic characteristic of healthy ecosystem and living organism. Eco-city Builders see the only solution to solve this problem by developing or converting existing cities into what are known as eco-cities. They define an eco-city as the following: "An ecologically healthy human settlement modeled on the self-sustaining resilient structure and function of natural ecosystems. The eco-city provides healthy abundance to its inhabitants without consuming more (renewable) resources than it produces, without producing more waste than it can assimilate, and without being toxic to itself or neighboring ecosystems. Its inhabitants' ecological impact reflects planetary supportive lifestyles; its social order reflects fundamental principles of fairness, justice and reasonable equity" [20].

Eco-city was a proposal for building the city like a living system with a land use pattern that will support the healthy environment of the whole city, improve biodiversity, and make the city's features resonate with the patterns of development and sustainability. The word 'eco-city' stayed mainly a compilation of various thoughts about sustainable urban planning, transportation, housing, circles of energy, water, wastes, as well as the protection of the environment, with useful examples [21] (Fig.1).

Fig.1. Eco-city Planning Process

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The German definition of an eco-city is an environmentally, socially and economically responsible city. Over the past several years, many eco-city ideas are available in planning theories. Nevertheless through the entire 1980s and 1990s, there was no typically accepted explanation of "eco-city. Now, various countries promote eco-city planning for sustainable development due to its beneficial aspects. An eco-city encompasses four basic community characteristics which are ecological integrity, economic security, quality of life and empowerment with responsibility''. Roseland [22] suggested that an accumulation of obviously disconnected ideas about urban planning, transportation, health, housing, energy, financial development, natural habitats, community involvement, and social justice all comprises a single framework, the eco city.

Eco-Town, a similar notion to that of Eco-City, is just a government-sponsored process which seeks to possess new towns built-in creating in the expectations of reaching sustainable development. A few of the strategies used to manage this balance contain building up rather than sprawling out, providing solid incentives perhaps not to use car, using renewable energy and green methods to help make the town self-sustaining.

Eco-cities might characteristically comprise compact, pedestrian-oriented, mixed-use neighbourhoods that provide concern to re-use of land and public transport. Since then, several related themes such as for instance "eco-neighbourhoods", "urban eco-village" and "eco-communities"

have emerged, all focusing ways of creating the city more environment-friendly and sustainable [21, 23] Some planners, researchers and survey reports observed different type of terminology and clear patterns that can be commonly used to describe the eco-related terms (Table 2 and 3).

3) THE VISION OF ECO- CITY

The overall ECOCITY objectives give a first indication of the issues that need to be considered in the different planning sectors. However, they are still relatively abstract. To develop a common image of the sort of settlement that eco-city planning should lead to, it is necessary to agree on a common vision. For an eco-city, this vision consists of a combination of different features, which, in interaction with each other, combine to form a sustainable settlement. Roseland [22] mentions that the term ''eco-city'' is relatively new, but is based on concepts that have been around for a long time. The idea of creating an eco-city is enticing, but very complex to realise even in the developed world. It is worthwhile examining the experiences and appreciating the differences in eco-city initiatives in western countries compared to the Indian situation. A closer look at such western initiatives usually reflects priorities (fig.2.). In a country like India, which is predominantly defined by vastness and diversity, an eco-city vision should reflect an awareness of history and society, relate the human, built, and natural environments, and respect the cultural and social use of space.

Table 2. Summarizes key eco-city descriptors and concepts

Term	Meaning
Eco-city / Eco-town	Synonymous terms, commonly used in four rather different ways: ✓ To describe a sizeable mixed-use new sustainable development, this is not a direct urban extension. ✓ attached to the name of a particular area of (or extension to) an existing city which has been or will be developed or retrofitted in a sustainable way ✓ attached to the name of the city as a whole, to denote an eco-initiative in one particular area of that city by local authorities, as umbrella label for various sustainability initiatives which are taking place across a city (which do not necessarily involve building work).
Eco-district/ neighbourhood	Synonymous with the second meaning of 'eco city/town' above. The term is not used to describe stand-alone developments or the city as a whole.
Eco- Community community	Usually signifies a development in a suburban or rural location, built or aspiring to ideals of sustainability.
Eco-village	Two meanings: ✓ Similar to an 'eco district' (see above) -reflecting the notion of the 'urban village' ✓ A rural community with an eco-agenda, perhaps a commune - too small in scale/scope to be included in this survey.
Eco-region	Two common usages: ✓ To varying sizes (rather than just one city), across which collective efforts are made to minimize negative impacts on the environment ✓ To indicate an underlying perspective which foregrounds a particular city, but positions it in relation to a broader hinterland (defined by, for example, a river basin or bordered by a mountain range). It therefore prioritizes an understanding of a city's sustainability as primarily dependent on its interaction with the natural flows and systems in its eco-region. This usage draws on earlier 'bioregional' schools of thought.
Eco- (industrial) park	Eco-industrial parks are typically mixed-use developments with a significant residential presence; mono-zoned developments are rare in any type of 'eco-city'. Their promoters usually aim to attract hi-tech and/or green industries, often as part of a wider attempt to diversify a local economy away from traditional polluting industry.

Source: A Global Survey Report [12]

Table 3: Other Terms Closely Related to 'Eco-City'

Term	Comment
Sustainable city	Synonymous with 'eco-city/town' (in any of the four meanings in Table 3). The UN-Habitat Sustainable Cities Programme has been promoting this concept since the early 1990s.
Sustainable community	Synonymous with 'eco-community'
Smart city	Used to emphasize hi-tech aspects of development - smart energy grids, IT networks, and related efficiencies in utility and service provision.
Slim city	World Economic Forum knowledge transfer initiative to encourage cities to increase efficiency across a variety of sectors like energy, transport, construction work.
Compact city	Use of this term typically implies an opposition to urban sprawl. It is an influential urban design concept whose guiding principles include high residential density and the discouragement of private car use.
Zero energy city / zero net energy city	Uses no more energy than it is able to generate locally. This is achieved through a combination of measures to reduce current consumption and the introduction of new renewable energy sources.
Low carbon city	The reference to carbon (in this and the following two terms) may reflect national aspirations to create 'low carbon economies' - often as part of policies designed to mitigate climate change. The focus is on the physical aspects of cities: energy, transportation, infrastructure and buildings. 'Carbon' is sometimes used as shorthand for all greenhouse gases.
Carbon neutral city / net zero city	Similar to 'low carbon city' - except defined more strictly as a city which offsets carbon /greenhouse gas emissions such that its net emissions are zero.
Zero carbon city	More specifically still, a city which produces no greenhouse gases and is run exclusively on energy from renewable sources.
Solar city	May have a relatively narrow focus on replacing fossil fuels with solar energy, and is in some cases limited in its ambitions. The Indian Government's Solar Cities programme aims to reduce conventional energy use by 10%, with solar energy being part of a mix of renewable energy generation to be promoted.
Transition town	The Transition Town movement, which originated in the UK and Ireland, is a growing international phenomenon. Transition Town activities are typically organised at grass-roots level rather than embedded in policies. The aim is to build up local communities' social and environmental resilience to the effects of climate change and fossil fuel shortages - both of which are assumed to be inevitable in future.
Eco-municipality	The label 'Eco-Municipality' describes a local authority which has adopted a particular series of values related to environmental and social sustainability, to guide policy making. The movement is most strongly associated with Sweden (where it has its roots in the 1980s), but has also gained recent ground in the USA.
Renewable energy city	The city is powered by renewable energy to various scales – from the buildings to the districts and the entire city. Renewable energy can be tapped from such sources as biofuels, sunlight, wind or geothermal, according to the local context. Cities are required to restructure their infrastructure (such as power generation and buildings) and institutions in a way that allows the penetration of renewable energy.
Garden city	The city incorporates intensive greening as part of the urban environment. Green areas can be placed in the lower-density enclaves of a city, such as suburbs, or can be integrated into the urban built environment, such as green roofs. Urban green areas can be also used for urban agriculture, renewable energy crops growing and greening the high density parts of cities.
Resource efficient city	The city relies on both upstream and downstream waste management systems. The city encourages the use of sustainable resources in both production and consumption practices while being equipped with citywide infrastructure designed to maximize the 3R habits (reduce, reuse, recycle), waste-to-energy technology and sustainable composting.
Self sufficient city	Eco-efficiency is realized through localized and self-sufficient production and consumption. The city can save the economic and environmental costs for importing as well as exporting products and services by maximizing the use of available resources inside the city.
Distributed city	The city, relying on small-scale and neighbourhood-based water and energy systems, can save costs occurred in the transmission process of the centralized system.

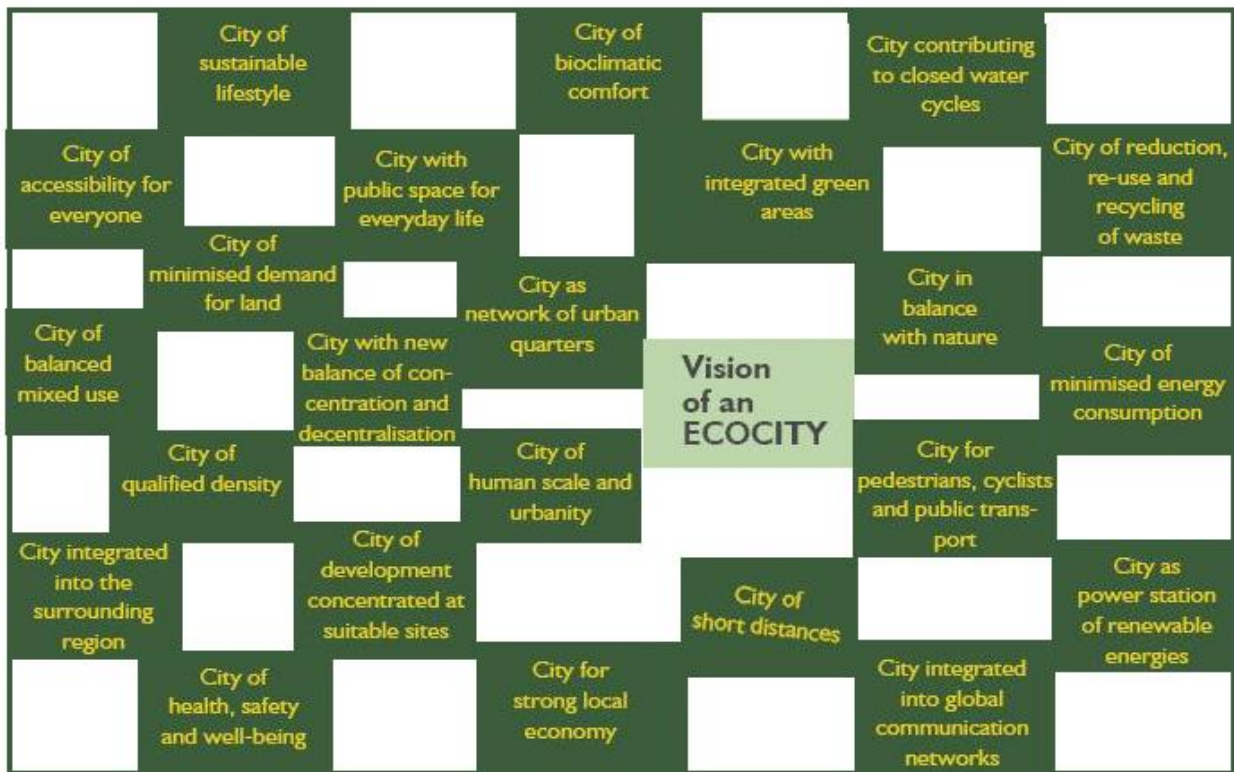**Source:** A Global Survey Report [12] and [24]

Figure.2. Vision of an Eco-city (Source: http://www.ecocityprojects.net/ index_public.php)

4) ECO-CITY IN INDIA

In the year 2002, the Eco-city Project was initiated by the Central Pollution Control Board (CPCB) with the grants-in-aid from the Ministry of Environment and Forest (MOEF), Government of India in partnership with the German born Specialized Co-operation beneath India-German Atmosphere Plan about "Advisory Companies with Environment Management" (ASEM) as part of the 10th Strategy activities. In 2001, as part of its 10th 5-year plan (2002-2007), the MoEF selects 6 towns, such as Kottayam, Puri, Thanjavour, Tirupati, Ujjian and Vrindavan geographically distributed across Asia. Kottayam was the first eco-city of six pilot eco-city initiatives, which means to make various retro-fit adaptations to well-known cities. Puri, Thanjavur, Tirupati, Ujjain, and Vrindavan were afterward preferred. All six MOEF eco-city initiatives were well-known with the same key objectives, which incorporated: improving sanitation in public spaces; making public transport more resourceful and environmentally sustainable; improving urban management; and improving amenities and situation for tourists. Overall, comparatively little improvement appears to have been made in the MOEF eco-city programme, with a lot of recommendations in each city not getting beyond the planning stage. India has more just seen numerous other eco-city initiatives sponsored by government ministries, which are not linked to the Ministry of Environment and Forest's pilot initiatives. The particular eco-city program throughout of India directed to ameliorate the existing environment, addressing generally to these elements that are producing the environmental destruction. The particular concentration from the program ended up being to manage polluting of the environment, boost environmental excellent, shield environmental methods like waterways and also waters, boost sanitary problems, improve necessary infrastructure and to create aesthetic environs inside the

selected neighborhoods. This specific challenge supposed to pave a means intended for altering the particular determined planned Cities/towns that are clear, well-kept and also environmentally friendly.

The Delhi-Mumbai Corridor eco-cities are not the only urban sustainability projects taking shape in India. In 2008, the Indian Ministry of New and Renewable Energy (MNRE) announced a development of solar cities initiative, to be implemented during the 11th 5-year plan (2007-2012). This set indirect financial support for 60 cities to work towards plummeting conventional energy demand by at least 10%, through the implementation of solar and other renewable energy sources, along with energy and water management, and the use of solar passive structural design. The project has been developed with input from the US Department of Energy, among others. In 2010 the Japanese government uttered interest in collaborating on one city. As of September 2011, MNRE had given 'in principle' conformity for 36 solar city programs to go ahead. In addition, the Indian Ministry of Urban Development is working with the US Department of Energy and US-based Brookhaven National Laboratory to make eight 'Near-Zero Energy Satellite Towns'. Rajarhat, a fast growing new township near Kolkata, was preferred in 2010 to be the first of these.

The Eco-city programme was conceptualized for improving environment and achieving sustainable development through urban improvement system employing practical, innovative and non- conventional solutions. The Eco-city Project in India aimed to ameliorate the existing environment, addressing mainly to those aspects that are causing the environmental damage. The focus of the eco-city program was to control pollution, improve environmental quality, protect environmental resources like rivers and lakes, improve sanitary conditions and improve the needed infrastructure and

to create aesthetic environs in the chosen towns. These eco-city programs anticipated to pave a way for transforming the identified project Cities/towns that are clean, orderly and sustainable. Table 4 is presenting all the existing eco-cities in India.

Table.4 - Eco-cities in India

Country	Project/ City name	
India	Auroville	
	Delhi-Mumbai Corridor Eco-Cities ✓ Changodar ✓ Dahej ✓ Manesar Bawal ✓ Shendra	
	Godrej Garden City (Ahmedabad)	
	Gujarat International Finance Tec-City (Ahmedabad)	
	Indian Eco-Cities	**State**
	Kottayam	Kerala
	Puri	Orissa
	Thanjavur	Tamil Nadu
	Tirupati	Andhra Pradesh
	Ujjain	Madhya Pradesh
	Vrindavan	Uttar Pradesh
	Kancheepuram	Tamil Nadu
	Magarpatta (Pune)	Maharastra
	Lavasa (Pune)	Maharastra
	Mahindra World City (Jaipur)	Rajasthan

Source: A Global Survey Report [12]

Parameters for selection:
Parameters for selection of the towns/cities protected under the Eco-city project of CPCB were as followed:
✓ Measurement of the town/city
✓ Cultural/historical/heritage/tourism significance
✓ Environmental Improvement needs
✓ Range for public-private partnerships and private investment
✓ Machines of economic momentum/urbanization
✓ Public involvement in decision-making method
✓ Regional circulation of neighborhoods

4.1 Auroville: It is situated in India, Asia and about 1500 inhabitants can live in this eco-city. This self-styled 'common town in the creating' is targeted on providing together individuals from different nations and backgrounds to reside in an ecologically friendly and beneficial way. Caused in the 1960s by several volunteers influenced by Indian scholar Sri Aurobindo, Auroville has been endorsed by UNESCO and the Indian Government. The progress includes a series of little settlements where sustainable farming is practiced. Auroville has additionally participated in many reforestation campaigns in the region. The challenge has, nevertheless, been criticized by some for counting on a polluting, private transfer program for goods and people [12].

4.2 Delhi-Mumbai Corridor Eco-Cities (Changodar, Dahej, Manesar Bawal, Shendra): In April 2010 India's Ministry of Commerce and Industry announced its plan to build four eco-cities inside the Delhi-Mumbai 'Corridor'. It is situated in India, Asia and about Over all amount of 1483 km moving through six states. Besides the eco-cities, the Corridor can

have 11 expense parts and 13 professional areas [12]. The eco-town plan is based on the Kitakyushu eco-town model in Japan. The program follows a new system of urban planning to the area and will stand for the biggest urban development programme since Chandigarh was built in 1953. Key features are compact, vertical developments, a well-organized public transportation system, the use of digital technology to create smart grids for improved management of civic transportation, recycling of sewage water for industrial use, reuse of industrial waste, green spaces, cycle tracks and easy convenience to goods, services and activities planned to promote a sense of community.

4.3 Godrej Garden City: It is Located in India having Size of 250 acres of urban expansion and phase-2 in under construction. The key results expected to be performed from the Eco-City Program were:
✓ Technological improvement Plans by Godrej Properties for a diverse residential and commercial growth within the city limits of Ahmedabad in Gujarat were authorized by the Clinton Climate Initiative's Climate Positive Development Program in 2009.
✓ Green technologies will consist of water treatment and recycling amenities, with the overall goal of producing net zero greenhouse gas emissions.
✓ There will be a stress on residents being able to walk to work or school.
✓ The progresses will aspect 40 acres of public green space.

4.4 Gujarat International Finance Tec-City: It is Located in India having Size 500 acres of new development and Phase-2 in under construction. The key results expected to be performed from the Eco-City Program were:
✓ Hi-tech innovations envision as an eco-city, this new expansion on Green field land near Ahmedabad will form the world's largest global funding centre. Just under a quarter of the land area will be given over to residential buildings, housing up to 50,000 people.
✓ It will incorporate solar and wind power, energy-efficient buildings and district cooling, with inhabited neighborhoods situated to support walking to work. Its green space will contain a waterfront park.
✓ The project is a joint scheme among the State Government of Gujarat and Infrastructure Leasing and Financial Services Ltd. Construction of the city has been deferred due to the universal decline, although preliminary work is complete, and the first phase is currently due to be done in 2014.

4.5 Kottyam: One of the main objectives of the Kottayam project was to improve the areas in the region of the city, and in exacting the sustainability of the city's rivers. Work began in 2005 to clean up the rivers and the contiguous swamps, to develop aquacultures, and to build more leisure areas. In addition, the aim was to execute highly developed grey water and waste management systems across the city. A sequence of environmental indicators was developed, in order to be able to determine the rate of improvement. An incorporated Solid Waste Management Treatment and Disposal system has been established, and the CPCB reported in 2006 that desilting work had been finished in the Mundar River and Kacherrikadavu Boat Jetty and Canal.

The Kottayam Municipality (Kerala) also help in 'Eco-city' programme to renovate Kacheri Kadavu Ship Jetty Canal and Rejuvenate Munda River that have been severely changed due

to siltation, weed growth and removal of domestic waste. The municipality carried-out these actions:

- ✓ Removal of weeds and vegetations in the Jetty canal and stream
- ✓ Dredging task was performed in the canal (up to 1100 m) and stream (upto 600 m).
- ✓ Construction of Sitting measures and preserving wall
- ✓ Restoration of parking area.

4.6 Puri: The project focused on the areas encompassing Lord Jagannath Brow, Fantastic Road, the religious reservoir and industrial and previous residential areas nearby the temple. The key results expected to be performed from the Eco-City Project were:

- ✓ Increased environmental quality
- ✓ Increased situation of traditional water bodies
- ✓ Increased sanitary conditions by successful management of solid waste and drainage system
- ✓ Increased management of traffic and transport system

4.7 Thanjavur: The eco-city programme recommendations here listening carefully on the improvement of four of the city's 'theerthams' (holy tanks of water supposed to have medicinal properties). Various measures have been taken to protect the usable aquifers from further degradation. CPCB, however, did not permit subsidy for the work to take place.

4.8 Tirupati: Eco-city challenge of Tirupati was a shared objective of the Tirupati Municipality and Participatory Employment Net (PEN), India in cooperation with GTZ-ASEM, United Countries Development Plan (UNDP), Global Environment Facility (GEF) and Small Grants Plan (SGP). The activities moved out were:

- ✓ The storm water pipes in the Upper, Southern and European sides of the temple were covered
- ✓ Narasimh Theertha reservoir was connected with Koneru pond through the pipeline to bring the fresh water to the pond
- ✓ Cleaning and de-silting of pipes in the key part of the Koneru was done
- ✓ The key part of town about Govinda Raja Swami forehead was improved

4.9 Ujjain: The Project on Ujjain centered on Mahakal Brow place including Harsidhhi Brow, Bada Ganapati Brow, Rudra Sagar and Previous Residential areas. The key results likely to be performed from the Project were:

- ✓ Resurrection of Rudra Sagar by improving the water quality of the pond
- ✓ Development in sanitary problems including solid waste management and drainage
- ✓ Development in environmental quality and traffic administration

4.10 Vrindavan: Eco-city Plan involving Vrindavan sorted out a number of difficulties like, advancement involving sanitary circumstances which includes reliable waste material operations in addition to discharge procedure, advancement involving traffic in addition to transport procedure, continuing development of traveler friendly routes, in addition to advancement involving environmental quality. It is usually expressing negligence village where job was executed combined with the place involving eco-zone, transport course in addition to environmentally friendly belt. Educated effort was also released from the Vrindavan Nagar Palika Parishad in order to meet all of these plans and also to boost urban operations in addition to planning.

Other recommendations in the eco-city development plan for Vrindavan, for environmental improvements to key pilgrim routes in the city, Banke Bihari temple, and Gandhi Park, have not been realised. These recommendations were accepted by the CPCB, and financial support was released in 2003. However, Vrindavan Nagar Palika Parishad (local authority) was incapable to accomplish its commitment to match the CPCB subsidy.

4.11 Kancheepuram: To propagate the environmental pleasant idea Department of Setting has organized an "eco-city program" for Kancheepuram Area through National Environment Engineering Research Institute (NEERI), Chennai. The overall aim of the plan was to add setting considerations in to downtown planning and prepare an Environmental Management policy for improving the environment quality. Specific objectives of the challenge were:

- ✓ To map the environment profile of examine region and to recognize the environmental pollution hotspots.
- ✓ To organize an setting administration program that include rehabilitation and mitigation steps
- ✓ To suggest directions for environmentally compatible land use planning.

4.12 Magarpatta: It is the first city of their sort in the India and has been created contemplating most of the aspects of the Eco-city construction. Everything is within strolling range, to call home, function, examine, play and store (Magar, 2009). There is a presence of abundant greenery encompassing residential regions of the city. Magarpatta Town is an effort to replace life's harmony, completeness, stability and achievement in the living process.

4.13 Lavasa: Lavasa lake city is being developed by Hindustan Construction Organization (HCC) near Pune within the European Ghat stages (Karunakaran, 2007). This sustainable community seeks to cut back environmentally friendly stress and improve citizens' quality of life. This is achieved by reducing the travel time. This Eco-city will make an effort to attain the balance between urbanism and environmentally friendly environments to have a distinctive life-style. Life in this city has been imagined as lively yet calm, aspirational yet inexpensive, hi-tech yet simple and urban yet close to nature.

4.14 Mahindra World City: It is Located in India having Size 3,000 acres of new development and Phase-2 in under construction. Mahindra World City is being developed by the Mahindra group in corporation with Rajasthan State Government's industrial development and investment agency as a sustainable business park. The key results expected to be performed from the Eco-City Project were:

- ✓ It will include an inert cooling system and solar peripheral lights, with two-thirds of its water got from recycled water sources.
- ✓ Landscape improvements will contain a tree planting method.
- ✓ Exhaustion building materials will be used in the construction process, with waste products recycled.

5) GUIDELINES FOR ECO-CITY PLANNING

Some guidelines below, these are helpful in promotion of eco-city planning projects.

5.1 Ecological sanitation: Efficient, cost-effective eco-

engineering for treating and recycling human waste, gray water, and all wastes.

5.2 Ecological industrial metabolism: Resource conservation and environmental protection through industrial transition, emphasizing materials re-use life-cycle production, renewable energy, efficient transportation, and meeting human needs.

5.3 Ecological infrastructure integrity: Arranging built structures, open spaces such as parks and plazas, connectors such as streets and bridges, and natural features such as waterways and ridgelines, to maximize accessibility of the city for all citizens while conserving energy and resources and alleviating such problems as automobile accidents, air pollution, hydrological deterioration, heat island effects and global warming.

5.4 Ecological awareness: It helps people understand their place in nature, cultural identity, responsibility for the environment, and help them change their consumption behavior and enhance their ability to contribute to maintaining high quality urban ecosystems.

6) INNOVATIVE USES OF GIS TECHNIQUES IN ECO-CITY PLANNING

GIS are furnishing new tools for analytical and descriptive subjects. Remote Sensing (RS) are also important for GIS database development because it provides spatial information that can be incorporated directly into GIS [27]. These modern techniques may be use in environmental planning, disaster management, environmental impact assessment and monitoring. For eco-city planning, there are need for many basic information like land use maps, climatic maps etc. For the collection of all these information, there is requirement of huge manpower and it would be time consuming process. GIS technique help us to collect the information about biological and physical status, earth's function pattern and their changes throughout locally, regionally and globally through aerial photographs, satellite images directly and frequently [28].

Urban planning to mitigate various environmental issues has also managed with the help of GIS tools for sustainable development. Clean air, fresh water and productive land are the basic needs of the peoples. Many past practices are being implemented for sustainable cities planning which are based on good housing, sanitation, electricity, environment quality and socioeconomic profile. Many techniques like, co-engineering design and development, landscape planning, eco-scape planning and legislation and green space monitoring and management are used for sustainable development of urban areas.

RS, GIS and much modern database technique are used now a day for the promotion of eco-cities. GIS has offered us the accessibility to find out various kinds of land use pattern and models. They vary in terms of data collection, spatial modeling. The data can offer an essential relationship between ecological, national and regional conservation and management diversity [29]. GIS is a vital tool to identify the eco-cities through data merging. In this method the information are collect in the form of different kinds of maps like soil map, climatic maps, topographic maps, land use/land cover maps, roads maps etc and suggested various models like spatial statistics model, agent based model, Fractal Based Model, cellular automata model, artificial neural network model etc. These modern techniques also help to create suitability map for green belt and plantation and also helpful

to identify the potential area for improvement the green systems in particular areas.

Innovative methods, techniques and strategies need to combine the social, economic and environmental factors involving cities, townships and minor habitations to watch growth and change over these and prediction parts of threat – all within just reduced timeframes compared to in the past accepted. Furthermore, they will be accommodating adequately to satisfy standard requirements such as land development, tenure and value applications, although become design to get interoperable and combine within just the city. GIS tools must assist the entire process of acreage government characteristics, although also needs to retain the control over key problems just like disaster management, flooding control, environmental management, health and transportation, for example, but also encourage economic development and reduce social inequalities. GIS techniques include:

6.1 Data collection & maintenance: High resolution satellite imagery is now commercially available at an affordable rate from a number of sources and also freely provided by Bhuvan and Google Earth. GIS software are using in geo-referencing of images and also to generate topographic and thematic mapping (at a scale of at least 1:5,000) and to better understand changes across the city, such as informal settlements.

6.2 Data integration and access: GIS can handle both spatial and non- spatial (attribute) information where spatial information relates to the geometry of the characteristics (works components) while non-spatial information stored in tabular form explain the characteristics of the different features (component attributes). Non-spatial data are be collected from different offices, through the field visit and door to door survey related to population, basic services, environmental quality, transportation, informal settlements etc. this data is merge with spatial data like (topographic map, landuse maps etc.). It helps to access the wide range of information. This will be the innovative use of spatial information.

6.3 Data analysis: Data and knowledge detection techniques allow the integration of a wide range of spatial information with attribute information. This creates the chance to perform more effective forms of analysis and decision-making, leading to more cost effective solutions such as targeting of limited city resources for health care and planning of cities.

6.4 GIS modeling: Many applications are enhanced by the use of 3-D spatial information, such as visualization of planning development proposals, flood predictions, modeling urban sprawl, tourist visit simulations and the design of transportation networks. Some GIS software also forecasts the future growth with the help of satellite images.

6.5 GIS for Suitable Site Selection

The suitable site selection is the primary and essential part of eco-city planning. GIS can be utilized to visualize whether a particular site meets the predefined criterions or not. It really helps to visualize the spatial interlinks or errors between various factors with that of chosen site for planning. Lejeune et al. [30] has promoted GIS based decision support system for locating suitable wind farm site. GIS is also used to confirm the sustainability of land use [31].

7) GIS FOR GREEN HOUSE GAS (GHG) EMISSION MONITORING

Construction industry is one of the main sources for GHG emission. Reducing the GHG emission from the construction activities is one of the challenging issues in construction industry (US-EPA, 2009). Hajibabai et al. [32] allow us to develop a model that can be utilized in GIS environment to reproduce the GHG emission from the construction site activities (such as equipment operations, material transportation etc.).

8) GIS FOR SPACE MANAGEMENT

Space management is among the major problems that facility managers confronted in green building construction. It is a sophisticated issue concerning the allocation of confined space to meet company goals, minimize operating costs, and promote an effective and productive environment. The ideal uses of space in successful manner decrease the building's per capita functional costs. There are several cases wherever GIS is effectively found in the management of spaces for different building types.

9) GIS FOR WASTE MANAGEMENT

GIS techniques can helps to generate waste management system for cities. It can be effectively used for the waste source identification and its final destination point.

10) CONCLUSIONS

Eco-city planning requires ecological security clean air, good water supply, food healthy housing, good municipal services and protection against different natural calamities. Eco-city planning is a whole systems approach integrating administration, ecologically efficient industry, people's needs and aspirations, harmonious culture, and landscapes where nature, agriculture and the built environment are functionally integrated. Many religious places like Tirupati, Ujjain, Puri always being polluted during spiritual walk pilgrims suffer many like lack of fresh and clean water, improper drainage, sanitation etc.. We will have to initiate projects at local, regional level to mitigate the problems and it could be possible only through the promotion of eco-city approaches. Suitability is a powerful tool for eco-city planning and help in finding a balance between different land-uses in the city as well as in formulating policies for ecological management of the city. Suitability analysis can be carried out using RS and GIS techniques, identified suitable sites for the ecological development. These sites will play a good ecological role and create elegant landscapes. Continuous development and refinement of suitability analysis, helps in proposing suitable area for Eco-city planning model. These eco-city planning model will not only help in improving the environment, it will also improve the relationship between people and their natural and social environment which will lead to more sustainable urban growth. This developmental process will benefit the citizens through renewed and effectively managed environment system.

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REFERENCES

1) Census of India. 2011. http://www.census2011.co.in/city.phpn.
2) Govindarajulu, D. 2014. Urban green space planning for climate adaptation in Indian cities. Urban Climate, 1-7.
3) Annepu, R.K. 2012. Sustainable Solid Waste Management in India. New York: Columbia University in the city of New York, Department of Earth and Environmental Engineering
4) Lazaroiu, G. and Roscia, M. 2012. Definition Methodology of the Smart Cities Model. Elsevier, 47(1), 326-332.
5) Kallidaikurichi, S. and Yuen, B. 2010. Developing living cities. Singapore: World Scientific.
6) Forest Survey of India. 2011. State of Forest Report. http://fsi.nic.in/details.php?pgID=sb_16.
7) Lehmann, S. 2010. Green Urbanism: Holistic Pathways to the Rejuvenation of Mature Housing Estates in Singapore, In: Eco-city Planning Policies. Practice and Design, 1, 151-180.
8) Singh, R.P., Tyagi, V.V., Allen, T., Ibrahim, M.H. and Kothari, R. 2011. An overview for exploring the possibilities of energy generation from municipal solid waste (MSW) in Indian scenario. Renew Sustain Energy Rev, 15 (9), 4797–808.
9) Zhou, N. and Williams, C. 2013. An international Review of Eco-City Theory, Indicators, and Case Studies. Report. Berkeley National Laboratory, USA.
10) Wu, F. 2012. China's eco-cities. Geoforum, 43, 169–171.
11) Joss, S. 2011[2nd]. Eco-cities: the mainstreaming of urban sustainability; key characteristics and driving factors, Int. J. Sustain. Dev. Plan. 6 (3), 268–285.
12) Joss, S., Tomozeiu, D. and Cowley, R. 2011[1st]. Eco-cities: A global survey 2011. London: University of Westminster International Eco-Cities Initiative.
13) Joss, S., R. Kargon, A. Molella. 2013[3rd]. Eco-cities in Pan-Asia international discourses, local practices, J. Urban Technol. 20 (1), 1–5.
14) Surjan, A.K. and Shaw, R. 2008. 'Eco-city' to 'disaster-resilient eco community': a concerted approach in the coastal city of Puri, India, Sustain Science, 3, 249-265.
15) Huang, Shu-Li., Yeh, Chia-Tsung. and Chang, Li-Fang. 2010. The Transition to and Urbanizing World and the Demand for Natural Resources. Current Opinion in Environmental Sustainability, 2, 1-8
16) Kumar, S., Dutta, V., Jain, S. and Sharma, D. 2012, Planning Eco-cities for maintaining the quality of urban ecosystem, Environews, International society of Environmental Botanist, Lucknow, 18 (4), 8-9.
17) Yigitcanlar, Tan. and Lee, Ho Sang. 2013. Korean ubiquitous-eco-city: A smart-sustainable urban form or a branding hoax?. Technological Forecasting & Social Change.
18) Register, R. 1987. Eco-city Berkeley: building cities for a healthy future. Berkeley, CA: North Atlantic Books, 1-143.
19) Register, R. 2006. Eco-cities: rebuilding cities in balance with nature, New Society, New Gabriola, BC.
20) Eco-city Builders. 2010. Eco-city Definition. Retrieved June 18, 2011, from EcocityBuilders.org:

http://www.ecocitybuilders.org/why-ecocities/the-solution/ecocity-definition/.

21) Roseland, M. 1997. Dimensions of the eco-city. *Cities*, 14(4), 197-202.

22) Roseland, M. 2001. The eco-city approach to sustainable development in urban areas. In: Devuyst D, Hens L, De Lannoy W (eds) How green is the city? Sustainability assessment.

23) Barton, H. 2000. Sustainable communities. Earthscan (London), 1-305.

24) Washington, D.C. 2009. Resilient Cities: Responding to Peak Oil and Climate Change. Island Press.

25) Magar,S. 2009. Magarpatta: A dream city, January 24. http://specials.rediff.com/money/2009/ian/24slidel-magarpatta-the-dream- city, htm

26) Karunakaran, N. 2007. A tale of two eco-cities - New urbanism taking roots in India, Business outlook, Jul 20. http ://business. outlookindia. com/article, aspx? 100048

27) Lee, K. H. 1991. Wetlands change detection methods investigation. EPA Environmental monitoring systems Laboratory, Las Vegas, Nevada, p.42.

28) Mishra, M., Mishra, K., Subudhi, A. and Phil, M. 2011. Urban sprawl mapping and land use change analysis using remote sensing and GIS: Case study of Bhubaneswar city, Orissa. Proceedings of the Geo-Spatial World Forum, January 18-21, Hyderabad, India.

29) Wilkie, D.S. and Finn, J.T. 1996. Remote Sensing Imagery for Natural Resources Monitoring. Columbia University Press, New York. p. 295.

30) Lejeune, P., Gheysen, T., Ducenne, Q. and Rondeux, J. 2010. Development of an Open Source GIS Based Decision Support System for locating Wind Farms in Wallonia (Sourthern Belgium). Delvin, G., Book Chapter: Advances in Decision Support Systems, Intech, Vukovar, Croatia.

31) Javadian, N., Aghajani, A., Rezaeian, J. and Sebdani, M.J.G. 2011. A multi-objective integrated cellular manufacturing systems design with dynamic system reconfiguration. Int J Adv Manuf Technol, 56, 307–317.

32) Hajibabai, L. 2011. Visualizing greenhouse gas emissions from construction activities". Construction innovation, 11 (3), p. 356.