INTEGRATED LAND-USE ZONING, USING TOPOGRAPHICAL DATA: OPTIMIZING VACANT SPACE FOR URBANIZATION AT AKOLE TALUKA, MAHARASHTRA, INDIA.

Aditya P. Shastri

Department of Civil Engineering
Postgraduate Student
Pillai HOC College of Engineering and Technology, Rasayani, Maharashtra, India

Raju P. Narwade

Department of Civil Engineering
Associate Professor
Pillai HOC College of Engineering and Technology, Rasayani, Maharashtra, India

Karthik Nagarajan

Department of Civil Engineering
Associate Professor
Pillai HOC College of Engineering and Technology, Rasayani, Maharashtra, India

ABSTRACT

Integrated urban land-use planning is becoming increasingly complex in India, as there is noticeable migration of rural population towards developed cities. Main reason behind it being, lack of education and employment opportunities, low levels of socio-economic development, as well as poor urban infrastructural base of rural areas. It is necessary to identify these areas and optimize its poorly developed or vacant spaces, to effectively manage the transformation of India's underdeveloped and rural areas into developed cities, resulting in development of the Country. This research attempts to present an integrative approach to the problem of land-use planning with the help of a conceptual model. The study examines, congested cities and identifies vacant spaces or underdeveloped areas adjoining them. Based on it, a village - Akole taluka in Ahmednagar district, adjoining two developed cities - Mumbai and Pune, of Maharashtra State, is analyzed for transformation and re-development purpose, through the use of topographic data. Finally, it is aimed at implementing new urbanism principles to the study area and produce a land-use model to maximize the quality of life of its people. Providing useful information for development of planning and design strategies for sustainable urbanization and enhancing quality of life is need of the hour. Therefore, key purpose of this research is to increase productiveness of citizen's habitat, by optimizing the use of vacant land. This is achieved by proposing an Urban

Sustainable Development Model (USDM) readily acceptable to accommodate a large number of permanent populations.

1. INTRODUCTION

The current population of India stands nearly 1.35 billion as of January 2019, which is almost 17.7% of total world population [1]. Huge number of people keep migrating in developing countries like India, in search of employment or education or both [2]. Obtaining good quality of life (QoL), better growth prospects and opportunities, because of rapid industrialization and urbanization are the main reason behind this migration. The result of which is the physical growth of urban areas and deterioration in limits of the city to occupy the residents [3]. This trend of urban growth has many environmental impacts on the surrounding ecosystems, urban area, topography, which is not desirable [4]. Above that, the infrastructure services in many metropolitan regions of India is at its saturation level and fail very soon, if there is no contingency plan [5]. This poses a severe challenge to urban India for managing the new growth and socio-economic development. Weapons of – effective urban planning strategies for future cities and optimization of spaces may help to combat this challenge [6].

Urbanization, being an indicator of socio-economic development, is the most effective outcome or the solution to ever increasing population, migration and demands of future growth. It is a powerful tool for making decision in development of land and improving the quality of built environment [7]. Regional plans, zonal plans, master plans, zoning regulations and building bye laws, as approved by the State Government, are the pre-requisites for Town planning and Urbanization in India. But still there are hindrances in implementation of modern and effective planning process towards increasing demands of cities, due to rigid and inflexible system, which calls for new paradigm [8].

Apart from that, if the master plans, prepared for future development, incorporate empty building spaces or vacant spaces, then the region will be more capable of handling future growth [9]. Optimization of vacant spaces will help in capacity building of these regions and make them self-sustainable. Utilization of vacant spaces in developing and developed regions have been minimal, thus neglecting a valuable resource. If identified and used intelligently, it may prove to be competitive asset for socio-economic development, as this may increase gross domestic product (GDP), increase the revenue generated from taxes, create new job opportunities, improve infrastructure and transportation facilities of the region and attract the masses migrating to congested metropolitan cities [10].

As an effective approach to make rural areas self-sustainable, integrated urban land-use zoning can contribute to land-use transformation, thus arresting migration [11]. Land use planning is the process of allocating a particular domain to a specific region in a well-defined area called as – zone. These domains may be – Residential, Commercial, Institutional, Industrial, Agricultural zone, etc. [12].

Urban development of villages, towns and cities of India is essential, since urban sector plays a vital role in transformation of economy and sustaining it. To ensure this, it is necessary

to, create alternative sources of education, employment, health facilities, communication facilities, power supply and transform under developed areas.

To assess village development in Maharashtra, major socio-economic indicators of development for rural Maharashtra have been examined and found that Mumbai (city and suburban) is most developed among all the districts in Maharashtra, from Figure. 1: Ranking and Mapping of Districts statistics, International Institute for Population Sciences, Mumbai. This district wise classification shows that many districts are predominantly under developed and have huge mass of rural population. Indicating lower levels of urbanization, surrounded by Mumbai, Pune, Aurangabad, Nashik, Beed, Osmanabad, Solapur, and having largest geographical area in the state, Ahmednagar district of Maharashtra state has been selected as study area.
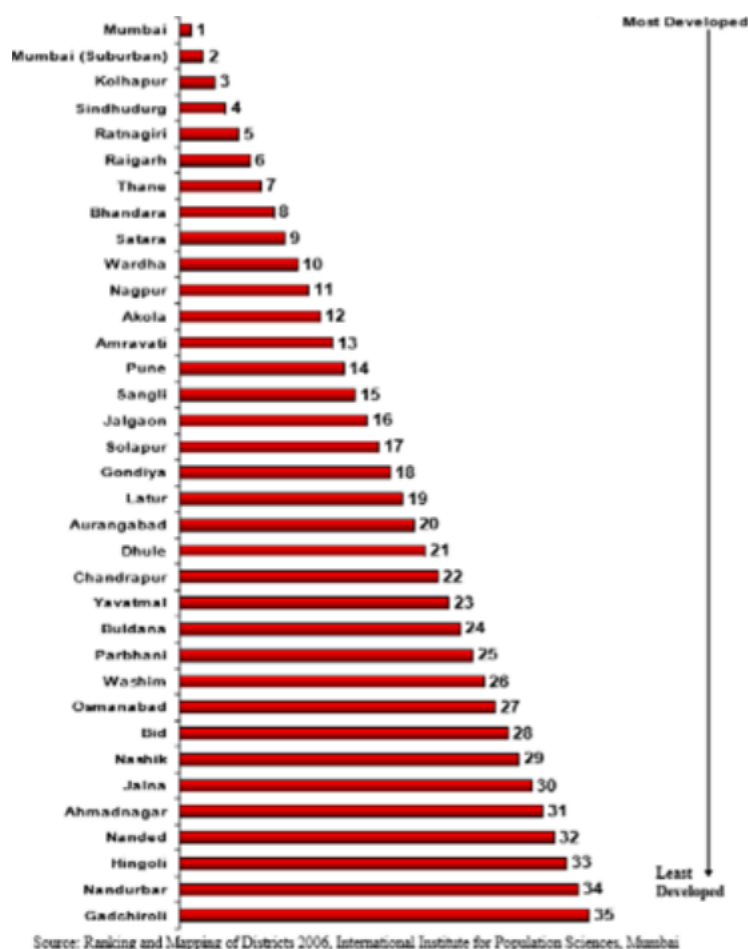

Source: Ranking and Mapping of Districts 2006, International Institute for Population Sciences, Mumbai

Figure 1 Ranking and mapping of socio-economic and demographic indicators of district statistics.

A Tender regarding City Development Plan (CDP) was out in May 2006 for preparation of plans under Urban Infrastructure Development Scheme for Small and Medium Towns, 2006 (UIDSSMT). The basic motive was to transform these regions into self-dependent cities, planned and ready to accommodate the growth successfully for a duration up to 25 years. As per this scheme a tentative planning represented systematically through CDP, which provides gap analysis of present situation, considering significant aspects of the region and present a master plan that can be implemented for socio-economic development of city was expected to be prepared. This is inclusive of methodology to be adopted for overcoming the gaps and strategy for capacity building of the city [13].

Objective of this study is to plan, design and manage the potential of vacant, underdeveloped and unplanned spaces in proximity to developed or saturated metropolitan areas from topographical data and resolve the socio-economic problems.

2. STUDY AREA

Figure 2. shows, location of Ahmednagar District, which is geographically the largest district of Maharashtra State having area of 17418 km., which is 5.66% of area of whole state [14]. It extends from 18° 10' to 20° 00' north latitudes and 73° 30' to 75° 37' east longitudes. Out of the total area, 391.5 sq. km. is urban area and remaining 16,656.5 sq. k. m. is characterized as under developed or rural.
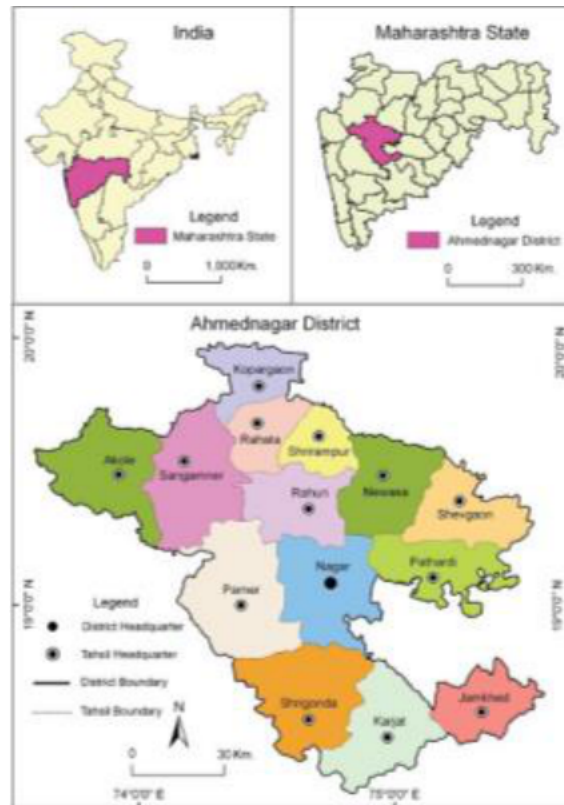

Figure 2 Location of Ahmednagar District.

2.1 DEMOGRAPHICS

As per Ahmednagar city census data, population was 45,43,159 in 2011; of which 195,467 are males and 184,378 are females [15]. There are basically four types of soils in Ahmednagar, which are – medium black, coarse shallow, deep black and reddish soil. Annual rainfall is 470 to 680 mm. Almost 13,594 km. of road length is available for transportation. Out of that, 43.24% roads are village roads, 0.45% are National highways, 12.55% are State highways, 19.34% are Major District roads and 24.42% are other District roads [16]. Figure shows, it lies in Seismic Zone III, which is of Moderate risk zone.

Figure 3 District lies in Seismic Zone III (Moderate Risk Zone).

The district is divided into 14 talukas, namely - Ahmednagar, Rahuri, Shrirampur, Nevasa, Shevgaon, Pathardi, Jamkhed, Karjat, Srigonda, Parner, Akole, Sangamner, Kopargaon and Rahata. 9 out of 14 Talukas – Sangamner, Kopargaon, Shrirampur, Pathardi, Nagar, Rahuri, Shrigonda, Jamkhed and Rahata are characterized urban in nature and rest 5 Talukas – Akole, Nevasa, Shevgaon, Parner, Karjat, are totally classified as rural [17].

Since Akole taluka out of those five, is geographically proximate and share common boundaries with Thane (Mumbai), Pune and Nashik, which are quite developed and huge mass of population is attracted here, it is selected as study area. With a view that population holding capacity of these regions is reaching its limit and the opportunities and services can be created in vacant space around them and serve as satellite towns, master plans are prepared for Akole taluka from satellite images and topographical data, to serve as an Urban Sustainable Development Model (USDM), readily acceptable to accommodate a large number of permanent populations. Figure 4. Shows location of Akole taluka in Ahmednagar, Maharashtra [18].
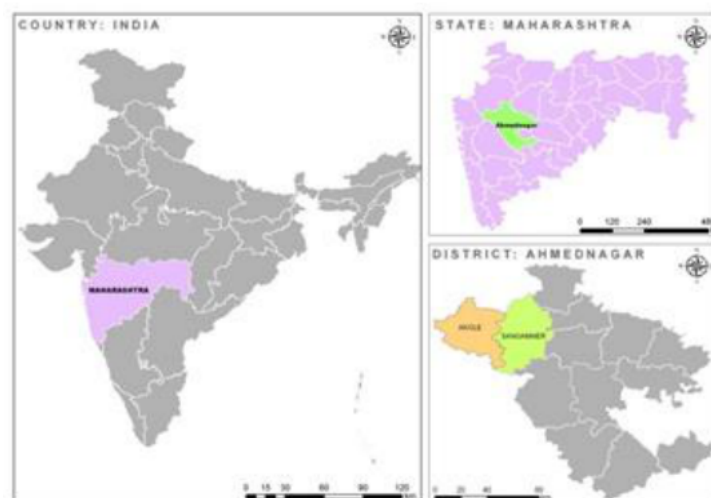

Figure 4 Location of Akole taluka.

3. METHODOLOGY

The study focuses on the identifying and building vacant spaces for which, satellite image of Akole taluka has been taken from an elevation of 10 km., from ArcGlobe 10.1 – ArcGIS, as seen in Figure 5
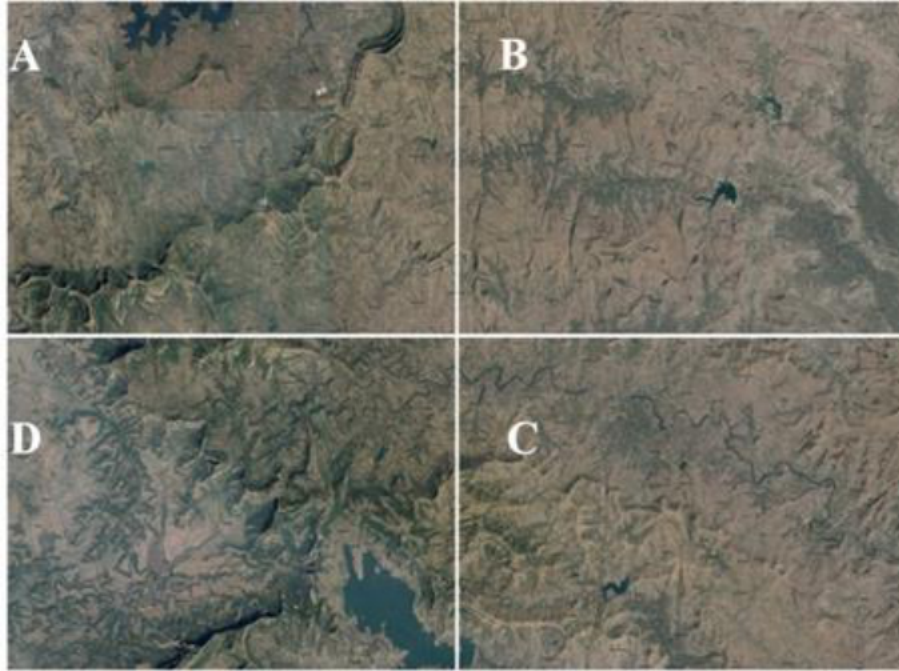

Figure 5 Satellite image of Akole Taluka.

Satellite images of area of interest (AOI) were procured, showing required details and accurate topography for preparation of Town Planning Scheme (TPS) and land-use allocation. All the important physical features on the ground like - existing structures, agricultural areas, plot boundaries, various plants and stations, water bodies, etc., were recorded and entire satellite image was divided into four parts namely – A, B, C and D, for ease in identifying area wise zonal distribution of land. Separate images to a higher resolution were extracted for each of them from ArcGlobe 10.1 – ArcGIS.

Table 1 shows the observations and B zone had largest vacant geographical area available for development purpose.

Table 1 Area wise zonal distribution of land.

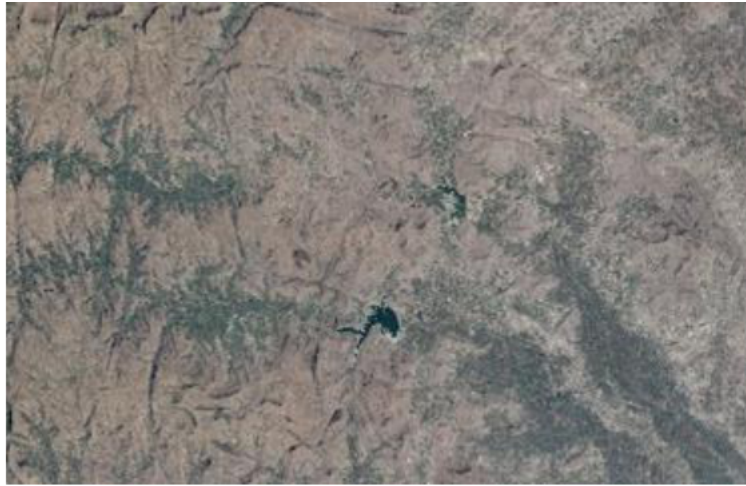| Zone	A Zone 280 Sq. Km.		B Zone 495 Sq. Km.		C Zone 505 Sq. Km.		D Zone 290 Sq. Km.	
	Area (Sq. Km.)	Area (%)	Area (Sq. Km.)	Area (%)	Area (Sq. Km.)	Area (%)	Area (Sq. Km.)	Area (%)
Agriculture	50.4	18	148.5	30	176.75	35	55.1	19
Forest	89.6	32	1	0.2	12.63	2.5	75.4	26
Water Bodies	22.4	8	33.66	6.8	25.25	5	40.33	13.9
Roads	4.2	1.5	9.9	2	13.13	2.6	5.8	2
Existing Growth	25.2	9	49.5	10	60.6	12	26.1	9
Available	88.2	31.5	252.45	51	216.65	42.9	87.29	30.1

Figure 6 Satellite image of B zone.

Figure 7 Demarcation of plots.

3.1. DEMARCATION

From the satellite image of B zone, as shown in Figure 6, details of existing area were extracted. The first major step was to layout road network connecting major roads and areas. Mostly grid and radial pattern were adopted to make appropriate connectivity with arterial road network. A total of 8% of roads and transportational facilities were added in addition to existing roads as shown in Figure 7.

3.2. Mixed use zoning

The principle adopted for planning is – Mixed use development which gives a combination of all above discussed zones and in better connectivity. This indicates integrated land-use zoning, that provides benefits for commuting, sense of security, community acquaintance, integration in all classes of people and better quality of life.

3.3. Maharashtra Regional and Town Planning Act, 1966 Guidelines

From clause no. 22, "Contents of Development plan the act were considered to prepare Development Plan", following zones were derived and used for preparing master plan:

3.3.1. Residential zone

It consists of apartments, row houses and townships for low, medium and high-income group of people. Ideally it should be planned within 20-65% of total area. Factors considered for locating residential zones are – cost of land, distance from work place, access to open spaces, ease of drainage and access to institutional and public spaces.

3.3.2. Commercial zone

It consists of banks, go downs, shops, offices and other commerce related structures. Ideally it should be planned within 2-10% of total area. Factors considered for locating commercial zones are – proximity to traffic, at the heart of cities and at the sides of main roads.

3.3.3. Industrial zone

It consists of light, medium and heavy weight industries. Ideally it should be planned within 1-25% of total area. Factors considered for locating industrial zones are – cheap land, facilities for waste disposal, proximity to markets, supply of raw materials and labours and public utilities.

3.3.4. Public & Semi-public facilities

It consists of business centres, shopping centres, institutional buildings, civic centres, etc. Ideally it should be planned within 2-20% of total area. Factors considered it, are – parking space, proximity to residential areas and transportation facilities.

3.3.5. Green spaces

It consists of sanctuaries, agricultural land, forest, botanical garden, theme parks. Ideally it should be planned up to 20% of total area. Factors considered it, are – proximity to residential, commercial and industrial zones, transitions zones and at boundaries of city.

3.3.6. Traffic and transportation facilities

It consists of – roads, highways, railways, bridges, signal, sign boards, milestones. Ideally it should be planned up to 15% of total area. Factors considered it, are – connectivity to important places, minimize travel time, use of public transport and traffic management devices.

3.3.7. Water bodies / Irrigation projects

It consists of – Irrigation projects, natural water bodies, artificial reservoirs. Ideally it should be planned up to 15% of total area. Factors considered it, are – proximity to catchment area, availability of groundwater and area to be served at downstream.

3.3.8. Recreational zone

It consists of – parks, playgrounds, cinemas, theatres, town hall, clubs, libraries, restaurants, etc. Ideally it should be planned within 10-40% of total area. Factors considered it, are – proximity to catchment area, availability of groundwater and area to be served at downstream.

3.3.9. Public utilities

It consists of – Water distribution network, drainage lines, telephone lines and towers, electricity towers and treatment plants. Ideally it should be planned within 2-25% of total area. Factors considered it, are – connection to important areas, connection to plants, topography of the region.

Plots providing the amenities discussed in above zones, were marked on the base map to along with the roads, considering following legends for zoning as shown in Table 2.

Table 2 Legends for land use zoning.

Sr. No.	Zone	Symbol
1.	Residential zone	
	Low income group (LIG)	
	Medium income group (MIG)	
	High income group (HIG)	
2.	Commercial zone	
3.	Industrial zone	
	Manufacturing industries	
	Miscellaneous industries	
	Special industries	
4.	Public & semi-public facilities	
5.	Green spaces	
	Open spaces	
	River front development area	
6.	Traffic and transportation facilities	
7.	Water bodies / Irrigation Projects	
	Natural	
	Artificial	
8.	Recreational zone	
9.	Public utilities	
10.	Inaccessible area	

Figure 8 shows the master plan prepared by using Mixed use zoning principle for B zone, at Akole taluka.
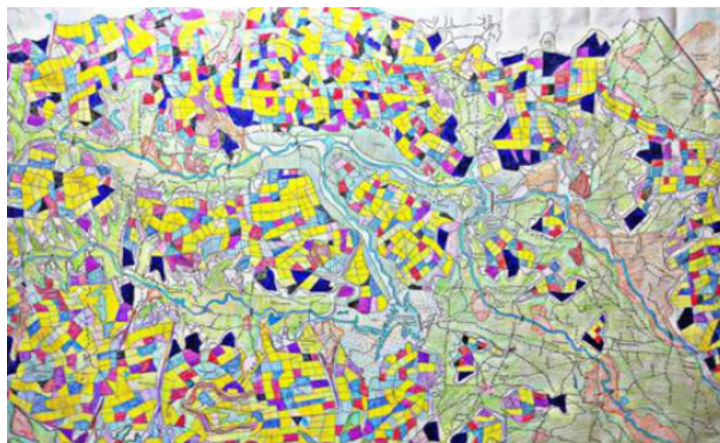

Figure 8 Master plan for B zone, Akole Taluka.

3.4. Floor Spacing Index / Floor Area Ratio

Floor Spacing Index (FSI) / Floor Area Ratio (FAR) considered for planning for the area inside and outside notified civil area, within cantonment limits was restricted to 1.0 and 0.5 as per building bye laws.

Following guidelines of Urban Development Plans Formulation and Implementation (UDPFI) were followed while designing of masterplan for residential as well as non-residential premises:

- Preparation of landscape plan.
- The permissible and floor area needed for different categories of plot are not less than specified limits.
- Minimum setback is provided for various plots as per UDPFI guidelines.

3.5. Development Norms and Standards for Hill Towns

Since few portions of Akole Taluka lie in hilly regions, significant aspects such as exposure to sunlight, degree of slopes, accessibility, conservation of nature, energy needs, communication network, mobile and emergency facilities, were considered while planning.

3.6. Land acquisition method

Land acquisition method can be adopted for ease implementation of the project. According to this method, planning authorities procure patches of land from farmers or land owners as per the Land Acquisition Act of 1894. Fair amount is paid to them against the land, sometimes even higher than actual land prices to eliminate the possibility of opposition from them. Later, the plans are developed, executed and built properties sold at higher rates than rate at which they are purchased [19].

4. RESULTS AND DISCUSSION

Akole taluka has been planned on a grid iron pattern for majority area and in loose grid for the rest. Major volume of roads is planned to be perpendicular to each other to divide the plots into decent sectors. Wherever possible, residential areas are planned and located proximate to work places. Commercial centers, public and semi-public facilities are accessibly and properly allocated throughout the region and industrial zones are planned away from residential areas and institutions. Land use distribution is represented in Table 3, considering optimum utilization of available land.

Table 3 Land use distribution

Sr. No.	Land Use	Developed area (%)	Developed area (Sq. Km.)
1	Residential	35	88.36
2	Commercial	6	15.15
3	Industrial	10	25.25
4	Public and Semi-public	11	27.77
5	Green & Open Spaces	5	12.62
6	Traffic & Transportation	8	20.20
7	Water Bodies	3	7.57
8	Recreational Zone	12	30.30
9	Public Utilities	10	25.25
	Total	100	252.45

The master plan for Akole taluka is prepared to serve as Urban Sustainable Development model (USDM) by achieving the following:

Socio-economic development by Integrated land-use zoning of Akole taluka for its transformation into a self-dependent city.

- Utilize its high growth potential due to proximity to the metropolitan city of Mumbai, Pune and developing cities like – Nashik and Aurangabad.
- Generating employment opportunities, providing education and arresting migration.

5. CONCLUSIONS

In India, including metro cities, we see people travelling every day to far off places for work and education. Travelling every day is tedious and energy consuming. There is waste of time, fuel and money. Deforestation is increasing and metro cities are becoming concrete jungles. There are many more problems that a common man has to suffer and will suffer in near future. All this is just due to lack of planning the city before construction.

Land use zoning and vacant space optimization allows the areas to be utilized for providing infrastructure services, accommodate new growth and give better quality of life (QoL). Master planning describes the vision for city's future, goals and objectives, land use, urban design, housing, infrastructure, parks, open space, transportation and commerce. The master plan for Akole taluka ensures that the natural open spaces are protected. Mixed-use type of zoning combines advantages of existing zoning methodologies and provides a common roof for a variety of zones to ensure self-sustainability. Since it comprises of various types of residential units (LIG, MIG and HIG) along with of essential public facilities and infrastructure, it brings socio-economic development along supported by harmony and social cohesion, rather than urban-rural sprawls.

Master plan proposed, can hence serve as Urban Sustainable Development Model (USDM) with an amalgamation of mixed housing principles, transportation and infrastructure facilities, public and semi-public facilities, sufficient green and open spaces which are planned and allocated for optimum utilization of available spaces. Pattern adopted for transportation network, ensures controlled traffic distribution and proper segregation. City Development Plans (CDP) of this kind can help in growth of rural areas, bring remote areas in connectivity with metropolitan areas of neighbouring regions and reduce stress on them.

As analysed, Optimization of vacant spaces, Integrated land-use planning, and Mixed-use zoning contribute to a large scale in socio-economic development and providing good quality of life (QoL) to the individuals of a region.

REFERENCES

[1] India Guide: Population of India, 2019. http://www.indiaonlinepages.com/population/india-current-population.html

[2] Khan, S. and Zaman, A. U. (2017) 'Future cities: Conceptualizing the future based on a critical examination of existing notions of cities', Cities. Elsevier, (March), pp. 0–1. doi: 10.1016/j.cities.2017.08.022.

[3] Loizou, E., Chatzitheodoridis, F. and Polymeros, K. (2014) 'Land Use Policy Sustainable development of rural coastal areas: Impacts of a new fisheries policy', Land Use Policy. Elsevier Ltd, 38, pp. 41–47. doi: 10.1016/j.landusepol.2013.10.017.

[4] Bhat, P. A., Mir, A. A. and Ahmed, P. (2017) 'Urban sprawl and its impact on landuse / land cover dynamics of Dehradun City, India', International Journal of Sustainable Built Environment. The Gulf Organisation for Research and Development, 6(2), pp. 513–521. doi: 10.1016/j.ijsbe.2017.10.003.

[5] Gandhi, S. S. (2007) 'Large-Scale Urban Development in India - Past and Present', (November).

[6] Rasheed, S. and Parambath, S. G. (2015) 'Urban Land Management and Planning', 5(7), pp. 58–62.

[7]   Alawadi, K. (2017). Rethinking Dubai's urbanism: Generating sustainable form-based urban
        design   strategies   for   an   integrated   neighborhood.   Cities,   60,   353–366.   doi:
        10.1016/j.cities.2016.10.012

[8]   Kumar, V. and Pandit, R. (2013) 'Indian urban develpment planning approach: Quench for new
        paradigm', International journal of engineering science and innovation technology, 2(2), pp.
        497–501.

[9]   Zutphen, A. Van et al. (2015) 'Changing urban dynamics: Empty building spaces', International
        Journal of Sustainable Built Environment. The Gulf Organisation for Research and
        Development, 4(2), pp. 265–269. doi: 10.1016/j.ijsbe.2015.10.001.

[10]   Kim, G., Miller, P. A. and Nowak, D. J. (2017) 'Urban vacant land typology: A tool for
        managing urban vacant land', Sustainable Cities and Society. Elsevier B.V. doi:
        10.1016/j.scs.2017.09.014.

[11]   Peng, J. et al. (2014) 'Integrated Urban Land-Use Zoning and Associated Spatial Development:
        Case Study in Shenzhen, China', pp. 1–11. doi: 10.1061/(ASCE)UP.1943-5444.0000245.

[12]   Stewart, T. J., Janssen, R. and Van Herwijnen, M. (2004) 'A genetic algorithm approach to
        multiobjective land use planning', Computers and Operations Research, 31(14), pp. 2293–2313.
        doi: 10.1016/S0305-0548(03)00188-6.

[13]   Tender for Urban Infrastructure Development Scheme for Small and Medium Towns,
        (UIDSSMT), Ahmednagar Municipal Corporation.

[14]   Study, T. H. E. et al. (2012) 'International Journal of Natural and Applied Science Original
        Article', 1(1), pp. 1–5.

[15]   Ahmadnagar   City   Census   2011   data   https://www.census2011.co.in/census/city/377-
        ahmadnagar.html#futurepop

[16]   Tahsil, A. (1818) 'Chapter Vi- a Profile of Ahmednagar District', pp. 221–237.

[17]   Pandurang, T. et al. (2013) 'Distribution and Concentration of Urban Population in Ahmednagar
        District of Maharashtra State', pp. 123–125.

[18]   Location   of   Akole   taluka.   https://scitechpark.org.in/domains/global-alliances/eu-dst-net-
        skills/project-area-2

[19]   Ballaney, S. (2008) 'Town Planning Mechanism in Gujarat, India', p. 41.

[20]   A. A. Adegun, N.O. Akande, R. O. Ogundokun and E.O. Asani, Image Segmentation And
        Classification Of Large Scale Satellite Imagery For Land Use: A Review Of The State Of The
        Arts, International Journal of Civil Engineering and Technology, 9(11), 2018, pp. 1534–1541

[21]   Nagaveni Chokkavarapu and Venkata Ravibabu Mandla, Impact Assessment of Watershed
        Management on Land Use/Land Cover Change using RS and GIS: A Case Study, International
        Journal of Civil Engineering and Technology, 8(4), 2017, pp. 394–400

[22]   Dr. Hemalatha K.L, Dr. E. Kavitha and Suresh B S, Improvisation of Land Use and Land Cover
        Classification Using Mahalanobis Classifier and Hybrid Feature Extraction. International
        Journal of Civil Engineering and Technology, 9(8), 2018, pp. 1613-1624.

[23]   I Wayan Sutapa, M. Galib Ishak, Vera Wim Andiese and Aan Fauzan, Influence of Basin
        Volume and Land Use of Lake Lindu On The Rawa River Discharge, International Journal of
        Civil Engineering and Technology, 9(7), 2018, pp. 278–288