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Case Study

LAND USE AND LAND COVER PLANNING OF GONDIA MUNICIPAL CITY, MAHARASHTRA STATE, INDIA USING REMOTE SENSING AND GIS TECHNIQUES

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The present paper ardently deals with the framework of Gondia city of Maharashtra State, India land use and land cover classification system was presented for use with remote sensor data. The classification system has been developed to meet the needs of Gondia Municipal Council for an up-to-date overview of land use and land cover throughout the Municipal area on a basis that is uniform in categorization. The proposed system uses the features of existing widely used classification systems that are amenable to data derived from remote sensing sources. It is intentionally kept open-ended so that municipal agencies can have flexibility in developing more detailed land use classifications in order to meet their particular needs and at the same time remain compatible with each other, the State and National system. Keeping the objective of selecting functionally safe waste disposal site for GMC, the present study has been undertaken to extract information from Toposheet No.64 C/3, high resolution PAN imagery IRS 1C LISS III and Google Earth regarding identification of classification of land cover/use planning. Spatial analyst of Gram++ was used for generating and managing complex environmental database system.

Keywords: Gondia Municipal Council (GMC), Ground Control Points (GCP), Indian Remote Sensing Satellite (IRSS), Composite Urban Land Development Units (CULDU's)

INTRODUCTION

The land use/cover study is of fundamental significance, as the land resources play a strategic role in the determination of man's economic, social, cultural and environmental progress. In fact the land use/cover of a region is always characterized by the spatial variations and is profoundly influenced by physio-socio-economic factors. The last four decades have witnessed the scientific and technological developments which have brought about tremendous change in Land/cover use. The study of changes in land use/ land cover is important in the field of engineering. The exponential growth

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of population has been responsible for large-scale environmental degradation. The world population has already crossed 7 billion and is projected to reach 10 billion by 2025. The serious repercussions that the growing impacts of human activities can have on the world's ecosystems can well be visualized. Cities are nodes of man's greatest impact on nature where he has altered the essential resources of land, air, organisms and water. A city is a perfect example of man's capacity to inaugurate the control changes in his habitat. In the newly created ecosystems the interactions of man, his works and nature is complex. The complexity grows as cities burgeon in the modern world. More than 6 billion people in developing countries were living, by the end of the century and the influx into urban areas in the developing nations is expected to continue at an accelerated pace.

The framework of a national land use and land cover classification system is presented for use with remote sensor data. The classification system has been developed to meet the needs of National, State and Local agencies for an up-to-date overview of land use and land cover throughout the country. Proposed system is uniform in categorization at the more generalized first and second levels and that will be receptive to data from satellite and aircraft remote sensors. The proposed system uses the features of existing widely used classification systems that are amenable to data derived from remote sensing sources. It is intentionally kept open-ended so that National, State, and local agencies can have flexibility in developing more detailed land use classifications at the third and fourth levels in order to meet their particular needs and at the same time remain compatible with each other and the national system.

A modern nation, as a modern business, must have adequate information on many complex interrelated aspects of its developmental activities in order to make decisions. Land use is one of such aspects, but knowledge about land use/ cover has become increasingly important as the Nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of wildlife habitat coupled with socio- economical and cultural aspects. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels. Urbanization has brought forth several maladies and suffering to human kind, besides bringing economic and cultural development in its fold. Due to pressure of urbanization most of the cities are growing fast and sometimes they develop beyond the planned limits. Generally the unplanned area of the city contains a quarter of the total population, where the spatial information is missing because of non-availability of up to date maps. One of the prime prerequisites for better use of land is information on existing land use patterns and changes in land use through time. Knowledge of the present distribution and area of such agricultural and urban lands, as well as information on their changing proportions, is needed by planners of Nation, State, legislators and local governmental officials to determine better land use policy specific to project transportation and utility demand, to identify future development pressure points and areas, and to implement effective plans for overall development. As Clawson and Stewart (1965) have stated "In this dynamic situation, accurate,

meaningful, current data on land use are essential". Land use and land cover data also are needed by National, State, and local agencies for water- resource inventory, flood control, water-supply planning, and waste-water treatment etc. Many National agencies need current comprehensive inventories of existing activities on public lands combined with the existing and changing uses of adjacent private lands to improve the management of public lands. National agencies also need land use data to assess the environmental impact resulting from the development of energy resources, to manage wildlife resources and minimize human-wildlife ecosystem conflicts, to make national summaries of land use patterns and changes for national policy formulation, and to prepare environmental impact statements and assess future impacts on environmental quality.

Land use is obviously constrained by environmental factors such as soil characteristics, climate, topography, and vegetation. But it also reflects the importance of land as a key and finite resource for most human activities including agriculture, industry, forestry, energy production, settlement, recreation, and water catchment and storage. Land is a fundamental factor of production, and through much of the course of human history, it has been coupled with economic growth. Often improper Land use is causing various forms of environmental degradation. Land use is a product of interactions between a society's cultural background, state, and its physical needs on the one hand, and the natural potential of land on the other (Balak Ram and Kolarkar, 1993). The land use/cover pattern of a region is an outcome of both natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce commodity due to immense agricultural and demographic pressure. Hence, information on land use/cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. Increasing human interventions and unfavorable bio-climatic environment has led to transformation of large tracts of land into wastelands. Remote sensing satellite plays an important role in generating information about the latest land use/cover pattern in an area and its temporal changes through times. The information being in digital form can be brought under Geographical Information System to provide a suitable platform for data analysis, update and retrieval. The present study was carried out to evaluate the present status of land use/cover in the district Gondia on 1:16,000 scales by using digital satellite data of IRS- 1C & Toposheet No.64c/3.

NECESSITY FOR STANDARDIZATION

For several years, agencies at the different governmental levels have been collecting data about land, but for the most division they have worked autonomously and without coordination. Too often this has meant duplication of attempt. There are many diverse sources of information on existing land use and land cover and on changes that are occurring. Local planning agencies make use of comprehensive information generated during ground surveys involving details and surveillance. Interpretation of large-scale aerial photographs also has been used widely (Avery, 1968). In some cases, extra information is inferred on the basis of value hookups, building permits, and similar information. Foremost

problems are present in the application and interpretation of the obtainable data. These include changes in definitions of categories and data gathering methods by source agencies, incomplete data coverage, changeable data age, and employment of mismatched classification systems. Current developments in data processing and remote sensing technology make the need for similar cooperation in land use inventories even more evident and more pressing. Development and approval of a system for classifying land use data obtained mostly by use of remote sensing techniques, but realistically compatible with existing classification systems, are the straight away needed first steps. In the mid-1940's, Francis J. Marschner began mapping major land use associations for the entire United States, using aerial photographs taken during the late 1930's and the early 1940's. Marschner produced a set of State land use maps at the scale of 1:1,000,000 from mosaics of the aerial photographs and then compiled a map of major land uses at 1: 5,000,000 (Marschner, 1950).

Remote sensing techniques, including the use of conventional aerial photography, can be used efficiently to harmonize surveys based on ground observation and inventory, so the potential of a timely and accurate inventory of the current use of the Nation's land resources now exists. At the same time, data processing techniques allow the storage of huge quantities of detailed data that can be organized in a diversity of ways to meet specific needs. The patterns of resource use and resource demand are constantly altering. Fortunately, the potential to obtain data about land uses related to resource development is improving because of modern technological improvements in remote sensing equipment, interpretation techniques, and data processing (National Academy of Sciences, 1970).

DESIGNING A CLASSIFICATION SYSTEM FOR USE WITH REMOTE SENSING TECHNIQUES

There is no single ideal classification of land use and land cover, and it is unlikely that one could ever develop. There are different perspectives in the classification process, and the process itself tends to be subjective, even when an objective numerical approach is used. There is, in fact, no logical reason to expect that one detailed inventory should be adequate for more than a short time, since land use and land cover patterns change in keeping with demands for natural resources. Each classification is made to suit the needs of the user, and few users will be satisfied with an inventory that does not meet most of their needs. In attempting to develop a classification system for use with remote sensing techniques that will provide a framework to satisfy the needs of the majority of users, certain guidelines of criteria for evaluation must first be established. To begin with, there is considerable diversity of opinion about what constitutes land use, although present use of land is one of the characteristics that are widely recognized as significant for planning and management purposes. One concept that has much merit is that land use refers to, "man's activities on land which are directly related to the land" (Clawson and Stewart, 1965). Land cover, on the other hand, describes, "The vegetation and artificial constructions covering the land surface" (Burley, 1961). The types of land use and land cover categorization developed in the classification system presented in this report can be related to systems for classifying land capability, vulnerability to certain management practices, and potential for any particular activity or land value, either intrinsic or speculative.

Concepts concerning land cover and land use activity are closely related and in many cases have been used interchangeably (Anderson, 1976). The purposes for which lands are being used commonly have associated types of cover, whether they are forest, agricultural, residential, or industrial. Remote sensing image-forming devices do not record activity directly. The remote sensor acquires a response which is based on many characteristics of the land surface, including natural or artificial cover. The interpreter uses patterns, tones, textures, shapes, and site associations to derive information about land use activities from what is basically information about land cover.

Some activities of man, however, cannot be directly related to the type of land cover. Extensive recreational activities covering large tracts of land are not particularly amenable to interpretation from remote sensor data. The size of the minimum area which can be depicted as being in any particular land use category depends partially on the scale and resolution of the original remote sensor data or other data source from which the land use is identified and interpreted. It also depends on the scale of data compilation as well as the final scale of the presentation of the land use information (Sreenivasulu and Bhaskar, 2010). When maps are intended as the format for presenting land use data, it is difficult to represent any unit area smaller than 0.10 inch (2.54mm) on a side. In addition, smaller areas cause legibility problems for the map reader. Users of computer-generated graphics are similarly constrained by the minimum size of the computer printout.

OBJECTIVES

The prime objective of the present work is to prepare a sustainable urban development plan for the Gondia Municipal Council and its environs by using GIS Technique. The preparation of a scientific and environmentally compatible development plan requires consideration of all components of the environment that exist today and the environment to be created tomorrow. Thus a comprehensive land use plan should inter relate all elements that form a community. Goals to formulate a sustainable urban land use plan is to focus on all physical, geographic, historic, socio-economic and cultural characteristics of the city and environ, harmonization of sector wise development portfolio on the basis of carrying capacity of the region. To carry out demographic analysis for identifying areas required for future urban development, the areas from the classified data were studied.

METHODOLOGY

The overall methodology adopted for this study is presented in Figures 1, 3 and 4. Population data pertaining to 1981, 1991 and 2001 census have been collected and population projections for the year 2025 have been made by adopting standard statistical techniques such as ratio method, exponential and conversion methods. Population projections under each scenario are made by analyzing the observed trends from year 2001. The projections obtained by geometrical method have been adopted for the study.

The total study area is covered in 64 $C/_3$ Survey of India topographic maps at 1:50,000 scale. A standard registration procedure has been adopted. This is done by dividing the entire area into 5' x 5' cardinal (network of latitude and longitudes) grids. On the basis of this spatial framework, a tile structure has been followed to capture the data with respect to different themes.

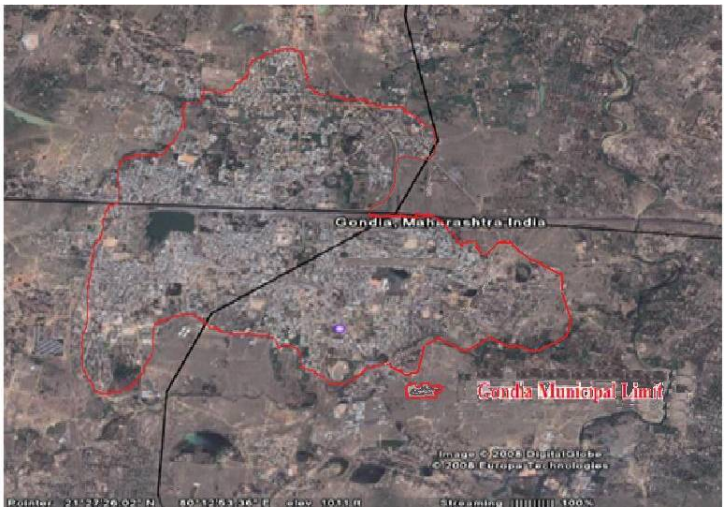
Finally a composite map has been prepared showing the Composite Urban Land Development Units.

IRC-1C LISS-III dated 11 march 2000 P100/ R057 image registration has been done by identifying common ground control points (GCP's) from the image. Visual interpretation techniques were used to study digitally enhanced products on the basis of the image characteristics such as tone, texture, shape, size, shadow, pattern as well as the associated elements viz. location and association. These elements of interpretation helped in identifying and delineating various types of features present in the urban environment and judge their significance in delineating thematic information related to urban land use/cover, hydro-geomorphology, surface water bodies.

CASE STUDY

Gondia urban complex has been chosen for the present study. Till the end of 19th century, Gondia was a small hamlet & Fulchur village was the main settlement. The Nagpur-Bengal broad gauge railway line was laid in 1905 & Jabalpur narrow gauge line in 1906, which was the 1st development of Gondia town. In 1911 Gondia-Chandrapur narrow gauge railway line was laid. By this time mainly due to improved communication facilities provided by Railways, the trade and commerce of Gondia town has been picked up. The hinter land of Gondia comprises of dense forest which are rich in Tendu, Palas, Teak, bamboo, yen etc. These sources also came to be trapped around 1910-20. As a result of this some Bidi industries were started in the town. Few Shellac industries and number of rice mills were also started in the town. By 1930 Gondia had become a full-fledged commercial center of the area. Quite a large numbers of refugee populations came to India after independence and settled at Birsi near Gondi at rehabilitation camp. During 1950-60 Gondia also gained much infrastructure wise, NMD degree level College was established in 1958-59, TB-Hospital started functioning in 1960; Over Bridge was constructed in 1954. After 1st revision of infrastructure development was not satisfactory. Manoharbhai Patel college of Engineering was started in the year 1983. Indira Gandhi stadium was constructed by GMC in 1992, apart from above Kudwa ring road was developed in 1991. On dated 1 May 1999 Government of Maharashtra has formed the Gondia as a new district. Gondia district is situated on North-Eastern side of Maharashtra State having state borders of Madhya Pradesh & Chhattisgarh. The total population of District is 1610511. This is underdeveloped district and most of land is covered with Forest. Wainganga River is the largest and most important river of flowing through the District. There are many rice mills in the district, as paddy is the main agriculture crop. Gondia city is popularly known as RICE CITY due large number of rice mills. Gondia district lies at Latitudes $20^0$39' to $21^0$38' North and Longitudes 79^0 45' to 80^0 42' east. Gondia urban complex is urban agglomeration of Tirora, Amgaon, Goregaon, Deori, Salekasa and some other small towns. It is situated on the central plateau of Sakoli formation with its cardinal points 21º 27' 26" N latitude and 80º 12' 53" E longitude an altitude of 318.82 Mts. above MSL. GMC covers an area of 18.60 Sq Km. as shown in Figure 1. According to census data of 2001 the population was 120902 but as on 2011 the population of GMC is approximately around 132888. In 2001 the number of household was

Figure 1: Showing the Land Cover/Use of GMC Courtesy



Source: www.GoogleEarth.Com

27702 and as on 2009 the number of household is 30472, (Pandey and Jain, 2010). It is the Railway junction on Nagpur-Kolkata broad gauge railway line of South-East Central Railway Gondia Municipal Council is 'A' Class Municipal Council. It was established in the year 1919.

REGIONAL SETTING

The adjoining districts to Gondia are on northern side Blight district of Madhya Pradesh and on eastern side Rajnandgaon district of Chattisgarh state. To the south and west are Chandrapur district and Bhandara district of Maharashtra as shown in the Figure 2.

Figure 2: Showing Location Map of GMC

Source: gondia.nic.in/

LANDSCAPE

The land with the town is plain. The east- west , Kolkata- Mumbai railway track passes along the ridge of the area. From Gondia railway station land is gently sloping towards north, north- east, and south, south- east respectively. The surrounding area of the town mainly consist of plain paddy lands crisis – crossed by number of sub-drains and punctuated by number of irrigation tanks except to the western side, that somewhat consists of hillocks and forest lands**.** There are few water bodies within the developed area. Due to densely populated surrounding areas, these water bodies have become somewhat firths. It is seen that the terrain is largely undulating plain and interspersed with more or less level ground in the western part. In some places the slopes are precipitous exposing the rocky outcrops. The hills forms a part of the southern-western branch known of the Gangazhari Hill, rising from an elevation of about 180 MSL, a great multiplicity of minor drainage's forms sinuous contours or a fluted pattern on the slope. It has Narrow plateaus rather than sharp ridges**.**

DEMOGRAPHY

As per Census year 1981 population of Gondia was 100423, in 1991 population of Gondia was 109470 souls. The census for year 2001 population of the town was 120902 souls. Outs of this 23364 were households.

GROWTH OF POPULATION

The population of Gondi was 4457 souls in 1901 where as it was 5847 in 1911, shows the increment about 32%. The increase in population in during 2nd decade was about 80%; it was because of further reasons

a) Just prior to 1911, Nagpur – Calcutta broad gauge railway line and Jabalpur, Chandrapur narrow gauge lines were laid. It was brought Gondia town prominently on the map of India.

b) From 1917 onwards number of Rice – mills, Bidi factories and Shellac factories were established, providing employment to the large segment of population from surrounding areas.

Incremental rate of population was just 3rd& 4th decade to 42.21% & 35.86%. In 5th decade it was increased by 80.54% due to, after independence number of Sindhi refugees were provided shelter at Birsi (about 14 km. away to the north of Gondia city), settled at Gondia as shown in the Figure 3 on 1:50000 covers an area about 1286 hectors. As per census year 1981 population of the town was 100423.

As per census year 1991 population of the town was 109470 and in 2001 it was 120902 souls. The land use/cover as shown in the Figure 4. It shows, in 9th and 10th decade the rate of increment of population has came to the naturals growth rate, vise 9% and 10.42%. It is because of

a) Enactments of progressive labor laws, number of industries were shifted to Andhra Pradesh, Madhaya Pradesh, Orissa and Bihar states.

b) Due to availability of basic infrastructure and facilities at the doorsteps of rural areas number of Rise mills are established in villages, thus minimizing chances of opening new Rise mills in the town.

c) Production of Shellac products has been fatly dwindling. Therefore, numbers of Shellac factories were closed with the results that, only

Figure 3: Showing Topographic sheet of GMC in 1981 (scale 1:50,000)

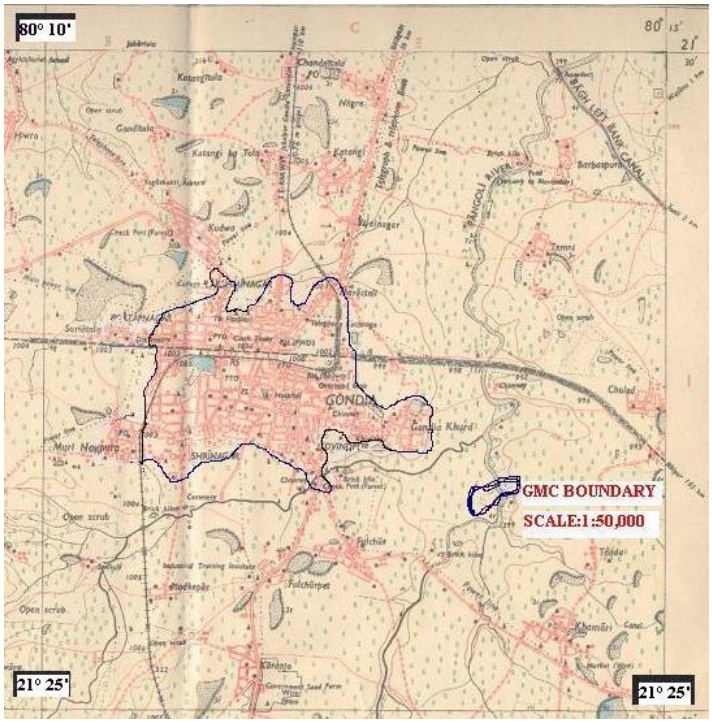
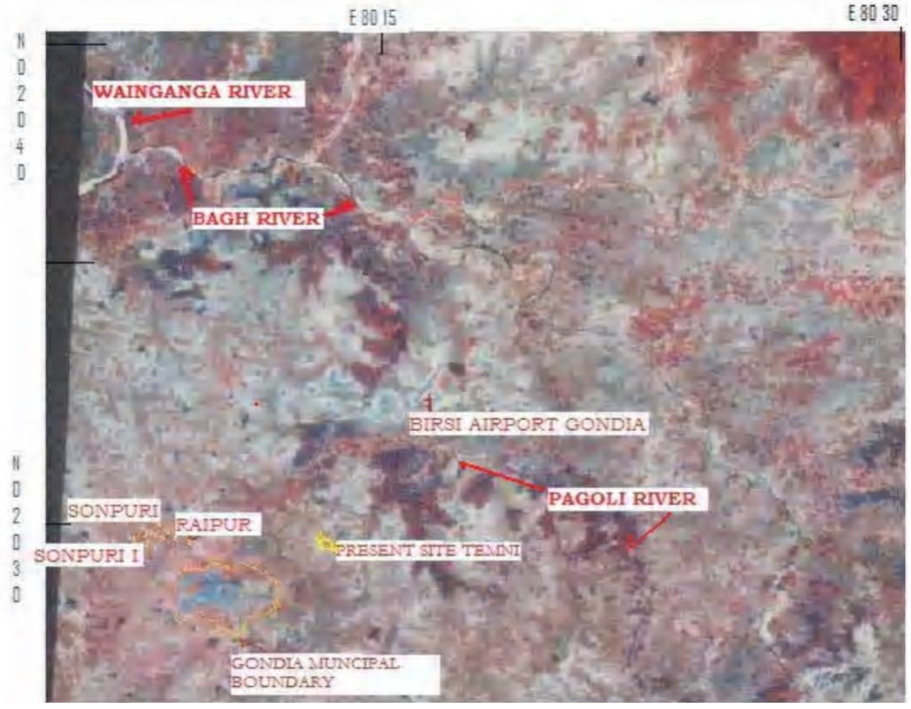


Figure 4: Map Showing GMC of year 2000 using Satellite LISS III IRS-1C



avenues available for employment were in consumer based industries.

DISTRIBUTION OF LAND

The development of the town is bisected by east – west, Kolkata-Mumbai railway line. The northern portions, bearing some Bidi industries were established in the past. Development of this area fulfills the socio – cultural needs of the town, especially in educational fields. Engineering college, Ayurvedic Medical College, Homoeopathy College and most of the High schools are situated in the north. In north part of the town, development is systematic. South part of the city, consists of congested residential with Commercial development. Almost commercial amenities are located in the southern part of the city. It shows organic development.

DISTRIBUTION OF LAND USES

1808 hectors land is included in the municipal limit. Till the first revision of development plan 546 hectors land was developed. After 1st revision of development plan total development area is only 717.45 hectors out of which the area under residential use is 308 hectors as shown in Figure 5. It is due to the decreased rate of population increment. The Residential development is nearly equal on either sides of the town. 155 hectors is under roads and 91.25 hectors land is under railway line.

Sector No. I

Out of 1808 hectors of GMC area this sector shares 253 hectors land. This sector comprises of above land from Mouza–Kudwa. Out of total area, 83.5 hectors of area is under different use. Due to newly laid 30 m. wide by- pass road, trend of commercial and residential development occurs along both sides of the roads.

This sector covers almost socio cultural needs of the society. 5 primary schools, 3 high schools, Homoeopathy college, T B Hospital, and N M D and D B Science College are situated in this sector. Engineering and Ayurvedic Medical College are also established about 1 km. away from Kudwa square. Because of above amenities trend of development is increased.

Sector No. II

This sector includes 194 hectors land, partly from Mouza-Kudwa, Gondi (Buzurg) and Katangi Kala. In this sector, 108 hectors is developed land, which is more than 50% of the sector area. Out of total developed area 61 hectors land is under residential use, it is about 56% of total developed area. About 20 hectors area is under roads, which includes newly developed 30m.wide by–pass road connected to Gondia–Balaghat highway. This sector also shows systematic residential development.

Sector No. III

This sector includes 193 hectors land from Mouza-Nagpura from which 73 hectors land is developed under different users. Out of total developed area 41 hectors land is under residential use. It shows the trend of development towards west side of Chandrapur railway line. It also includes Chandrapur broad gauge railway line having area about 12 hectors and 17 hectors area is under roads. This sector also includes well–developed Sindhi colony besides railway water tank. Educational facility includes 10 Primary schools, 2 High schools and 2 colleges.

Sector No. IV

It includes 73 hectors area, out of this 69 hectors land is developed under various users for commercial development. Peculiarity of this

sector is that, almost commercial development is concentrated in this sector. It shows residential accommodation of trading communities. Because of commercial potentiality numbers of high rise buildings are being developed in this area. It includes Indira Gandhi stadium belonging to GMC, vegetable market, M C office, etc. It includes K T S Govt. Hospital and 3 private hospitals provide health and medical facilities. It has 12 Primary schools, 8 High schools and 3 Junior Colleges.

Sector No. V

This sector comprises of 151 hectors land of town, from Mouza-Pindkepar and Gondi (Buzurg). Out of total sectored area, 70.5 hectors area is developed. From this developed area 27 hectors is under residential use, having density of population 295/hectors. As number of agro-industries are located in this sector considerable 7.5 hectors land is under industrial use. This sector is connected to village Pindkepar and Nagpura, which is adjacent to the GMC Boundary. This sector includes Agricultural Produced Marketing Council yard at which agricultural products are collected from surrounding area. 12 hectors area is under public/semipublic use.

Sector No. VI

This sector encircles 106 hectors land from Mouza-Gondia (Buzurg); out of which 50 hectors is developed area. Among this area 24 hectors land is under residential use, includes newly developed Ganesh Nagar, Bank colonies and other housing societies. This sector includes 3 high schools and 6 primary schools. This area is also rich in health and medical facilities.

Sector No. VII

This sector includes 128 hectors land from Mouza-Gondia (Buzurg), out of which 97.25 hectors land is developed under different users. Out of total developed area 28 hectors land is under railway, 15 hectors land is under roads and 33 hectors land is under residential use. This sector includes old Gondi (Gaothan) that played an important role in the development of the town. Civil line area is also included in this sector. Prominently, this sector includes Railways staff quarters, Tahsil Office as well as S.D.O. Office, Irrigation office & staff quarters, P&T Office, BGW Hospital and staff quarters, ZP office, GMC sanitary office; Court building etc. accommodates about 9 hectors land. This sector also includes entertainment places like Nirmal Talkies, Subhash Garden and Pratap Club etc. As this sector is segregated by Gondia-Amgaon state highway this sector area possesses wide range of communication activities. This area also shows number of Rice Mills & Shellac factories along Amgaon state highway. It includes 8 private hospitals & public hospital in its vicinity.

Sector No. VIII

Surrounded area by this sector boundary is 235 hector from Mouza-Gondia (Khurd, kh.). Out of total sectored area only 84.75 hectors land is developed under different users, which includes 43 hectors residential area. Considerable 19 hectors land is under roads and 11 hectors land is under railways. Old Gondi (kh.) Gaothan is included in this sector. Govt. Technical high school and office of Bagh Irrigation project is located in this sector that encircles about 8 hectors land. Numbers of slums are developed nearby old Gaothan area. It possess 3 primary and 3 high schools, provides preliminary educational needs of the society, but with inadequate medical facilities.

Sector No. IX

This sector consists of 46 hectors land from Mouza-Gondia (Khurd) surrounded by Gondi-Kolkata, Gondia-Balaghat railway lines and Gondia-Balaghat State Highway. Out of total sectored area 22.6 hectors land is developed under residential and office and staff quarters of telecom department and rest of the land is still vacant. This sectored area also shows scarcity of educational as well as Medical facilities.

Sector No. X

This sector includes 429 hectors land from Gondi (Khurd); Katangikala is included in this sector. Considerable 306 hectors land is in agricultural use. Only 55.25 hectors land is developed under several users. Out of developed area 13 hectors land is in residential use. As Gondia-Balaghat high way, 30 m. wide bypass road passes through this sector and Gondia-Balaghat railway line divides sector no. II, IX and X, about 30 hectors land is under road and railway line. It provides wide impact to communication. Some industrial development has occurred along the Gondia-Balaghat state highway. 62.25 hectors land is vacant.

SLUMS

Looking to this problem, town fetches serious problem on this front. About 58 slums are identified in the GMC, in which 8125 hutments are located & about 45137 human populations is accommodated. Maximum slum pockets are developed through municipal council by providing hygienically environment with good layouts. GMC has also undertaken phase wise program of constructing houses for the economically weaker society every year. It will provide the sufficient tenements and better hygienic environment in the town. The land use analysis of GMC as shown in the Table 1.

Figure 5: Shows Sectional Development Plan Map of Gondi Municipal City.

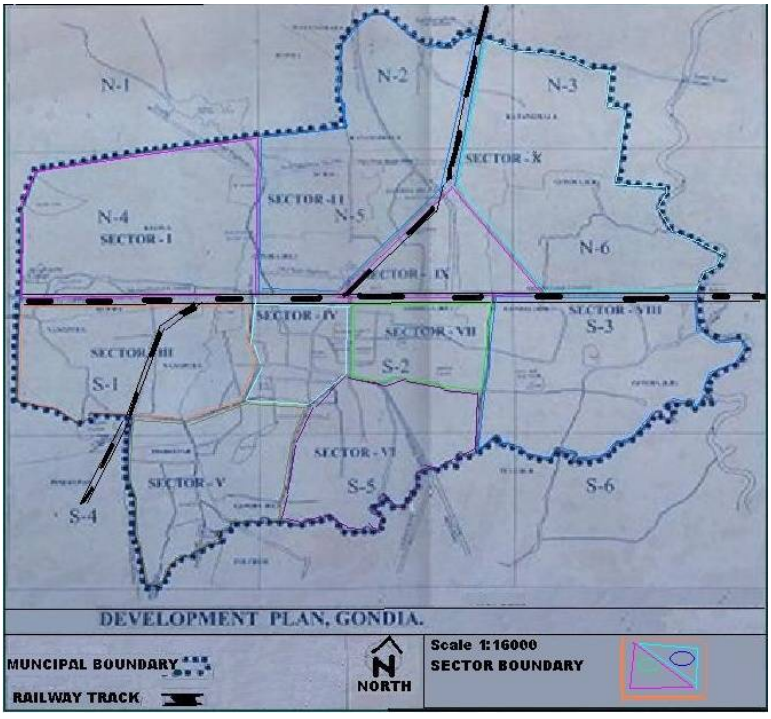


Table 1: Existing Land Use Analysis of GMC

S. No.	Land Use	Area in Hectors	% of Total Developed Area	% of Total Area (1808 Ha.)
1	Residential	308.00	42.93%	17.03%
2	Commercial	32.50	4.53%	1.80%
3	Industrial	34.00	4.74%	1.88%
4	Public/Semipublic	70.00	9.76%	3.87%
5	Public Utility	6.25	0.87%	0.35%
6	Transport & CommunicationI)			
	I) Roads	155.00	21.60%	8.57%
	II) Railways	91.25	12.72%	5.05%
7	Gardens, Play-Fair Grounds	20.45	2.85%	1.13%
	Total developed area	**717.45**	**100.00%**	
8	Agricultural	485.50	……..	26.85%
9	Water bodies	39.00	…….	2.16%
10	Vacant & Barren land	566.05	……	31.31%
	Total	**1808.00**		**100%**

COMMERCIAL FACILITIES

In the GMC area, there are about 1567 shops of various categories. These are 52 hotels, 324 are service shops, 592 are consumer shops, 389 clothes and fabrics shops, 93 medical shops, 2 Malls and 117 are miscellaneous.

TRANSPORT AND COMMUNICATION

Railways and Public Road Transportation are the major means of external communication. Gondia is itself is a main railway junction on Mumbai-Howrah broad gauge railway and also connected by Chandrapur and Jabalpur by broad gauge railway line it is link for Gondia with internal village of Chandrapur district and MP. Towards East Gondia is linked with Raipur, Bilaspur, Bhilai, Durgapur, Kolkata and other important towns of MP, Chhattisgarh, Bihar, Orrisa and West-Bengal. Mumbai, Nagpur, Bhandara, Tumsar, Tirora to the west and Amgoan, Salekasa to the east of Gondia are also connected by railway line. There are two state highways passing through Gondia. State highway No. 275 connects Gondia to N.H. No. 6 via Goregaon-SadakArjuni-Kohmara (hence it is connected to Raipur and Nagpur). Another state highway No. 249 connects Gondia to Bhandara via Tirora-Tumsar and it connects to Nagpur through NH No. 6. Another major road is Blight road that connects the town with MP.

MAIN ROAD OF THE TOWN

One major road passing east west from Public Works Department office connected to ring road at Kudwa Square via Pal Square. Another main road running east to west from Jaistambh Square

to Gandhi-statue, merges at secondary links. In addition, there are number of internal roads from the congested network. GMC consist only roads as mode of transportation, most of the roads are of about 6 meters width. In northern area of railway line there is only one link between railway station and Tirora bypass road through Railtoly area. In southern area of railway line, there is no hierarchy of road width. Except Murri road and roads in Sindhi colony, all other roads are of about 6 meters width.

GENERAL CONDITION OF ROADS

Total road length of 148.65 km. in all. Out of this length 19.36 km. roads are of cement concrete, 49.26 km. roads are constructed with asphalt. 37.23 km mettle roads and remaining 42.80 km. are WBM roads. Concrete roads laid in the commercial area have started deteriorating which need to be maintained.

POPULATION PROJECTION

In the Sectional Development Plan, population for the year 1991 and 2001 was estimated to 1,39,000 and 1,85,000 respectively. However, the actual population recorded by census is 1,09,470 in 1991 and 1,20,878 in 2001. The % rise in the population in last two decades is 9% and 10.42% in the year 1991 and 2001 respectively. This is very low as compared to % growth in the previous 8 decades. This downward trend of % growth is due to following reasons.

Many rice mills established in the past are shifted in the territorial area outside the MC limit. Most of the rice mills are closed due to shifting in the outer area.

In the last two decades educational institutes like Engineering Collage, Homeopathic collage, I.T.I. etc. Are come up in the year by rural areas, so as administrative buildings, Z.P., Police Head quarters and many such offices and business activities are come up in the rural areas outside the MC boundary in Mouza-Fulchur and nearby Mouza Karanja which is situated on Goregaon and Amgaon state highway.

Due to fast development in the outside area, many residential colonies are come up in that area .In that contest more and more population is tend to settle down there. This ultimately checked the population growth within the town itself .The another reason for fast development is due to fact that the land in the MC area are very costly as compared to the land in outside area and the properties in the GMC area are heavily taxed.

Due to social awareness and rise in education percent, small size family concept is developed which ultimately checked the population growth during last two decades in the town.

In the above reference the % rise ,that of 9% to 10%in the past two decades that is in the year 1991 and 2001 reflect the natural growth of the population .However since Gondi is declared as district headquarter from 1.5.1999. Due to change in status of the town many more government offices and establishment are come in the city and outside the city limit thereby resulting slight change in % growth of population. Considering the average rise for the last two decades and also considering the change in status of the town, overall average % rise in population per decade could be 20% flat which seems to be reasonable while accessing the population for the year 2011 and 2021. Considering the flat percent rise of 20% per decade population for the year is worked out as below.

1) For year 2011-120878*1.20=145054 souls say 145100 souls.
2) For year 2021-145054*1.20=174064 souls say 174100 souls.
3) For year 2031-174064*1.20=208877 souls say 208900 souls.

ESTIMATE BY VARIOUS FORMULAS

The population census data of last 5 decades (1951-2001) is taken into consideration to estimate the projected population. The population worked out by various methods for the year 2011 and 2021 is shown in the Table 2.

It is seen from the Table 2 that the population figure worked out by Geometrical progression method is highest as compare to other three methods. These are as shown in the Table 3.

Decadal % rise of the population in 1951 is as high as 80.54% which rapidly comes down to 28.76% in the decade 1981- However in the last two decades i.e.in the year 1991 & 2001 average % rise per decade is steady between 9% to 10%.

As discussed above in Para 1 and 2 population worked out by considering flat rate of 20% and geometric progression method (Adopting growth rate of 1991-2001) is nearly co-ordinate, with each other as shown in the Table 4.

From the above, it is fair and reasonable to estimate the projected population for the year 2011 at 1,80,000 souls for framing the proposals of Development plan (2nd revision).

SECTOR WISE DISTRIBUTION OF POPULATION

For planning at micro level, area under GMC

Table 2: Showing Projected Population

Method/Formulas used		Adopting growth rate of 1981-91		Adopting Growth rate of 1991-01	
	2001	2011	2021	2011	2021
Public health formula	119322	130061	141766	133473	147381
Arithmetical progression	127666	145862	164058	137018	153158
Geometrical progression	144982	192014	254303	147060	178913
Graphical	132000	144000	151000	130000	137000

Table 3: Showing Growth Rate Method Projected Population

Year		2011	2021
A	Adopting growth rate of 1981-1991	192014	254303
B	Adopting growth rate of 1991-2001	147060	178913

Table 4: Showing Flat Rate and Geometric Progression Method Projected Population

Year		2011	2021
A.	Flat rate of 20%	145100	174100
B	Geometrical projection	147060	178913

jurisdiction is divided into 10 sectors. Above mentioned projected population is required to be distributed sector wise, based on population in existence within those sectors as per the Census of 2001, projected population on this basis per sector for the year 2015 and 2025 is worked out as shown in the Table 5.

GROWTH TREND

Area to the north of Manohar colony was restricted in Sectional Development Plan (SDP) for development as shown in Figure 5. Due to the development of Gondia-Tirora ring road, both sides of this road is shaping towards commercial development as well as unplanned residential colonies. Along Blight state highway, industrial belt was proposed in SDP, as number of rice mills, Shellac factories etc were started along both sides of Road. But due to establishment of Maharashtra Industrial Development Corporation about 3 Km. away from the northern side of town, industrial development is restricted along both sides of the road. Commercial and residential ribbon development occurred on this road. Hence this area would develop commercially as well as residential in near future. East and west sides of Blight railway track were also restricted by agricultural zoning in SDP. Though, number of residential colonies are developed in this area, planning towards future development, construction of 45 m. wide ring road proposal is moved by state PWD Department. Its alignment is passing through Collector office, running north south and connected to old 30 m. wide Gondia-Tirora ring road. GMC has also submitted the proposal of Sports Complex inclusive of lands, situated in the north east corner of Gondi Blight railway line and Nagpur Kolkata railway line. Therefore, inner side of proposed ring road and surrounded area of Sport Complex would develop in future.

PROPOSED LAND USE

The Gondia municipal limit comprises of 1808 hectors area, which is divided into 10 sectors as discussed. Out of this 809.25 hectors area is proposed for residential use with overall average density of 235 souls/hectors. It is about 44.76% of total municipal areas shown in the Table 3. In addition to this, under non-confirming user (industrial to residential) 34.95 hectors of land is intended for residential use, which will add another 1.93% to the overall % of municipal area under residential use. This will lower down the overall density to 220 souls/hectors 41.61 hectors area is proposed in industrial zone, which is 2.30% and 0.76% respectively and 6.99% area is proposed for public/semi-public user, which is 126.30 hectors.

Considering the prospective requirement of transportation facilities in the town, 242.26 hectors land is proposed for road network, parking facilities and truck terminals etc. which is 13.40% of total GMC area. In addition to this 87.25 hectors of land is under railway, which is 4.83% of total

Table 5: Showing Distribution and Projected Population

Sector No.		1	2	3	4	5	6	7	8	9	10	Total
Year	2015	25277	18385	25120	8431	13847	9012	14741	18934	7348	15904	157000
	2025	30600	22250	30400	10200	16750	10900	17850	22900	8900	19250	190000

Table 6: Shows Land Use Area of GMC

S. No.	Land Use	Area in Hectors	% to Developed Area	% of Total Area
1	Residential	809.25	54.11	44.76
2	Commercial	41.61	2.78	2.30
3	Industrial	13.71	0.92	0.76
4	Non confirming use(industrial or residential)	34.95	2.34	1.93
5	Public or semipublic	126.30	8.44	6.99
6	Public utility	19.91	1.33%	1.10%
7	Transport and communication a) Roads	242.4	16.20	13.40
	b) Railways	687.25	5.83	4.83
8	a)Gardensb)Playgroundsc)Fairground	53.4966.83-	3.584.47-	2.963.69-
	Total Developable area	**1495.56**	**100.00%**	**82.72%**
9	Water bodies	37.00	-	2.05
10	Agricultural	275.44	-	15.23
	Total area	**1808.00**	-	**100%**

GMC area. 19.91 hectors area is proposed for different public utility purposes, 53.49 hectors area is proposed for gardens, 66.83 hectors area for playgrounds, which are 1.10%, 2.96%, and 3.69% respectively. All the water bodies are maintained as it is in this development plan, measured area 37.00 hector and remaining 275.44 hectors area is proposed in agricultural zone as shown in the Table 6.

CONCLUSION

The study of demographic pattern plays an important role in the preparation of sustainable urban development plan. Such study helps to assess the past and present growth trends and to estimate the future growth of the city. The knowledge of basic demographic trend, in the area to be planned, is very essential to perceive the problems and exact needs of the area. It gives the idea about living conditions of the people and their immediate needs of basic amenities which planner should attend while preparing such development plan. Therefore, the analysis of demographic factors in relation to various urban functions facilitates the requirement or the need for housing, industry, commerce, amenities and recreation.

The GMC area has extended well beyond the present municipal limits.

The generated trend of growth from 1901 to 2001 was observed mainly along the transportation network. After 1991, the average annual growth rate has increased to 20%. Rapid commercial/industrial development has caused encroachment on productive agricultural land.

Because of rapid urban development, the agricultural land in the surrounding villages of Gondia municipal area was irretrievably lost. The increase in GMC area through incorporation of surrounding rural areas in the GMC limits has been a process and can be seen as an administrative response to an essentially economic phenomenon. Additional area required for urban development for the year 2015 has been determined on the basis of population trends, distribution, density and net area available for development. The projected population of the year 2015 will be about 145054. There will be an increase of about 29010 populations by the year 2025. A population density of 220 souls/ hectors (carrying capacity of the region) has been considered for calculating the area required for urbanization.

RS and GIS techniques based approaches have improved the preparation of development plans based upon various natural resources information base. The information system created using RS and GIS based methodologies has facilitated to work out for sustainability of urban environment and generate an alternate planning scenario.

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