Effective use of GIS based Spatial Pattern Technology for Urban Greenery Space Planning: A Case Study for MIDC Area of Nanded City

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***Abstract* – The aim of this study is to find out the conceptual framework for urban greenery planning. The present investigation proposes a GIS based model which will summarizes a strategy for supplying the ecosystem services for urban area through the required planning process. The proposed model acts as a decision support system for local government by providing suggestion of best suitable tree on particular location with their description to help the environment and human health. The model will also allow easier adaptation for Local Government and for other similar communities wishing to implement standard policies for Green City / Green India programs.**

Key Words – GIS, Urban Green Space, Spatial Patterns, Correlations

I. INTRODUCTION

In Today's world, entire human race is facing tremendous problems caused by rapid urbanization scenario, global climate change, explosion in population and developmental activities. These activities disturb natural flora and puts pressures on environment & ecosystem. To maintain eco balance collaborative, long-term and strategic management of urban green space planning is necessary. This must support proactive management approaches. Further, its results must have increased operational efficiency, risk reduction, increased urban forest canopy and leaf area. This has enforced us to create greenery spaces with urbanization and developmental activities. Various planning processes have been introduced in past [1] with a synergistic planning approach acting as a key factor for reducing urban heat and its associated effects. We have also understood that while planning the urban environment,

it is very important understand the fundamental needs of urban area by having concise understanding for how to preserve the green infrastructure, how long it required the planning, how to implement such plans such questions should be focused while developing any plan for urban green space. The creation of greenery space is a complex decision making process. It needs to consider all variables related to planning, selection, plantation and cultivation of plants. It demands several inputs about soil, air, water, fertilizers, diseases, preventive measures etc. We felt that, this decision making for can be supported by applying Geographical Information System (GIS). The GIS is an emerging technology for developing a spatial analysis of data using geographical information and highly generated computerized maps as an interface based on the location[2]. It is a computerized system for collecting, analyzing, mapping, manipulating, querying the geographically related information which had made enormous progress over the last few year for better analysis. GIS software is the natural evolution of the modern database, which combine the functionality of a database management system (DBMS)[2]. The GIS also provide the platform to perform the spatial analysis and allow displaying the data visually. Various studies have been introduced in the GIS research area which has shown how a GIS based analysis can support integrated distribution of population, manpower, material resources and financial resources, city greening planning design, construction, transportation cost and the maintenance management and other comprehensive factors which explores the importance of urban green space[1,3]. On the backdrop of this discussion, the main goal of this research is to create a Geographical Information System model for decision making for Greenery Space within a limited study area. The suburbs of Nanded City, Maharashtra State, India were considered as research area. The outcome of this research will be totally based on the data criteria and their parameters. This system model will guide us for determining the area for the urban greenery space planning implementation. The result of this study will be represented as the tools for education of the general public on green infrastructure, its concepts, and implementation. The model will also allow easier adaptation for Municipal Corporation and for other similar communities wishing to implement standard policies

1. Proposed Model

The primary objective of this study is to design a GIS based model and apply it for urban areas for the preservation. The key principle of this study is the effective and efficient methodology. The conceptual model is as shown below,

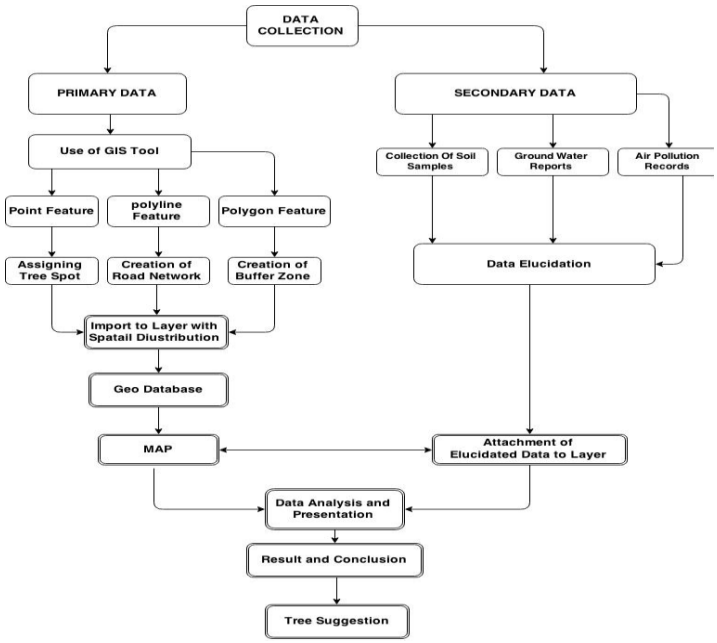

Fig. 1: Methodology for Spatial pattern of urban greenery space planning

The data collection for this study is straightforward. The main focus of this study is to establish the technical needs of green infrastructure for urban areas. This research study is based on primary data and secondary data sources. Before collecting the actual data we have performed various necessary actions on data collection protocols which result efficient process for data collection. The Primary data source can provide first- hand testimony or direct evidence related to a topic under investigation. Primary data are created by spectators or recorders who went through the events or conditions being documented. The strength of a GIS is to handle the sophisticated functions which consist of numerous tasks for utilizing both spatial and attribute information stored within them. Following features are used for the primary data sources. The Point feature in GIS environment represents the discrete location on the surface of the earth. A point feature represented by x-y coordinates pair which depends upon the latitude and longitude which is stored in individual records. The point features are used to represents the location for planting the tree along with road network. Tree spots are assigned by putting 10 x 10 meter and 5 x 5 meter distance according to space requirement of selected trees. The Poly lines are created when more than two lines are joined to form lines of line. In GIS poly lines represents the shape and location of any geographical object. We have used the poly line feature to create a road network of the study area. One of the most commonly used spatial feature is Polygon which server the intention of keeping the real world feature.

The representations of buffer zone in GIS application are always in vector polygon enclosing other polygon, line or point feature. We have used the Polygon feature to represent the commercial areas, industrial area, open space, etc. The Import to Layers is the mechanism which used to display geo datasets in GIS tool. Each layer addresses a dataset and specifies how dataset is depicted using symbols and text labels. Layers can be displayed in a particular order and can be seen in content table of the map. The above mentioned features process are merged in layer to create the geo-database. The component Geo- database is a collection of various types of geo-graphical data sets stored in common file system. While creating a datasets it is important to design and build a geo-database. Geo-database represents the spatial relationship between each data set. We can define geo-database as a spatial relational database management system which has storage of geographical data stored in central location for access, retrieve and management. The Map is the visual representation of information. These maps are main source of data for the GIS tool which has roots in the analysis of information to overcome the limitations of manual analysis. Our model also needs Secondary data to provide the base for the comparison of data to understand the research problem. . In this study the secondary data is collected by applying field work method which includes collection of soil samples, air pollution reports, ground water test reports. Various statistical analysis methods are used for interpretation of data which is a major component of data management. Data Elucidation is a fundamental success plan for the projects. The data interpretation technique is used to reach on important decisions. There is also an attachment of Elucidated data to GIS: Attaching the data to a GIS is a management technique which provides the accuracy in results.

2. EXPERIMENTATIONS, RESULTS AND DISCUSSIONS

Once the research work is completed, it is necessary for the researcher to analysis and interprets the result with the conclusion regarding suggestion of best suitable tree on particular location i.e. point with their description to help the environment and human health. Trees in urban are helps to reduce air temperature and heat effect. This not only leads to use low energy but also it also improve the air quality of the surroundings A verity of tree species are available in the world it is very important to understand the plantation of tree in urban environment is depend up on air pollution, nature of the soil, capacity of tree to tolerate the pollution.. There is need to keep some efforts for urban tree management which will be beneficial for those trees which regrettably die due to soil compaction, root disturbance, change in soil grade, and impervious surfaces which reduces or prohibits percolation and water consumption by tree roots. It is very important to understand which trees should be preserved on a given site and the best ways to minimize damaging these trees. By putting focus on theses point and discussion with expertise following trees are suggested for Nanded city with their availability and geographical nature.

1. Ashoka tree { Saraca asoca } : Evergreen tree which founded in Indian subcontinent. The reason behind planting Ashoka tree is its effectiveness in alleviating noise pollution, dust particles absorption.
2. Banyan Tree { Ficus benghalensis }:It is planted for the soil conservation. absorb carbon dioxide from the atmosphere, but also take in poisonous gases responsible for pollution.
3. Gulmohar tree { Delonix regia } : This tree is evergreen tree which is useful for air pollution control.
4. Neem { Azadirachta indica }: Neem tree is a natural chemist which have various chemical in its body. Neem tree is the only tree which generates the oxygen during the day time as well as night time also.
5. Pimple Tree {Ficus religiosa}: Well known fact about pimple tree is that it utilizes co2 for photosynthesis and generates the oxygen during daytime.
6. Subabul Tree {Leucaena leucocephala}: It is fastest growing tree which is popular in farm forestry at worm location.

We have chosen some basic chemical terms like pH, EC, Alkanity, Chloride, Magnesium, Calcium, Sodium, Potassium, Moisture Contents, Organic Matter, Phosphors. The selected soils samples are represented in tables 1 and 2. In the present research the collected soil data exposed that there were considerable variations in the quality with respect to their physicochemical characteristics. A composite surface soil sample from 0- 20 cm depth was collected from the experimental area before initiating the experiment and was analyzed for physical and chemical properties. The Table 3 represents the correlation analysis which describes the relationship of each parameter with each other. The correlation analysis defines the dependence of each parameter with each other. The positive and negative results have perspective values. The negative range with different values defines variations in results. Correlation analysis also defines the strength and directions of relationship. After examine and discussion with the expertise we concluded that the selected soil samples consist of rich calcium and magnesium. The soil is black cotton soil which has high range of water holding capacity

Sample No	pH	EC	Alkanity	Chlorides (Cho)	Magnesium (mg)	Calcium (cl)
1	8.51	440	10.37	0.04	0.42	0.65
2	8.73	470	8.40	0.05	0.59	0.93
3	8.48	480	11.50	0.05	0.25	0.36
4	8.92	390	9.50	0.07	0.79	1.25
5	8.13	280	8.50	0.09	0.63	0.98
6	8.18	320	11.00	0.09	0.52	0.74
7	8.43	440	12.00	0.09	0.58	0.90
8	8.08	280	5.50	0.08	0.75	1.15
9	7.89	300	6.00	0.09	0.41	0.65
10	8.14	220	7.00	0.09	0.65	0.94
11	8.07	260	5.00	0.07	0.70	1.07
12	7.82	300	5.00	0.11	0.20	0.24
AVG	8.28	348	8.31	0.07	0.54	0.82
MAX	8.92	480	12.00	0.11	0.79	1.25
MINI	7.82	220	5.00	0.04	0.20	0.24

Table 1: Physical and chemical properties of soil samples-1

Sample No	Sodium Na)	Potasium (K)	Moisture Contents	Organic Matter	phophers (P)
1	0.01	0.02	1.89	0.49	0.01
2	0.02	0.01	3.58	0.49	0.04
3	0.02	0.01	2.77	0.50	0.02
4	0.02	0.01	4.81	0.48	0.01
5	0.02	0.01	3.07	0.46	0.05
6	0.01	0.01	5.28	0.49	0.03
7	0.06	0.02	2.11	0.49	0.02
8	0.00	0.01	4.42	0.42	0.04
9	0.00	0.01	1.79	0.48	0.05
10	0.03	0.01	0.71	0.49	0.01
11	0.02	0.02	3.91	0.44	0.07
12	0.01	0.01	1.06	0.46	0.04
AVG	0.02	0.01	2.95	0.47	0.033
MAX	0.06	0.02	5.28	0.50	0.070
MINI	0.00	0.01	0.71	0.42	0.010

Table 2: Physical and chemical properties of soil samples-2

Sr.No.	pH	EC	Al	Cho	Mg	Cl	Na	K	MC	O.M	P
pH	1	0.74	0.63	-0.62	0.30	0.34	0.28	0.33	0.36	0.49	-0.56
EC		1	0.72	-0.64	-0.29	-0.23	0.27	0.18	0.09	0.60	-0.43
Al			1	-0.36	-0.11	-0.09	0.46	0.26	0.17	0.70	-0.63
Cho				1	0.03	-0.01	0.14	-0.25	-0.19	-0.33	0.21
Mg					1	1.00	0.19	0.47	0.53	-0.39	0.06
Cl						1	0.19	0.49	0.53	-0.37	0.07
NA							1	0.49	-0.27	0.36	-0.32
K								1	0.08	0.01	-0.11
MC									1	-0.30	0.19
O.M										1	-0.64
P											1

Table 3: Correlation analysis of soil samples

It is very important to analysis the ground water quality due to increased substantially and suitability for consumption, irrigation and industrial activities. As per the expert opinion the ground water quality is very unhealthy. The ground water of this area is not suitable for human health as it not meets the drinking water standard. The average calculation of NO3 and total hardness had crossed the maximum standard which represents the unhealthy quality of ground water. As per the expert opinion the ground water quality has failed to meets the bacteriological quality parameters. The tables 4 represents ground water sample of study area. The table 5 represents correlation analysis of ground water parameters. Figure 2 illustrates it graphically.

Sr. No	MIDC Area	Fl	Cl	Ph	No3	Ir	Tds	Tur	TH	AL
1	Graminp.s	0.73	76	7.23	30.9	0.04	498	0.78	204	212
2	Indra Nagar	1.01	240	7.37	162	0.06	1114	0.86	678	220
3	Cop.soc.	0.71	282	7.18	184	0.71	1310	0.49	726	260
4	Cable Hos	0.99	450	7.82	195	0.08	1563	0.97	640	220
5	Marotimandir	0.32	313	7.11	172	0.05	1218	0.95	612	282
6	zp school	0.77	382	7.15	279	0.17	1493	0.49	730	292
7	Jaiknagar	0.86	321	7.48	101	0.13	1210	2.33	618	296
8	Lahuji Salve nagar	0.12	299	7.23	105	0.06	1127	2.52	628	266
9	Sukhdevnagar	1.55	483	7.18	476	0.11	2421	0.45	788	338
10	Near power House	1.63	238	7.41	202	0.2	1358	0.28	688	394
11	Average Caculation	0.86	308	7.31	190.6	0.161	1331	1.012	631.2	278

Table 4: Ground water Quality with their chemical parameters

Sr .no	Fl	Cl	pH	No3	Ir	Tds	Tur	TH	Alkialirity
FL	1	0.21	0.30	0.56	0.04	0.53	-0.57	0.301	0.54
CL		1	0.22	0.75	0.009	0.88	-0.01	0.749	0.25
PH			1	-0.17	-0.19	0.030	0.16	0.001	-0.18
NO3				1	0.084	0.949	-0.48	0.700	0.50
IR					1	0.088	-.30	0.332	0.10
TDS						1	-0.28	0.775	0.50
TUR							1	-0.14	-0.21
TH								1	0.49

Table 5: Correlation analysis table of Ground water

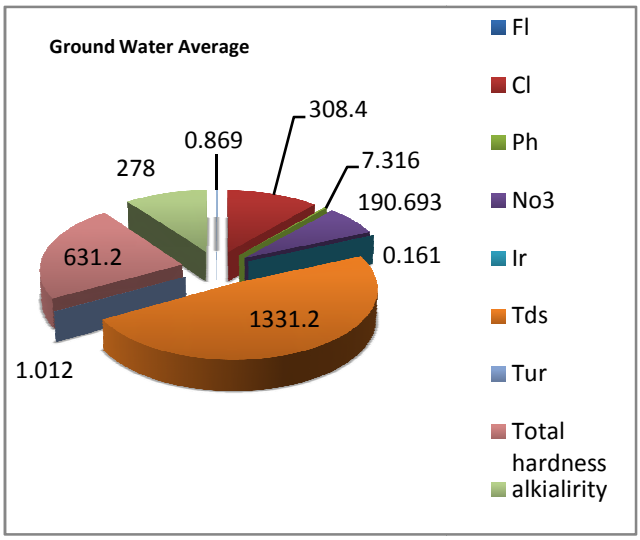

Fig. 2: Graphical representation of ground water elements

Based on above experimentation, tables and analysis, we have selected only those trees which satisfy the correlations. The tree properties and their pollution controlling aspects have taken into consideration. These values have added to Arc GIS 10.1 software (trial and legal version valid for two months). The results are shown in Figures 3 & 4 . The selected study area comes under the new Nanded city. The given map describes the study area of MIDC with road network. The area study area consists of 22 kilometers of road network which consist of major road along with internal road network. The major road network consists of state highway and other road network. Industrial sites were shown in the map. Various industrial organizations are situated in MIDC area which is shown by polygon. The residential area has not been focused for the study. We have selected various points with their latitude and longitude which commonly known as coordinate system. 4248 points are selected by putting the 5 x 5 meter and 10 x 10 meter of distance for tree plantation in MIDC region. Some tree spots are manually assigned to place where there is a free space is available in between two different locations. The locations for tree cultivations are selected as per the NWMC (Nanded Waghala Municipal Corporation) guideline. Tree spots are plotted at the both end of road network. The present map depicts the zoom in view of MIDC study area. The map also shows the assigned tree spots along polygon feature. The green line which is displayed in map along with road network indicates the spots where trees are already presents. The map also shows the GIS features which are used in the Map. It is highly recommended that trees should not be planted at the location where road is having large curve to avoid the accident because most of the accident are happened at the spots where road having large curve sites. The Ashoka tree is exalted evergreen tree which founded in Indian subcontinent. The reason behind planting Ashoka tree is its effectiveness in assuaging noise pollution, dust particles absorption. The Ashoka trees have pyramidal growth with height of 12 meters and above. It required near about 2 meters of space for its circumferences. Due to its pyramidal structure the leaves are long narrow with undulate margin. The Ashoka tree is a rainforest tree. The recommended space for planting Ashoka tree is 5 x 5, 7 x 7. Our study suggests planting Ashoka tree towards the residential area with both side of road network, because Ashoka tree have high capacity to control noise pollution as well as it will absorb dust particles in higher amount. The air pollution record of MIDC area various chemical gases are entered in environment with more laid-back noise and scatter dust particles. Ashoka tree will absorb such pollutant elements and helps to protect the human health with environment. The Banyan tree is an evergreen tree which grows in any region across the world with independent growth. The Banyan can grow to an average height of around 100 feet (approximately 30.5 meters). The trunk of banyan tree can covers around 200 meters of size which have large amount of spread out branches. The banyan tree can group very fatly. These roots of Banyan tree will become embedded in the ground and considered as minor trunks. The leaves are broad, oval and glossy. The Banyan tree is a long-lived tree with high resistance to wind dark-gray and rough bark . The Banyan tree canopy can cover near about 450 meters of area. Our model recommends planting the banyan tree at central part of study area where there is a less amount of residential site, industrial area is present. While planting Banyan tree we should focus on amount of open space is available .The points are suggested by putting focus on these standard. The Gulmohar tree is evergreen tree which is useful for air pollution control .The maximum height of Gulmohar is 12 meters, standard height is 5 meters. The height of this tree is depending up on the soil type. This tree can grow up on any type of soil. Tree trunk is tall and un branched. This tree consists of large no. of leaves with 10-12 pairs of pinnate. Each pinnate consist of 30-60 opposite leaflets. This tree can cover the width around 6 – 12 m. The recommended space for planting for Gulmohar is 5 x 5 or 10 x 10. The Gulmohar tree looks like an umbrella which provide high amount of shadow. The Gulmohar tree is useful for increasing rainfall level in the area. Small road network are recommended for planting Gulmohar tree which also provide attractiveness to area. The Neem tree is evergreen and fast growing tree with a straight trunk, long spreading branches and moderately thick, rough, longitudinally fissured bark which can reach up to 15-20 meter of height and 60 cm of diameter at top and 2 meters diameter at the base .This tree can grow up very fatly in black cotton soil. Neem tree can improve the water holding capacity of soil and soil fertility. Neem

tree is a natural chemist which has various chemical in its body. This tree can grow up widely with soil pH range up to 10 which make it more versatile and important tree in sub-continent. The recommended space for planting Neem tree is 5 x 5 or 10 x 10. Long road network are more suitable for Neem tree plantation. Pimple tree have some sort of same characteristics like Banyan tree have. Pimple tree is large dry season-deciduous evergreen tree which can grow up to 30(close to 98 ft.) meters in height and 3 meters (near about 10 ft.) of trunks diameter. The tree leaves are cordite in shape. The leaves are 10-18 cm long with 8-12 cm broad. The pimple is a large in size whose roots travel very long distances and whose branches spread expansively; it can give a wide area of shade. Well known fact about pimple tree is that it utilizes co2 for photosynthesis and generates the oxygen during daytime. Our model suggests to plant Pimple tree at the end of road network with small residential area with large amount free open space. Most commonly planted in urban forestry is Subabul tree which is fast growing evergreen species. The Subabul tree is best suitable in warm region where temperature is30ºC and above. It is fastest growing tree which is popular in farm forestry. At worm location the Subabul tree are more suitable as it has strong and deep root system. This tree can grow under a wide range of conditions as a range plant, roadside plant, in pastures, etc. The Subabul tree can adopt 1.27m x 1.27m (50" x 50") of area. The recommended space for planting Subabul tree is 3 x 3 meter, 5 x5 meter. The Subabul tree is highly suitable for green-manuring and composting which fixes the flow of nitrogen gas in environment. Our model has suggested a site for Subabul tree at residential area along with road network.

Fig 3: a) Study Area (MIDC) Original Map b) Zooming View in GIS c) Spot for Ashoka Trees d) Spot for Banyan Tree

Fig 4: a) Spot for Gulmohar Trees b) Spot for Neem Tree c) Spot for Piple Trees d) Spot for Subabul trees

IX. CONCLUSION AND FUTURE SCOPE

The presented research work has proposed a GIS based model as a strategy for urban planning process. The proposed model acts as a decision support system for local government by providing suggestion of best suitable tree on particular location with their description to help the environment and human health. An attempt has been made to represents the systematic spatial analysis of urban green space planning for selected work area – MIDC area of Nanded city. Our model has demonstrated suitability of six types of plants for various locations of MIDC area. Our model can be used as role model for greenery planning of any area of any city

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