Evaluating the Urban Green Space benefits and functions at macro, meso and micro level: case of Bhopal City

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Abstract--Green Space in urban area performs multidimensional functions and provides enormous benefits to the citizens. Importance is still more due to its limited availability in urban area as a result of urbanization. It not only performs the regulatory but also environmental and social functions and provides various types of benefits as per its location and size at various spatial levels. The hypothesis of this study is that the benefits and functions of Urban Green Space at various spatial levels perform differently. To examine this hypothesis and to evaluate extent of the green space benefits and functions at various spatial level, the Bhopal city is chosen as a case example. Bhopal offers a mix of traditional splendour at its very best and a feel of the old and modern city along with lush green environs coupled with natural beauty within the city limits as well as in its surrounding. This paper intent to looks at both qualitative and quantitative aspects of Urban Green Spaces in terms of its benefits to user.

Key words: - Benefits, City, Functions, Macro, Meso, Micro, per capita Green, Urban Green Space, Ward, Zone.

1. BACKGROUND

In the recent past decades, loss of urban green spaces, particularly in the developing countries has become a dominant trend. One of the major concerns is that despite of various acts and byelaws for protection , management and development of Urban Green Spaces, decline is continue to take place in almost all major cities of developing countries. Urban green spaces are one of the most significant elements of any urban ecosystem, both due to its ecosystem dynamics and its essential contribution in well-being of human race. However , it is ironic that despite of its immense significance, vegetation is undergoing destruction and degradation in the modern times due to rapid and haphazard urbanization in developing countries, making urban settlements major source of GHG emissions and at the same time making them more vulnerable to global environmental change impact (bhaskar, 2012).The increasing urbanization and human population growth during recent decades have resulted significant loss of habitats in the urban landscape (Gairola, 2010).In country like India, whose economy is based on agriculture also facing the loss of urban green spaces due to rapid urbanization.

2. Need, Relevance and Objective

The urban population in India at the beginning of 20th century was only 25.85 million constituting 10.84 percent of India's population in 1901,which increased to 285.35 million comprising 27.78 percent of total population in 2001 (B, 2006) with natural growth contributing about 60% and rest added by migration and expansion of cities (Sivaramakrishnan k, 2005). India's urban population grew from 286 million in 2001 to 377 million in 2011-an increment of 91 million, which is larger than the rural population increment of 90.5 million for the first time since independence (B B. R., 2011) and expected to hit figure of 550 million or 42% of the total population by 2030 (Roberts B, Kanaley TB, 2006).

Table 1: Table showing Pattern of Urbanization in India

Census Year	Urban Population in Million	% Urban	Annual exponential urban Growth rate
1961	78.94	17.97	-
1971	109.11	19.91	3.23
1981	159.46	23.34	3.79
1991	217.18	25.72	3.09
2001	286.12	27.86	2.75
2011	377.10	31.16	2.76

Source: (B B. R., 2011)

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Table 2: Table showing % of green areas in different Indian cities

Name of the City	% of green areas (Recreational area) to total city area	Name of the City	% of green areas (Recreational area) to total city area
Mumbai city	0.65%	Kolkata	0.20%
Chennai	4.17%	Chandigarh	13.16%
Ahmedabad	2.03%	Jaipur	4.42%
Hyderabad	5.08%	Pune	8.52%
Bhopal	11.26%	Mumbai Suburban	19.28%

Source: (Jain, 2011)

Urban Green spaces are integral part of any city landscape, providing city and its residents with numerous benefits both tangible and intangible (Gaodi X, Wenhua L, Xiao Y, Zhang B,Chunxia L, Kia A, Wang J, kANG X, 2010), ecosystem services like pollutant sequestration and ambient temperature regulations etc. (bhaskar, 2012) (Jim C Y and Chen W Y, 2008) (Nowak D J, et al, 2006), Social services and health (Grahn P and Stigsdotter U A, 2003) (bhaskar, 2012)and also economic services like tourism, increased property prices (choudhary P and Tewari VP, 2010) etc. Through accelerating urbanization, mass demographic growth and expanding global consumption patterns, more and more open spaces in cities continue to be converted into industrial, commercial or residential areas. Green space has become an increasingly scarce resource, for which many competing forces battle for the right to control and manipulate it. The loss of Open spaces in cities will put tremendous strain on resources and threaten human health. Evidence indicates that the frequency of physical activity is negatively affected by a lack of greenery. Thus public Green Space per Capita, as a land-use indicator can be valuable for examining the citizens' daily well-being and quality of life. There is an urgent need to look after the issues related to the urban green spaces at grass root level or at local level.

Hence the main objective of this study was to analyze the urbanization impact qualitatively and quantitatively over the city green spaces over three major spatial levels i.e. City level(Macro level), Zonal level (Meso level) and colony or ward level(Micro Level) in terms of per capita green availability and also by mapping its benefits and functions. And also identification of the factors which are responsible for the transition in Green spaces.

3. URBAN GREEN SPACES (BENEFITS AND FUNCTIONS)

The parks, green spaces, open areas and playgrounds within an urban area influence the quality of the urban environment for residents, contributing to the overall health of the city environment. Green spaces symbolize peace, minimal stress and a cleaner environment for many people, which are considered as important factors in making a city livable, pleasant and attractive for its citizens and guests. The major functions performed by Urban green space are as follows:-

Table 3: Table showing major functions of Urban Green Spaces

S. N.	Type	Functions
1	Regulation functions	Regulates the chemical composition of atmosphere and purifying the local air
		Controlling the run off and flooding
		Regulating the hydrological cycles
		Supporting biological diversity in the city
		Preventing the soil erosion and sediments
		Regulating the local and global climate
2	Carrier functions	Conserving the energy in the city through controlling the micro climatic variations
		Helping the recreation and tourism
		Integrating the urban man to the nature.
3	Production function	Recharging the ground water table
		Providing medical resources
		Providing Raw material for some of the human activity
4	Information function	Aesthetic information
		Spiritual and religious information
		Cultural and artistic inspiration
		Scientific and educational information sources

The features of well-functioning of urban green spaces could be mapped on the basis of these principles (Chen, 2004).

- No visual stress production: a spatial environment means that visually perceived space i.e. is neither to diverse nor too monotonous.
- Legibility: It is the inference that one can explore environment without becoming lost.
- Coherence: It is the sense that all parts of conceptually perceived environment without becoming lost.
- Complexity: Environment is a complex if it contains enough variety to make it worth to learn about.
- Distance: For neighbourhood level park distance should not be more than 2-3 km but for larger green area time taken to reach should not be more than half

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an hour it becomes unreasonable to how much time could be spent in the green area.

- Size: The size of the green area should be large enough to accommodate the people of all age groups to perform their activities with freedom and it retain its quality in long term.

Major benefits obtained through urban green spaces are categorized under two perspectives i.e. tangible and in tangible they are as follows:-

Tangible Benefits

Ecological benefits – (Grahn P and Stigsdotter U A, 2003) (bhaskar, 2012) (Jain, 2011)

- Green spaces have been to absorb pollutants, moderate the impact of human activities for eg. absorbing pollutants and releasing oxygen.
- They contribute to the healthy urban environment by providing clean air, water and soil.
- They improve the urban climate and maintain the balance of the city's natural urban environment.
- In studies vegetation has been shown to lower wall surface temp, by 170c which led to reduced air conditioner use by an average of 50%.
- UGS provide safe play space for children & contribute to their physical, social and mental development.

Benefits at planning level: (Grahn P and Stigsdotter U A, 2003) (bhaskar, 2012) (Jain, 2011)

- A network of high quality green spaces linking residential areas with business, retail and leisure developments can help to improve the accessibility and attractiveness of local facilities and employment centres.
- It encourages people travel safely by foot or by bicycle for recreation.
- Well-designed UGS provide a barrier to noise and can function as a visual screen.

Economic Benefits: (Jain, 2011)

- Research all around the world shows that the property owners value the urban forest by the premium they pay to live in the neighborhood UGS and urban parks. For e.g. Just one km increase in the distance to the nearest forested area leads to an average 5.9 % decrease in market value of the dwelling.
- Study on effects of neighborhood parks on the transaction price of high rise private residential units in Hong Kong indicated that neighborhood parks could lift price by 16.88%, including 14.93% for availability and 1.95% for view. Comparing with other landscape elements, Neighborhood parks induced the heaviest investment intention in the home buying behavior. (Chen, 2004)

Intangible Benefits

Social benefits: (Grahn P and Stigsdotter U A, 2003) (bhaskar, 2012) (Jain, 2011)

- Green spaces provide a refreshing contrast to the harsh shape, colour, and texture of buildings and stimulate the senses with their simple color, sound, smell and motions.
- Well managed and maintained green spaces contribute to social justice by creating opportunities for people of all age groups to interact.
- Encourages volunteerism, Promotes stewardship, Promotes individuals with disabilities.
- It supports seniors ,helps in development of youths and enhances education
- They enhance cultural life by providing venues for local festivals, civic celebrations and theatrical performances.
- Reduces crime, Strengthens community by reflecting the different communities they serve and meeting their varying needs.

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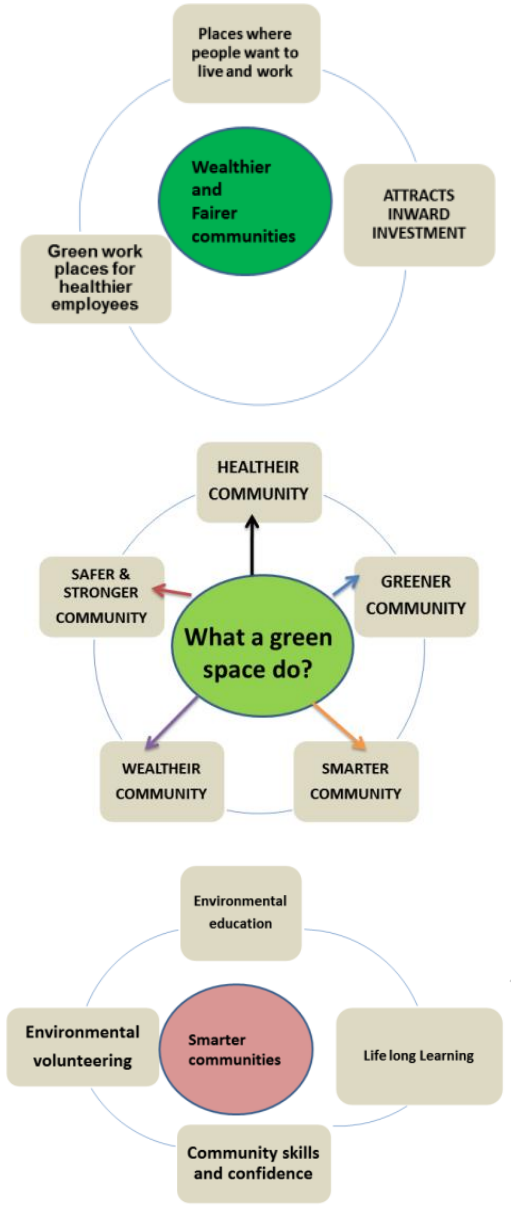

Figure1: Pictorial representation of Intangible benefits offered by urban green spaces for community

Health Benefits:
Decrease obesity, Boosts immune system, Relieves stress, Life expectancy, Reduces depression.

Improves quality of life
Recreational activities are a medium in which participants can change their self-image and gain personal satisfaction. Quality of life benefits from recreational activities include:

- Enhanced self –esteem through improved feelings of self–worth, reliance and gain personal satisfaction.
- Personal growth
- Enhanced expression of and reflection on personal spiritual ideals and
- Feelings of satisfaction from one's personal, neighborhood and community life.

4. STUDY AREA

Bhopal city (23 16'N, 77 22'E) is selected as a case example to map the qualitative and quantitative benefits and functions of Urban Green Spaces. In 1956 Bhopal was declared the capital of newly reorganized state of Madhya Pradesh. Bhopal has not grown as a single city but as a discreet township, with sparse outgrowth in between i.e. Old city, Capital Project, Bairagarh New outgrowth like Kolar, Ratibadh etc. As per census 14.35 lakhs live in Bhopal city, in 70 wards or14 zones covering a gross area of 285 sqkm including lakes and hills. This makes it low density city 50 persons hectare gross or 63 person hectare net if area of the lake about 38sqkm is deducted. Even if the area of steep hill is deducted the density on a habitable land remains low at 80 persons per hectare. Growth of the city is seen maximum in southeast direction about 10 km and minimum at Northeast about 4 km due to natural barrier. Source: City development plan 2005(Bhopal)

5. RESEARCH METHODOLOGY

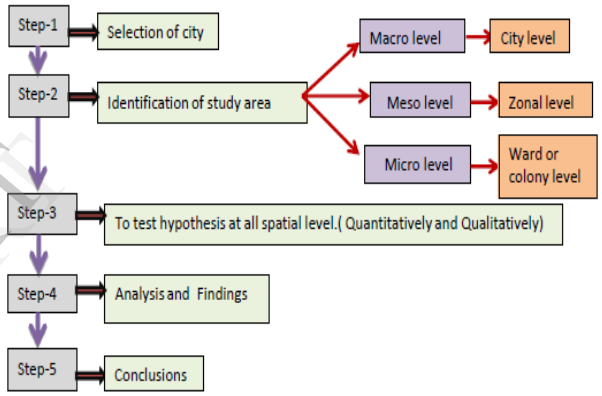

Figure 2: Methodology adopted for research

Hypothesis:
The hypothesis of this study is that the benefits and functions of Urban Green Space at various spatial levels perform differently.

Scope and limitations:
Both structured (Parks . symmetries, planned green avenues) and Unstructured green spaces are considered(social forestry, Catchment area, steep hill vegetation) only Green on banks of nallah , road side plantation is not considered. Census data of 2001 is considered for population.

Method adopted for Quantitative analysis:
Calculation of Per capita green space is adopted for quantitative analysis. As per WHO norms minimum per capita green requirement is 9 m^2 per/person and as per UDPFI guidelines it is about 12-14m2 per/person.

Per capita Green = Total area under green / Total population

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Method adopted for Qualitative analysis:
Primary survey, Photo documentation, Observation and also secondary data collection method is adopted for qualitative analysis. And it is also analyzed through scaling technique.

Major factors under analyzing the qualitative aspects are as follows:

- Level of use of green spaces under which age group category.
- Accessibility and connectivity.
- Attractive ,active supporting health and wellbeing
- Degree of maintenance and management
- Biodiversity supporting ecological network
- Urban green space functions

Data collected under subhead as only informative purpose are as follows:-

- Type of green space
- Ownership

6. DATA ANALYSIS

Qualitative Analysis

S. N	Level	Population	Total area under green in M2	Per capita green M2 /person
1	**Macro level**			
a	City	14,35,000	21869400	**15.24 M2 /person**
2	**Meso level**			
a	Zone a	5,08,668	4600136	**9.04 M2 /person**
b	Zone b	7,07,344	8841800	**12.50 M2 /person**
c	Zone c	2,18,988	8427464	**38.48 M2 /person**
3	**Micro**			
a	Ward 38	21860	3746.64	**0.171 M2 /person**
b	Ward 48	16753	170061.25	**10.15 M2 /person**

Macro Level

Green Cover Study Bhopal

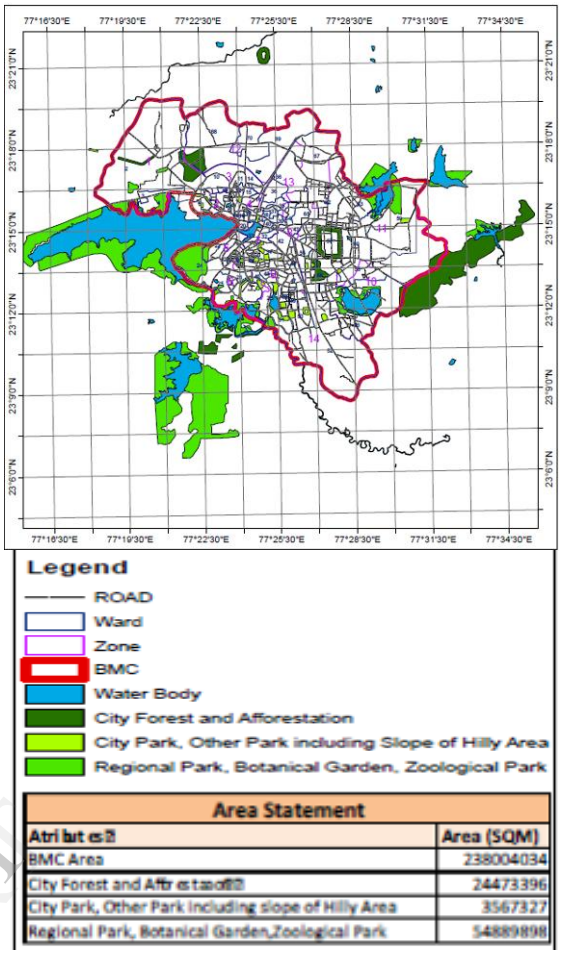

Figure 3:- Map showing the various green zones at city level (Source: Author)

Meso level

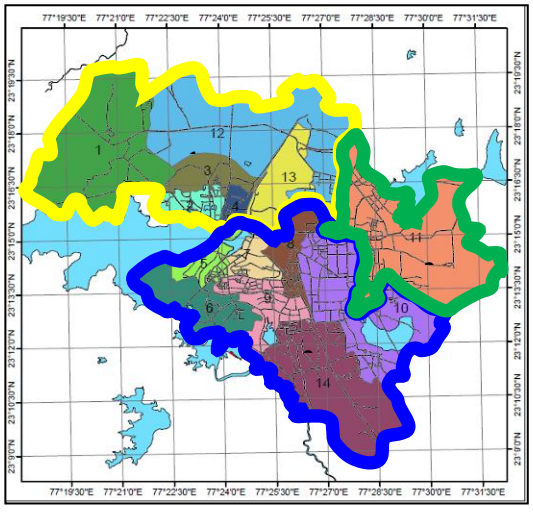

Figure 4:- Map showing the various selected zones for study (Source: Author)

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Micro level

At micro level smallest spatial unit i.e. ward is selected for study status of per capita Green. The two spatial units selected are ward no-48 and 38. Both have a diverse surrounding condition and give a very different picture.

Ward no 48 comprises of Arera colony Bhopal. This colony is considered to be one of the posh colonies of Bhopal with less FAR compared to other wards it is a mix of commercial and residential but more of residential area. It has a small pockets of open and green within the ward providing recreational services and also surrounded by neighborhood parks like Ekant Park and Shahpura park and its environmental affectivity is still enhanced by surrounding public domain and educational buildings having lush green campus.

Ward no- 38 is comprised of Aishbagh colony it is highly densified colony. Like Areara colony it is neither surrounded by any neighborhood park nor have an enough number of parks within.

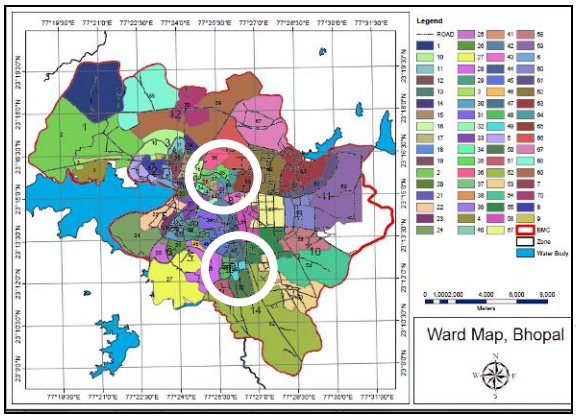
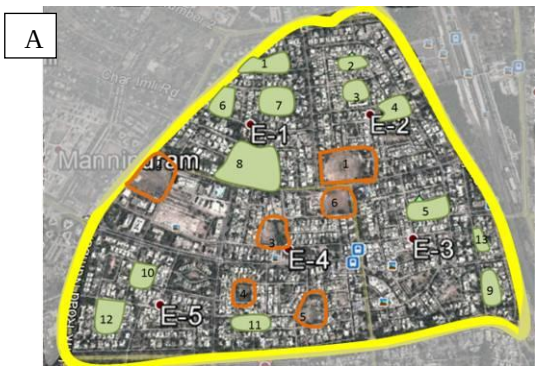
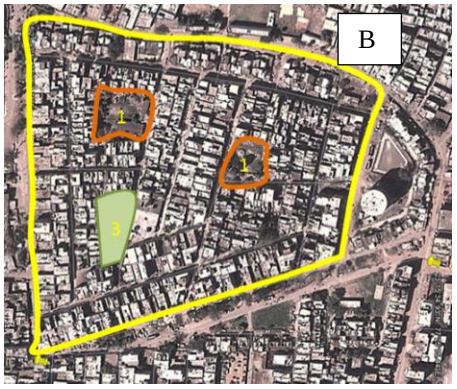


Figure 5: Figure showing the ward map of Bhopal (source: Author)





GREEN	AREA sqm	OPEN	AREA sqm
1	8387.9	1	25683.75
2	3448.18	2	14801.64
3	4033.91	3	8437.10
4	9143.44	4	3513.18
5	9917.80	5	9709.19
6	8194.09	6	8188.07
7	9258.90		
8	27897.97		
9	4502.86		
10	5841.12		
11	5144.39		
12	9366.69		
13	2779.14		

GREEN	AREA sqm	OPEN	AREA sqm
1	1482.74	1	1486.33
		2	777.57

Figure 6: Figure showing the Google map of (A) Arera colony-48 ward and (B) Aish bagh colony 38 ward along with green space calculations

Qualitative Analysis

Macro level

As per city master plan green spaces are subdivided into three major divisions:

- Regional and city level parks
- Planning unit level Neighborhood Parks (zonal parks and Playground)
- Sector level (Housing Parks)

Figure 7: Showing rich green corridors and patches within city vicinity (PC: Vickyson and author)

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At city level, availability of all type of green spaces makes it appear to be rich in biodiversity and green network .As a hole it is performing all the sufficient functions like regulatory, carrier, production and information. It is providing both tangible and intangible benefits to the city inhabitants. National park in the city heart functions as a lungs and also lakes and hills brings the potential and opportunity to governance to introduce recreational services to the inhabitants.

Meso level

Zone - 1

Figure 8: Showing Bada bagh and kamla park in the old city vicinity

Figure 9: Availability of green in Heritage Hotels vicinity used for community ceremonies

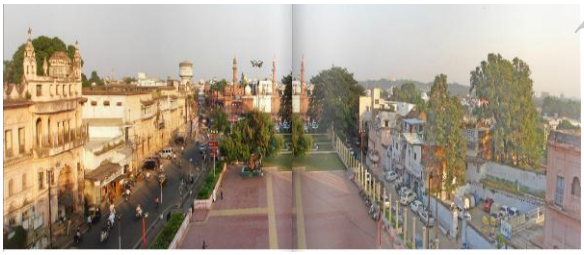

Figure 10: Iqbal Maidan one of the famous open space in Old city for multipurpose activities

Zone-2

Figure 11: Van Vihar park providing environmental, recreational and biodiversity functions

Figure 12: Health and Recreational benefits in lake front vicinities like Shahpura and Lake View

Figure13: Other city parks like Mayur and Chinar Park

Zone - 3

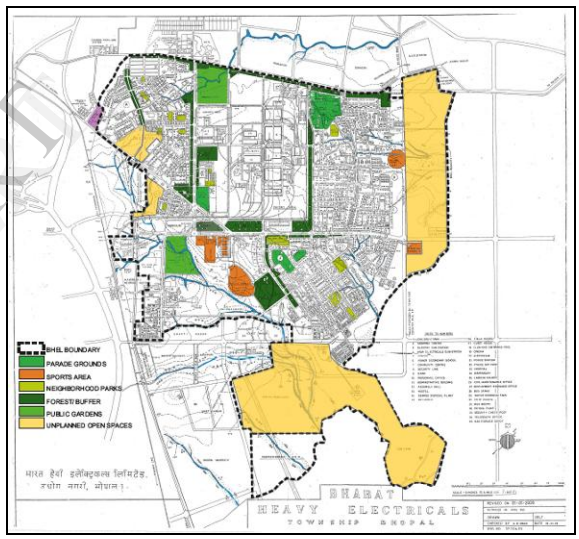

Figure 14: Zone 3 covering the area under BHEL premises, Green spaces benefiting people

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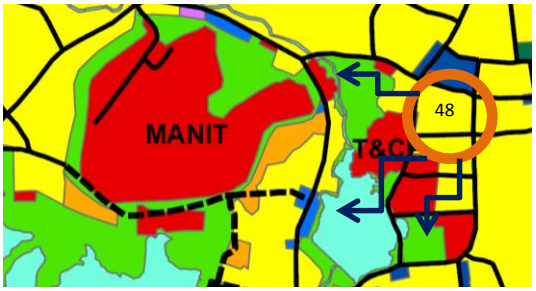
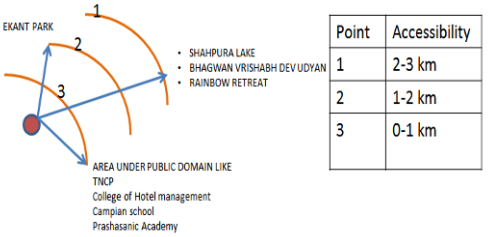
All the three zones are experiencing different extent of benefits and functions from their Green spaces. First if we consider the zone-1 and compare with the principles of proper functioning of green spaces (No visual stressing, Legibility, Coherence, complexity, size and distance) we find that the green spaces in this particular zone is fragmented in different area unequally , Hence not completely benefiting the city people of all economical sector. They have to move to Zone 2 where recreational benefits and environmental benefits are in abundance but due to attraction of city's large population to these areas create congestion and brings problem to local governance waste management system to keep the city green and clean. Now if we address the zone 3 it covers the BHEL Township, here in this vicinity green is in abundance. As it is considered as the necessity of this particular area which had a large industrial setup along with small scale industries in Govindpura. Most of the green in this area acts like a patch and corridor and some of them as a planned recreational area. These areas act as a buffer zone between residential and industrial area .Like BHEL park just in front of industry not only providing the environmental benefit but also providing the recreational benefits and acting as a buffer between residential and industrial sector.

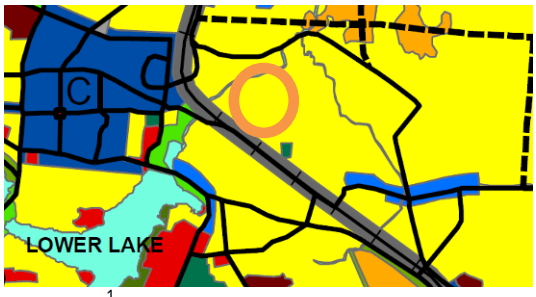
Comparing qualitative attributes of the both wards it will be clearly inferred that both of them have an diverse character .Ward no-48 reflects self sustained layout along with amenity open spaces and also had an accessibility to city park and regional park in 3km periphery. It is surrounded by various other public domain buildings and institution having lush green campus making the ward inhabitants enjoy full of environmental, social and health benefits. But if we consider the ward no-38 it had a very few open spaces within and with no neighbourhood park in its 5 km periphery which made it distressed and not environmental friendly.

Figure 15: City and regional parks benefits to people of all age group (PC: Author)





Accessibility to neighbourhood environmental services



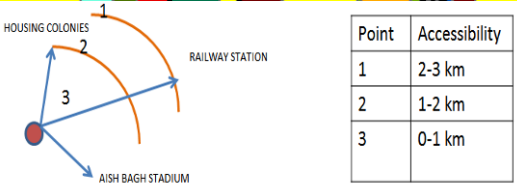


Figure 16: Accessibility of both the wards to neighbourhood amenity benefits

7. CONCLUSION

Above findings clearly depicts that vision alters when it moves from macro spatial level to micro level. Many factors are responsible for availability of Green Spaces at

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macro and micro spatial level. Major reason is demand of housing which created a land scarcity due to urbanization in city vicinity. The Bhopal city comprises of three major zones with diverse characteristics i.e. Old city, New Bhopal and outgrowth and BHEL campus. Old Bhopal followed haphazard growth process and it is considered as first settlement of City. Status of quantum of Urban Green space in old city is very less compared to other two study zones, most of the Green Spaces are available integrated with heritage buildings or on steep hill slopes where accessibility for recreational purpose is minimum. New Bhopal is a result of development plans hence abundance of green spaces are traced in the form of National park, Regional parks , city parks , community parks and local residential amenity open spaces along with avenue of road side plantation which providing a maximum benefits to its users. Similarly BHEL campus also had an abundance of greenery due to limited population its benefits are more. Factors which were affecting the availability of Green Spaces in abundance in New Bhopal are land under public domain, Institutional campus , Heritage hotel, Tourist spot development and steep hills etc. In order to tackle the land availability problems for Green spaces it is an urgent need to address the Urban sprawl issue which all developing countries like India are facing. Holistical approach is needed involving all stake holders like general public, corporate sector and Ngo's not just the decision makers of any urban eco system .And to facilitate these conservative measures ,remote sensing can play a vital role in both monitoring the land use changes and sustainable Urban planning. It also need to improve the management approach from Bottom up and top down by inserting strategic policies to make it ease at all spatial units and make city livable and healthy for all.

Further research

Further research can be done in the field of Spatial strategic planning measures for Urban Green Space management, Protection and Development. There is much scope in this field to research about developing an optimization model for Urban Green Space where land is in scarce.

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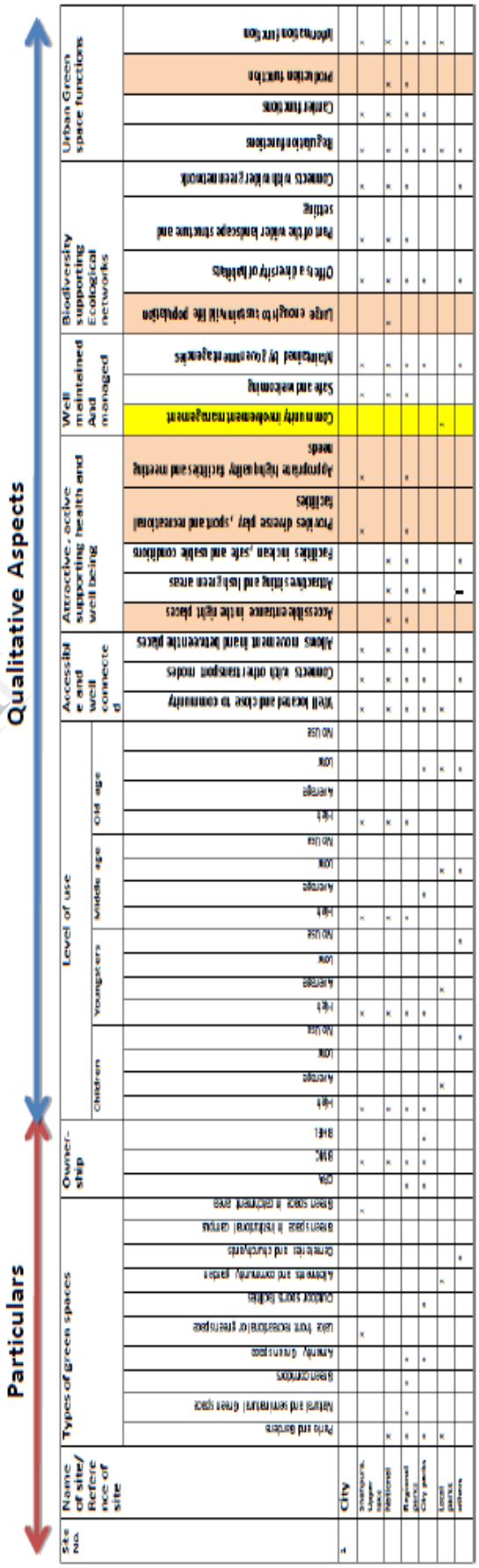
ANNEX

Annex 1: Sample of Analysis chart

Site No.	Name of site/ Reference of site	Types of green spaces	Ownership	Level of use				Accessible and well connected			Attractive , active supporting health and well being				Well maintained And managed			Biodiversity supporting Ecological networks				Urban Green space functions			
				Children	Youngsters	Middle age	Old age	Well located and close to community	Connects with other transport modes	Allows movement in and between the places	Accessible entrance in the right places	Attractive sitting and lush green areas	Facilities in clean ,safe and usable conditions	Provides diverse play ,sport and recreational	Appropriate high quality facilities and meeting needs	Community involvement in management	Safe and welcoming	Maintained by government agencies	large enough to sustain wild life populations	Offers a diversity of habitats	Part of the water landscape structure and setting	Connects with wider green network	Regulation functions	Carrier functions	Production function	Information function
1	CITY	Parks and Gardens	CPA	High	High	High	High																		
		Natural and semi natural Green space	BMC	Average	Average	Average	Average																		
		Green corridors	BHEL	Low	Low	Low	Low																		
		Amenity Green space		No Use	No Use	No Use	No Use																		
		lake front recreational or green space		High	High	High	High																		
		Outdoor sports facilities		Average	Average	Average	Average																		
		Allotments and community garden		Low	Low	Low	Low																		
		Cemeteries and churchyards		No Use	No Use	No Use	No Use																		
		Greenspace in institutional campus		High	High	High	High																		
		Green space in catchment area		Average	Average	Average	Average																		
				Low	Low	Low	Low																		
				No Use	No Use	No Use	No Use																		
2	ZONE																								
3	WARD																								

Annex 2: Qualitative attributes at Macro Level



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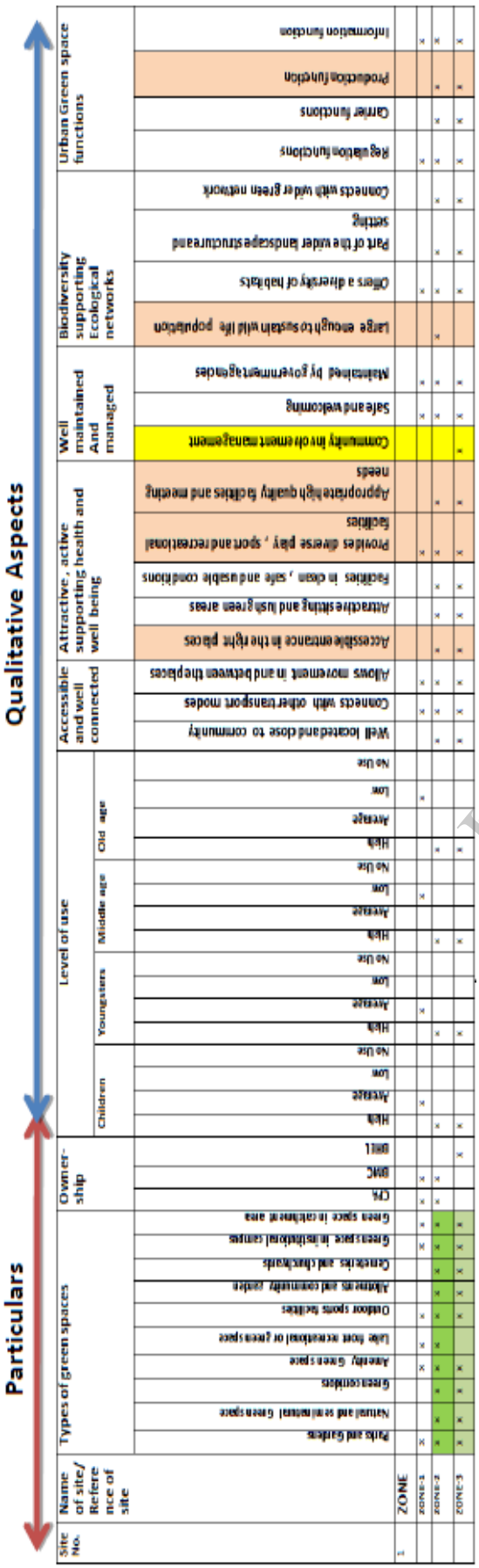
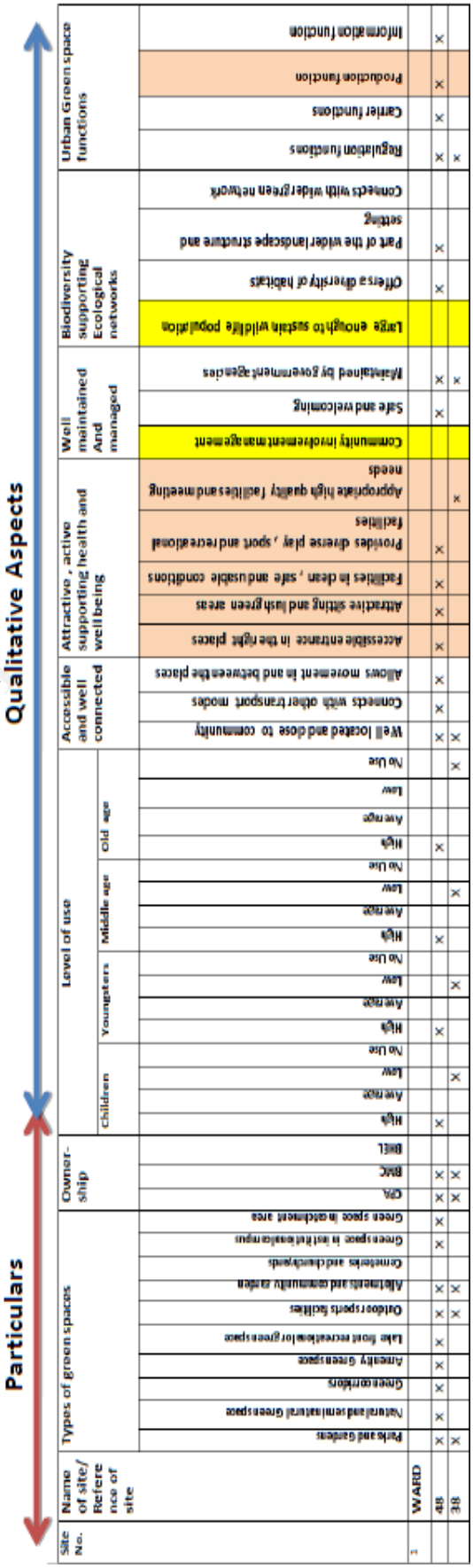
Annex 3: Qualitative attributes at Meso Level



Site No.	Name of site/ Reference of site	Particulars: Types of green spaces	Particulars: Ownership	Particulars: Level of use – Children	Particulars: Level of use – Youngsters	Particulars: Level of use – Middle age	Particulars: Level of use – Old age	Qualitative Aspects: Accessible and well connected	Qualitative Aspects: Attractive, active supporting health and well being	Qualitative Aspects: Well maintained And managed	Qualitative Aspects: Biodiversity supporting Ecological networks	Urban Green space functions
1	ZONE	Parks and Gardens	CPA	High	High	High	High	Well located and close to community	Accessible entrance in the right places	Safe and welcoming	large enough to sustain wild life population	Regulation functions
	ZONE-1	Natural and semi natural Green space	BMC	Average	Average	Average	Average	Connects with other transport modes	Attractive setting and lush green areas	Maintained by government agencies	Offers a diversity of habitats	Carrier functions
	ZONE-2	Greenways	BMTL	Low	Low	Low	Low	Allows movement in and between the places	Facilities in clean , safe and usable conditions	Community involvement management	Part of the wider landscape structure and setting	Production function
	ZONE-3	Amenity Green space		No Use	No Use	No Use	No Use	Accessible entrance in the right places	Provides diverse play , sport and recreational facilities		Connects with wider green network	Information function
		Lake front recreational or green space						Attractive setting and lush green areas	Appropriate high quality facilities and meeting needs			
		Outdoor sports facilities						Facilities in clean , safe and usable conditions				
		Allotments and community garden						Provides diverse play , sport and recreational facilities				
		Cemeteries and churchyards						Appropriate high quality facilities and meeting needs				
		Green space in fort Rekhagarh										
		Green space in catchment area										

Annex 4: Qualitative attributes of Ward – 48 and Ward – 38



Site No.	Name of site/ Reference of site	Particulars: Types of green spaces	Particulars: Ownership	Particulars: Level of use – Children	Particulars: Level of use – Youngsters	Particulars: Level of use – Middle age	Particulars: Level of use – Old age	Qualitative Aspects: Accessible and well connected	Qualitative Aspects: Attractive, active supporting health and well being	Qualitative Aspects: Well maintained And managed	Qualitative Aspects: Biodiversity supporting Ecological networks	Urban Green space functions
1	WARD	Parks and Gardens	CPA	High	High	High	High	Well located and close to community	Accessible entrance in the right places	Safe and welcoming	Large enough to sustain wildlife population	Regulation functions
	48	Natural and semi natural Green space	BMC	Average	Average	Average	Average	Connects with other transport modes	Attractive setting and lush green areas	Maintained by government agencies	Offers a diversity of habitats	Carrier functions
	38	Greenways	BMTL	Low	Low	Low	Low	Allows movement in and between the places	Facilities in clean , safe and usable conditions	Community involvement management	Part of the wider landscape structure and setting	Production function
		Amenity Green space		No Use	No Use	No Use	No Use	Accessible entrance in the right places	Provides diverse play , sport and recreational facilities		Connects with wider green network	Information function
		Lake front recreational or green space						Attractive setting and lush green areas	Appropriate high quality facilities and meeting needs			
		Outdoor sports facilities						Facilities in clean , safe and usable conditions				
		Allotments and community garden						Provides diverse play , sport and recreational facilities				
		Cemeteries and churchyards						Appropriate high quality facilities and meeting needs				
		Green space in fort Rekhagarh										
		Green space in catchment area										

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