GIS AND REMOTE SENSING APPLICATIONS FOR POTENTIAL URBAN GREEN SPACE DEVELOPMENT SITE SELECTION: THE CASE OF ABIY ADDI TOWN (CENTRAL TIGRAY, ETHIOPIA)

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Content outline

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Statement of the problem

- Various researches on the condition of forests (Zenebe, 1999 and Alemayehu, 2005). But not on UGS that include (forests, parks, residential gardens, street trees etc)

- May be various greens spaces in towns, that unplanned left over dominates with some properly designed spaces in the study area.

- They are not enough due to
  - Low attitude of the public and private sectors
  - Low prioritization provided

In turn due to:
low economic status of society and municipality where large budget goes to housing units

- More emphasis given to urbanization.
- Urban areas are
  - Centers of technological development
  - Sources of emissions

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- LULC and green cover changes monitoring is required (Bhaskar, 2012) showing a need for green space dev't sites identification

- Hence, researches need to be conducted so that balance is maintained

- Inspite of the seriousness and global nature of the problem, little and utmost no researches done in this regard in the country and study area.

- For example, Mikyas (2011) and Kumlachew (2007) try to see the use of UGS in Meskel square and leghar (Addis Ababa). They do not include GIS applications and no site selection rather description of their use and what is happening with them.

- Therefore, this research will serve as an eye opening in this perspective especially GIS applications for UGS site selection processes.

Objectives of the study

- **General**: develop GIS based site suitability for urban green space development potential

While the specific objectives were:

- Describing the existing conditions of green spaces

- Pinpointing the possible factors affecting the development of urban green space sites

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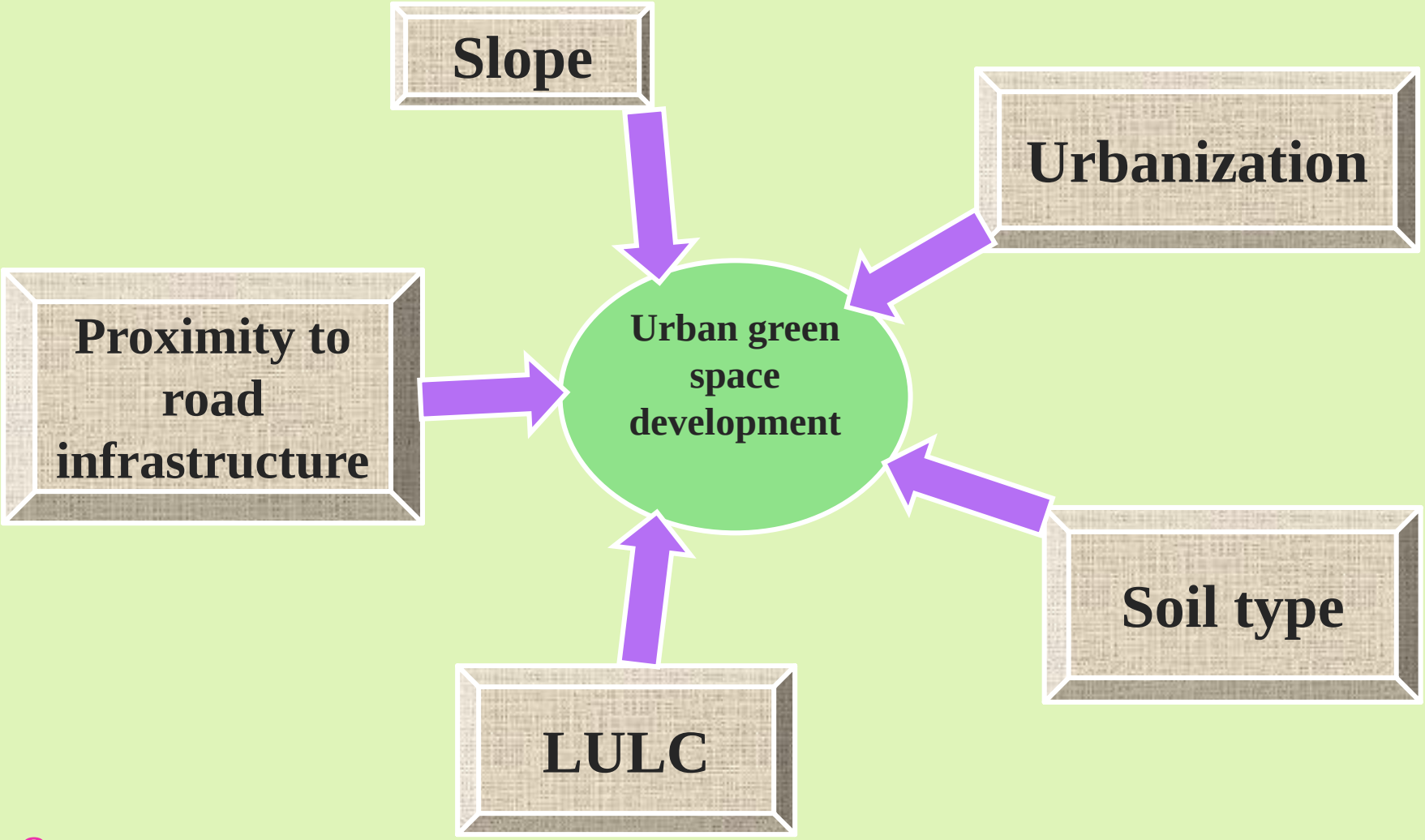
- Specify the current major land use/ land cover classes
- Produce a map of urban green space sites potential
- Compare the site suitability map with the study area's 10 years master plan (2001 to 2011 E.C)

Research questions

- Are there any green spaces existed in the study area?
- What factors are affecting the development of urban green space
- What are the current landuse/cover classes of the study area?
- How can a map of urban green space potential of the study area be produced?
- Is there any difference between the study area's master plan and GIS based suitability analysis map?

Conceptual framework



Methodology and Data sources

- **Research design**: Mixed research design was used
- **Sample design**:
  - Population – all the HHs of the town (4798)
  - Sampling frame – list of all HHs in the three kebelles
  - Sampling unit – HHs and employed experts
- **Sampling techniques**:
  - Judgmental – for experts (4 planners and 2 env'talists)
  - Systematic random sampling – for HHs respondents and proportional allocation formula was applied

Therefore, both probability and non probability methods were used

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- **Sample size**: by applying fowler's formula cited in Siraj (2011) a total of 161 sample HHs were selected

Number of sample size taken from each *kebele*

No	Kebele	Total pop^{n}	No of HHs (Ni)	Sample size ($k = \left(\frac{Ni}{N}\right)n$) (n = 161)	Interval	Sampling method
1	01	5112	1359	45	29	Systematic random sampling
2	02	6712	1778	60		
3	03	6248	1662	56		
Total			4518 (N)	**161**		

Cont…

- **Data collection techniques**: both primary and secondary data were collected from sources using:

- **Primary data collection**
  - GPS
  - Questionnaire
  - Indepth interview
  - Observation

- **Secondary data collection**
  - Images

Data	Acquisition date	Source	Resolution	Path/raw	Reference
Images	27/01/1988	www.landsat.org	30m	169/51	WRS-2
	01/01/2012	www.earthexplorer.usgs.gov	30m	169/51	WRS-2
DEM	-	Amhara design and supervision bureau	20m		

Document review

Method of data analysis

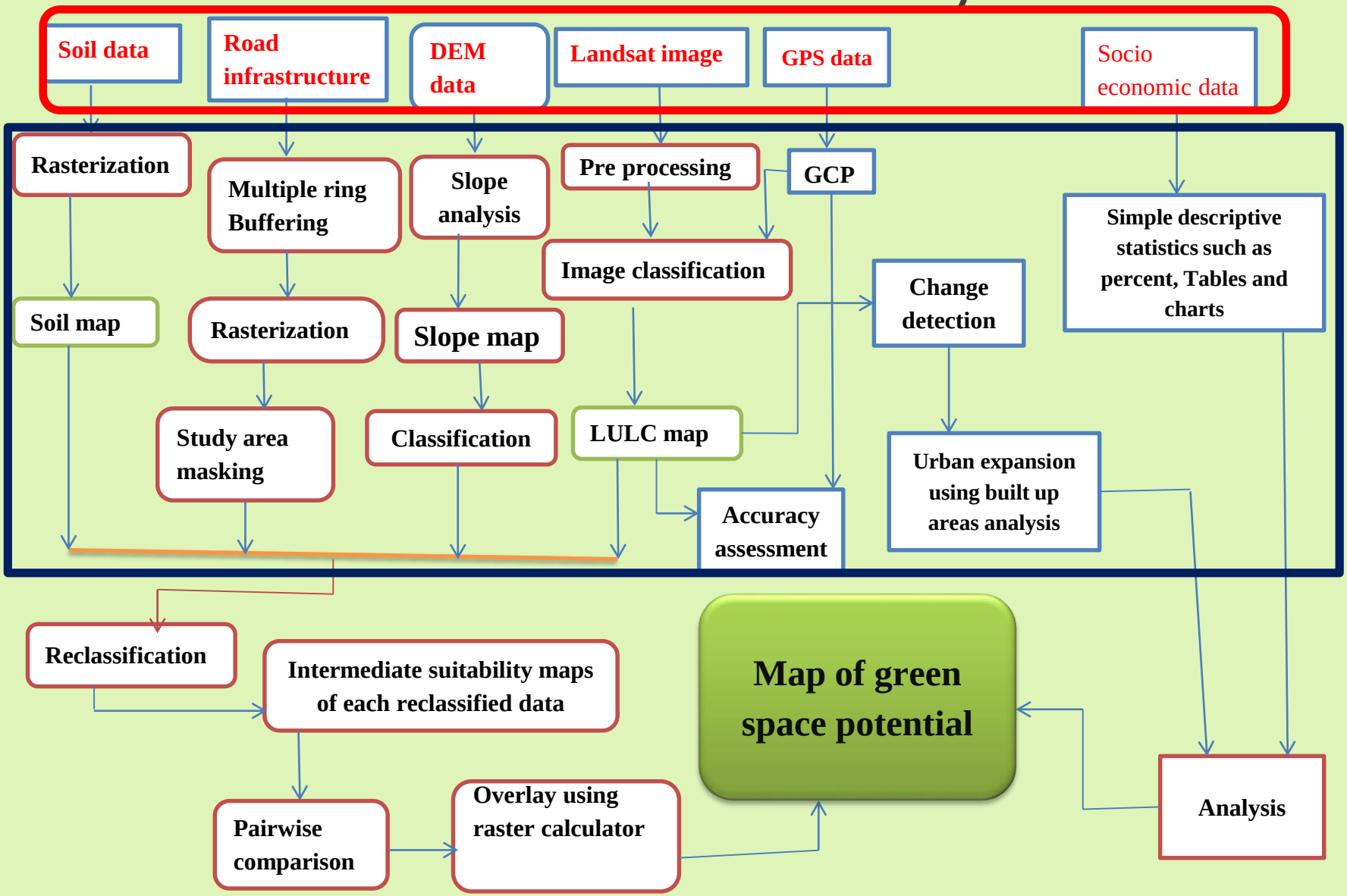

Figure 3.4: General work flow

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- Criteria are basis for site suitability selection. Criteria need to be helpful for achieving the objectives set (Malczewski, 1999).
- Therefore, criteria selection was made based on discussion with experts and review of documents (journals, articles, theses and dissertations).
- Accordingly, required criteria for each factor was developed

Parameters	Sub classes	Range of suitability					Source of criteria
		Suitable			Not suitable		
		high	moderate	marginal	currently	Permanently	
Slope		0-5	5-10	10-15	15-25	>25	Miller et al., planners opinion, urban planning sanitation and beautification bureau of Ethiopia
Soil type		fluvisols	Vertisols and lithic leptosols		Arenosols		UNSEPA
Proximity to road infrastructure		Within 300 m buffer	300 – 600m buffer is less suitable		Greater than 600m		ANGSt of English nature
LULC	Built up or urban				✓		Miller et al.
	Forests			✓			
	Shrub land	✓					
	Bare land			✓			
	Public open space or range land	✓					
	Agricultural lands		✓				

Cont…

- Then after, suitability analysis for each factor based on the criteria was done. According to FAO (1993), five suitability classes were identified, namely: highly, moderately, marginally (suitable), currently and permanently (not suitable). For this analysis, 1 to 5 values were assigned for each of the suitability classes respectively.
- For LULC;
    - Image preprocessing
    - Based on CORINE classification system
    - Both supervised and unsupervised

Result and discussion

A. Existing condition

- Some properly designed UGS (teachers training college, botanical garden, Stadium and Maylomin recreational site) all covering 1.4% of the total area
- From LULC classification = 28% covered by forests, shrubs
- Hence, very wide gap exists indicating..
  - Less emphasis given for designed dev't of UGS
  - Large greening materials taking the whole LULC classification but exposed to removal
- Inspite of the long run emphasis of env'tal protection, currently construction of houses is day to day activity

Type and areal coverage of the existing green spaces

Name of site	Area (ha)	Remark
Maylomin botanical garden	4.2	Ongoing
Teachers training collage compound	15.2	Completed
Maylomin recreational site	6	Completed
Stadium	11.4	Ongoing

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B. Factors of UGS

- UGS are mosaics of human and natural reinforcements and their factors are multifold
- They can be economic, social, environmental (physical)
- LULC, slope, soil types, distance from road infrastructure and urbanization (conceptual framework)
- From HH respondents: low economic status, low attitude, lack of infrastructural facility, using of them as waste disposal sites….

Urbanization and UGS

- Though green network plan (master plan), currently emphasized on housing expansions. This is confirmed by 89.1% of the respondents. So, spatial pattern of UGS is affected.
- From LULC despite of the unsuitability for UGS (Miller *et al*, 2005), the lions share is taken by built ups.
- This expansion either changes the existing or hindered its dev't. Bhaskar (2012) confirmed that, despite of their significance, they are getting low due to rapid and haphazard urbanization

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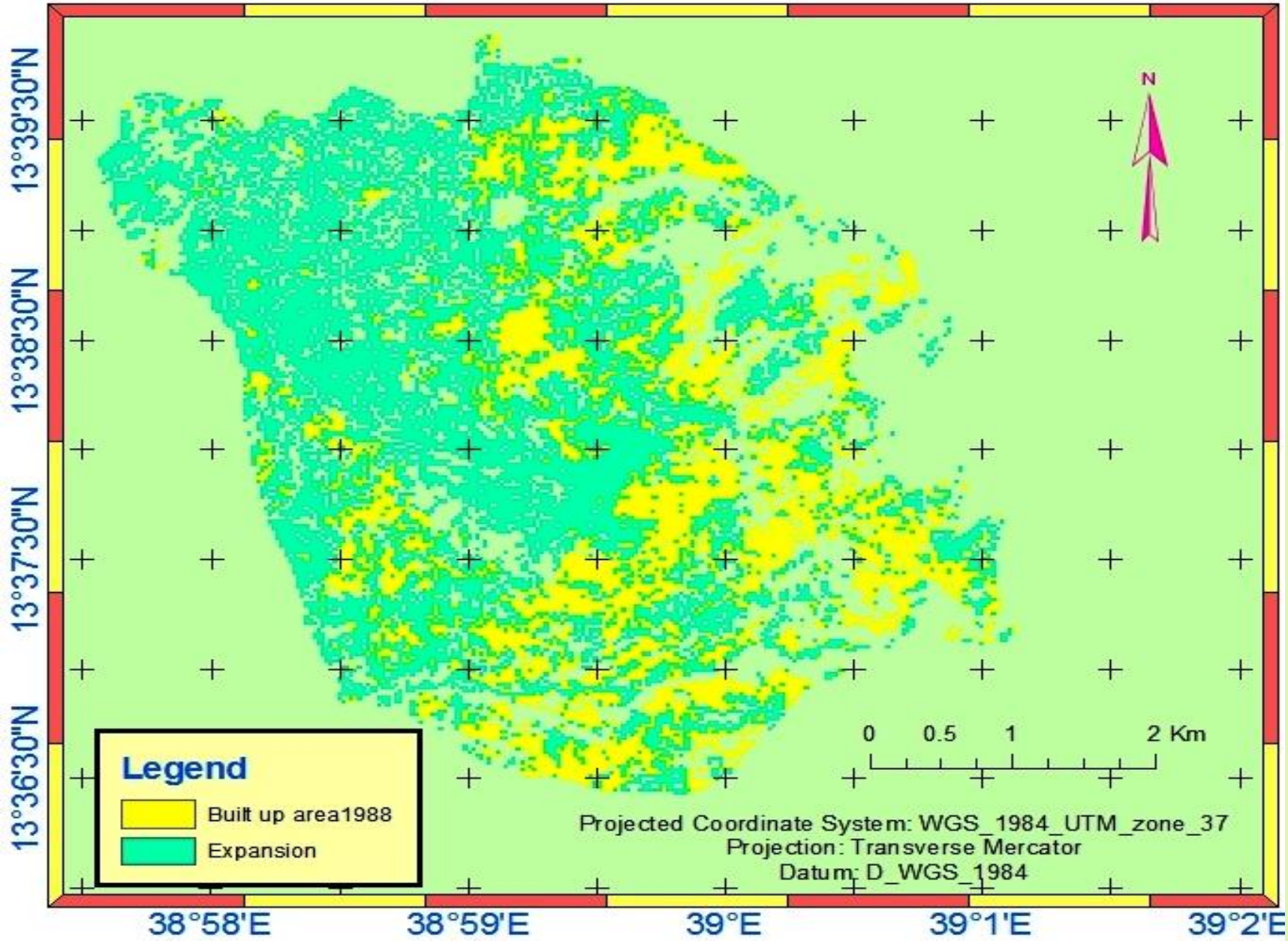
13°39'30"N
13°38'30"N
13°37'30"N
13°36'30"N
38°58'E
38°59'E
39°E
39°1'E
39°2'E
N
0 0.5 1 2 Km
Legend
Built up area1988
Expansion
Projected Coordinate System: WGS_1984_UTM_zone_37
Projection: Transverse Mercator
Datum: D_WGS_1984

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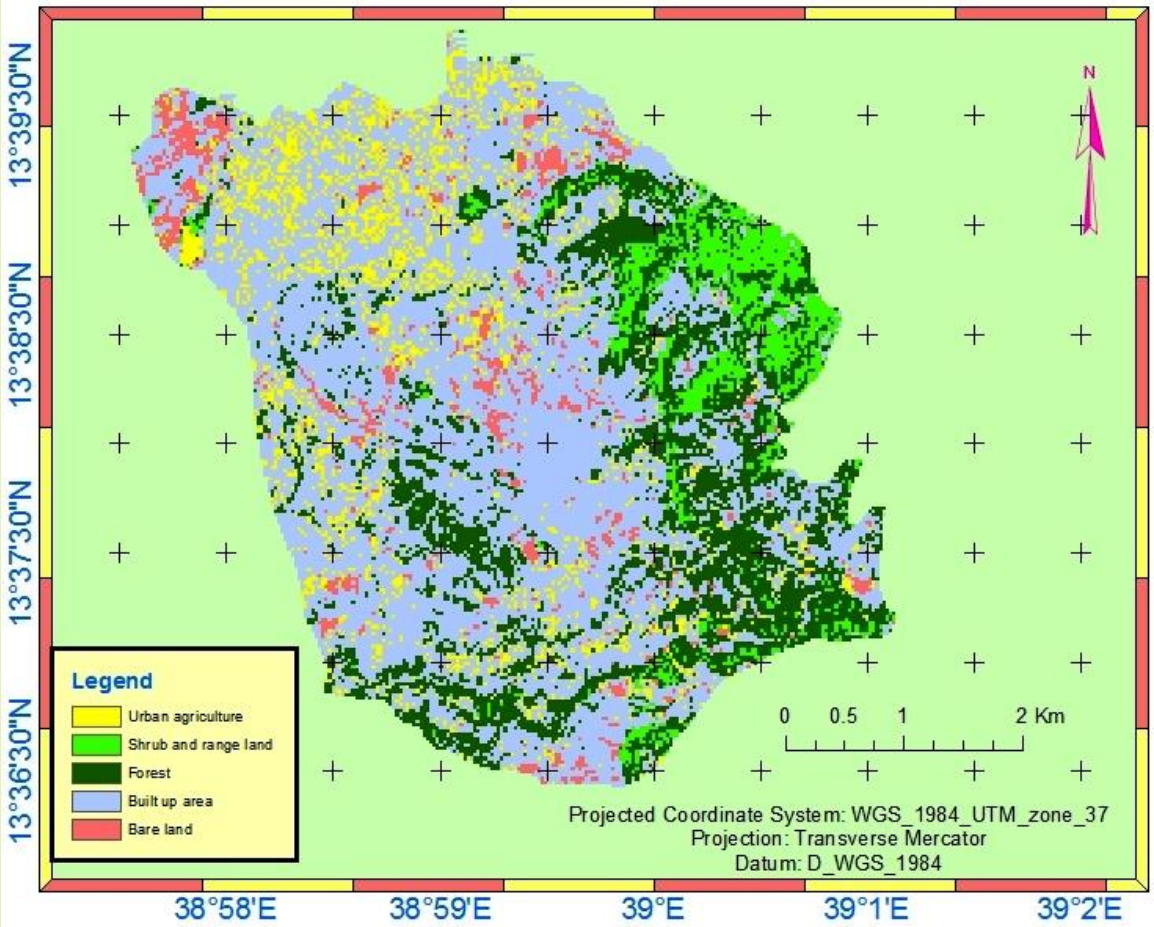
C. Current LULC classes of the study area



Current land classes

- built up area = 57.2%
- shrub and range land = 6.4%
- urban agriculture = 9.8%
- forest = 21.6%
- bare land = 4.8%

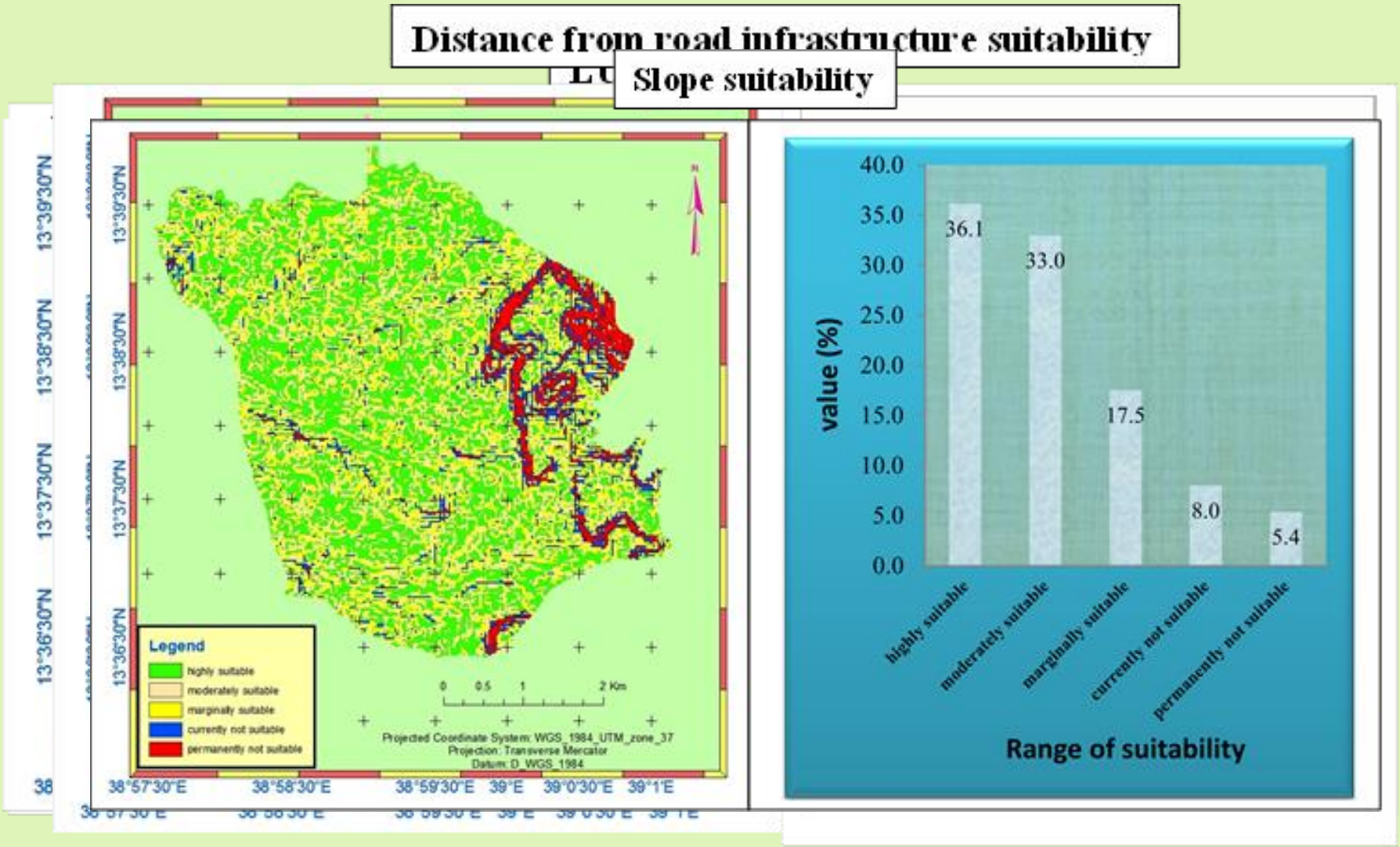
Ahadu (2009) also identifies 49.81% was covered by built ups

Accuracy assessment

- overall classification accuracy = 86%
- kappa statistics = 0.8128 showing strong agreement of classifn

As to Congalton (1996), >0.8 = strong, 0.8 – 0.4 = moderate and <0.4 poor agreements for kappa value.

D. Potential urban green space development site selection



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- After having suitability analysis for each factors based on their respective criteria, they were overlaid in the raster calculator.
- The respective eigenvector weights derived from the pairwise comparison of IRISI Andes software for each of the suitability factor maps were considered.

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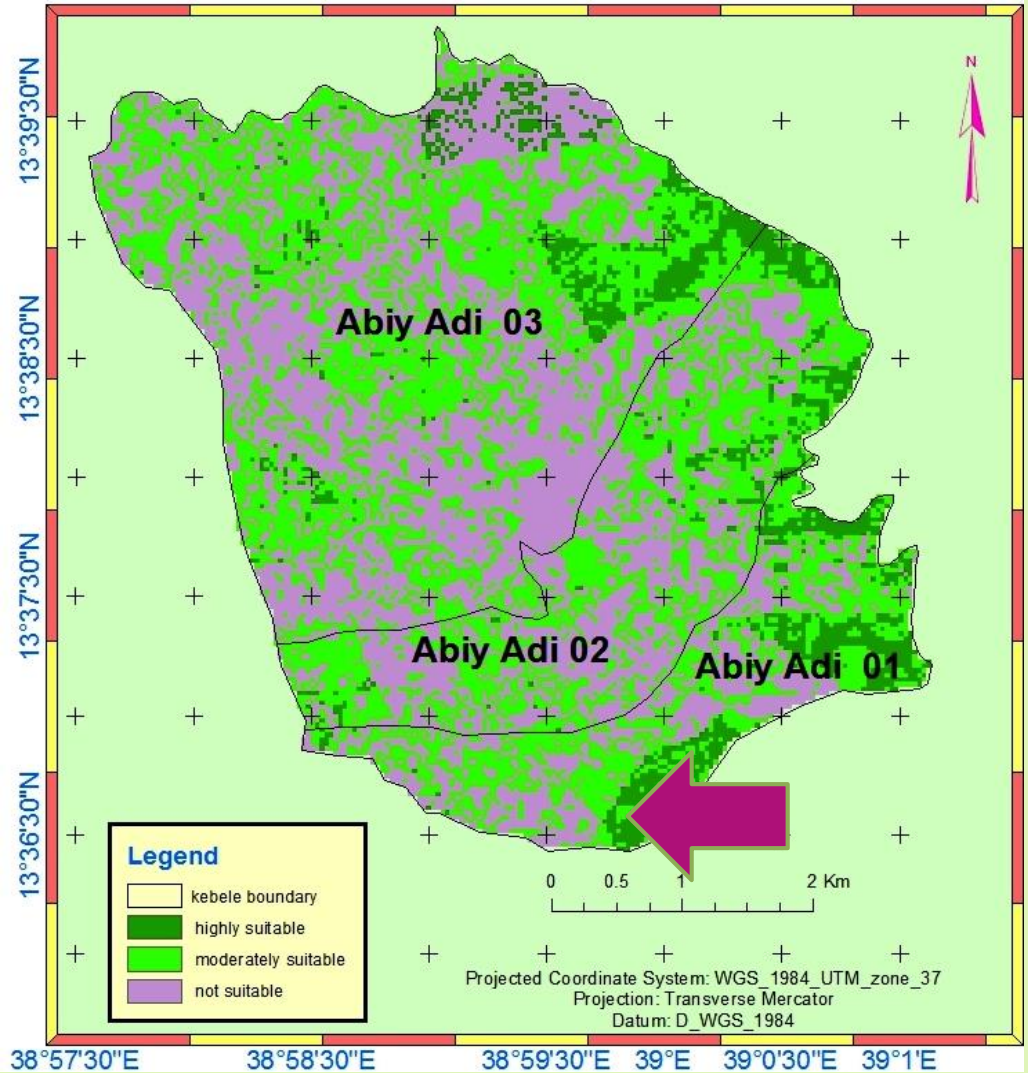
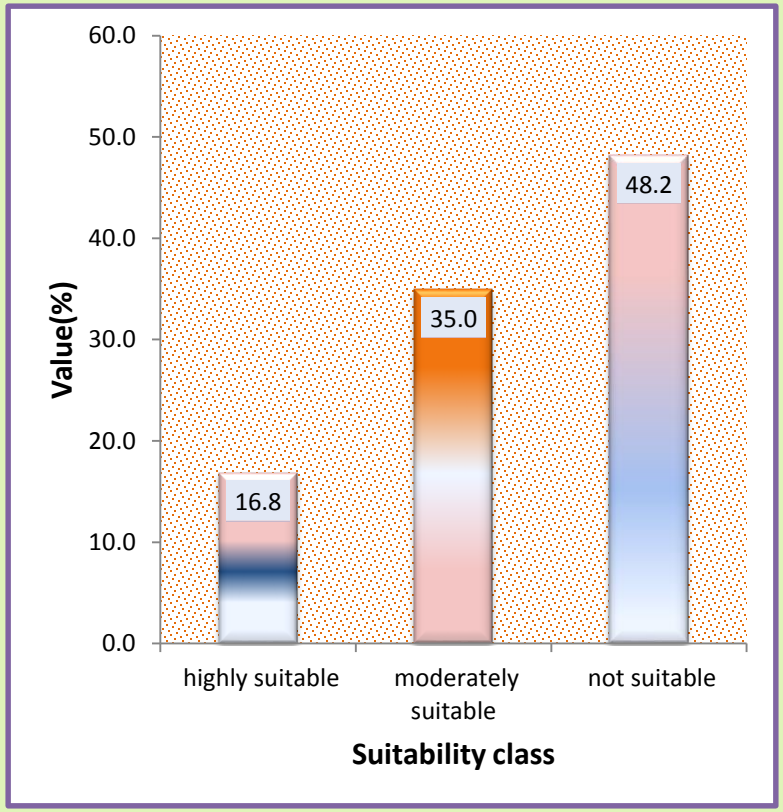
Overall suitability





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E. Comparison between the proposed suitability map and master plan

Map

- Sites are everywhere
- Consider criteria (factors)
- Emphasis on green site development
- More decentralized and systematic

Master plan

- Small pocket areas like Endaraesi, maylomin recreational area, botanical garden….
- Based on current landuse and historical cultural value
- Emphasizes on housing expansion
- Proposed green network not yet implemented

Area of the existing green spaces in terms of their suitability

Name of site	Area (ha)	Suitability class (ha)		
		Highly suitable	Moderately suitable	Not suitable
Maylomin botanical garden	4.2	-	3.02	1.18
Teachers training college compound	15.2	-	6.8	8.4
Maylomin recreational site	6	3.05	1.8	1.15
Stadium	11.4	1.9	5.7	3.8

Conclusion and Recommendation

Conclusion

- Though environmental complexity due to interwoven nature, GIS becomes an ideal tool too

- Analysis for UGS system is new and need to be investigated more. It is broad including many parts with it having a definition of **all the greening indices ranging from very small tree avenue to large forests**

- Hence, this was done aiming at developing GIS based suitable site selections for UGS

- The main motivation to this was the existence of low and even unplanned leftover greens in the study area

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- Suitability analysis is difficult – requiring large factors and data
- Five factors (slope, soil, LULC, distance from road infrastructure and urbanization) were identified
- The overall suitability map reveals that, 16.8%, 35% and 48.2% of the area is highly suitable, moderately suitable and not suitable respectively
- Since GIS application of suitability analysis is new and flexible, refinement is possible by planners, residents etc at a need

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Recommendation

- ✓ More researches need to be done in this regard for enhancing and improving the existence of urban green spaces.
- ✓ Creation of urgent concern and meaningful awareness among decision makers, planners and the public at large is recommended for their improvement and long lasting existence
- ✓ vertical built up expansions rather than horizontal
- ✓ It could be very advantageous for the municipality if it applies this model of site selection
- ✓ The soil data used for this analysis is not as detail as required
- ✓ Since the term green space in this case is too general, researches in terms of the specific types of green spaces with respect to their development potential and merits they contribute for atmospheric gasses sequestration can be of advantageous

THANK YOU