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Habitat Based Micro-ecological Analysis of Urban Space in Mountain Environment with Special Reference to Woodland and grassland Habitat-An Appraisal of the Gangtok Town, India

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Abstract: ***Urban habitats differ from those of other terrestrial eco system in two respects. Firstly a massive energy flow is found in form of fossil fuel consumption and secondly huge volume of verity of material are generated from long distance are concentrated, transform, consume and turned into wastes to be disposed within the limit of urban area. Urban habitats are those habitats which are confined within town or city. Urban habitats are acts as Habitat Island in respect to the surrounding area. Development of towns and cities destroyed or engulfed the rural landscape and newly modified or isolated urban habitats are created. Sometime these habitats are found as a remnant habitat. Urban landscape are dominated by different types of development like buildings, transport links, disposal sites etc. Urban areas are usually in lack of extensive green space which has been fulfilled by parks in many cases. Urban area is not static but constantly expanding towards its periphery and internal renewal. This urban dynamism influenced the development of urban habitat. Urban habitats are the house of many bird species, large and less tolerant mammals, fungi species are found, especially in woodlands, cemeteries and along railway (Thomas, 1992). The study focused on habitat characterization at micro-level and extent of urban signature over the habitat. The study carried out based on the field observation and data accumulation. Along with these, Google imagery also used for mapping in GIS platform.***

Keywords: Urban habitats, Habitat Island, Urban landscape, Ecosystem, GIS platform

1. Introduction

There are three general ways in which urban environment can be discussed. These are (i) Eco *system within city*- The doctrine of urban ecology originates from the Chicago School (1940) when Ernest Burgess and Robert Park founded the first school of urban analysis. They called their approach "Human Ecology" to consider human social adjustment to urban area and it was influenced by Darwin's concept 'Survival of the fittest 'within natural environment. Burgess postulated that, spatial competition created. (ii) *City as an eco system*- City as an ecosystem refers to the understanding of city as human body. The concept of urban metabolism is the prerogative. City in this approach acts as consumer and digester of resource and creator of waste product .In this approach a complex of factors is examined rather than any specific problems. (iii*) Cities with in regional or global ecosystem*- Cities within regional and global system are the third approach to study urban ecology. In these approach cities within the global framework acts as a total system and are inter link to each other. This linkage formed by the flow goods, services, investment, finance people and knowledge. It is better known as global city concept. The approach ecosystem within cities is a holistic approach. It explores the issues related to urban ecosystem especially the brown agenda of health, water, and sanitation. Along with these issues like air pollution, city park wild life of urban park and urban agriculture also discussed. The perspective of this approach is to explore city as a natural environment. The study includes the habitat based ecological analysis of Gangtok town. The urban places cannot be self- contained sustainable units rather it is the interaction between the land use pattern arising from physical environment as the habitat of urban people and external support in form energy. In this regard determination of ecological footprint is very essential. Water and materials created a mosaic of habitats with in an urban system. Urban habitats are semi natural in nature but sometimes total alteration are also common in case of urban habitat however an amazing range of habitats are found on fringe of a town or a city. Semi natural habitats of urban land with their associated plants and animals i.e. woodland, parkland, arable land, play ground, buildings, walls, sewage, church and temple. The range of urban habitat extends from a small derelict site to large biosphere reserve or wild life sanctuary located in the urban area. Depending on the nature of urban habitat, it is divided into two basic type. These are terrestrial urban habitat and aquatic urban habitat. Most of the major terrestrial habitats are found in the urban areas either in form of remnant of previous environment or semi-natural altered habitats. This study includes only woodland and grass land habitat.

2. Introduction of Study Area

Gangtok is a small town in the mountainous tracts of Sikkim in India. Gangtok means "the town on the hilltop' in the local Bhutia language. The city is situated between 88º 30′ 36″ and 88º 35′ 49″ East longitudes and 27º 17′ 00″ and 27º 22′ 00″ North latitudes. At an average altitude of the study area is 5500 feet. Gangtok is the capital of the state of Sikkim with a population of approximately 50,000 and it is historically important transit point on the trade route to Tibet and became the capital of Sikkim in 1894. Being capital city, Gangtok is very important from administrative point of view. Physiographically, Gangtok can be said to have its feet in the ocean and its head in the sky. The altitudes vary from 300 meters to 8500 meters above mean

sea level. The entire state is a young mountain system with highly folded and faulted rock strata at many places.

3. Objectives

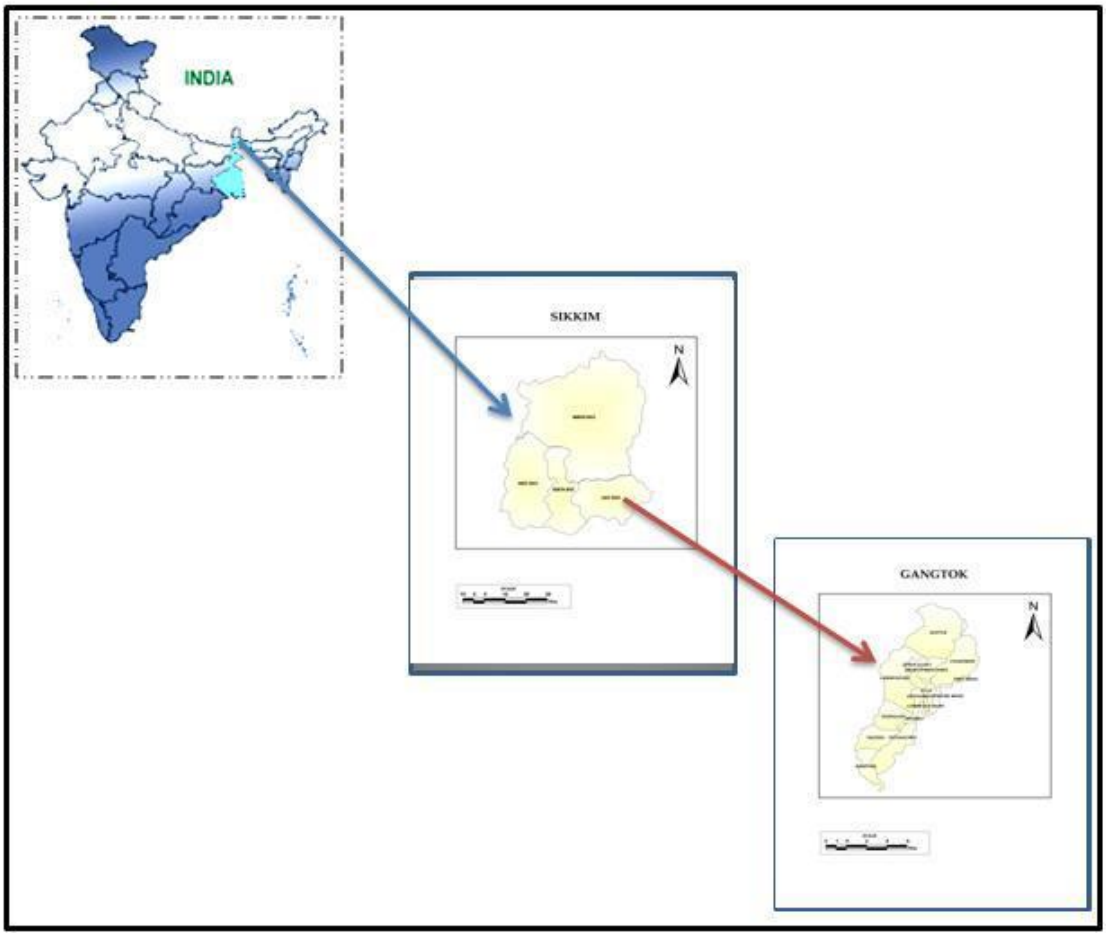
i. To find out micro-level habitat characteristics of Gangtok city.

ii. To examine the role of woodland and grass land habitat which are giving unique character to this mountain urban centre.

iii. To examine the micro environmental variation within each habitat.

iv. To study impacts of urbanization on natural habitat.

LOCATION MAP OF STUDY AREA



Source: NATMO, 2015

Figure 1

4. Methodology

This paper analyse habitat characterization of Gangtok town. Open source satellite data have been used for characterization of the landscape and identification of various habitats. Large scale Google image have been used for delineation of micro zones of each habitat according to tonal variation of the vegetation. After that each micro zones are surveyed with the help of G.P.S ground survey and prepare the map of specific micro habitat. Soil and water samples are collected randomly from different habitat to get information about the nature and characteristics of soil and water and their quality. Apart from that, herbarium specimens were collected from each habitat for analyzing the habitat character as well as the species diversity, richness and uniqueness of each habitat. Finally micro zones are identified according to hydro-geomorphic and ecological characteristics.

5. Analysis of Woodland Habitats

Woodland habitats in the urban area, in maximum cases are representing the remnants of the inbuilt environment they are important in urban environment because of their role and function as screening air pollution noise pollution, supporting wild life and for aesthetic purposes. Woodlands in the urban environment are often small in size and fragmented in nature. The locational characteristics depending on the topographical variation, amount of slope and accessibility of human being. Tree species in urban habitat depends on the location, history and management. In many cases introduction of alien species of exotic species may create stress on the endangered species. Urban woodland habitat are semi-natural in characteristics depending on the location, species variation, species composition or association are also varies. Urban woodlands are situated on steep slope, at the both side of jhora and the area which are not utilized by the people in any way. Woodland density, species number and other

characteristics are determined by their location on the geographical situation. Geomorphic location of woodland habitats in Gangtok town.

Location	*Characteristics*
Cliff slope	• Dominated with dense forest at extensive area.
Shoulder slope	• Open forest and mixed forest with under growth. • Open bamboo bush having relatively high moisture condition.
Foot slope	• Open forest with less lesser undergrowth at the sun face slope. • Extensive woodland at the free face slope.
Steep slope or highly inaccessible area	• Moist woodland with considerably high intermediate shrubs laid.
High altitude	• Extensive dense forest with lesser under growth.

Source: Field observation, 2015

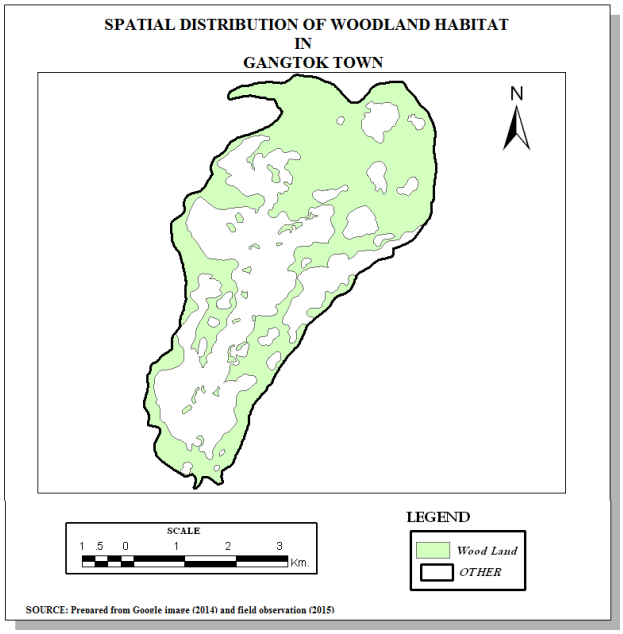


Figure 2

Coverage area of the woodland patches are not so much extensive in comparison of the natural habitat being urban woodland it is fragmented, isolated and fringed by the urban land use mainly residential areas and roads. Coverage are various with its location. Where the slope amount is higher the coverage area reach up to 1-3 km². But isolated patches are more in number which are distributed all over the Gangtok city. City fringes and wasteland are the area, where coverage of woodland area is significant.

Site based case study-1:

This Woodland habitat is situated in between Palzor stadium and B. R. Ambedkar Road. This woodland extended at East-West direction. Within woodland habitat different micro zones have been identified on the basis of plant species association which varies with topographic characteristics moisture availability. Micro zones are primarily identified from satellite image from tonal variation. After that each micro zones are observed minutely and depending on its characteristics these zones are redrawn.

5.1. Micro Zonation of Woodland Habitat

1) Relatively cool shaded sub-environment with Utis (*Alnus nepalensis*) dominated woodland.
2) Open bamboo(*Bambusa arundinacea*) bush sub-environment along cliff south sloping
3) Dhupi (C*ryptomeria japonica)* and Mehagini (*Mahonia nepaulensis Dc.)* dominated moist woodland sub-environment along middle cliff slope.
4) Asoka *(Saeac indica linn*) dominated woodland patch along middle cliff slope
5) Mehagini (*Mahonia nepaulensis Dc.)* dominated woodland along south sloping cliff slope
6) Hanithus and Malaka (*Macarauga sp.)* dominated extensive woodland sub-environment at lower cliff slope.
7) Woodland sub-environment with Utis (*Alnus nepalensis*), Dhupi (*Cryptomeria japonica)* and Bamboo (*Bambusa arundinacea*) combination at the slope.

Table 1: Hydro-geomorphic Characteristics of Micro-ecological zones of Woodland habitat

Micro zones	Soil Condition				Infiltration rate	Organic matter	P^H	Major Plant Species		Number of Fauna Species		Signature of Urban Stress
	Depth (cm)	Exposure (%)	Texture	Debris				Name	No	Avifauna	Insect	
1	10	-	Sandy Clay	Low	1cm/15'	High	5.5	Utish Dhupi Bamboo	8 7 12	2	6	Dumping of garbage
2	3	-	Sandy	Low	1cm/12'	High	6.0	Utish Golgotha	27 12	4	6	Building Construction
3	4	20	Sandy	Low	1cm/30'	High	7.0	Omshing Dhupi	7 20	7	8	Cutting down of trees
4	7	5	Sandy Loam	Very Low	1cm/70'	High	5.5	Pilpi Punshi	27 14	8	10	Waste dumping
5	5	25	Sandy	Low	1cm/30'	High	6.0	Utish Dhupi	10 8	6	17	Wood Collection
6	17	5	Sandy Clay	Low	1cm/5'	Low	6.5	Omshing Bamboo	12 25	4	9	Road Construction
7	9	15	Sandy Loam	High	1cm/35'	High	7.0	Dudilo Taga	18 14	6	8	Waste dumping

Source: Prepared from field study, 2015

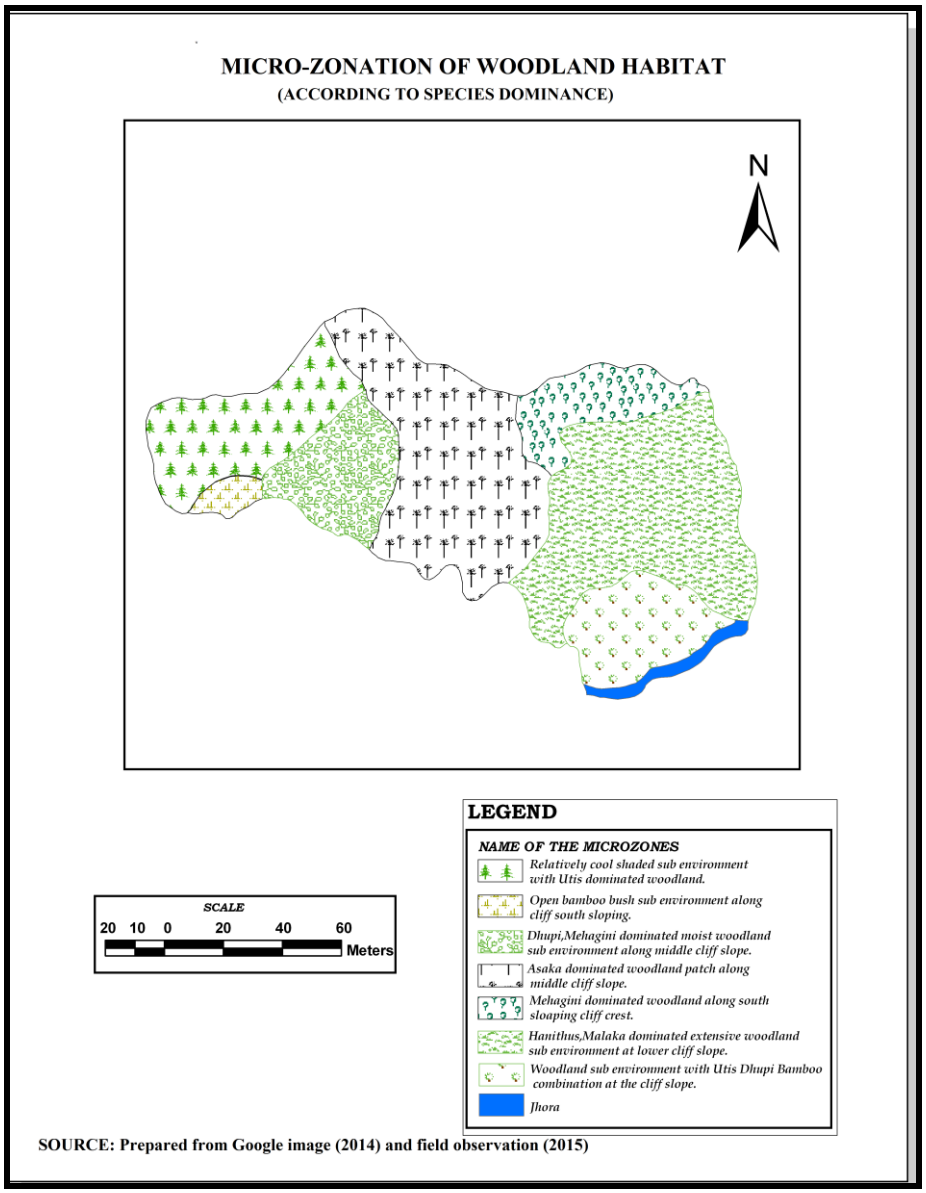


Figure 3

5.2. Nature of Diversity and there Ecological Significance

Woodland habited not only associated with long trees but scrubs and grasses are also found. The diversity of woodland plant is the manifestations of local micro climate, with the increase of moisture availability no. of species increase. Dhupi *(Cryptomeria japonica)* is dominated in each woodland habitat, Dhupi is the most suitable for mountainous environment and association also found with Ashoka (*saeac indica linn*), Utis *(Alnus nepalensis D.Don)* and Bamboo (*Bambusa arundinacea)*. Beside the tree so many shrub, herbs creeper and herbaceous plant are cover the forest floor. These are *Drymaria cordata*, *Hedera helix*, *Azalia sp. Vernomia sp*, *polygonum runcinatum.*

- Woodland in urban areas are important for small mammals
- Many birds including pigeons, crow, and owls, breeding mature trees.
- The seeds and fruits of trees, shrubs and herbaceous plant attract birds.
- Trees whether dead or alive are very important for wide range of invertebrates.
- Dead and deeding wood provides homes for files moths.
- Soil erosion and extremes of temperature are reduced by vegetation.
- Tree act as watersheds, reducing the amount of rain water which needs to be disposed of in drainages system.
- Atmospheric pollution is also ameliorated by trees, particularly since particular material collection leaves and fissures in the bark and in then washed into the soil and reduced dust fall and intercept the suspended particles in the air.
- Other pollutions of urban area such as NOx, SOx, COx and halogens are removed by trees. Bamboo (*Bambusa arundinacea*)
- Urban trees reduced noise pollution.
- Total ecological balance within the habitat maintained by their co-relation and interaction.

5.3. Impact of urbanization on the woodland habitat

The human impact on the environment it is probably started with vegetation. With the increase of urbanization woodland faces so many changes. Human being altered the soil, influences the climate, affects geomorphic process; alter land use and species alteration. These are combinedly affected on the woodland. Natural woodlands are transformed into semi natural woodland habitat.

1) Areal coverage decreases due to deforestation ,
2) Establishment of alien plant species, these are rapidly destroy the Indigenous species .
3) De-colouration and loss of needless and leaves ,
4) Death of herbaceous vegetation beneath trees ,
5) Lichens are also sensitive to the air pollution. Epiphytic lichen flora largely effected by Sulphar dioxide pollution ,
6) Abnormal growth of plant ,
7) Alteration of morphology of leaves ,
8) Excessive heavy metal accumulation in plant reducing leaf litter decomposition.

6. Grassland Habitat

Urban Grassland is fragmented and encircled by urban sprawl & these are often fairly small although they are quit diverse and important habitats especially at a local level grass land are found to occur in relatively drier condition .They occupy the low land & where the soil is acidic in nature supporting the communities of grass and dwarf shrubs .Spatial trend of grass height is determined by the moisture gradient. Grasslands are separated by a soft edge that represents the contrast with the sharper ecotone more usual in urban habitat.

6.1 Nature, Characteristics and distribution of Grassland habitat

Geomorphic location of the grassland are limited at relatively flat and geophysical stable part of the slope grass may classified according to the height – tall grass (2-3 m), middle size grass (1-2 m) and short grass (0.1-0.5 m). Grasses of the mountain environment are restricted by deep penetration of root. Grasslands are mainly dominated by grass & herbs but some time it dotted by trees. grass are the dominant species having needle leaf with sharp edge. Trees are and broad lead herbs depressed zone heavy high moisture content. Slope and soil texture also play important role in determining the grass species composition. Relatively shorter and narrower leaved. Coarse grass covered over the rock exposure at higher elevation. Mixed herbs types are dominant at higher elevation over organic rich sandy loam soil .Some time root mat are found to occur that can hold huge amount of moisture. Root mats are supposed to resist N_2 loss by inhibiting denitrifying micro-organism. A large amount of nutrients is stored in the living biomass and turnover time of this biomass is significantly high.

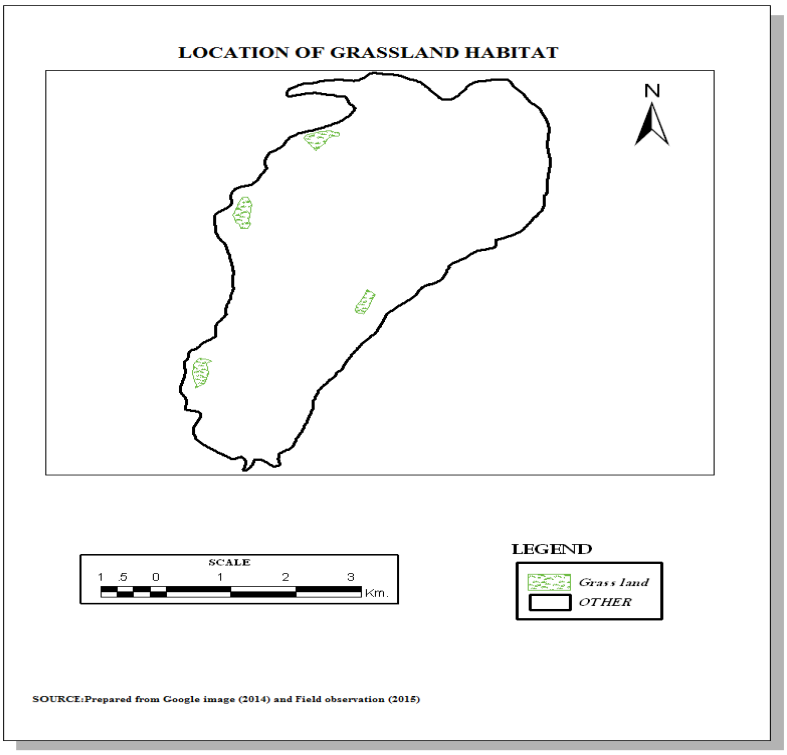


Figure 4

Grasslands are temperature compensation in nature dominated with C4 plants .The species of *legnuminosac, poacceae and asteraceac* are found with the micro level variation in topography; slope and moisture content species composition species characteristics also change .So micro zones within the grassland habitats can be recognized.

6.2. Identification of micro ecological zone:-

In the first case study six micro ecological zones have been identified.

i. Herbaceous flowering plant dominated sub environment at relatively higher elevation having high depth of soil.

Veronia sp. and *Cardaminie sp.* are common terrestrial association they belong to same family along with it both prefer moist and waste land. *Cardamine sp.* also prefer moist shady situation. So, there association is common within the zone.

ii. Broad leaved herb land sub environment at high moisture condition. *Bambusa arundinaeea* are common in sloppy land having sandy texture with moist environment. *Brachiaria* and *Arundinellia sp*. under the *bambusa* shade.

iii. Fine textured very small grasses over fairly drained soil. *Brahiarria sp.* favors moisture condition. *Artemisia nelagrica* and *Bidens bitemala* is the common terristial plant favour the land free from water logging. This zone is relatively elevated basically heap of constructional waste so this species favour to associates here.

iv. Moist herbaceous sub environment at lower elevation. This micro zone is mainly situated at free slope of road dominated with *Bambusa nutaus*. *Geranium sp & Globba sp* are found to occur under the shade of Bambusa which is the favorable condition for both of them.

v. Pure herb land patch over central depression zone. This micro zone is relatively high & it is the forest fringe which is favorable for the growth of *Ponzolzia hirta. cardamina* sp also favored to lived in the forest shades. Due to moist condition give growth to the *Brachiassa.*

vi. Broad and small leaves herb land sub environment at lower elevation. Moist condition of zone gives favorable condition for the growth of *Brachiassia.* There is cemented an old drain in this zone which is favour for the growth of *Dryopteris tilimax.*

Table 2: Hydro-geomorphic Characteristics of Micro-ecological zones of Grassland habitat

Micro zones	Soil Condition			Infiltration rate	Organic matter	P^H	Major Plant Species	Number of Fauna Species		Signature of Urban Stress
	Depth (cm)	Exposure (%)	Texture					Avifauna	Insect	
1	12	25	Sandy	1cm/10'	<0.5	6.5	3	1	2	1. Fragmentation of grassland due to urban sprawl. 2. Over grazing causes huge destruction of
2	10	10	Sandy	1cm/14'	<0.5	7.5	2	1	1	
3	8	10	Sandy	1cm/12'	<0.5	7.0	3	1	1	
4	8	20	Sandy	1cm/6'	<0.5	6.5	2	1	1	
5	12	30	Sandy	1cm/8'	<0.5	6.6	1	1	2	
6	10	35	Sandy	1cm/6'	<0.5	7.0	2	1	1	

Source: Prepared from field study, 2015

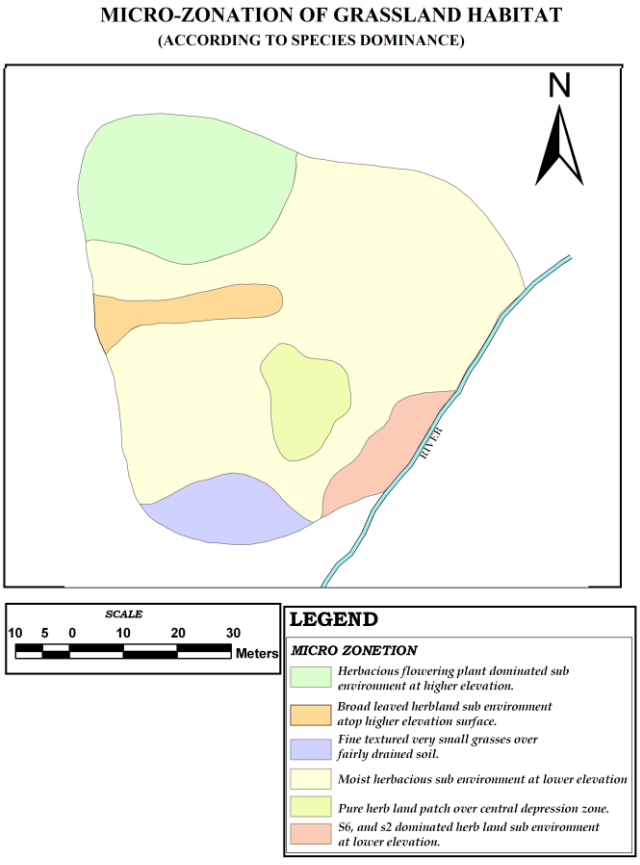


Figure 5

6.3. Ecological Assessment

Being diversified in nature grassland provide a wealth of opportunities for wild life in urban areas occasionally even central city sites so many vascular plants, birds have been recorded in the urban grass land. Grass land plants attract invertebrates, butterflies including other flying insects, snails and web spinning spider. Grassland is very much important for refuge wildlife .grassland boast enormous herds of grazing, browsing hoofed animals including wild beasts. Nutrient cycling phenomena has been found three level i.e. Intra specific cycling, internal cycling and extra system cycling. Grazing in an important factor for maintaining a plant community production .Grass land act an nutrient trapper by reducing surface flow ,soil erosion and leaching that ultimately lead to vigorous growth of plant .It maintain proper ecological pyramids by the balancing plant growth and grazing.

6.4. Impact of Urbanization on Grassland Habitat

i. Continuous disposal of solid waste and adversely effects plants growth.
ii. Industrial wastes are frequently abolished species richness and increases toxicity of soil.
iii. Urban cultivation and pasturing are other threats to the crop land.

7. Major Findings

Major findings of the study are as follows-

1) Urban habitats are giving unique characteristics in comparison to the surrounding rural area.
2) Each micro-zones of a habitat are different in terms of pedo-hydro-geomorphic and species characteristics.
3) Urbanization impacts are clearly seen in woodland and Grassland habitat in terms of waste disposal site, fragmented and isolated habitat, de-colouration of leaves etc.
4) Habitats are under gone changes due to urban pollution. Heavy traffic flow hindered the bird species during breeding periods. Highly threat are found in Woodlands habitats in terms of rapid down cutting of trees, plant diseases due to air pollution. Grassland are occupied by urban developer or captured by urban dweller for agricultural activity.

8. Conclusion

Woodland and grassland habitats are largest habitat within urban area. The ecological and bio-physical criteria have great extent of influence over urban eco-system. Despite of inverse impact of urbanization, Gangtok town is still hold quite unique and commendable rich bio-diversity composition. Habitat management steps should be taken to control unprecedented growth of urban expansion, rapid vegetation destruction. There are huge scope for development of new habitat for the local species within park, pavement and other artificial habitat within the urban space.

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