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Vegetation and Microclimate (Case Study of Shri Mata Vaishno Devi University, Katra J&K)

Architecture

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ABSTRACT

Microclimates are caused by the local differences in the amount of heat or water received or trapped near the surface. A microclimate may differ from its surroundings by receiving more energy, so it is little warmer than its surroundings. On the other hand, if it is shade it may be cooler on average, because it does not get the direct heating of the sun. Its humidity may differ; water may have accumulated there making things damper, or there may be less water so that it is drier. Also, the wind speed may be different, affecting the temperature and humidity because wind tends to remove heat and water vapour. All these influences go into making the microclimate. Microclimates help to explain part of patchiness in vegetation that occurs on the smaller scale, they determine which plant can grow where. Furthermore, microclimates are the building blocks of climate of a particular region.

INTRODUCTION

Microclimate is a climatic condition in a relatively very small area, within a few feet's or less above and below the Earth's surface and within canopies of vegetation. The microclimates of a region are perceived by the parameters such as temperature, moisture and winds of the atmosphere near the ground, vegetation, soil, etc. Wet ground, for example, encourages evaporation and increases atmospheric humidity. The drying of plain soil, on the other hand, creates a surface coating that inhibits ground moisture from dispersing upward, which promotes the diligence of the dry atmosphere. Microclimates control transpiration and evaporation from surfaces and influence precipitation, and so are important to the hydrological cycle—*i.e.,* the processes involved in the circulation of the earth's water.

The initial disintegration of rocks in the process of rock weathering and the subsequent soil formation are also part of the fundamental microclimate. The fracturing of rocks is accomplished by the regular freezing of water trapped in their permeable parts. The final weathering of rocks into the mineral and clay constituents of soils is a chemical process, where such microclimatic conditions as relative warmth and moisture influence the rate and degree of weathering.

Where Microclimates can be found?

Microclimates are generally found in areas near water bodies which may cool the local atmosphere, or densely populated urban areas where concrete, brick and asphalt absorb the sun's energy, heat up, and re-radiate that heat to the ambient air which subsequently forms an urban heat island; a kind of microclimate.

The parameters typically associated with microclimate include conventional variables such as:

- Air temperature
- solar insulation flux
- Wind speed
- Atmospheric humidity
- Air thermal gradient
- Soil temperature
- Wind direction
- Soil moisture content
- Soil thermal gradient
- Wind instability (vertical and horizontal), near surface wind shear
- Animal metabolism and animal behavior

Factors affecting microclimate

- *Soil types:*

The type of soil found in a particular area also affects microclimates. For example; if soil has many air cavities, then the heat would be entrapped below the topsoil, resulting in the increased possibility of frost at ground level. On the other hand; soils heavier in clay content can act like pavement, controlling the near ground temperature.

- *Topography :*

Topography is often important factor since it can lead to confined ponding of water and hence restricted anomalies in relative humidity; the topography greatly affects air flow patterns and localized wind shear, providing exposure to winds or areas of relative shelter. Topography also effects surface runoff, thereby altering upper soil water retention and hence local humidity and temperature.

- *Vegetation:*

Vegetative cover is extremely important factor which influence microclimate, dramatically altering the following:

- Local temperature and humidity,
- Air flow patterns.

Vegetative cover has a deep influence on near surface (wind speed and direction); in extreme cases of a dense forest canopy, a calm zone can be created beneath a forest, in other cases the structure of vegetation simply modifies the airflow. The trees will also alter the wind speed and direction in the surrounding area, thus shaping the microclimate. The density and type of vegetation will alter the rate of water vapor from stomata on leaf surfaces, but will also affect the soil surface evaporation rate; both affecting local humidity and temperature.

SHRI MATA VAISHNO DEVI UNIVERSITY: A CASE STUDY

INTRODUCTION:

Shri Mata Vaishno Devi University (SMVDU) has been established in 2004. The University is located on 470 acres of land in the lap of Trikuta hills, the abode of Shri Mata Vaishno Devi at about 2700 feet above the sea level.

The surrounding green hills and the perennial stream of Jhajjar in the east minimize the effects of hot and cold winds and produce a pollution-free environment on the campus. A moderately

high hill full of trees and plants on the western side of the campus shields the campus, particularly the residential zone, from the long summer afternoons. An early morning and late evening walk, along the Shrine Axis and other loop roads, surrounded by evenly placed lovely trees and clear sky with sparkling stars, is very refreshing for body, mind and the soul.

Such proximity of the campus with spiritually and culturally rich pilgrimage center is an idyllic setting for inspiring the students to reflect on rich traditional and cultural heritage which needs to go hand in hand with keen scientific temper.

BIODIVERSITY

Katra town has been regarded as heaven on earth, and is also called the biomass of state J&K. Katra has fairly rich diversity of plant life. The varied plant life also contributes to food and habitat needs of human population and wildlife. The faunal component of biodiversity of the town is rich with interesting and unique forms both in the forest zone and above forest line. The variety of animal forms ranges from higher groups like vertebrates, including mammals, birds, reptiles, amphibians and lower groups like invertebrates including insects and even unicellular micro-organisms.

VEGETATION

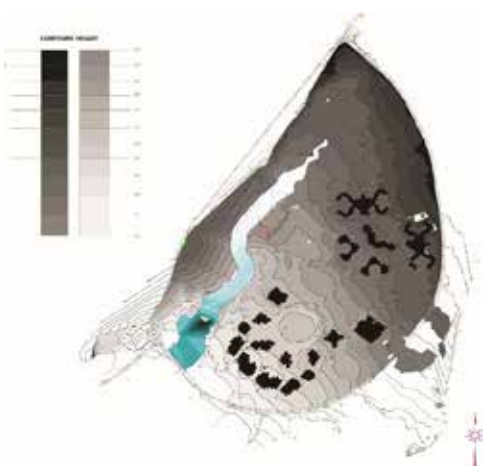

Fig 1: Relief map of site

The composite vegetation of the place includes deciduous, evergreen and coniferous cover and the species mainly include: *Pinus roxburghii, Mangifera indica, Ficus religiosa, Ficus benghalensis, Acacia Arabica, Dalbergia sissoo, Terminalia arjuna, Ficus virens, Cassia fistula, Nyctanthes arbor-tristis, Syzigium cumini, Tectona grandis, Azadirachta indica, Bombax ceiba,Delonix regia,Jacaranda mimosifolia, Alstonia scholaris, Gurvillea robusta.*

TOPOGRAPHY

Situated along the lower Himalayan range, the actual topography map of Trikuta hills provides a broad variety of landforms. The site slopes from northeast corner to the south-west corner with an approximate drop of 30 m. The site is characterized with undulating terrain, vegetation cover, water drains and moderate slopes. Jajjhar river flows on the eastern side of the site. The water channels are preserved from developable area with the presence of 100 m. buffer which runs along the width of the water body overlapping with the steep slopes, which are non-developable.

RAIN FALL

The rainfall is through South-west monsoon, which lasts from July to September. The maximum rainfall occurs during month of July, August and middle of September. During the remaining period, it is intermittent. The average annual rainfall varies between 120 cms to 180 cms. In the year of 1981 rainfall recorded was 2146 mm (as per census record). The higher reaches of Trikuta Hills enroute of Holy cave such as Sanji Chatt and Vaishno Devi Ji Darbar get about 4'and 1' snowfall respectively, in winter month.

SOURCE OF WATER

The main source of water is "Jajjhar nallah" flowing on eastern side of the university. The source of water is the precipitation in the university basin area which gets collected in the artificial lake through surface run-off. During the rainy season when the water level rises in the lake, overflow from the lake take place through outlets (in the form of pipe) which drains into the Khad which joins Jajjhar nallah. The site is also fed by "baolli"- natural spring which is situated on the western hillock; thus providing natural gradient for water flow into the university.

GEOLOGY OF THE AREA

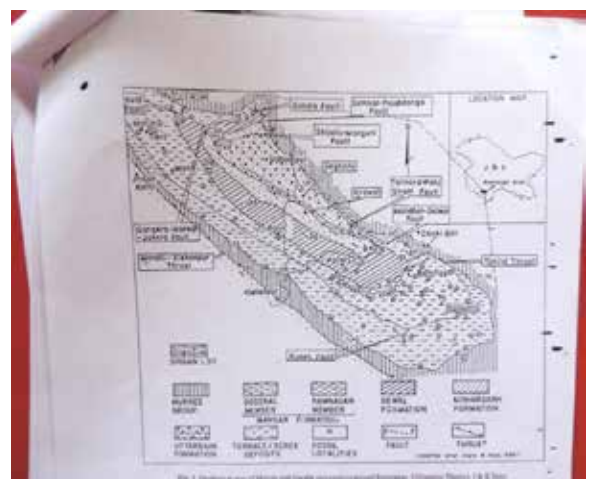

Fig 2: Geological map of the area

The area is classified as Shivalik group of rocks; which is the oldest litho-unit of Shivalik group. It consists of discontinuous layers of fined grained, hard and compact sandstone, siltstone, mudstone and clay. The sandstone are buff, grey and light greenish grey in colour. The clay are brown, purple, yellowish red and red. The huge sandstone bands stand out as prominent small mounds and ridge, while clay and siltstone generally form depressions. At places the stand stone bands contain lenticles of pseudo conglomerate consisting of pellets and fragments of mudstone, claystone and shale which is bounded with arenaceous matrix.

CHANGES IN EFFECTS OF MICROCLIMATE IN S.M.V.D.U

The land use of this area before 2004 was agriculture and forest area. The annual rainfall was recorded between 150mm to 190mm. In summers, whenever the temp increased to 35^0c or above precipitation took place in the form of local rains which was confined within a diameter of 8 kms. Since the area was very green, the area had its own microclimate which was entirely different from the adjoining areas. There was variation in microclimate of the University and its adjoining areas as temperature difference recorded in summers during the past ten years since its evolution in 2004 when huge land was acquired by Shrine Board from the local people for making of the University. It involved large scale construction and native vegetation was cut down for planning new vegetation which led to total change in microclimate of this area. It happened to the extent that there was no or very less rainfall in the initial four years of making of the University campus and the summer temperature

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reached around 42^{0}C during this period; which was supposed to be unusual for the place of Katra where temperature normally goes as high as 38^{0}C.

(a)

(b)

(c)

(d)

Fig 3: Site image of SMVDU in (a) 2004, (b) 2006, (c) 2009, (d) 2012.

In the new landscape (planting design), the fast evergreen trees like *Alstonia scholaris, Jacaranda mimosifolia, Terminalia arjuna, Moringa oleifera, etc.* with some local shrubs were planted which took around 10 years to mature. After 2014, the microclimate is again shaping to its original form, which was observed before 2004. The annual summer temperature has also seen a decline from the last four years and the annual rainfall has increased phenomenally.

CONCLUSION

- Trees influence the microclimate to great extent by reducing the amount of sunlight reaching soils and crops through shading. Trees provide, under their canopies (locally restricted), significant improvements on thermal comfort principally during early afternoon and mid-day as they provide overhead shading by reducing the solar radiation.
- Tree canopies lower temperatures by shading resulting in more topsoil moisture and hence increasing humidity during dry summers and in turn changing the microclimate.
- The existing vegetation should not be cut which results in the change in microclimate of the area. Instead planning of buildings should be done in such a way that the native vegetation is preserved.
- Due to shading and evapotranspiration, the vegetation in hot climates reduced solar radiation and lower air temperature. Lower air temperatures are essential both to limit energy use for cooling and to improve thermal comfort conditions of pedestrians.
- Rows of trees and even isolated trees have a rather small impact on the decrease of air temperatures. However, the lower surface temperatures of façades and roofs caused by the vegetation will contribute to lower cooling loads.

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