GIS Based study on Development of Sericulture Resources in Assam: A Case study of Goalpara & Sibsagar District

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Abstract: *Site suitability analysis for mulberry plantation has been carried out in Goalpara and Sibsagar districts of Assam using Remote Sensing and Geographic Information System (GIS). The study was carried out considering the need for more silk production to fill the gap between demand and supply in recent time. Agriculture plantation sites, Scrub land comprises of dense open or Grassland & grazing land were considered and mapped as the potential sites to be taken for suitability analysis of sericulture plantation. Several other parameters were also considered for site suitability analysis namely- Soil depth, Soil texture, Soil pH, Soil drainage, Slope, Ground water availability & Meteorological conditions. Ultimately after the completion of the analysis both the study areas have been categorised into several classes depending upon their inherent characteristics. Finally, four suitability classes namely – (i) Moderately suitable (ii) Marginally suitable (iii) Highly suitable & (iv) Not suitable have been identified in both the districts based upon number of baseline suitable parameters. Suitability statistics have been generated for different revenue circles of Goalpara and Sibsagar districts to build a future planning strategy for the overall development of mulberry cultivation in the state. Identified suitable areas can be considered for mulberry and non-mulberry plantation by the state sericulture department to meet the increasing demand of silk in the state. Between the two districts Goalpara district shows a positive trend for the future growth and development mulberry plantation in coming years. As a substantial portion of area out of the total geographical area has the possibility to bring under the sericulture plantation scheme by the effort of both Government and local body.*

Key Words: *Sericulture, GIS, Suitability analysis, Cultivable wasteland, Mulberry plantation*

1. INTRODUCTION:

Sericulture is one of the prominent sectors of economy in India and plays an important role in programmes of poverty alleviation. Compared to agricultural crops, sericulture provides more vibrant employment option all-round the year and fetches higher income for rural farm families. Sericulture allows commercialization and diversification of farm enterprises. It is also an environmental friendly farm activity because the silkworm food plants like mulberry, som, etc. are perennial crops protecting the soil from erosion. India continues to be the second largest producer of silk in the world and has the distinction of producing all the four varieties of silk, viz., Mulberry, Eri, Tasar, and Muga. In 2010-11, Mulberry accounted for 80.2%, Eri 13.5%, Tasar 5.7%, and Muga 0.6%, out of the total raw silk production of 20,410 MT in the country. However, total annual consumption of silk in the country is 29,300 MT (*Anon, 2011*). By the year 2025, domestic demand is expected to increase to 45,000 MT/year showing tremendous growth potential in sericulture which could provide additional employment opportunities for up to four million rural families (Patil. *et.al*., 2009). To meet the gap between demand and supply, there is need to increase the area under sericulture host plants. The main activities of sericulture development include food-plant cultivation to feed the silkworms spinning silk cocoons and reeling the cocoons for unwinding the silk filament for processing and weaving (*Anon, 2012*). In India, the major mulberry silk producing states are Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu and Jammu and Kashmir which together account for 92 percent of country's total mulberry raw silk production. Total area under mulberry plantation in the country is 170,000 ha. However, the anticipated achievement is 197,000 ha by the end of the XI Five-year plan (2007–12) against the target area of 218,000 ha (Anon.2011). To meet the target for mulberry plantation and for production of silk as per demand, there is need to identify suitable areas in new and presently unused left out areas also. Therefore, the objective of the present study was to identify the potential areas for cultivation of mulberry food plants in Assam.

2. STUDY AREA:

Goalpara and Sibsagar districts were selected on pilot basis to find out suitable areas for mulberry plantation using the recent techniques of Remote Sensing & Geographic Information System (GIS). Land use suitability and mapping has been recorded as one of the most useful application of GIS (Joerin. *et.al*, 2001). Geospatial techniques

were earlier used to map the existing and potential areas under sericulture at 1:250,000 scale in different parts of the country (Nageswara Rao. *et.al.*1991). Remote sensing in the present study has been used for preparation of different thematic maps & GIS for spatial analysis to find out the suitable areas in the study area and map those areas at 1:50,000 scale. Maximum average temperature reaches up to 32° C in May-June, minimum average temperature falls up to 10° C in December-January. The Goalpara district is predominantly (about 80%) covered by remnants of Meghalaya plateau. The total area of Goalpara district is 1969.21 Km^2. It exists between latitude 25°53'47''N to 26°13'34''N and longitude 90° 06'59''E to 91° 05'58''E. The normal average rainfall in the district is 1500 mm. Maximum average temperature reaches up to 32° C in May-June, minimum average temperature falls up to 15° C in Dec-Jan. Goalpara district receives most of the rainfall during monsoon season. Sibsagar district is another important district for the future development of sericulture based activities IN Assam. The total area of Sibsagar district is 2668 sq.km. Sibsagar lies between 26.45°N and 27.15°N latitudes and 94.25°E and 95.25°E longitudes. Sibsagar district enjoys a cold winter and cool and pleasant spring. The district is characterized by highly humid atmosphere and abundant rains. Rainy season sets in the middle of June and lasts till September. The location extent of Goalpara and Sibsagar districts has been represented in Figure.1.Soil is predominantly alluvial in nature and suitable for sericulture cultivation.

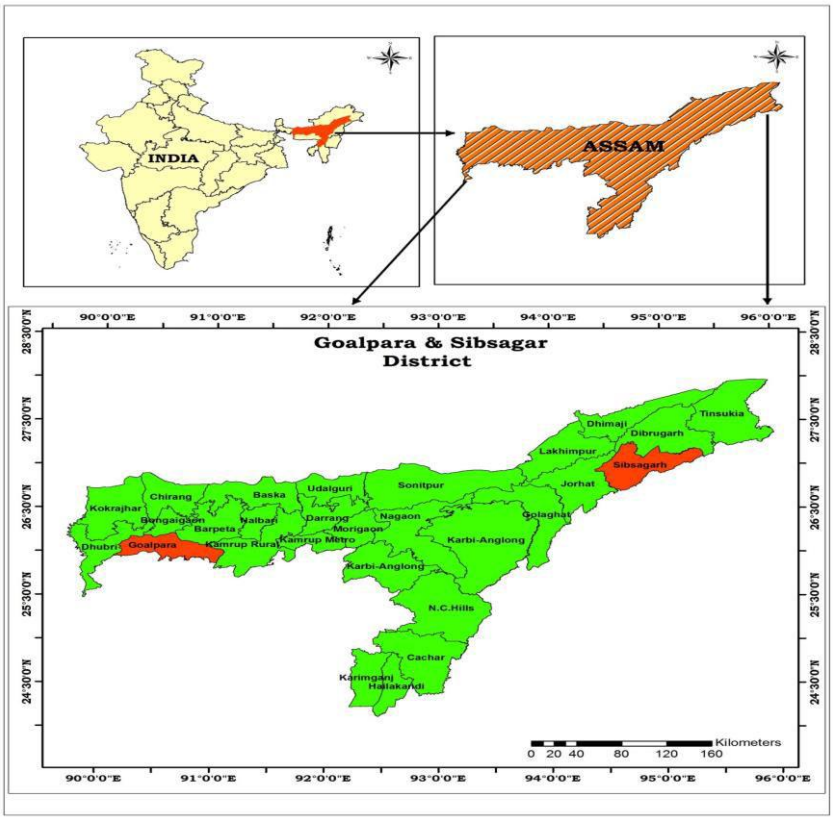

Figure1. Location map of Goalpara & Sibsagar District

3. METHODOLOGY & MATERIALS:

Mulberry silk comes from the silkworm, *Bombyx mori* L. or *Bombyx textor* in Assam (Pat). Brilliant white or off-white coloured silk thread is derived and is mostly used for its very bright texture. Which, solely feeds on the leaves of mulberry plant. Different parameters based on (a) Topography (b) Soil characteristics and (c) Climatic conditions applied for identification of suitable areas for mulberry plantation have been given in Table.1 Information on these parameters were generated in spatial domain at 1:50,000 scale using the geospatial techniques except climatic parameters.

Methodology has been illustrated in Figure 2. Suitability mapping was carried out within the cultivable wasteland sites of each district, which was masked from the Agricultural plantation, Scrub land (dense & open) & Grass/Grazing land database of respective district prepared using three seasons, viz., rabi (Jan–Mar), kharif (Aug–Nov), and zaid (Apr–May). LISS –IV satellite data of Goalpara & Sibsagar districts were utilized for the generation of overall Landuse/Land cover maps. Satellite data has a spatial resolution of 5.6 m with four spectral bands, two in the visible, one in near-infrared and one in the SWIR (Short wave Infrared) region. Survey of India (SOI) topographic maps have been used for generation of different layers, viz., roads, railways, settlements, drainage-notified forest boundaries and spot heights. These layers have been used for planning and carrying out the Ground Truth operation. A reconnaissance survey was carried out before starting the onscreen interpretation for wasteland mapping by taking the hard copy print outs of satellite images and SOI topographic maps.

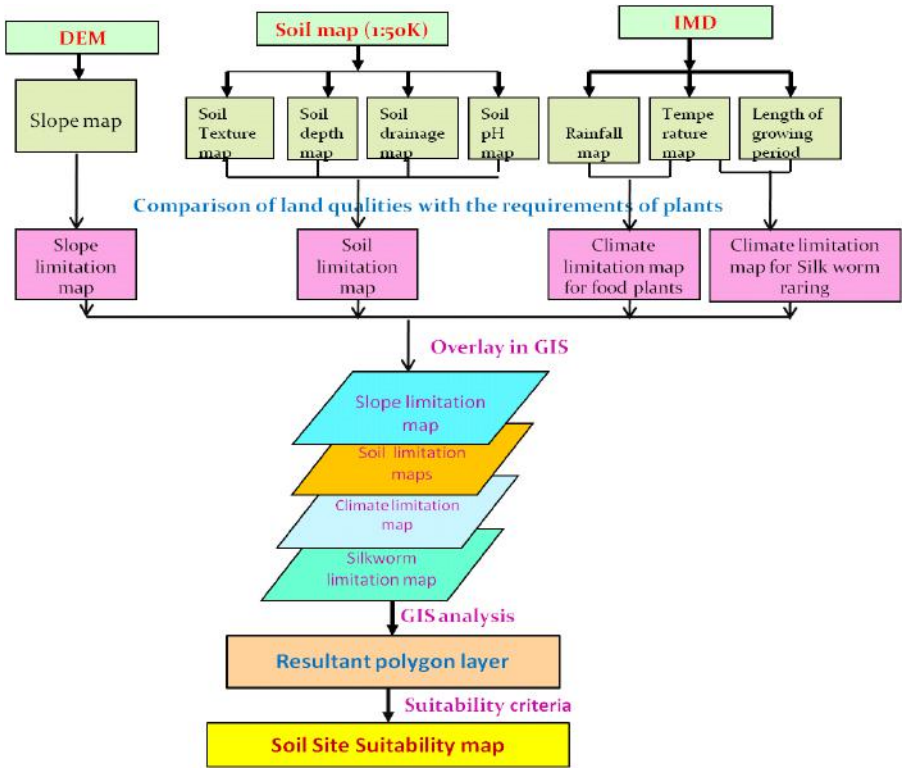

Figure 2. Flowchart showing the Methodology followed for Soil suitability analysis

Transects in different directions had been followed to collect Ground Truth points and to generate the interpretation keys for different classes. The satellite image was displayed on the computer screen at 1:35,000 scale for onscreen visual interpretation. Open scrub & dense scrub categories were considered as cultivable wasteland. Polygons of cultivable wasteland were masked out from the output wasteland vector layer.

Table 1. *Suitability Criteria for Mulberry Plantation*

Soil-site characteristics		**Degree of limitation & Suitability class**			
Limitation **Suitability**	**Unit**	**0-1** **None to slight** **S1** **(Highly suitable)**	**2** **Moderate** **S2** **(Moderately suitable)**	**3** **Severe** **S3** **(Marginally suitable)**	**4** **Very severe** **N** **(Not suitable)**
Topography and landscape					
Slope	(%)	0-5	5-15	15-33	>33
Soil characteristics					
Drainage	Class	Well	Moderately well	Imperfect	Poor/Excessive
Ground water	Availability	Good	Fair	Fair to moderate	Poor
	Quality (EC mmohs/cm)	Very good < 2000	Fair to good 2000 - 3000	Moderate 3000 - 4000	Poor > 4000
Texture	Class	Clay loam–gravelly clay	Fine loamy	Coarse loamy	Sandy fragmental
Depth	Cm	>100	75-100	50-75	<50
pH		6.5-7.5	5.5-6.5 7.5-8.5	4.5-5.5 8.5-9.5	<4.5 >9.5

Soil mapping units were delineated based on physiographic and land use/land cover maps prepared by Assam Remote Sensing Application Centre (ARSAC), Guwahati. A field survey was conducted for studying soil profiles representing all the delineated soil units following Soil Survey Manual (Anon.1970). Each polygon was attributed

based on the dominant soil series in association with other semi-dominant soil series and correlated with the soil series already established for the area. Soil series consist of pedons that are grouped together because of their similar pedogenesis, soil chemistry, and physical properties. The representative samples from each profile were chemically and mechanically analysed. The soil map was categorized based on the drainage, texture, depth and pH. Ground water status map with input of water yield was taken from the Atlas prepared by National Remote Sensing Centre, Hyderabad, under the project Rajiv Gandhi National Drinking Water Mission (Anon.2010).

Slope map was prepared by taking the digital elevation model as input generated using CARTOSAT DEM with a spatial resolution of 2.5 mt. with a recording swath of 30 km. Slope map was categorized in different slope categories, viz., level to very gentle, gentle, moderate and steep.

Meteorological databases were generated from downloading last two decades records from www.indiaweatherportal.com an open access website. Length of growing period (LGP) was computed for the plant growth when precipitation exceeds 50 percent of the potential evapotranspiration (PET). Monthly potential evapotranspiration was calculated using Thornthwaite method (Thornthwaite, 1947). One hundred twenty days LGP has been considered suitable for mulberry. All the layers, viz., soil, slope and ground water were masked using the cultivable wasteland layer (open scrub) as an input. All these layers were overlaid and intersected using "Analysis Tool" function of Arc GIS 10.4 software package to identify the suitable sites for mulberry plantation in Goalpara & Sibsagar districts respectively. Later, area statistics were generated for each suitability classes using "Field calculator" function. Finally, village boundary was overlaid over suitability map to generate suitability statistics for different villages of Goalpara and Sibsagar districts to delineate the ideal suitable sites for micro level planning and management.

4. RESULTS & DISCUSSION:

It has been already mentioned that classes like Agricultural Plantation, Scrub land (dense & open) and Grassland/Grazing land were defined as "Wasteland" category that can be brought up under vegetation cover with reasonable effort and which are currently under-utilized and deteriorating due to lack of appropriate water and soil management or on account of natural cause." (Anon,1991). Different wasteland categories identified were Dense scrub, Open scrub, Grassland/Grazing land and gullied land. In Goalpara, wasteland occupied 31.13 % of total geographical area. Agricultural plantation showed dominance and occupied 59.73% of total wasteland category followed by Scrubland open (19.00%) and Scrubland dense (11.97%). Grassland/Grazing land occupies 9.28% of total wasteland category. In Sibsagar district, wasteland occupied 19.46% of total geographical area. Similarly, in Sibsagar district also agricultural plantation occupies 18.41% of total wasteland area which stands highest followed by Scrubland dense 0.52%, Scrubland open 0.46% and with 0.09% Grassland/Grazing land accounts the least share of area.

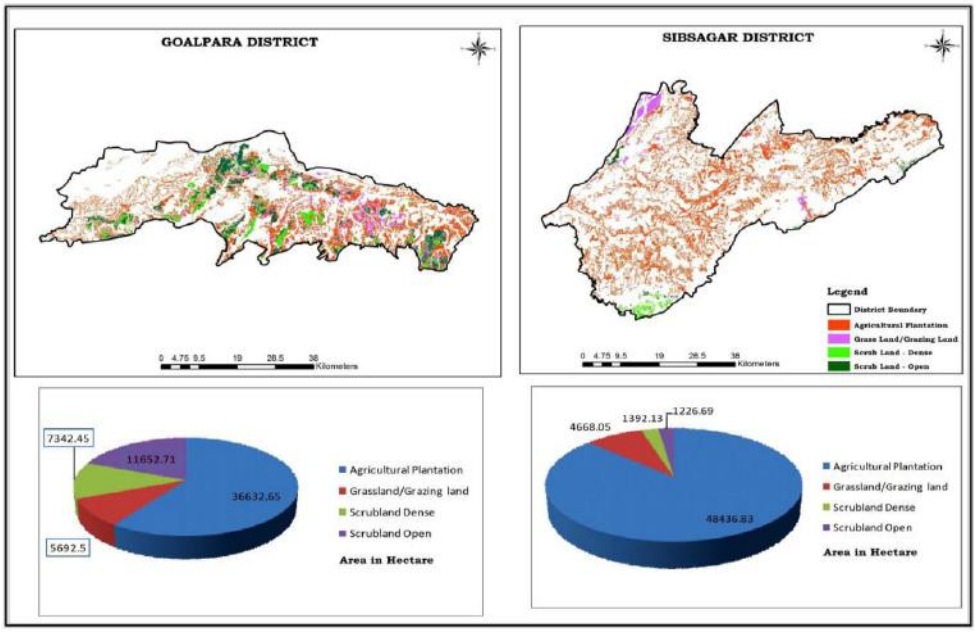

Figure 3. Distribution of Wastelands in Goalpara & Sibsagar Districts

In Goalpara district, several soil mapping units have been delineated associated with 5 soil parameters. In entire Goalpara district level of Soil depth is mostly more than 100 cm (Figure.3), pH ranged between 4.78 to 6.75 (Figure.3), only five classes of texture were recorded, i.e., Fine Silty, Sandy, Clayey, Fine and Very Fine (Figure.3). Drainage pattern was represented in three classes namely- Well drained, Moderately well drained and Imperfectly drained (Figure.3). Ground water availability in both the districts has been categorized into Imperfect, Moderate &

Poor or Well (Figure 3,4). Slope pattern was categorized in four classes starting from 0-3, 3-5, 5-15 and more than 15 (Figure.3).

In Sibsagar district as like Goalpara district several numbers of soil mapping units have been identified based on variations in physiography, image characteristics and categories have been identified during the field observation.

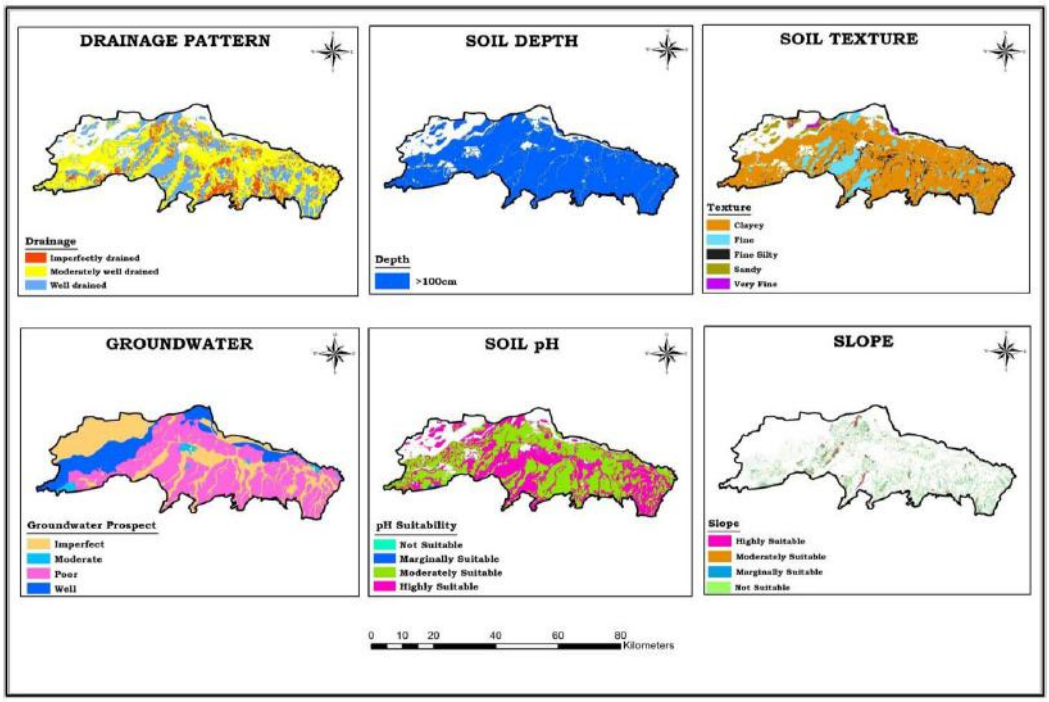

Figure 4. Drainage, Depth, Texture, Groundwater, ph & Slope pattern of Goalpara District

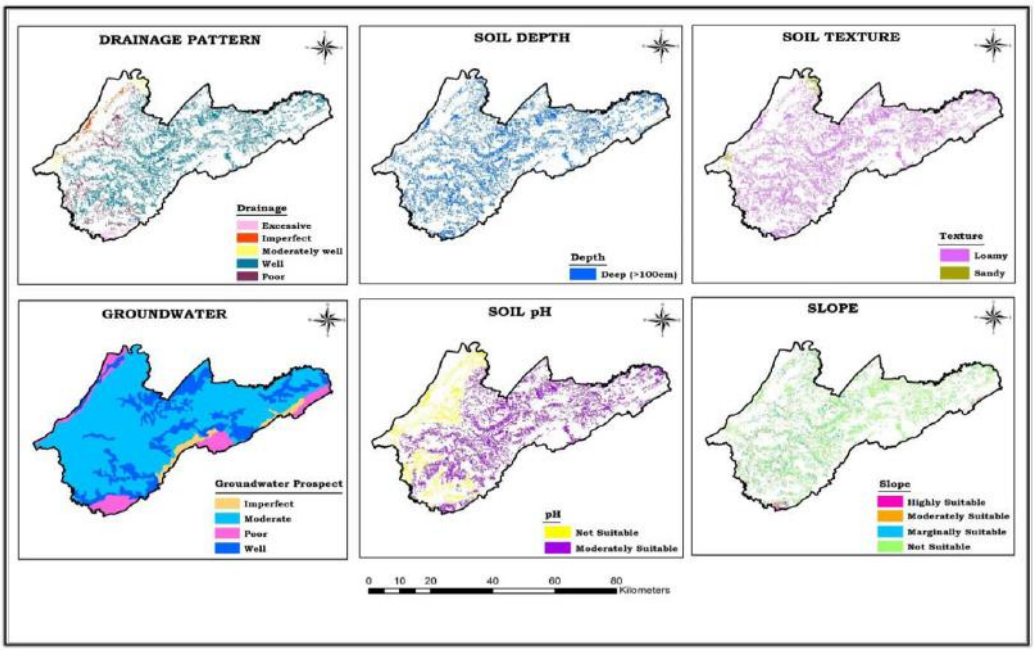

Figure 5. Drainage, Depth, Texture, Groundwater, ph & Slope pattern of Sibsagar District

In entire district Soil depth is more than 100 cm except few places (Figure.4), pH ranges in between 4.5 to 5.5 (Figure.4), soil texture in the entire district is mostly loamy in nature, drainage pattern was represented in all the four classes same as like Goalpara district (Figure.4). Ground water availability has been classified into Well, Moderate, Poor and Imperfect categories. Slope pattern found in between level to very gentle to steep (Figure.4).

Suitability level of meteorological parameters for Goalpara and Sibsagar districts have been presented in Table.1 & Table.2. Suitability for temperature was high and for rainfall suitability was moderate in both the districts. Length of growing period for mulberry plants was 150 days and 120 days for Goalpara and Sibsagar districts respectively. Overall climatic suitability was high in both districts.

Table 2: Climatic Suitability for Mulberry in Goalpara and Sibsagar Districts

Climatic	**Goalpara**			**Sibsagar**		
Characteristics	Existing		Overall	Existing		Overall

	Condition	Suitability	Suitability	Condition	Suitability	Suitability
Mean temperature (°C)	24.55	Highly suitable (S1)	Highly suitable (S1)	23.17	Highly suitable (S1)	Highly (S1)
Total rainfall (mm)	236.56 mm	Moderately suitable (S2)		531 mm	Moderately suitable (S2)	
LGP (days)	150 days			120 days		

The total area under wasteland category in the entire state of Assam is 7457.92 sq.km and out of the total area the area under Dense scrub forest is 188147.30 ha. followed by Open scrub category 2334.56 ha. and area under Agricultural plantation is 383645.40 ha. Using present approach, suitability analysis for mulberry plantation can be carried out for all the districts of Assam. Further, land with open scrub of entire country which occupied 93033 km^2, i.e., 20% of total wasteland area can be taken for mulberry suitability analysis.

Table 3. Area under Different Suitability Classes in Different Revenue circles of Goalpara district.

Revenue Circle	**Highly Suitable** (In Ha.)	**Moderately Suitable** (In Ha.)	**Marginally Suitable** (In Ha.)
Rangjuli Circle	NA	135.83	1920.93
Dudhnoi Circle	NA	2.53	841.89
Matia Circle	16.22	226.03	2356.01
Balijana Circle	361.06	368.48	2257.34
Lakhipur Circle	326.59	1320.52	1670.16

Table 4. Area under Different Suitability Classes in Different Revenue circles of Sibsagar district

Revenue Circle	**Highly Suitable** (In Ha.)	**Moderately Suitable** (In Ha.)	**Marginally Suitable** (In Ha.)
Sibsagar Circle	NA	NA	4846.66
Nazira Circle	NA	NA	8201.52
Mahmora Circle	NA	NA	8477.71
Dimow Circle	NA	NA	7453.42
Amguri Circle	NA	NA	4519.02
Sonari Circle	NA	NA	15916.40

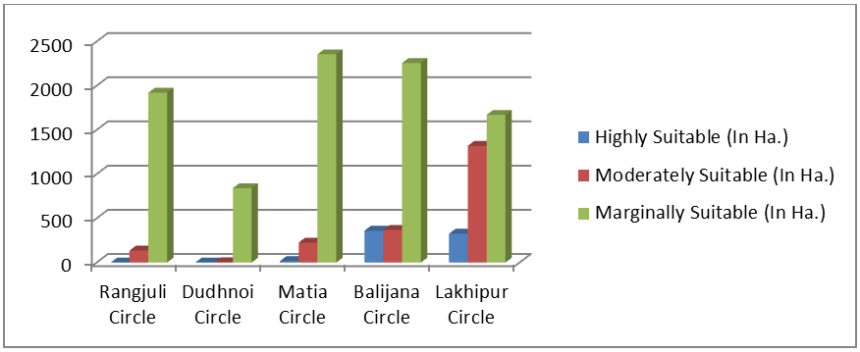

Figure 6. Diagram showing the distribution of suitability classes in revenue circles of Goalpara district

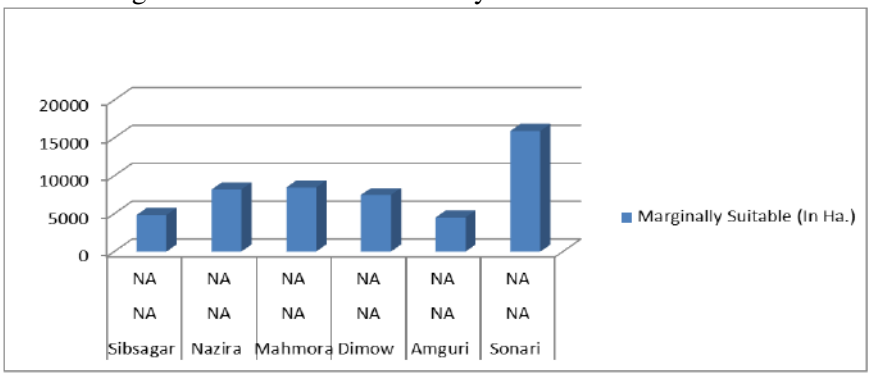

Figure 7. Diagram showing the distribution of suitability classes in revenue circles of Sibsagar district

In both the districts Cropland and agricultural land is currently covering a significant portion of land. Suitability analysis for Goalpara & Sibsagar districts shows that there is a high possibility of finding out more suitable

sites for mulberry plantation in future. Present study was carried out at a micro level presently, in Goalpara district Balijana revenue circle offers highest area under highly suitable class with 361.06 ha of land, followed by Lakhipur circle 326.59 ha and Matia circle 16.22 ha respectively. Main patches of highly suitable areas in Matia circle are visible in the centre and southern part, followed by Balijana (368.48) and Matia (226.03) circles. Whereas, a highest concentration of moderately suitable areas are mainly concentrated in Lakhipur circle. Amongst all the revenue circles of Goalpara district Dudhnoi offers the least areas under suitable sites for mulberry cultivation in all three categories of highly, moderately and marginally suitable categories. It is mainly because a large shrunk of land area under rubber plantation and teak forest in the entire Dudhnoi circle.

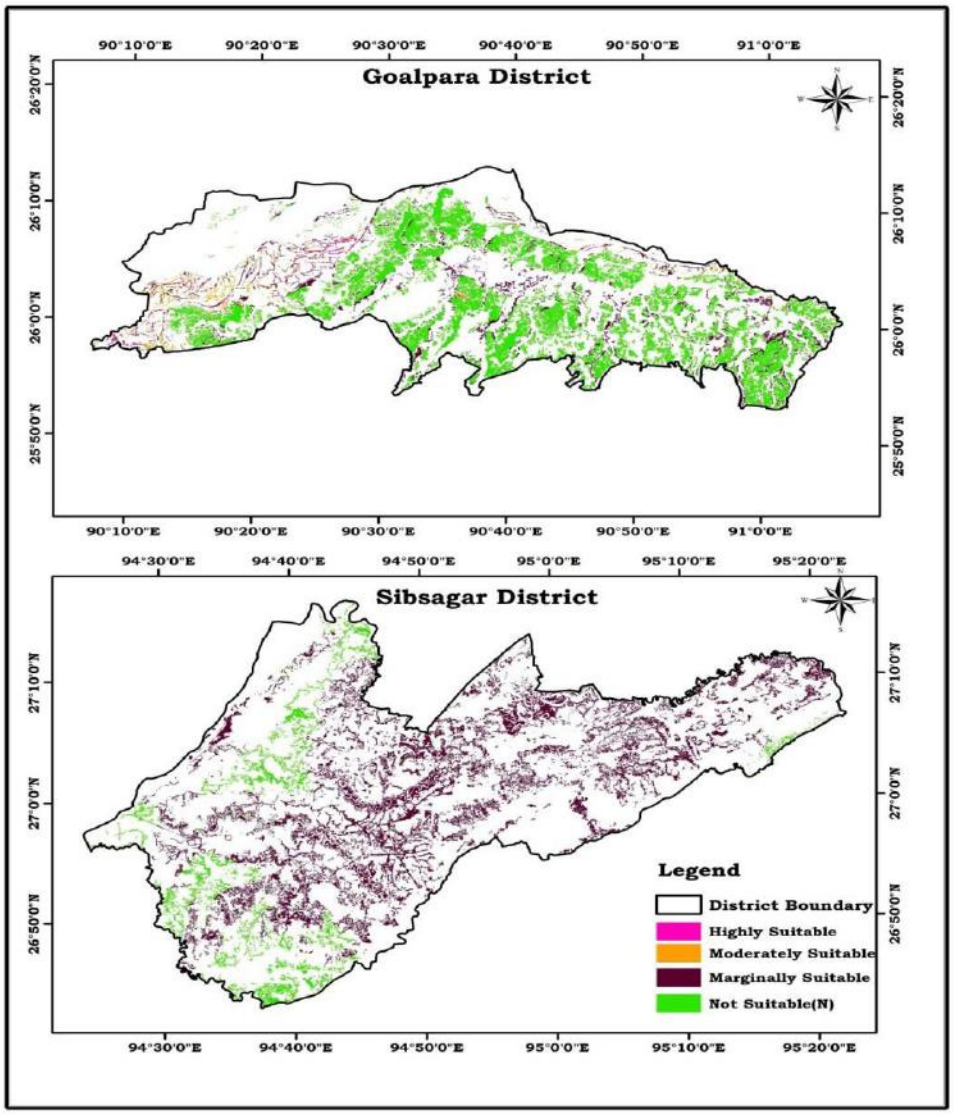

Figure 8. Mulberry Plantation Suitability Map of Goalpara & Sibsagar District

On the other hand, the area under probable suitable sites for mulberry plantation in Sibsagar district is not that much available in comparison to Goalpara district. Analysis shows that in all the revenue circles of Sibsagar district the availability of suitable sites for sericulture development is not that much noticeable. In all the revenue circles existence of highly and moderately suitable land is totally negligible. Sonari offers has the largest area under marginally suitable category of land which stands at 15916.40 ha followed by Mahmora, Nazira, Dimow, Sibsagar and Amguri circle respectively. There is not any significant area under Highly and Moderately suitable site for mulberry cultivation in the entire Sibsagar district it can be attributed to the presence of less amount of wasteland category of land. In the entire district existence of a large numbers of tea garden is also contributed to the non-availability of highly and moderately suitable sites in the district. So, the cultivation of mulberry can provide employment throughout the year. Additionally, mulberry leaves are food for cattle being highly palatable and digestible (70%–90%) to herbivorous animals and can also be fed to monogastrics. Therefore, there is an urgent need to take the suitable sites under mulberry plantation by the sericulture department.

5. CONCLUSION:

The present study utilized the techniques of remote sensing and GIS for mapping of suitable areas for mulberry cultivation in different parts of the state. This kind of particular study opens the scope for massive future

expansion of sericulture farm development in the state. Although, in the more emphasis has been put on the plantation of mulberry plant in the highly suitable, moderately suitable & marginally suitable areas of the respective districts but areas mapped under the currently not suitable category can be further converted to highly suitable, moderately suitable or marginally suitable areas. Increment of area under mulberry plantation will provide employment opportunities to farmers resulting socio-economic empowerment of the farmers. Along with the other traditional farm practices sericulture practices in the selected sites of the mentioned districts can overall benefit the local people in economic terms. This goal can be achieved by the active support of concerned state government authorities.

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