Geomatics-based agroclimatic characterization of Meghalaya

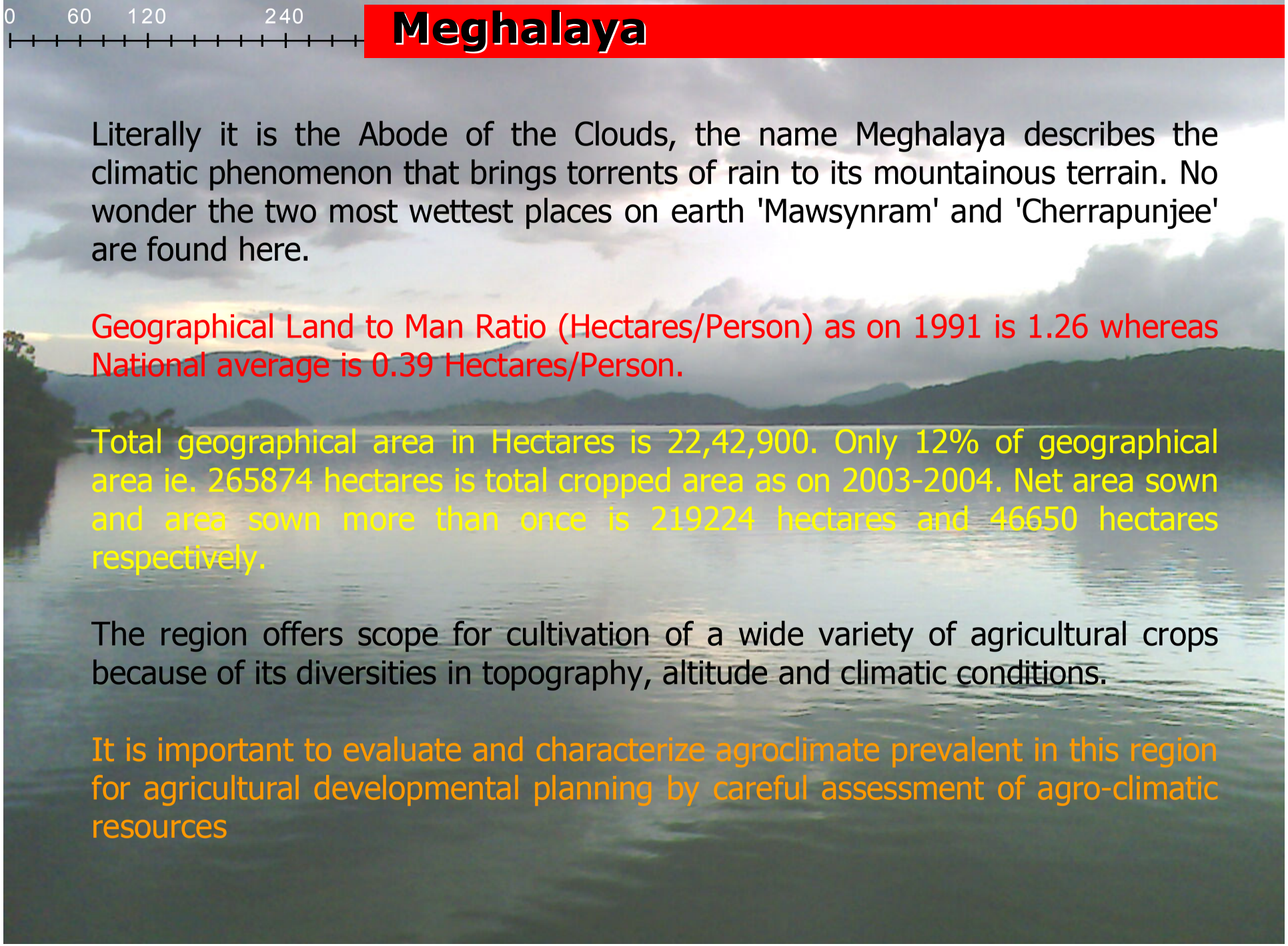
J.GOSWAMI

(Email: jonali.goswami@nesac.gov.in)

North Eastern Space Applications Centre
Dept. of Space, UMIAM-793103



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Meghalaya

Literally it is the Abode of the Clouds, the name Meghalaya describes the climatic phenomenon that brings torrents of rain to its mountainous terrain. No wonder the two most wettest places on earth 'Mawsynram' and 'Cherrapunjee' are found here.

Geographical Land to Man Ratio (Hectares/Person) as on 1991 is 1.26 whereas National average is 0.39 Hectares/Person.

Total geographical area in Hectares is 22,42,900. Only 12% of geographical area ie. 265874 hectares is total cropped area as on 2003-2004. Net area sown and area sown more than once is 219224 hectares and 46650 hectares respectively.

The region offers scope for cultivation of a wide variety of agricultural crops because of its diversities in topography, altitude and climatic conditions.

It is important to evaluate and characterize agroclimate prevalent in this region for agricultural developmental planning by careful assessment of agro-climatic resources

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Agroclimatic zones of NE Hill Region

NARP* map shows regional level classification

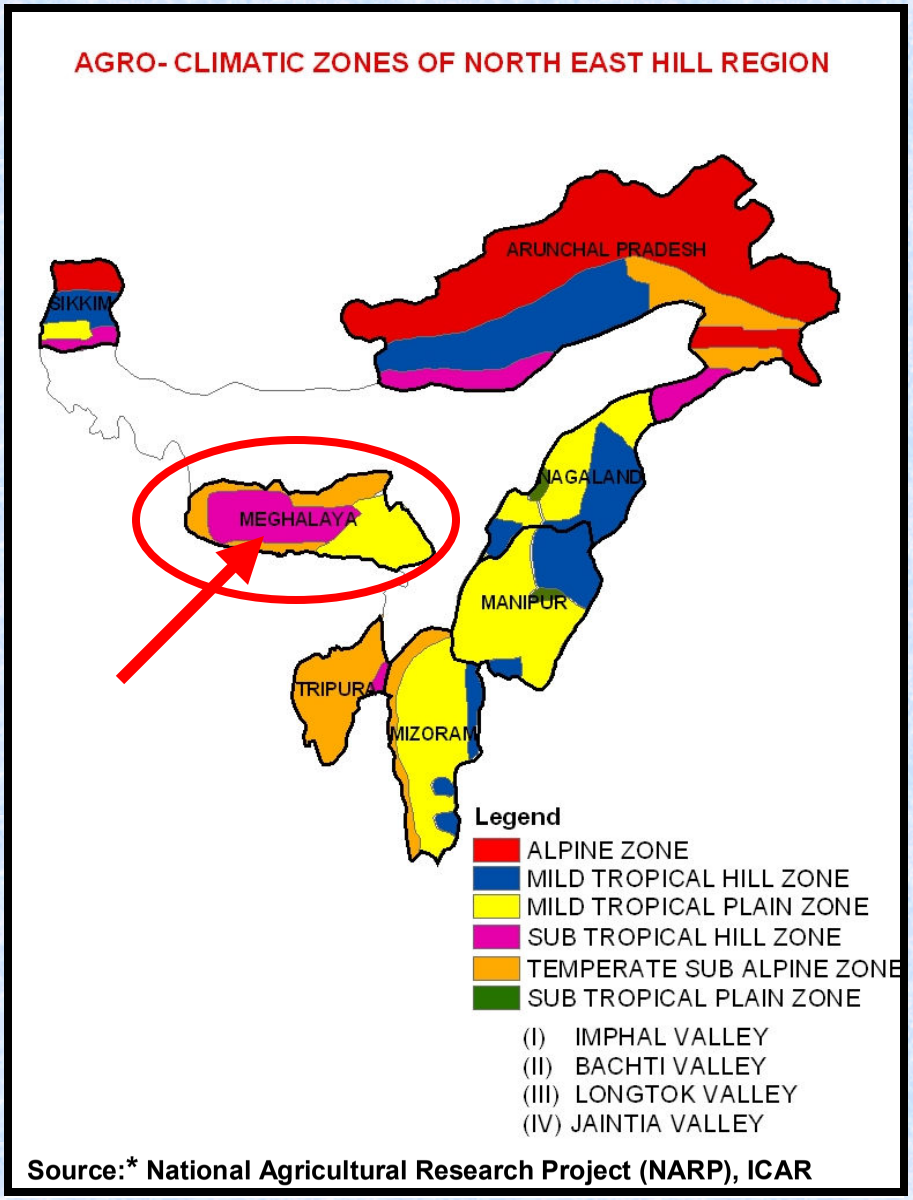
There is no clear line of demarcation between two zones.

Climatic parameter are often taken as non spatial data in GIS environment.

Information on spatial distribution of temperature, rainfall etc at varying scale are not available like other spatial layers such as land use land cover, geology, geomorphology, drainage etc.

Detailed information on agroclimatic zone at large scale (District/block level) is a limitation for proper decision making.

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Study area and Data Used

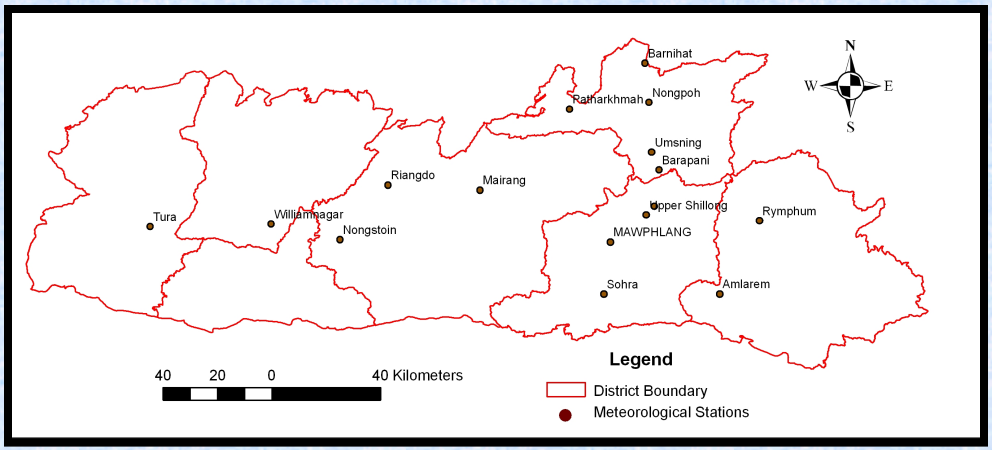
Spatial Information:

- **Administrative Boundary**
- **Digital elevation map.**
- **Land Use and Land Cover (LULC) map.** (Natural Resources Database, NRDB; Biodiversity project).
- **Soil map at 1:2,50,000 scale.** (National Bureau of Soil Survey and Land Use Planning, NBSS&LUP).

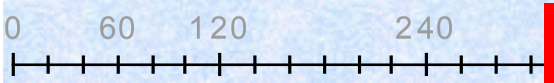
Non Spatial Information

- **Weather data : rainfall, maximum and minimum temperature for aleast 10 years.**
- **Information on Agroclimatic zone of Meghalaya.**

Study area

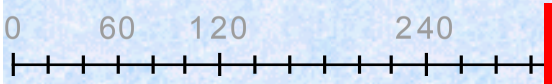


Meghalaya State



Spatial information generated.....

- MAXIMUM/MINIMUM TEMPERATURE
- RAINFALL
- POTENTIAL EVAPOTRANSPIRATION(PET)
- AGROCLIMATIC INDICES: MOISTURE INDEX
- AGROCLIMATIC INDICES: THERMAL INDEX
- AVAILABLE WATER CAPACITY(AWC)
- AGROCLIMATIC ZONE MAP



SPATIAL DISTRIBUTION OF TEMPERATURE

Long term monthly and annual averages of mean temperature of all the stations when regressed against corresponding elevation data, a good correlation was observed between annual mean temperature and elevation.

Annual mean temperature=27.346-0.0066 × elevation, R2=0.93).

0 60 120 240

SPATIAL DISTRIBUTION OF RAINFALL

The spatial variation of annual rainfall was generated in GIS environment using kriging interpolation technique where surface was created based on the formula given in Eq.1

Kriging assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the surface.

$$Z(s_o) = \sum_{i=1}^{N} \lambda_i Z(S_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.1$$

where:

$Z(s_o)$ = the value at the prediction location s_o.

$Z(s_i)$ = the measured value at the i^{th} location.

λ_i = an unknown weight for the measured value at the i^{th} location.

N = the number of measured values.

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SPATIAL DISTRIBUTION OF POTENTIAL EVAPOTRANSPIRATION(PET)

Monthly potential evapotranspiration (mm) is calculated for all the stations by Thornthwaite method(1948).

$$PET = 16 \times C \times (10 \times T/I)a \quad \text{for } T \leq 26.5^0C \quad \ldots\ldots\ldots\ldots\ldots \text{eq.2}$$

$$PET = C \times (-0.43253 \times T2 + 32.244 - 415.85 \times T) \quad \text{for } T > 26.5^0C \quad \ldots\ldots \text{eq.3}$$

Where

PET = Potential evapotranspiration (mm/month)

T = Mean monthly temperature (0C)

I = annual heat index for 12 months in a year ($I = \sum i$)

i = Monthly heat index $\{i = (T/5)1.514\}$

a = 6.75×10-7×I3-7.71×10-5×I2×1.792×10-2×I×0.49239

C = Correction factor for each month

C = (m/30) × (d/12)

m = No of days in a month, d = Monthly mean daily duration in hour

Average annual PET were regressed against temperature data and the relation developed were used to get spatial distribution of PET.

Annual PET=7.5942 × annual mean temperature-66.384, R2= 0.97

0 60 120

SPATIAL DISTRIBUTION OF AVAILABLE WATER CAPACITY(AWC)

AWC of soil for different combinations of soil texture and vegetation cover was generated based on the Thornthwaite and Mather(1957) method. AWC is calculated using LULC and soil layers.

Table 1: Available water capacity of soil in different combinations of soil texture and vegetation type.

Vegetation	Soil texture	AWC (mm)	Vegetation	Soil texture	AWC (mm)
Shallow rooted Crop	Fine sand	50	Orchards	Fine sand	150
	Fine sandy loam	75		Fine sandy loam	250
	Silt loam	125		Silt loam	300
	Clay loam	100		Clay loam	250
	Clay	75		Clay	200
Moderately deep rooted Crop	Fine sand	75	Mature Forest	Fine sand	250
	Fine sandy loam	150		Fine sandy loam	300
	Silt loam	200		Silt loam	400
	Clay loam	200		Clay loam	400
	Clay	150		Clay	350
Deep rooted Crop	Fine sand	100			
	Fine sandy loam	150			
	Silt loam	250			
	Clay loam	250			
	Clay	200			

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AGROCLIMATIC CHARACTERIZATION OF THE STUDY AREA USING ANNUAL WEATHER VARIABLES:

Two agroclimatic indices, moisture index (MI) and thermal index(TI) by Krishnan and Mukhtar Singh(1972) were worked out using following equation

$$MI = \frac{P - PET}{PET} * 100$$

Where, MI= Moisture Index,
P = Precipitation,
PET= Potential Evapotranspiration

Sl. No.	Moisture Index Value	Climatic group
1	<80	Extremely Dry
2	-80 to -60	Semi Dry
3	-60 to -40	Dry
4	-40 to -20	Slightly Dry
5	-20 to 0	Slightly Moisture
6	0 to 50	Moisture
7	50 to 100	Wet
8	>100	Extremely Wet

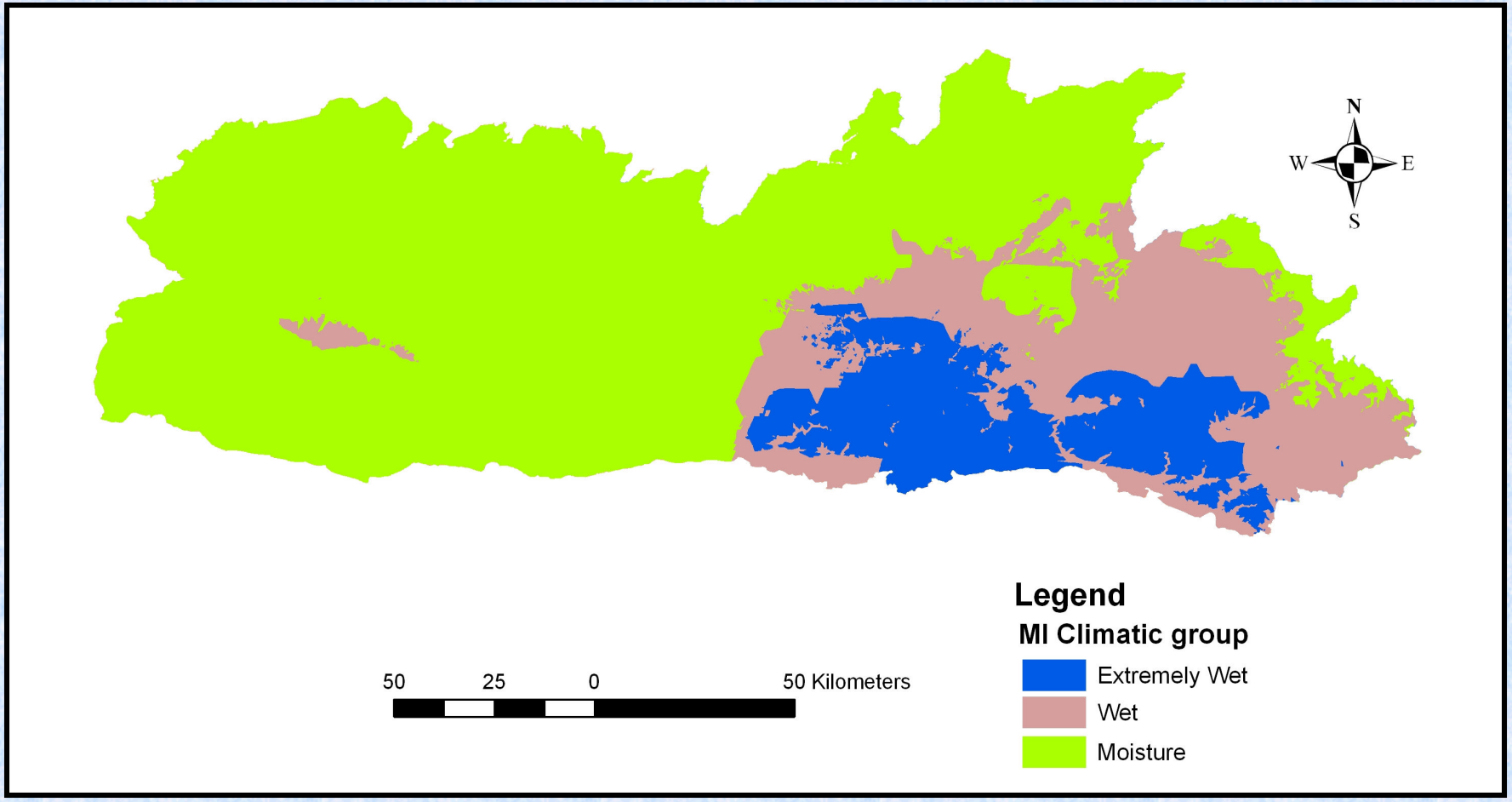
$$TI = \frac{T_{max} + T_{min}}{2}$$

Where, TI= Thermal Index
Tmax= Maximum temperature
Tmin= Minimum Temperature

Sl. No.	Thermal Index Value	Climatic group
1	>28°C	Very Hot
2	25°C to 28°C	Hot
3	20°C to 25°C	Mild
4	10°C to 20°C	Cold
5	<10°C	Very Cold

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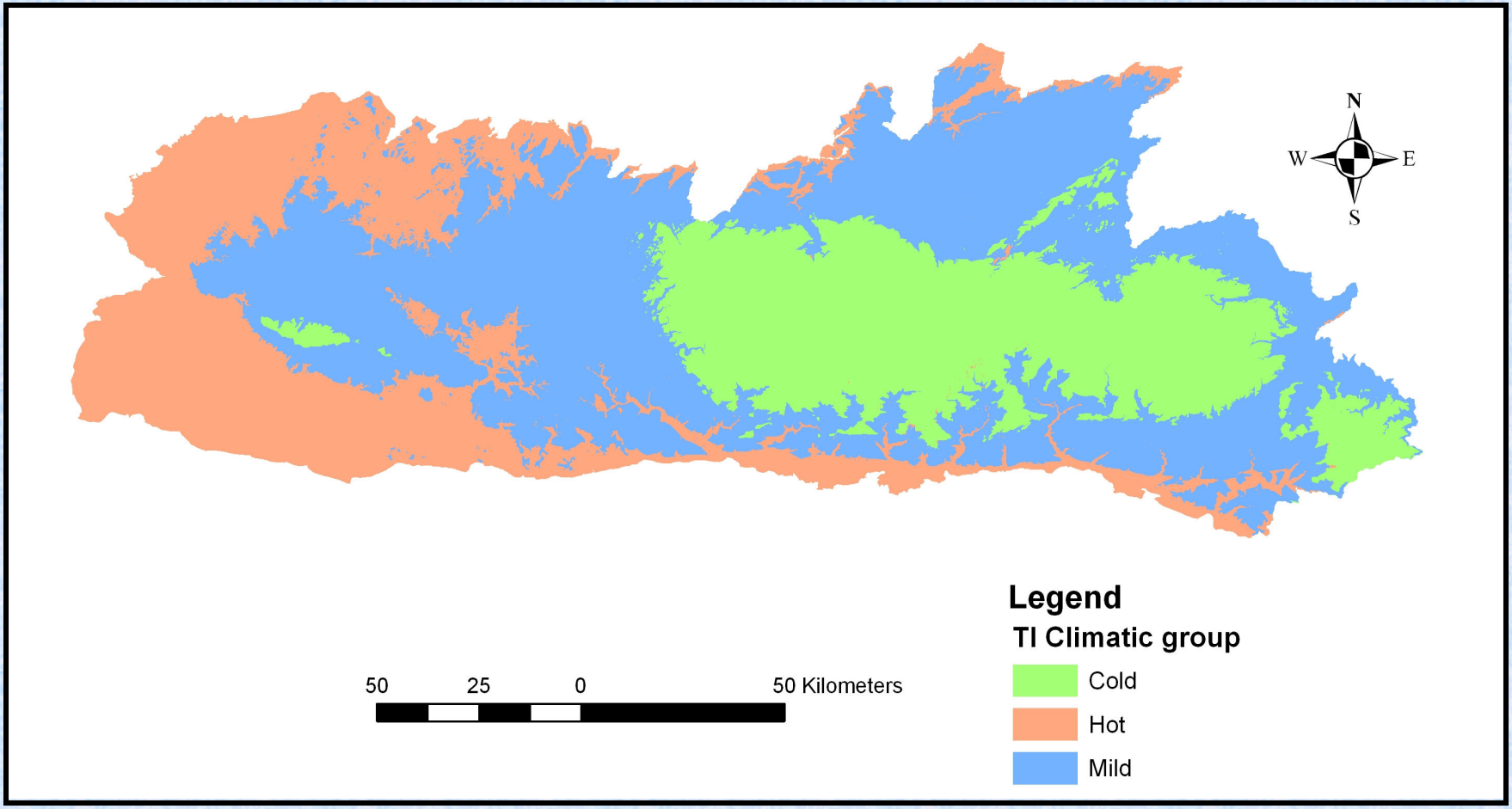
Agroclimatic Indices: Moisture Index



Moisture Index Map click here

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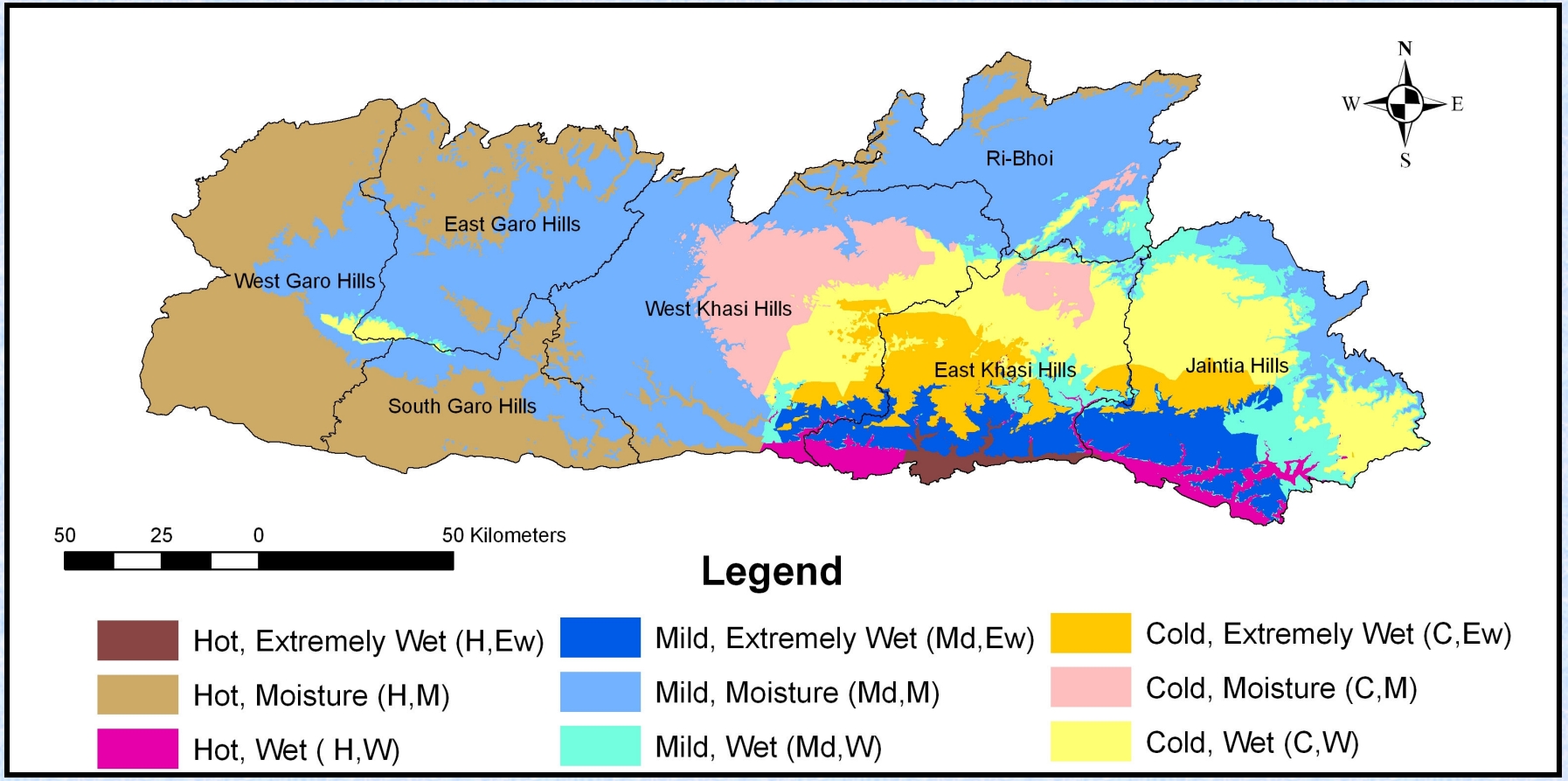
Agroclimatic Indices: Thermal Index



Thermal Index Map click here

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Agroclimatic Zonation

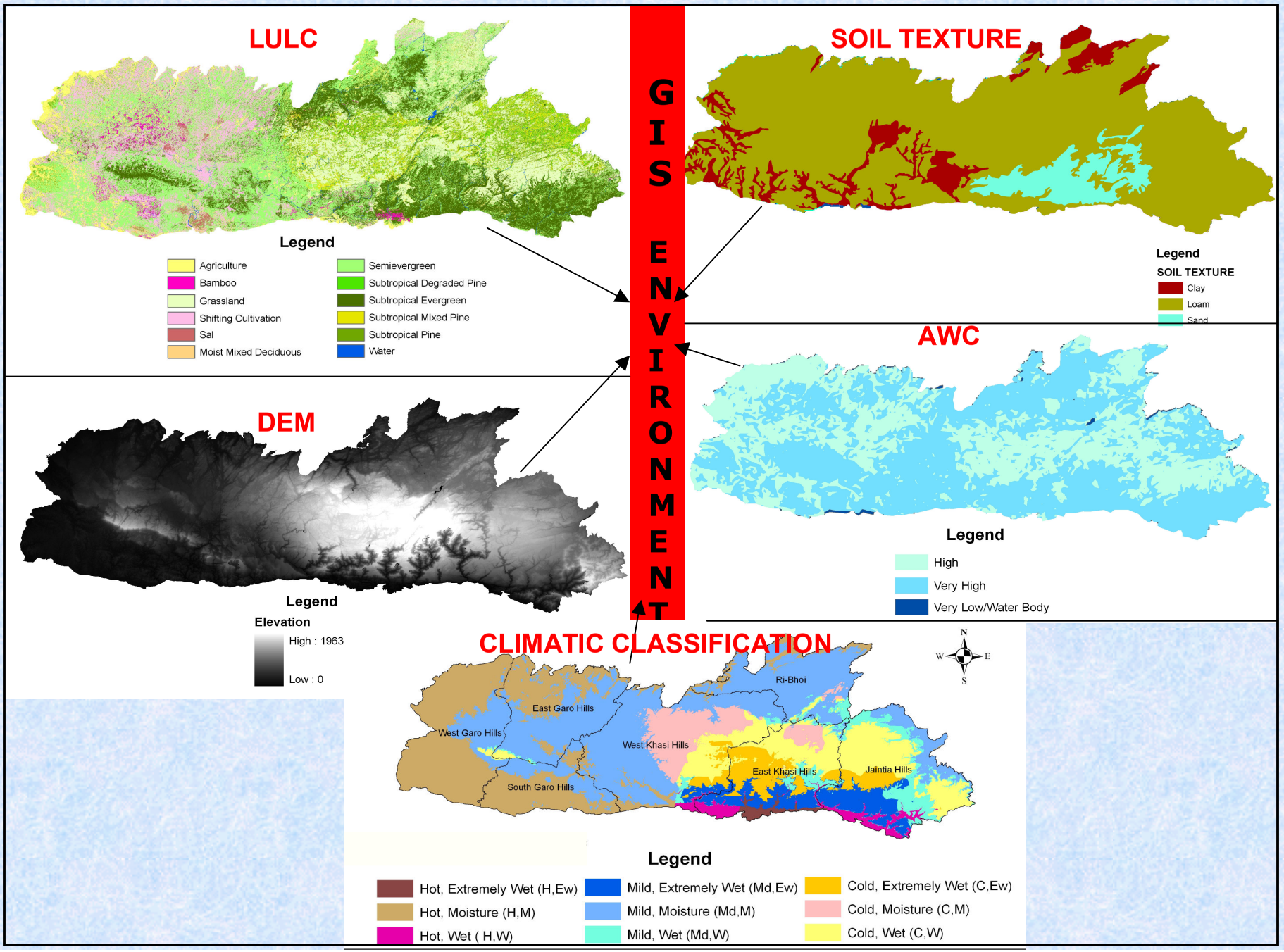


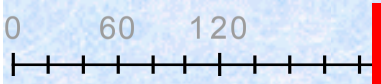
Climatic classification of Meghalaya based on MI and TI

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Agroclimatic Characterization





Agro-climatic characterization

Climatic Group *	Elevation (mm)	AWC	Soil texture	Present LULC	Area (Sq.Km)	% Area
CEw	1000-1900	Very High (VH), High(H)	Loam, Sand	Plantation crop, Grass land, pine, subtropical forest,	1250	5.6
CW	1000-1800	VH,H	Loam	Agro-Horticulre, pine, grass land subtropical forest	2874	12.8
CM	1000-1500	VH,H	Loam	Agro-horticulture, degraded forest, grassland, subtropical forest	1487	6.63
MdEW	200-1300	VH,H	Loam, Sand	Grass land, pine, subtropical forest,	1314	5.85
MdW	200-1300	VH,H	Loam, Sand	Grass land, pine, subtropical forest,	1233	5.49
MdM	200-1100	VH,H	Loam, Clay	Agriculture, current and abandoned jhum, semievergreen and evergreen forest.	7959	35.47
HEw	<200	VH,H	Loam, Sand	Agriculture, Sub tropical grassland	177	0.77
HW	<200	VH,H	Loam, Sand	Agriculture, Sub tropical grassland	498	2.22
HM	<200	VH,H	Loam, Clay	Agriculture, Bamboo, current and abandoned jhum, forest	5640	25.17

* The abbreviations used in the table are explained in previous slide. Click here

Comparison of the agro-climatic zone map prepared by Indian Council of Agricultural Research under National Agricultural Research Project (NARP) with the map prepared in the present study shows the following points:

- The NARP classification was for the entire Hill Region of NER as a unit and has only six distinct zones. Whereas the present study was done for Meghalaya state alone and it has been classified into nine climatic groups.

- It is difficult from NARP map to draw a clear line of demarcation between two zones.

- NARP map do not provide spatial distribution of zones in each district /state. It has mentioned only about few parts of the district or state covered by each zones. There was no clarity about other parts of the district/state.

- Each district has more agro-climatic zones than defined by NARP methods.

Click here

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District wise agroclimatic regimes-a comparison with the existing climatic zone.

District Name	Existing Climatic Zone	Present study classification* (%area covered)	Remarks on existing zone
Ri-Bhoi	Mild Tropical Hill	MdM(79),MdW(5),HM(12), CM(2),CW(2)	Mentioned only about southern part of Nongpoh. Ri-Bhoi was not separated from East Khasi Hills District at the time of study.
East Garo Hills	Sub tropical Hill and Mild Tropical Hill	MdM(59),MdM(0.5),HM(39), CW(1.5)	Western part comes under Sub Tropical Hill and eastern part under Mild Tropical Hill zone.
West Garo Hills	Sub tropical Hill and Mild Tropical Plain	MdM(20),HM(78),CW(2)	Nokrek and Kailash area comes under Sub Tropical and lower part of the district in Mild Tropical Plain zone.
West Khasi Hills	Sub Tropical Hill and Mild Tropical Hill	MdM(48.8),MdEw(2.5), MdW(1.7),HM(5.5),HW(1), CEw(3.8)CM(23.5),CW(13.2)	Part of nongstoin subdivision comes under Sub Tropical Hill and part under Mild Tropical Hill zone.
Jaintia Hills	Sub Tropical Hill, Sub Tropical Plain and Mild Tropical Hill	MdEw(17),MdM(14),MdW(20), CEw(7), CW(35)	Mawkhang area falls under Sub Tropical Hill. Umkhiang area is Sub Tropical Plain and southern part under Mild Tropical Hill zone.
East Khasi Hills	Temperate Sub Alpine	MdEw(18),MdM(1),MdW(8.4) , HEw(6),HW(6),CEw(27),CM(7.9)CW(26)	Mentioned only about Upper Shillong, Mawphlang.
South Garo Hills	Sub tropical Hill and Mild Tropical Plain	MdM(30),HM(70)	West and South Garo Hills was one district at the time of study.

The number in the parenthesis indicate per cent area under each agroclimatic zone

* The abbreviations used in the table are explained in previous slide. click here

Conclusion

- Specific climatic group define the favourable climate for growth of specific crops
- Useful in Evaluation of the soil suitability by comparing characteristics or qualities with the requirements of the crops. click here
- These are useful for planning a uniform agricultural development of the state and for designing the most profitable cropping pattern.
- In determining proper agronomic and cultural practices one should consider strategies appropriate for each climatic zone.
- The work can be extended to other states of North Eastern region.

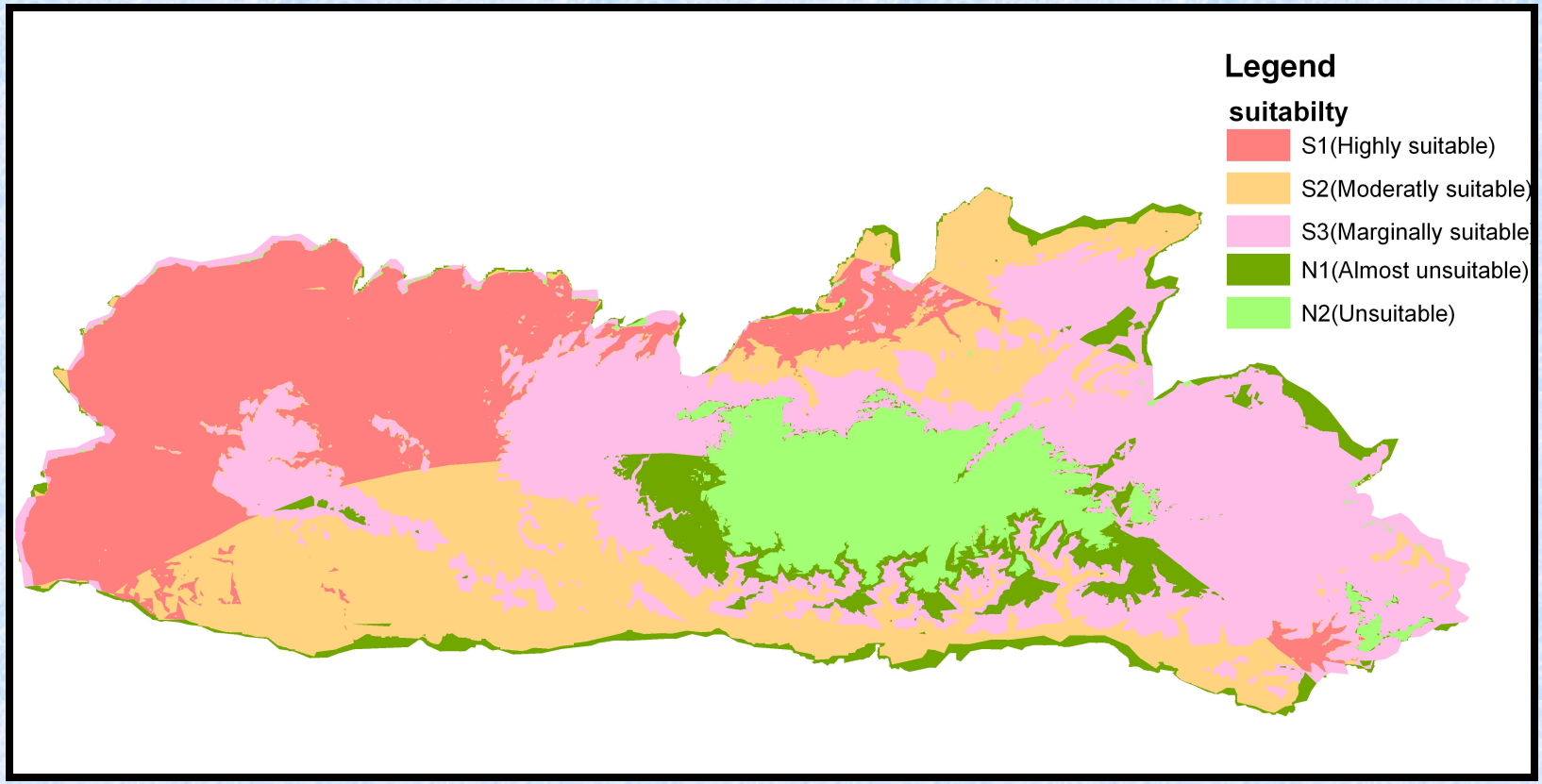
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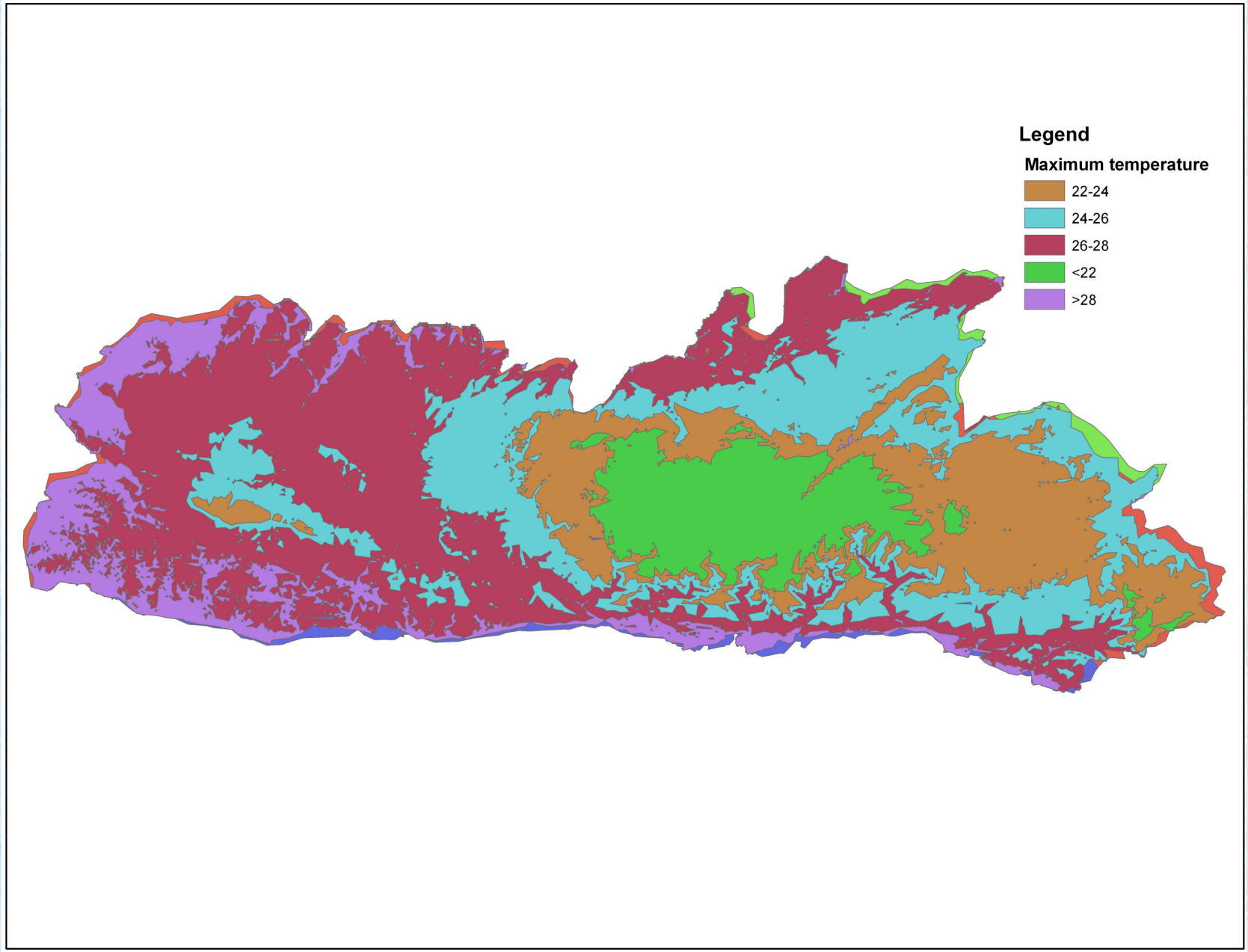
Evaluation of site suitability for Rubber based on limiting condition model(Sehgal1996):

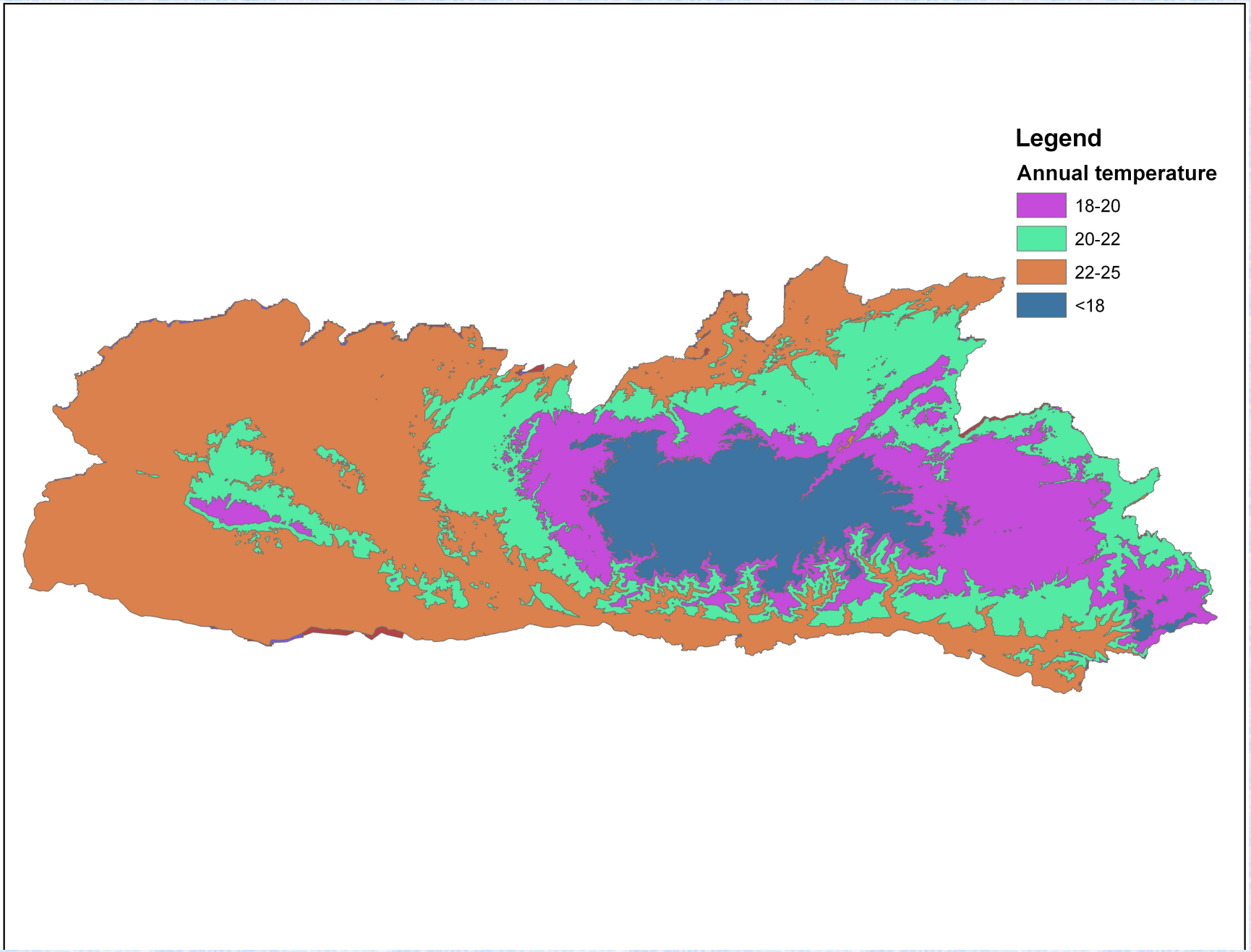
Parameter considered

- Total Rainfall
- Mean annual temperature
- Mean annual maximum temperature
- Elevation
- AWC

Back




Legend
Maximum temperature
22-24
24-26
26-28
<22
>28


Legend
Annual temperature
18-20
20-22
22-25
<18