Micro-level delineation of agro meteorological zones in the Sivagangai district of Southern India using remote sensing and GIS techniques

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ABSTRACT: Different zonations like agro climatological and agro-ecological zonations are already available for crop planning, but they have not included inventories like length of growing period, soil textures, biomass, etc which are needed for efficient usage for agriculture. The study used the integration of remote sensing and geographical information system based on a weighted overlay approach to demarcate the micro-level agro meteorological zones for agricultural planning of Sivaganga district, Tamil Nadu, India using spatial analysis tools in ArcGIS 10.5 software. Rainfall and satellite images were used to prepare five thematic layers such as land-use/land-cover, length of growing period (LGP), biomass, soil texture, and elevation and generated maps were converted into the raster format. Sivagangai had LGP classes of (L1 (9-13 weeks), and L2 (14-17) weeks, which had a period of two to four months. Biomass was categorized into four classes *viz.,* poor, moderate, good and excellent based an NDVI values of 0.06 – 0.10, 0.10 – 0.20, 0.20 – 0.40 and > 0.4, respectively. In district B4 category (excellent) covered larger area followed by B3 (good). Soil texture was broadly classified under four categories *viz.,* S1, S2, S3 and S4, based on the likely performance of crop in respect of the group. Here the category S4 which had a loamy texture occupied most of the area indicating better suitability for cropping. Elevation was classified under three categories as E1 (<500 m), E2 (501-1000 m) and E3 (>1000 m). Sivagangai had E1 category alone, owing to its proximity to east coast. The results revealed that the study area can be categorized into 16 agro-micro meteorological zones. This could be attained by efficient planning and utilization of available natural resources.

INTRODUCTION

For agriculture development and sustainable crop production, a country needs proper planning based on benchmark information. Remote sensing technology is being effectively utilized in various areas for sustainable agricultural development and management. It can also be used as an inevitable tool in agro-ecological zonation. In this regard it can be emphasised that remote sensing satellites in recent years have emerged as a vital tool for generating the biophysical information, which further helps to evolve the optimal land use plan for sustainable development of an area. The micro level zoning is possible by combining remote sensing and Geographical Information System (GIS) data by utilizing inventories on the natural resources (Bala *et al*., 2005). This type of zonation using remote sensing and GIS as tools for agro-ecological zoning at micro level has to be done in India (Patel *et al*., 2002) and FAO has also laid down guidelines on this.

Planning Commission of India during 1988-1989 divided the country into 15 agro climatic zones by taking administrative units, temperature, topography, cropping and farming systems, water resources and rainfall (Khanna, 1989) for planning and has requested each state in the country to divide their state into sub agro climate zone within 15 agro climatic zones. This has led to dividing India in to 127 agro climatic sub zones. Thereafter, in order to plan agricultural activities more accurately ICAR (India Council of Agricultural Research) identified a total of 127 agro – climatic zones under NARP based on a comprehensive review of each state. While delineating zonal boundaries the physiographical region of each state, its rainfall pattern, soil type, availability of irrigation water, existing cropping pattern and administrative units were taken into considerations.

Considering the importance of micro level agro climatic zonation, a study was carried out delineation of micro-level agro meteorological zones using remote sensing and GIS for Sivagangai district of Tamil Nadu, India

STUDY AREA

Sivagangai is situated in Southern agro climatic zone of Tamil Nadu lying between 9.52° and 10.41° N latitude and 78.12° and 79.02° E longitude. The district occupies an area of 4, 22,948 hectares and is bounded on the north and northeast by Pudukkottai district, on the southeast and south by Ramanathapuram district, on the southwest by Virudhunagar district and on the west by Madurai district. The altitude of the Sivagangai is about 102 m above mean sea level. The district receives an annual rainfall of about

735 – 850 mm. The mean maximum temperature varies from 28 to 38°C and minimum temperature ranges from 21 and 27ºC. The soil of the Sivagangai is black, red, alluvial and lateritic. In black soils only one crop, either cotton or sorghum is raised. On red soils, groundnut crop is raised. Direct seeded rice is cultivated under rainfed condition in light textured soils.

METHODOLOGY

The methodology followed is indicated in the form of flow chart as given in Fig 1. The inventories using satellite and observational resources were first made for creating five layers of GIS. The required estimation like land use, length of growing period, biomass, soil texture and topography was done using these data sets and layers were created in GIS. Thematic maps were prepared by overlaying different layers. The non-agricultural areas were omitted and agro ecological zones were delineated. The materials used and methods employed are described below.

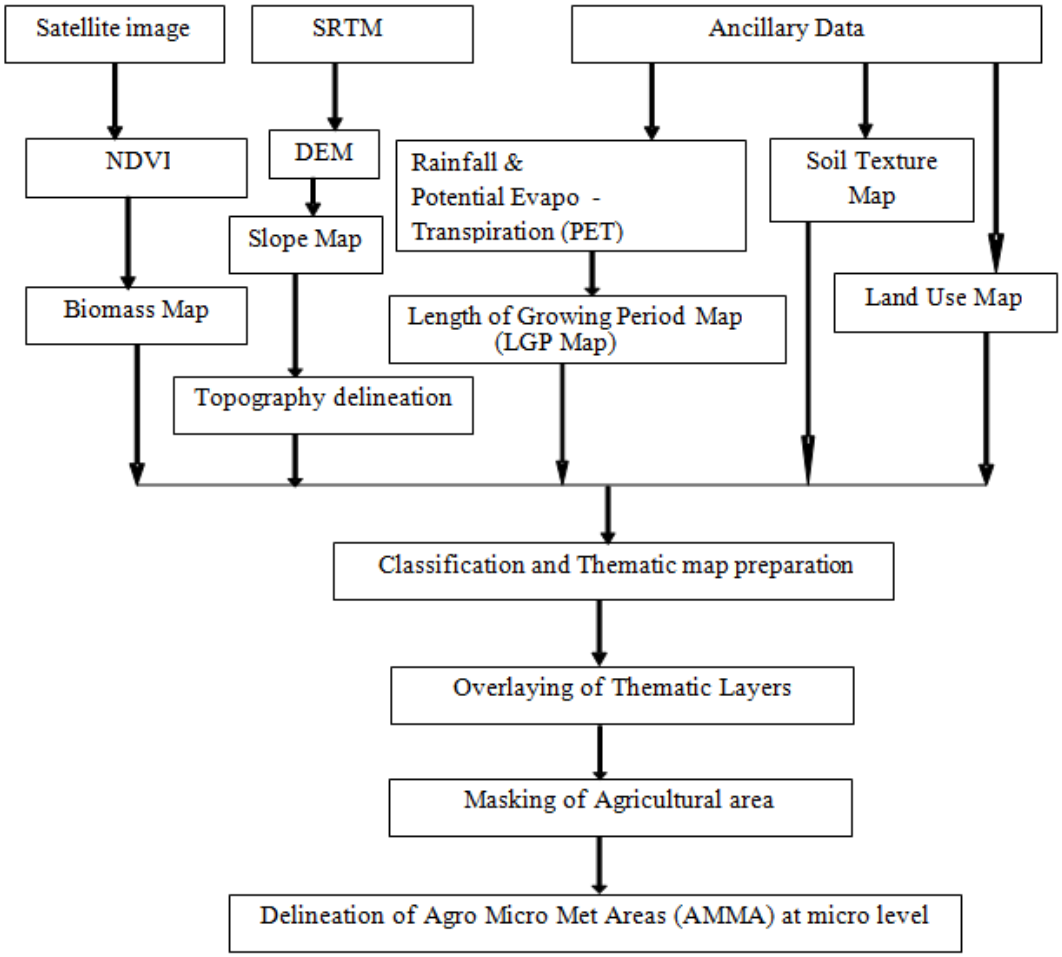

Fig 1. Flow chart representing methodologies

THEME INTEGRATION AND ZONING

For theme integration and micro level zoning, only agricultural area was considered and classified under land use map. Then all the layers were over laid to identify different zones for the selected district. In the process of zonation using all the four layers in the agricultural area, few of the zones were omitted based on the area covered by each zone. An area of less than one square kilometer (100 ha) which was considered to be non-effective for transfer of technology were merged with the adjacent zone for delineation of zoning. The Geographical Information System used in the study was ArcGIS 10.5 which was developed by ESRI Inc.

RESULTS AND DISCUSSION

Agro Micro Meteorological Area zonation was done by overlaying all the layers. In Sivagangai there were 16 zones. The dominance of this zone in terms of area coverage could be attributed to the fact that the contributing factors like LGP, biomass, soil and elevation were similar over large agricultural area this zone in the two districts. The shorter LGP in case of Sivagangai made the zone L1B4S4E1 be the biggest with other variables being same as those in this district.

Table 1. Agro Micro Met Area (AMMA) zones finalized for Sivagangai district

SL.No	Zones	Area (ha)	% area
1	L1B3S1 E1	14,738	3.48
2	L1B3S2 E1	25,719	6.08
3	L1B3S3 E1	20,488	4.84
4	L1B3S4 E1	71,781	16.97
5	L1B4S1 E1	16,056	3.80
6	L1B4S2 E1	34,175	8.08
7	L1B4S3 E1	31,525	7.45
8	L1B4S4 E1	91,013	21.52
9	L2B3S1 E1	194	0.05
10	L2B3S2 E1	644	0.15
11	L2B3S3 E1	163	0.04
12	L2B3S4 E1	794	0.19
13	L2B4S1 E1	556	0.13
14	L2B4S2 E1	456	0.11
15	L2B4S3 E1	581	0.14
16	L2B4S4 E1	2,331	0.55
	Total Area	4,22,948	

The Agro Micro Meteorological Area zonation of the Sivagangai district indicated that of Tamil Nadu state included in the present study are highly suitable for both rainfed and irrigated agriculture. The study revealed that with shorter LGP though there is likely in case of Sivagangai, the shortage of moisture during lean period be met with creation of suitable irrigation infrastructure to achieve good harvest.The number of Agro Micro Meteorological Area zones in respect of Sivagangai after the merger of negligible area was 16. The micro met zones are listed in table 1 and depicted in Fig 2. The micro met zone L1B4S4E1 of Sivagangai covered an area of 91,013 ha with a share of 21.5% of total agricultural area. The second biggest zone of Sivagangai was L1B3S4E1 with a share of 17.0 per cent while the zone L1B4S2E1 ranked third, in respect of area coverage.

CONCLUSION

For categorization different types of inventories are to be formed and then zonations are to be delineated. Different zonations like agro climatological and agro ecological zonations are already available for crop planning, but they have not included inventories like length of growing period, soil textures, biomass, etc which are needed for efficient usage for agriculture. Hence, an Agro Micro Meteorological Area Zonation, which voids the limitations of agro ecological zonation, could be used for transfer of technology at micro level with efficient usage of natural resources.

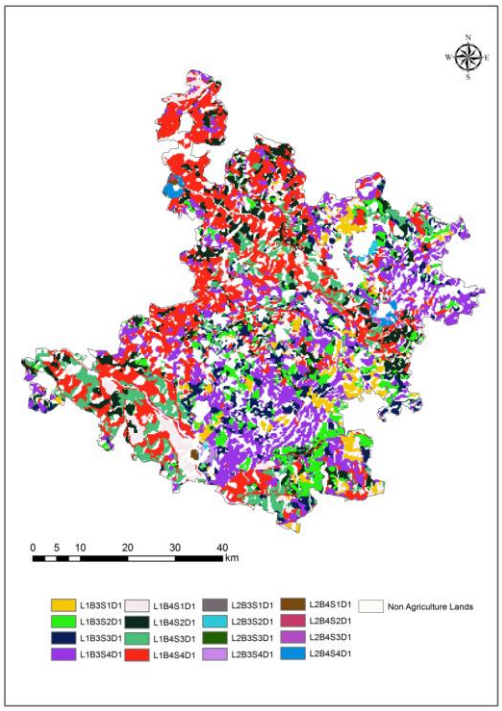

Fig. 2. Agro Micro Meteorological Area Zones of Sivagangai district

From the study it was concluded that under land-use inventory, Sivagangai district had more agricultural area whereas district, had shorter LGP because of unimodel rainfall. In case of Biomass more area was under excellent category followed by good category and soil texture had more under loamy soils, which are most suitable for agriculture. Elevation ranges showed only one category (E1 (< 500 m). The overlaid GIS layers finally lead to delineation of 16 Agro Micro Meteorological Areas (AMMA), for Sivagangai district. These AMMA zones could pave way for better agricultural management and transfer of technology.

REFERENCES

Bala, S. K., B.U. Choudhury, Anil Sood, G. S. Bainsa and J. Mukherjee. 2005. Characterization of agro-ecological zones of Punjab state using remote sensing and GIS tools. **In:** ISPRS Archives XXXVIII-8/W3 Workshop Proceedings Impact of Climate Change on Agriculture, p 331-335.

Khanna, S.S. 1989. The agro-climatic approach. **In:** Survey of Indian agriculture, 1989. The Hindu, Madras, India, p 28-35.

Patel, N. R., P. Endang, Suresh Kumar and L.M. Pande. 2002. Agro-ecological zoning using remote sensing and GIS - A case study in part of Kumaon region. **In:** Sustainable agriculture development, Proceeding of 2nd International Conference on Sustainable Agriculture, Water Resources Development and Earth Care Policies, New Delhi, December, p 18-20.