SOIL RESOURCE APPRAISAL IN LOWER VELLAR BASIN, TAMIL NADU, INDIA USING REMOTE SENSING TECHNIQUES

J. SOMASUNDARAM*, S. NATARAJAN, K.K. MATHAN and V. ARUNKUMAR**
Department of Soil Science and Agricultural Chemistry
Tamil Nadu Agricultural University (TNAU)
Coimbatore, India – 641 003
* showmaa@usa.net
** varrun@usa.net

KEY WORDS: IRS-IB LISS II, Taxonomic grouping, visual interpretation, basin

ABSTRACT

IRS-1B LISS II Geocoded false colour composite (FCC) imageries on 1:50,000 scale corresponding to the Survey of India (SOI) toposheets (58J/15 and 58J/16) were used for soil resource appraisal of the Vellar basin of Pudukottai district, Tamil Nadu. Visual interpretation of FCC imageries was carried out on the base map using imagery interpretation keys and twenty nine Imagery Interpretation Units (IIU's) for the study area were delineated on the base map. The pre-field map was prepared by tracing the base map showing all twenty nine IIU's. Based on the pre-field map the ground truth investigation was carried out. A field trip was made in the study area, each IIU with different soil was marked as a pedon and thirteen such representative pedons were identified for the study area. Some of the interpretation units were found to have similar soil composition, which were regrouped together under one mapping unit. Thus 24 map units were delineated. The landform characters, and morphological properties were recorded and soil samples were collected by horizonwise and analysed for particle-size distribution and other physico-chemical properties by adopting standard analytical procedure. Based on morphological, physical, chemical and exchangeable properties the soil series were classified upto family level as per USDA Soil Taxonomy (Soil Survey Staff 1996). Thirteen pedons were classified in the Orders of Entisols, Inceptisols and Alfisols. Finally a soil map and fertility map was prepared by transferring the boundaries of Image Interpretation Units (IIUs) finalised after field work to the basemap. It could be concluded from the present study that remote sensing technology is a highly dependable tool for soil resource and fertility evaluation studies.

1. INTRODUCTION

In earlier days, scientific inventory of soil resources were obtained through conventional soil survey methods. Although acquired data through this approach were reliable and somewhat accurate, adverse weather conditions, timeliness, distance and diversity of area were some of the limitation to this approach. In recent years the advancement in space and information technology especially in the field of remote sensing has become an important tool in soil resource inventory. The remote sensing technology is found to be more efficient and economical than conventional survey.

In India, application of remote sensing techniques for natural resources survey and management has come of age since its beginning with well known experiment on the detection of coconut root wilt disease using aerial colour infrared. The successful launching of IRS series (IRS-1A/1B/1C/ID/P2/P3/P4) and LANDSAT series satellites in India have been pillars of space segment for mapping entire forest area of the country at two time periods and bringing awareness about its decrease, showing extents of wastelands and their categorization; mapping the entire coastline of the country etc.

Remote sensing as a tool had been widely used in the field of agriculture, includes soil mapping and status (moisture, fertility, degradation) (Dadhwal, 1999); delineating Kcmong River basin in Arunachal Pradesh, India (Raghavswamy, 1982), soil mapping and soil productivity assessment for coastal lands in Ramanathapuram district, Tamil Nadu, India (Natarajan *et al*., 1997). The satellite imageries were visually interpreted to study fertility constraints (Fertility capability class) in Upper Gundar basin, Tamil Nadu, India (Natarajan *et al*., 1996). Hence it is realized that remote sensing data with confirmation of groundtruth data by conventional soil survey is operationally being utilized for mapping various resources in a economic and efficient way.

The objective of this study is to use the remote sensing data and ground truth collection of lower Vellar basin for characterisation and classification (Taxonomical, Fertility constraint) of soils.

2. MATERIALS AND METHODS

2.1. Study area

The study area with an extent of 30,075 hectares is distributed in Alangudy, Thirumayam, Pudukottai and Aranthangi taluk of Pudukottai district, Tamil Nadu, India. It lies between 78°47' 13" and 78°58'32"N longitude and 10°25'13" and 10°7'33"E latitude. The study area is described in Survey of India (SOI) toposheets 58J/15 and 58J/16. The area is dry and the rainfall is scanty with a mean annual precipitation of 539 mm. The mean annual air temperature is 30.1°C. The soil moisture regime of the study area is Ustic and the temperature regime is classified under isohyperthermic. The slope of the study area ranges from 1-3% and elevation varies from sea level to 150 m above mean sea level.

2.2. Visual interpretation

IRB-1B LISS II Geocoded FCC with spectral bands 2,3 and 4 satellite imageries on 1:50,000 scale acquired from National Remote Sensing Agency (NRSA), Hyderabad, India was used for this study. The base map of the watershed was prepared by using toposheets of 58J/15 and 58J/16 by transferring the boundaries of the watershed and important bodies. On the light table the base map was overlaid on corresponding satellite imageries and visual interpretation was carriedout by using imagery interpretation keys such as tone, texture, size, shape, pattern, mottles and association. Areas showing different combination of tone, texture, size shape, pattern, mottles and association were delineated as a unit. Twenty four Image Interpretation Units (IIU's) were finally developed for the study area. The pre-field map was prepared by tracing the base map after visual interpretation showing all IIU's and used for field trip.

2.3. Ground truth investigation

A field trip was made in the study area, each unit (IIU) with different soil was marked as a pedon in the pre-field map, and thirteen such representative pedons were identified. The landform characters such as slope, erosion, drainage, land cover etc. and morphological properties of the pedons were recorded.

The final resource map was prepared by merging the boundaries of IIU having similar soil composition on the base map of 1:50,000 and cartographic reduction with optical pantograph. Based on the Fertility Capability Classification (FCC) system proposed by Buol *et al* (1975) and modified by Sanchez *et al* (1982), soils were classified based on constraints for better crop production.

2.4. Laboratory investigation

The horizonwise soil samples was collected from representative pedon were analysed for relevant properties by adopting standard analytical procedures. Soil series were classified upto family level as per USDA Soil Taxonomy (Soil Survey Staff, 1996) and fertility capability classification (Buol *et al*, 1975; Sanchez *et al*., 1982).

3. RESULTS AND DISCUSSION

3.1. Soil resource mapping and fertility capability classification

The soil samples were analysed for physical and chemical properties and presented in Table 1. Thirteen soil series were recognised in the study. They were classified under three soils orders, viz., Entisols, Inceptisols and Alfisols. The soil of the study area were grouped into II FCC units based on the fertility constraints comparing 11 types and substrata types and 5 condition modifiers include: dry condition (d), basic reaction (b), magnesium deficiency (m), potassium deficiency (k) and phosphorus fixation by iron compounds (i) (Table 2). Based on the analytical results, the IIU having similar soil composition were merged into one mapping unit base map. 24 such mapping units were developed for the study area and the final soil resource map was prepared on 1:50,000 scale.

4. CONCLUSIONS

The IRS-1B LISS II Geocoded FCC on 1:50,000 scale used in this study was found to be more useful in identifying the different physiographic units like uplands, river basin, hills and different type of soil during the field trip in a more efficient and economic way than conventional methods. It is concluded that 29 units identified using remote sensing techniques, were regrouped into 24 soil association based on ground truth data collected and the reconnaissance level map (Soil resource map, fertility class map) was prepared. This map would show the spatial relationships of land units developed in the varied climate, geologic and topographic environment.

Mapping through remote sensing techniques was found to be effective over conventional method for soil survey, interms of cost and time. The experimental results could be extrapolated to areas having similar image characteristics, there by, reducing the personnel requirements and cost.

REFERENCES

Buol, S.W., P.A. Sanchez, R.B. Cate and M.A. Grander. 1975. Soil management in tropical America. N.C. State University Raleight. N.C. USA, pp.126-141.

Dadhwal. 1999. Remote sensing application for Agriculture: Retrospective and Perspective. In: Abstract volume. National symposium on remote sensing applications for Natural Resources: Retrospectives and perspective by Indian Soc. Remote Sensing, Bangalore, p.3.

Natarajan, S., D. Jayanthi, G. Selvakumari and S. Chellamuthu. 1997. Remote sensing for soil productivity assessment in Delta and coastel land forms of Ramanathapuram district Tamil Nadu. In: Abstract volume. National Symposium on Remote Sensing for Natural Resources by Indian Soc. Remote Sensing, Hyderabad p.39.

Natarajan, S., T.P. Swarnam, G. Selvakumari and Raniperumal. 1996. Remote sensing on the assessment of fertility constraints of soils of upper Gunder basin, Tamil Nadu. In: Abstract volume. National Symposium on Remote Sensing for Natural Resources by Indian Soc. Remote Sensing, Pune. p.28.

Raghavaswamy, V. 1982. Role of satellite remote sensing in land system mapping, land resources inventory and land resources inventory and land use planning: A sample study of Kcmong river basin, Arunachal Pradesh. J. India Soc. Soil Photo Int. & Remote Sensing 10(3), pp.31-39.

Sanchez, P.A., W. Couto and S.W. Buol. 1982. The fertility soil classification system: Interpretation, applicability and modification, Geoderma, 27, pp.283-309.

Soil Survey Staff. 1996. Keys to Soil Taxonomy, 7^{th} edition, soil conversation service, (U.S.D.A: Washington, D.C.)

Table 2. Fertility Capability Classification – soil sample coding

S.No.	Soil series	Soil Taxonomy	Type / Substrata type	Modifiers	Slope (%)	Fertility capability unit
1.	Aliyanilai	Loamy skeletal, mixed, isohyperthermic, Typic Ustorthents	L	dk	0 – 1	Ldk (0-1%)
2.	Nayakarpatti	Fine loamy, mixed, isohyperthermic, Typic Haplustalfs	SL	dk	1 – 3	SLdk (1-3%)
3.	Madathupatti	Fine, mixed isohyperthermic, Vertic Ustropepts	SC	kb	0 – 1	SCkb (0-1%)
4.	Kamakshipuram	Fine loamy, mixed, isohyperthermic, Ultic Haplustalfs	S	dkm	0 – 1	Sdkm (0-1%)
5.	Tanjur	Fine loamy, mixed, isohyperthermic, Aquic Haplustalfs	LS	kb	0 – 1	LSkb (0-1%)
6.	Arimalam	Fine loamy, mixed, isohyperthermic, Typic Ustropepts	L	d	0 – 1	Ld (0-1%)
7.	Vamban	Fine, mixed, isohyperthermic, Typic Rhodustalfs	LC	di	0 – 1	LCdi (0-1%)
8.	Mettupatti	Coarse loamy, mixed, isohyperthermic, Typic Ustifluvents	CL	dm	0 – 1	CLdm (0-1%)
9.	Periyanayagipuram	Fine loamy, mixed, isohyperthermic, Vertic Ustropepts	LC	kb	0 – 1	LCkb (0-1%)
10.	Purakudikadu	Fine loamy, mixed, isohyperthermic, Typic Ustropepts	C	dikb	1 – 3	Cdikb (1-3%)
11.	Pudhuarimalam	Fine, mixed, isohyperthermic, Typic Ustropepts	C	-	0 – 1	C (0-1%)
12.	Adappankarachatram	Coarse loamy, mixed, isohyperthermic, Ultic Haplustalfs	SL	dk	1 – 3	SLdk (1-3%)
13.	Vengalangadu	Typic Ustopsamments	L	dkm	1 – 3	Ldkm (1-3%)

Table 1. Salient features of soils of Lower Vellar Basin (Surface and Subsurface Soil)

Soil series	Depth (cm)	Soil colour (dry)	Clay (%)	Texture	pH (1:2)	CEC [c mol (p^+)/kg]	Exchangeable cations [c m		
							Ca^{2+}	Mg^{2+}	K
1. Aliyanilai	0 - 24	5 YR 5/6	13.15	sl	5.00	17.10	7.0	4.0	0.1
	24 - 70	5 YR 5/6	15.82	sl	6.30	24.10	9.0	5.0	0.1
2. Nayakarpatti	0 – 17	10 YR 5/3	4.93	ls	5.90	14.80	6.5	2.5	0.1
	17 – 34	10 YR 6/6	21.21	scl	4.70	17.50	7.5	3.5	0.1
3. Madathupatti	0 – 14	10 YR 5/4	6.06	ls	7.10	16.70	6.0	3.0	0.1
	14 – 23	10 YR 4/4	8.93	ls	7.60	15.80	4.0	3.0	0.1
4. Kamakshipuram	0 –18	10 YR 6/1	5.15	s	6.50	15.10	4.0	2.0	0.0
	18 – 74	10 YR 6/6	8.29	ls	6.50	17.30	6.0	4.5	0.0
5. Tanjur	0 –21	10 YR 6/2	15.23	sl	7.60	16.30	7.0	3.0	0.1
	21 – 44	10 YR 5/4	8.29	ls	7.70	18.40	6.0	3.5	0.0
6. Arimalam	0 – 13	10 YR 5/4	33.91	cl	6.60	20.80	8.0	4.5	0.2
	13 - 38	2.5 YR 4/6	33.86	cl	7.40	21.90	7.0	3.5	0.1

Table 1. Contd....

7. Vamban	0 – 13 13 – 35	2.5 YR 4/6 2.5 YR 4/8	19.46 33.28	sl sc	6.60 5.60	17.10 17.40	8.5 7.5	4.0 3.5	0.24 0.22
8. Mettupatti	0 – 15 15 – 34	10 YR 5/4 10 YR 5/4	31.26 12.31	sc sl	6.50 6.80	18.50 16.50	7.0 5.0	2.0 1.5	0.25 0.26
9. Perianayagipuram	0 – 20 20 – 46	10 YR 4/4 10 YR 5/6	15.23 33.41	l c	7.70 8.20	17.40 16.30	6.5 5.0	2.5 2.0	0.12 0.10
10. Purakudikadu	0 –28 28 – 109	2.5 YR 4/6 7.5 YR 5/6	33.21 34.11	c c	7.40 8.30	21.20 24.40	7.0 5.5	3.5 3.0	0.19 0.11
11. Pudhuarimalam	0 –12 12 – 39	7.5 YR 5/6 7.5 YR 5/6	34.98 34.21	c c	5.30 6.90	20.70 19.80	5.0 7.0	3.5 4.5	0.27 0.16
12. Adappankarachatram	0 – 10 10 – 39	10 YR 7/4 7.5 YR 5/6	6.15 13.11	s sl	6.10 5.90	15.00 17.40	5.5 5.0	3.5 3.0	0.14 0.12
13. Vengalangadu	0 – 20 20 - 43	10 YR 5/6 10 YR 5/6	6.90 6.12	ls ls	5.1 5.1	16.10 16.30	5.5 6.5	2.0 2.0	0.12 0.18