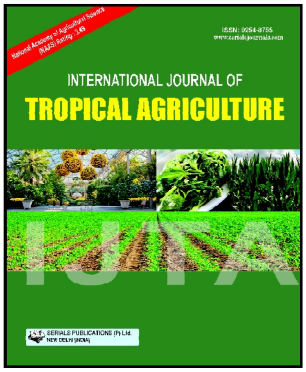

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Micro level Natural Resources Planning of Village Dabo of Mungeli District using Geospatial Technology

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Abstract: Farm level efficient land and water resources planning was carried out using false colour composite (FCC) of IRS-P6 LISS IV geocoded data in conjunction with survey of India (SOI) toposheet on 1:50000 scale by extracting information on existing land use/ land cover, slope, aspect and physiography for characterization and mapping of soils in the Village Dabo of Block and District Mungeli (Chhattisgarh). The revenue maps of 1:4000 scale was digitized and converted to vector shape file with attributes of field details like owners name & caste and coverage area, perimeter etc. This revenue map was overlapped to the FCC of mosaic satellite data for retrieving the true land characterization of the project area. Two farming situations were characterized and mapped as per the local names of the agro climatic zone viz. *Matasi*and *Dorsa* comprising of 52.3% and 47.7% area respectively. The village was classified into nine land use classes and found that the total agricultural land comprising of harvested fields, lowland paddy, midland paddy and soybean crop covering a total area of 250.46 ha. Total of 420 farm fields were digitized and converted to vector layer and micro level land and water resources management plan was developed for the same. Total five new small ponds and two check dam were proposed as per the best identified site for harnessing of runoff and recharging of ground water. The technique was applied for the efficient land and water resources planning for the four watershed comprising of 180 villages with complete cadastral level informations.

Keywords: Cadastral mapping, farming situations, geospatial, GIS, remote sensing

1. INTRODUCTION

A major challenge in Indian agricultural development in the present decade and beyond lies in the effective involvement of farmers in the extension and research programs. The continued stress is more on developing procedures or methods that encourages farmer's participation in planning and management of above programs. The top down approach in vogue in planning and implementation of programmes and projects by and large has not resulted in desired effects. Such developmental approaches many a times stem from planners who are not familiar with situations at the gross root level. In the planning process formulation of proposals often take place with little or no consultation with the people for whom the planned activities are intended. Farmers do not adopt many new ideas largely because they do not take into account all the factors influencing the farmer's decision to accept an innovation. Appropriate recommendationsspecific to crop situation can be developed by involving farmers in the whole process of technology development. This requires major changes in the attitudes, approach and role of researchers.For sustainable agricultural development cultivable land information plays vital role. With detailed and reliable information, it is easier to implement better agricultural practices. Nearly about 75 percent people are living in rural areas and are still dependent on Agriculture. Cadastral or revenue map have traditionally dealt with land ownership and land use at the level of the individual landowner or occupier. They operate in the context of national laws and land use policies with regional and local planning inputs. In many countries this includes considerable involvement with land consolidation projects designed to improve the efficiency of agriculture and/or to implement rural or urban development.Land resource information at the village level has become essential under the present scenario of the farmers' agitation for not parting with the fertile agricultural land which is the back bone of food security. For any agricultural planning and development, an inventory of natural resources is a prerequisite. Soil is part of the land which is a non-renewable natural resource. Soil is the base for every production system but most of the crop production system and knowledge on their properties, extent and spatial distribution is extremely important. Therefore, it is imperative to maintain soil resources to sustain the ecosystem (Beckett and Webster, 1971;Gessler, 1996). In this context, characterization and mapping of different types of soils and their interpretation attains greater importance for micro level planning (Sahu*et al.*, 2014). We are well aware that most of the problems exist at the field level which can be tackled only by formulating and adopting rational, site-specific and viable land-use options suitable for each and every parcel of land at village or watershed level. Any other macro-level planning will not have the desired effect in solving the problems faced by our farmers. To address the issues at farm or field level, we need a detailed site-specific data base covering each and every plot or parcel and survey number occurring in each village. Detailed natural resource information at larger scales (1:4,000 to 1:10,000) can only provide such basic information for optimal utilization of natural resources. Accurate baseline information and methods to evaluate the quantity and quality of resources is a prerequisite for mapping and characterization of soils (Laake, 2000).The region has several hot spots of rural poverty, as most farmers in the region are small holders with diverse farming systems, which are highly risk prone. In addition, these farmers have poor access to support services such as extension, the agricultural Land information, knowledge, technology and financial credit. The new Agricultural Land Information System brings sustainable revolution by empowering the resource to poor farmers with up-to date knowledge and information about agricultural land and technologies, best practices, crop information, soil-moisture conditions and the environment etc.

The traditional methods of cadastral level planning, gathering information was expensive and time consuming due to large number of observations. However, advances in computer and information technology have introduced new group of tools, methods, instruments and systems. Rapid developments in new technologies such as Remote

Sensing (RS), Global Positioning System (GPS) and Geographical Information System (GIS) provide new approaches to meet the demand of resource planning and successfully used in studying the various aspects in spatial and temporal domain (Shrestha 2006, Yeung and Lo 2002). The field of remote sensing and GIS has become exciting and glamorous with rapidly expanding opportunities (Patra 2011). Most of the problems exist at the field level which can be tackled only by formulating and adopting rational, site-specific and suitable land-use options for each and every parcel of land at village or watershed level. For addressing such type of problem the pilot study in Dabo village, Mungelidistrict in the state of Chhattisgarhwas carried out to develop cadastral level agricultural resource information system using remote sensing and GIS techniques for identifying the problems and potentials and to conserve and manage them at farm level for improving their productivity.

2. MATERIALS AND METHODS

2.1. *Study Area*

Village Dabo is situated in Block & District Mungeli of Chhattisgarh State and lies between 81°35'0"E to 81°36'15"E longitude and 21°05'12"E to 22°06'45"E latitude with and average altitude of 298 m above mean sea level (Fig. 1). The village lies within the hydrological boundary of Tesua watershed with an average rainfall of 924 mm with hot and arid climate. Dabo micro-watershed is covered by topographic map No. 64F/12 of 1:50,000 scale having 10 m contour interval. This topographic map was collected from Survey of India, Raipur, Chhattisgarh for use in this study.

2.2. Cadastral/ Revenue data

Initially the cadastral map of the Dabo village at 1:4000 scale has been collected from Land Record Department (LRD) Mungeli. The satellite imagery of the study area has been rectified by selecting ground control points from SOI toposheet 64F/12 at 1:50000 scale using ERDAS IMAGINE 9.2 and ArcGIS 10.

2.3. Remote sensing data

The cloud free digital data of the study area were obtained from National Remote Sensing Centre (NRSC), Hyderabad in Compact Disc (CD). LISS IV sensor path 102, row 57. Scene of IRS-P6 satellite with date of pass 10th October 2014was used for the study to prepare the land use/cover maps of the Dabo micro watershed. The satellite data were in four electromagnetic spectral bands (band 2: 0.45-0.52 mm, band 3: 0.52-0.59 mm, band 4: 0.62-0.68 mm and band 5: 0.77-0.86 mm). Its sensor provided the data of 5.8 m x 5.8 m spatial resolution.

2.4. Hardware and Software Used

Geoinformatics Laboratory of Department of Soil and Water Engineering at R. H. Richariya Rice Research laboratory, IGKV, Raipur was utilized for the Hardware and Software requirement of the study. All the required software, ArcGIS 10.5 for digital data analysis, ERDAS IMAGINE 2016 for image processing, large size colour scanner for scanning the topographic maps were used in the study.

Assessment of availability and utilization trends of surface and groundwater, crop water requirement and surface runoff calculation by SCS curve number method. Various thematic maps were prepared by

Table 1
Details of satellite image used in the study

Toposheet no.	*Satellite*	*Sensor*	*Resolution(m)*	*Path*	*Row*	*Date of Pass*
64F/12	IRS-P6	LISS-IV	5.8	102	57	10/10/2014

using Survey of India toposheets (1:50000 scale), IRS P6 LISS IV satellite data dated 10th October 2014 and other hydrological & meteorological information's, ERDAS IMAGINE software was used for image rectification, enhancement and classification operations. IRS P6 LISS IV satellite data has been used to classify land use/land cover. On Screen interpretation has been used to extract thematic layers. Interpretation was made in conjunction with the topographical map and also supported by adequate ground actual data for accurate output. Required thematic layers - hydrology (drainage), DEM, Soils, Slope, Land use / Land cover have been derived from the image. Arc GIS 10.0 software has been used to integrate the individual layers to generate suitable land use models and to develop a cadastral level management plan. Methodology has been applied to classify the land use categories and recommendations were suggested appropriately.

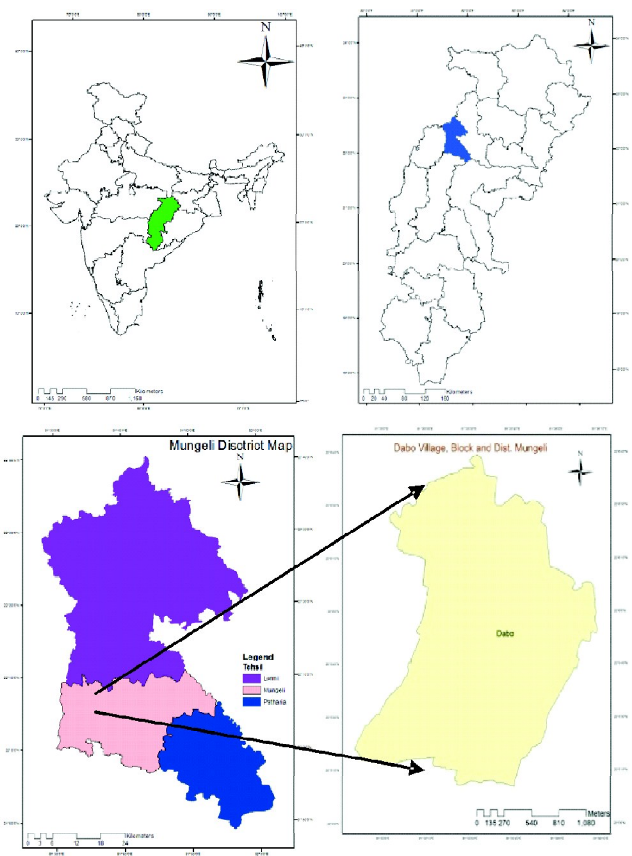

Figure 1: Location map of the study area

3. RESULTS AND DISCUSSION

3.1. Soil

The study area comprises siltyclay (262.93 ha), clay loam (95.49 ha) andsiltyclay loam (37.76 ha) as shown in Fig. 3. The soil textural class of silty clay dominates the village comprising of 66.32% followed by clay loam and silty clay loam with 24.14% and 9.5% respectively.

3.2. Land use pattern

The area is characterized under Chhattisgarh plains Agro climatic zone. Cropped area related data of *kharif* and *rabi* seasons were available and collected from the Department of Senior Agricultural Development Officer, Mungeli block. The data were analysed to depict land use pattern of the watershed according to the percentage of cropped area of that village. Based on image characteristics, the nine major land use/ land cover identified (Fig. 4) are midland paddy (79.41 ha), soybean (81.64 ha), lowland paddy (32.53 ha), harvested field (56.88 ha), barren land (10.39 ha) and current fallow (76.27 ha). Other land use were delineated as settlements, water bodies and plantation with 51.16 ha, 2.21 ha and 5.94 ha area respectively. On analyzing the present land use/ land cover pattern it can be clearly identified that nearly than 22% of land is still unused and has to be brought under cultivation by adopting suitable and sustainable land and water resource management plan.

3.3. Irrigation

Data related to irrigated area through distributaries of canal and tubewell under *kharif* and *rabi* season were available and collected from the Department of water resources, district Mungeli Govt. of Chhattisgarh and Senior Agricultural Development officer, Mungeli block of Mungeli district.

3.4. DEM and Slope

Digital Elevation Model (DEM) was generated using the contour map along with the field surveys done using global positioning system (GPS). The elevation of the project area was found to be in the range of 295 – 301 m above mean sea level. The slope map was generated by the classifying the relief in four classes. Four slope classes viz (a) flat (0.2 - 1% slope) covering an area of 63 ha (b) moderately flat (1.1 - 2 % slope) covering an area of 202 ha, (b) moderate gently slope (2.1 - 3 % slope) covering an area of 107 ha and (c) gentle slope (3.1 – 3.8 % slope) covering an area of 24 ha has been derived (Fig. 5). The slope map played the major role in delineating the farming situations for preparation of site specific management plan.

3.5. Farming situations

Based on the visual interpretation and field survey, two farming situations (Fig. 6) viz. *matasi and dorsa* were identified and characterized based on soil morphology, land use, land cover, drainage, slope and aspect. As per the local names of the agro climatic zone viz. *Matasi*and *Dorsa* comprising of 52.3% and 47.7% area respectively consists of Inceptisol and Alfisol soil taxonomy.

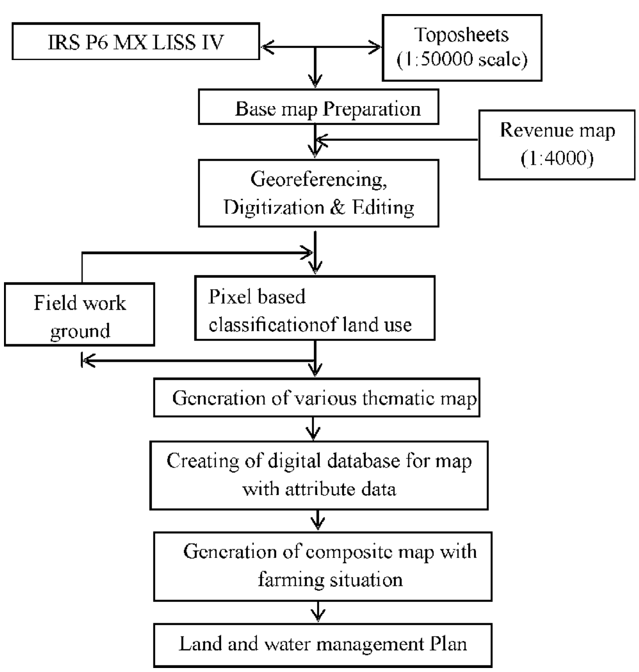

Figure 2: Flow chart of the methodology

3.6. Land and water resource management

The integration of physiography, soil, land use, land cover, slope and cadastral maps under GIS environment has brought out the two farming situations of Dabo village of Mungeli District, which leads to identify the areas for alternate land use, resource development and conservation. The cadastral map digitized showed that 420 number of farm fields was available in the village (Fig. 7). Total of 48 number of farm fields covering an area of 45.65 ha is under current fallow under *matasi* farming situation and similarly 43 number of farm fields covering an area of 29.48 ha under *dorsa* farming situation lays under current fallow. Total 91 number of farm fields covering 75.13 ha land is left fallow and can be brought under cultivation by proper land management practices. For bringing this 75.13 ha of land under cultivation additional water resources is required. Five farm ponds and two check dams at appropriate sites were suggested with its approximate command area. These water resources will definitely help in increasing the production and productivity of the moderately fertile farming situations (Fig. 8). The details of total field and farming situation is presented in table 2

Table 2
Fields under different farming situation in village Dabo

		Matasi		*Dorsa*	
	Classes	*No of Fields*	*Area ha*	*No of Fields*	*Area ha*
1	Plantation	2	1.14	3	2.25
2	Settlement	25	31.49	14	20.3
3	Midland Paddy	43	42.54	47	35.48
4	Water body	2	0.5	2	1.5
5	Soybean	32	47.12	27	38.71
6	Barren land	12	8.1	11	2.94
7	Current Fallow	48	45.65	43	29.48
8	Harvested Field	21	18.29	23	36.36
9	Lowland Paddy	27	11.36	38	23.27
	Total	212	206.2	208	190.3

4. CONCLUSIONS

The good and fertile land is very limited in the form of *dorsa* and *kanhar* farming situations. More than 52 % of the land was occupied by poor to moderately fertile farming situation of *matasi,* which is also characterised by their low soil depth and poor infiltration capability leading to poor production potentiality of the farming situations. In order to make sustainable management plan, due emphasis was given to utilize each farming situation and to enhance its potential be adopting necessary measures. In this context, actual numbers of field laying vacant as current fallow was identified and proposed for cultivation with the additional water resources development plan. Excavated farm ponds were proposed by intercepting the natural drainage line of the region in the *matais and dorsa*farming situations. The stored water will act as life saving and supplemental irrigation to the *kharif* crops and will help in supporting the *rabi* relay crops. Check dams and farm pond was proposed to check and store the excess runoff water. Thus, an operational strategy for land and water conservation structures could be planned based upon geospatial technologies and could be blessing for tribal dominant agro climatic zone with limited resources for development of sustainable site specific management plan.

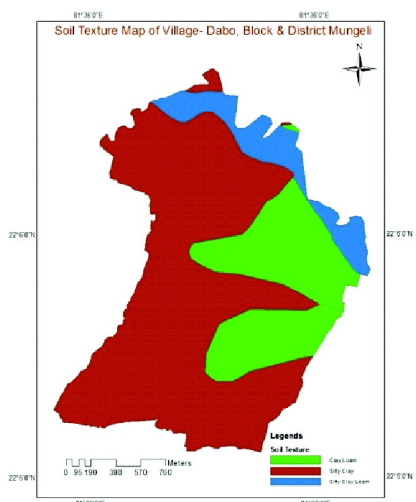

Figure 3: Soil Map

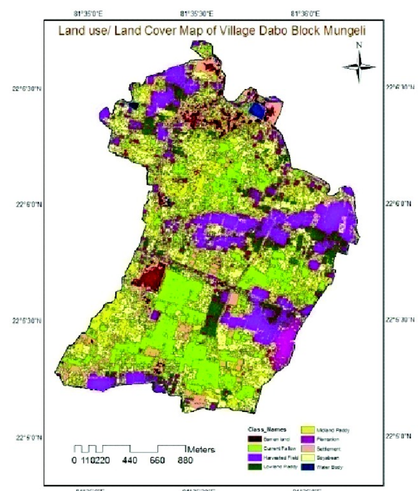

Figure 4: Land use land Class

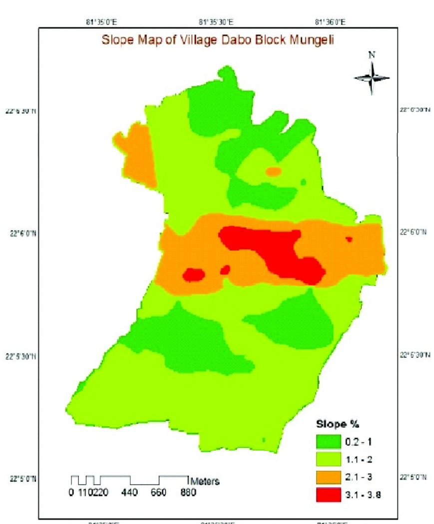

Figure 5: Slope Map

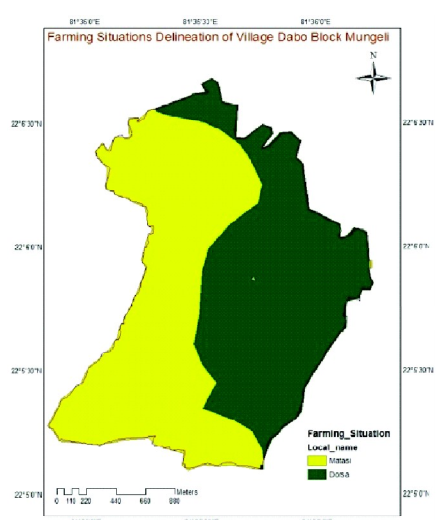

Figure 6: Farming situations map

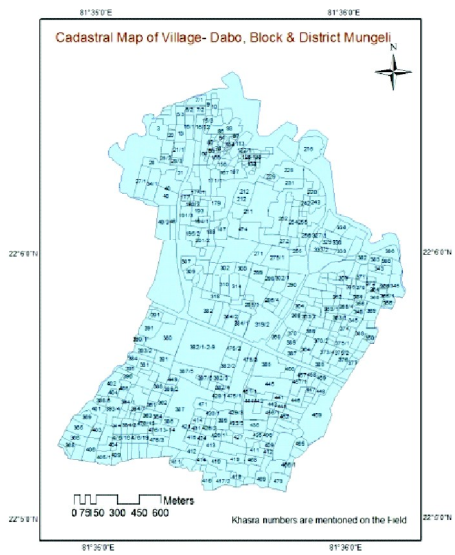

Figure 7: Cadastral Map

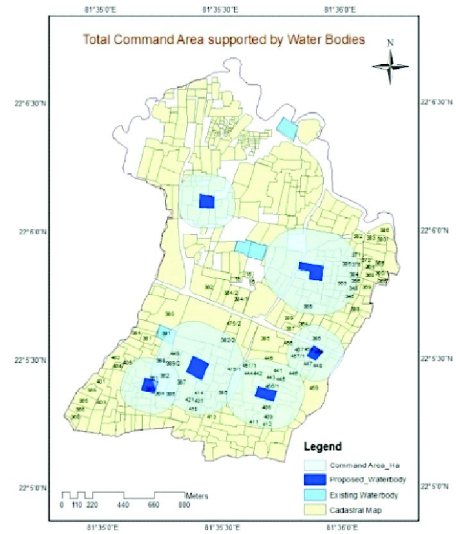

Figure 8: Land and water resources plan

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