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Land use land cover mapping, change detection of musi command area in Nalgonda district, Andhra Pradesh

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Abstract
The land use land cover map of Musi command area developed, it could be inferred that among the eight classes, the rice crop occupied the highest area among all crops, covering 20.1 per cent (5043 ha) of the gross command area (24, 906 ha), followed by other crops 19.7 per cent (4925 ha), plantations 7.5 per cent (1875 ha). The built up area also (22.2 %) occupied a major portion of command area (5534 ha) followed by current fallow (12.4 %) (3106 ha), Musi river coarse (sandy mass) (10.2 %) (2608 ha) and to a small extent scrub land (0.024 %) (60 ha). The overall accuracy obtained was 94.2 % with kappa's co-efficient of 0.91. The information generated from current existing land use/ land cover map of Musi command area can serve as a guide for computing irrigation crop water requirements as per the areas occupied by agricultural crops (rice and other crops) and irrigation planning can be done by the authorities, more scientifically for better water use efficiency.

Keywords: LULC, Musi command area

Introduction
Land use and land cover is an important component to understand global land status; it shows present as well as past status of the earth surface. Land use and land cover are two separate terminologies which are often used interchangeably (Dimyati *et al.* 1994) [1]. Land cover is a basic parameter which evaluates the content of earth surface as an important factor that affects the condition and functioning of the ecosystem.

Land cover is a biophysical state of the Earth surface, which can be used to estimate the interaction of biodiversity with the surrounding environment. Nowadays, land use land cover analysis plays an important role in the field of environmental science and natural resource management. The Land cover reflects the biophysical of state of the earth's surface and immediate surface, including the soil material, vegetation and water. Land use refers to utilization of land resources by human beings and land cover changes often reflects the most significant impact on environment due to excessive human activities. Land use and land cover is dynamic in nature and is an provides a comprehensive understanding of the interaction and relationship of anthropogenic activities with the environment (Prakasam, 2010) [3]. Land use/cover changes also involve the modification, either direct or indirect, of a natural habitats and their impact on the ecology of the area. Land use/cover change has become a central component in current strategies for managing natural resource and monitoring environmental changes (Tiwari and Saxena, 2011) [4].

Materials and methods
The multispectral images from LISS-III sensor of IRS –P6 (Resourcesat-1) was acquired from National Remote Sensing Centre, Balanagar, Hyderabad. The LISS-III sensor operate in four spectral bands, viz., B2 (green), B3 (Red) and B4 (NIR) in the visible region and near infrared region (0.520-0.590 µm, 0.620-0.680 µm and 0.77-0.860 µm respectively) and B5 in the short wave infrared (1.550-1.700 µm). The LISS-III sensor has radiometric quantization of 7 bits and provides a combined swath of 141 km with a spatial resolution of 23.5 m. The image was utilized for preparation of land use land cover map, delineation of major crops grown in the study area. The details of the satellite data used for the investigation are given in Table 1.

Table 1: Details of the satellite data used for the investigation

	Sensor sub-scene	Path/orbit	Row/sector	Date of pass
IRS P6	LISS-III	101	61	6th February, 2012.

The Survey of India (SOI) topographical maps of $57O_7$, $57O_8$, $57O_{11}$, $57O_{12}$ on 1:50,000 scale covering Musi command area in Nalgonda district, Andhra Pradesh were used as reference maps for geo referencing of the remote sensing data and demarcating study area. These maps helped in proper orientation in the field and served as good base, complementary to FCC to locate and plot blocks for ground truth collection.

Equipments and software used

Global Position System (GPS) – (Model- Garmin72H)

The GARMIN, GPS 72H GPS receiver in stand-alone mode was used to collect the information regarding the geographical location of the ground truth sites during the present investigation.

Computer hardware and software

In the present study, De-scan scanner was used for scanning of the toposheets pertaining to the study area and saved as JPEG format and imported into Erdas software as *.img* format for further use. For digital image processing and analysis of Remote sensing data HP desktop having 4 GB RAM work station with ERDAS Imagine version 9.3 software was used. Geographic Information System (GIS) software, ARC GIS version 9.3 was used for mapping the processed image.

Delineation of the study area

Study area was delineated with the help of command area boundaries, the geo referenced topo sheet and distributaries map. The data pertaining to the command area was extracted as a subset for further processing. The procedure followed for geo referencing of $57O_7$, $57O_8$, $57O_{11}$, $57O_{12}$ toposheets presented as flow diagram in Fig 3.5 by using Erdas 9.3 software.

Digital image analysis for generation of land use / land cover map

Initially the digital image (satellite) data were processed to transform it for improving the image contrast and to generate photo-products for subsequent interpretation. The standard monoscopic visual interpretation was employed to realize the objectives.

Land use land cover map of study area

The LISS-III of IRS-P6 image was imported with ERDAS IMAGINE 9.3 image analysis software. Initially the study area was identified and extracted in the datasets. Using map to image transformation algorithm, ground control points (GCPs) were identified both on LISS-III image as well as on the topographic map and the former was geo-referenced with a sub-pixel accuracy using polynomial transformation. Later on, the other data sets (satellite image) were registered to each other with sub-pixel accuracy and data was re sampled using nearest neighborhood algorithm. Thus, all the data sets were brought to a common projection. The procedure followed for land use/ land cover map is presented as flow diagram in Fig.3.11. Using ground truth data collected during the sampling survey the spectral signatures details of ground truth data are presented in Fig.3.12

Accuracy assessment

Separability analysis of signature files: A measure of statistical separation between category response pattern was computed by module for all pairs of classes and presented in the form of matrix. The statistical parameter, used for this purpose is transformed divergence, a covariance weighted distance between category means. In general larger the transformed divergence, greater the statistical distance between training patterns and higher probability of correct classification of classes.

Confusion error matrix: One of the common means of expressing classification accuracy is the preparation of classification error matrix (error matrix). By using the ground truth information; a raster image of ground truth was prepared and used for error analysis in final classified land cover maps. Error matrices compare on a category by category basis. The relationship between known reference data (ground truth) and the corresponding results of automated classification. These matrices are square, with the number of rows and columns equal to the number of crop classes, whose classification accuracy is being assessed. The error matrix tabulates the relationship between the true crop cover classes and classes mapped. It also tabulates error of omission (producer's accuracy) and error of commission (users' accuracy) as well as the overall proportional error.

Classification error matrix which is one of the most common means of expressing classification accuracy was prepared. The commission error and omission error were calculated by following the formulae as indicated below.

$$\text{Commission error (Users accuracy)} = \frac{\text{Total number of correctly classified pixels in row}}{\text{Total no of classified pixels in row}}$$

$$\text{Omission error (Producers accuracy)} = \frac{\text{Total number of correctly classified pixels in column}}{\text{Total no off classified pixels in column}}$$

Overall accuracy was computed by dividing the number of correctly classified pixels by number of reference pixels.

Another discrete multivariable technique for accuracy assessment is Kappa analysis (KHAT statistics) which is a basis for determining the statistical significance of the given matrix (or) the difference among the matrices (Lillisand and Kiefer, 2000) [2].

KHAT statistics is computed as $K = \frac{N \sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} (x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^{r} (x_{i+} \times x_{+i})}$

K = Kappa co-efficient (KHAT statistics)

N = Total number of observations included in the error matrix

x_{i+} = Total of observations in row i (shown as marginal total to right of matrix)

x_{+i} = Total of observations in column i(shown as marginal total at bottom of the Matrix)

x_{ii}= Number of observations in row i and column i(on the major diagonal)

Results and discussion

The land use / land cover map was prepared from the LISS-III FCC (False colour composite) through digital image processing. Initial processing of the data was carried out in ERDAS imagine 9.3 software. Ground truth observations made in the study area during multiple number of survey works for collection of samples and during crop growth period were used for generating the training sets. The image characteristics like colour, texture, shape, size, pattern and association and also the collateral data from the toposheets were also used to prepare land use / land cover map and final map composition was made by using Arc GIS 9.3 software.

The map is presented in the Figure 3 and data in Table.2. A total number of eight distinct land use / land cover types were classified, namely river/tanks, built up land, *rabi* paddy, other crops, scrub land, current fallow, plantations and Musi river coarse (sandy mass). Among the eight classes, the rice crop occupied the highest area among all crops, covering 20.1 per cent (5043 ha) of the gross command area (24,906 ha) followed by other crops 19.7 per cent (4925 ha), plantations 7.5 per cent (1875 ha). The built up area also (22.2 %) occupied a major portion of command area (5534 ha) followed by current fallow of 12.4 per cent (3106 ha), Musi river coarse i.e. sandy mass of 10.2 per cent (2608 ha) and to a small extent scrub land of 0.024 per cent (60 ha).

Part of the ground truth data collected was used for accuracy estimation of the land use / land cover map generated. The error matrix generated is presented in Table2. Based on the data generated in error matrix table, producer's accuracy / classification accuracy /omission error, user's accuracy / mapping accuracy / commission error, over all accuracy and kappa co-eficient were computed and presented in Table.3. The producer's accuracy (classification accuracy / omission error) ranged from 75 to 100 % and user's accuracy (mapping accuracy / commission error) from 55 and 100 %. The overall accuracy obtained was 94.2 % with kappa's co-efficient of 0.91. Within individual classes the highest accuracy (100 %) was obtained from *rabi* paddy, other crops and tanks classes. It was followed by built up land (92 to 92.3 %) and plantations (86 to 90.4 %). Low accuracy was obtained with regard to shrub land (60-75 %), current fallow (76 – 83 %) and Musi river course i.e sand mass (55 to 84%).

Table 2: Results of Land use/land cover information in Musi project command area, Nalgonda district.

	Area	**Percent of area**
River/tanks	1755 ha	7.04
Built upland	5534 ha	22.2
Rabi paddy	5043 ha	20.1
other crops	4925 ha	19.7
scrub land	60ha	0.66
current fallow	3106 ha	12.4
Plantations	1875 ha	7.5
Musi river coarse(sandy mass)	2608ha	10.4
Total	24906 ha	100

Table 3: Contingency error matrix table for land use / land cover map of Musi command area, Nalgonda district.

Data	**Tanks/Rivers**	**Built upland**	***Rabi* paddy**	**Plantation**	**Shrub land**	**Musi river coarse (sand mass)**	**Current fallow**	**Other crops**	**Row total**
Tanks/River	95	0	0	0	0	0	0	0	95
Built upland	0	48	0	0	2	0	0	0	50
Rabi paddy	0	0	6	0	0	0	0	0	6
Plantation	0	0	0	19	1	1	0	0	21
Shrub land	0	2	0	3	6	0	0	0	10
Musi river coarse (sand mass)	0	0	0	0	1	5	3	0	9
Current fallow	0	2	0	0	0	0	10	0	12
Other crops	0	0	0	0	0	0	0	9	9
Column Total	95	52	6	22	8	6	13	9	210

Table 4: Omission and Commission error of land use / land cover map of Nalgonda district

	Producers accuracy (Omission error %)	**Users accuracy (Commission error %)**
Tanks/River	100	100
Built upland	92.3	92
Rabi paddy	100	100
Plantation	86	90.4
Shrub land	75	60
Musi river coarse (sand mass)	84	55
Current fallow	76	83
Other crops	100	100

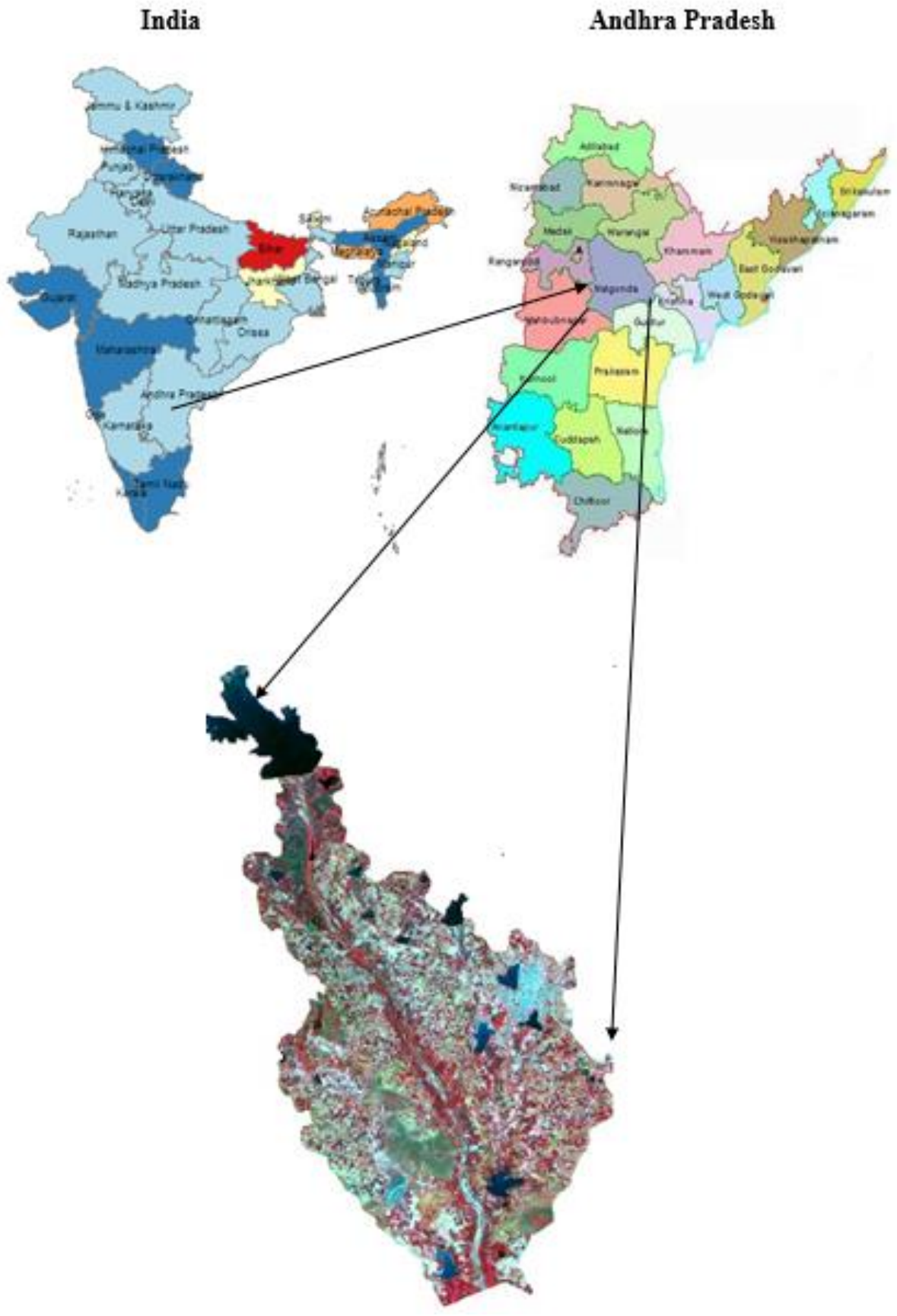

Fig 1: Location map of Musi command area, of Nalgonda, district, Andhra Pradesh

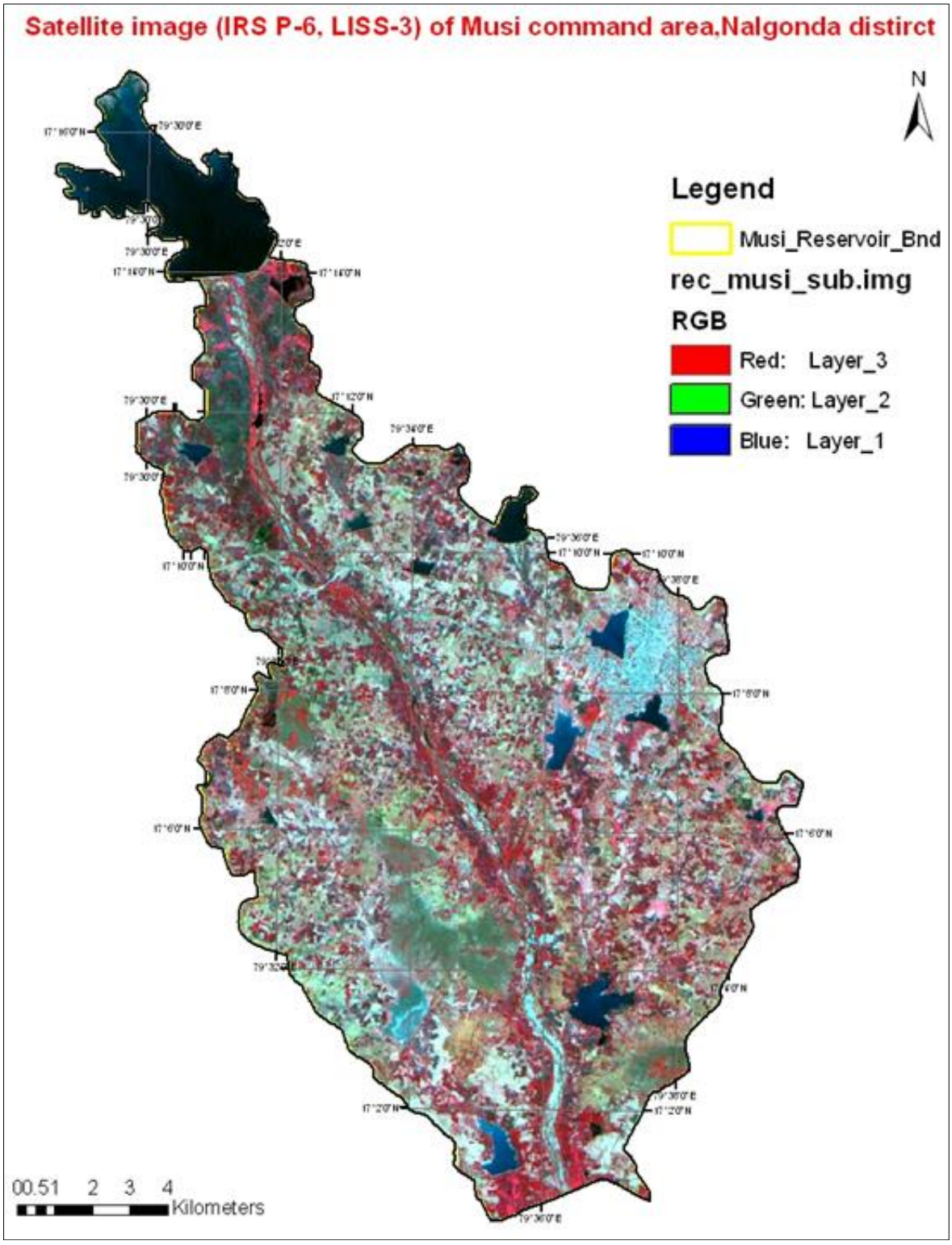

Fig 2: Raw satellite data of Musi command area

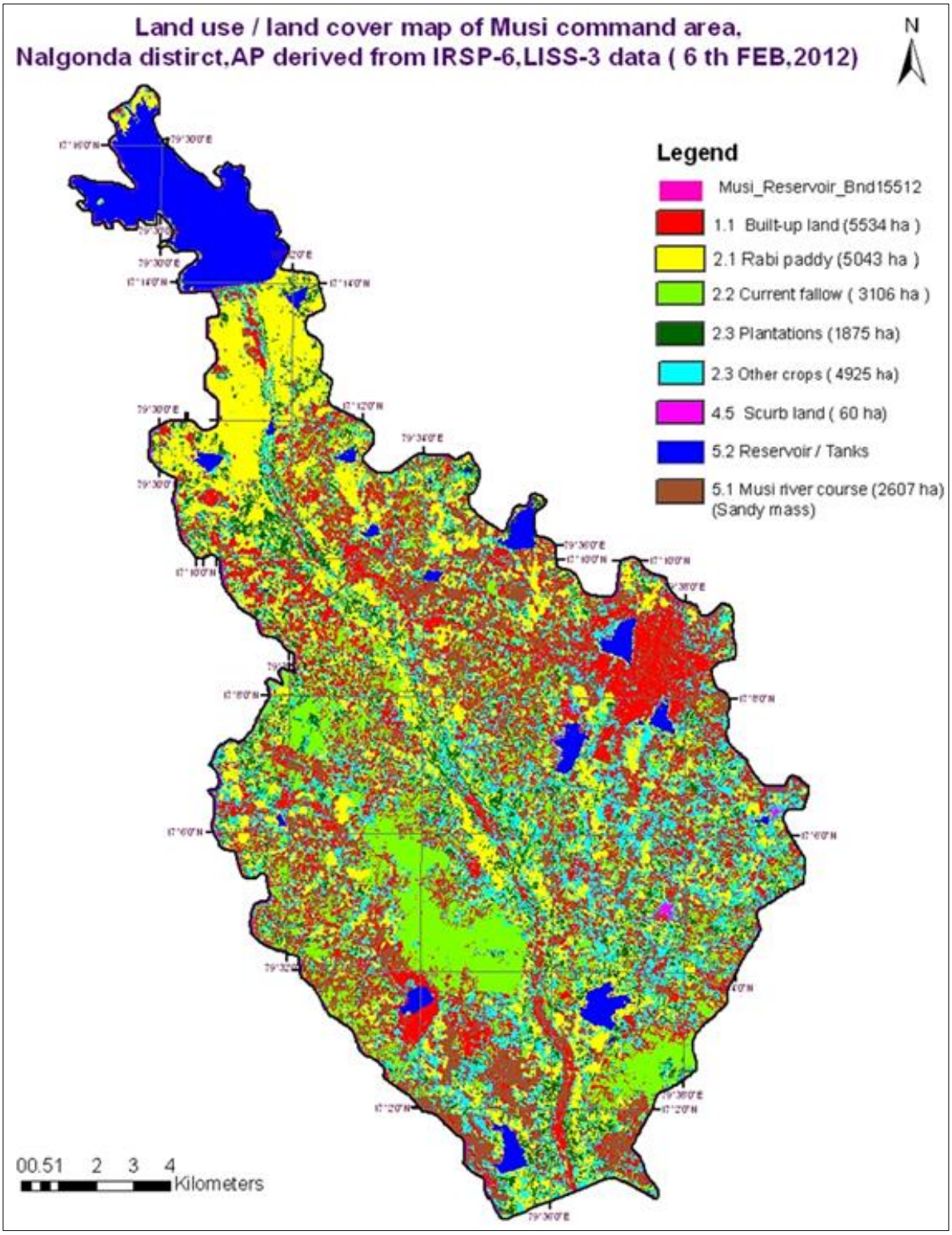

Fig 3: Land use land cover map of Musi command area, Nalgonda district, A.P.

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