ESTIMATION OF COVER MANAGEMENT FACTOR OF RUSLE AT SUB-WATERSHED LEVEL

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ABSTRACT

Vegetation cover is one of the most important biophysical indicators to soil erosion. Vegetation cover protects the soil by dissipating the raindrop energy before reaching the soil surface. The value of cover management factor depends on land use/ land cover, vegetation type, stage of growth and cover percentage. Google image and Landsat 8 image were used to prepare land use / land cover map. Supervised classification technique was selected to create the land use / land cover map for the study area. Total 185 ground truthing sample points were taken using GPS from different categories of land cover of study area to check the accuracy of land use / land cover map. The study revealed that about 41.55 per cent (3203.55 ha.) land is used for cultivation, while 31.95 per cent area was covered by forest land and 2043.34 ha (26.50 %) area was under both wasteland with scrub/pasture and wasteland without scrub with low density residential area. The overall efficiency and Kappa co-efficient were computes as 0.87 and 0.83, respectively, which are in acceptable range. The crop management factor map (Figure 6) depicts that maximum area of sub-watershed has cultivated land and the C value or crop management factor of which was found to be 0.358, followed by deciduous forest (0.4); pasture (0.6); wasteland without scrub (1.0); mixed forest (0.08); evergreen forest (0.004) in descending order of area under each type of land cover. The lowest value of c factor 0.004 was for evergreen forest, but it covers a very small area in the watershed and maximum area comes under cultivated land, which is prone to erosion.

KEY WORDS: Accuracy, Assessment, Land use / land cover map

INTRODUCTION

The amount of protective coverage of a crop for the surface of the soil influences the soil erosion rate. The cover and management factor is the ratio of soil loss from land cropped under specified conditions to the corresponding loss from clean-tilled, continuous fallow land. The C factor based on the land use ranges from near 0 for a high density of vegetation to 1 for barren land. The value of C factor depends on land use / land cover, vegetation type, stage of growth and cover percentage. An attempt has been made to derive cover management factor at sub-watershed level in this study.

MATERIALS AND METHODS

Study area

The All India Soil and Land Use Survey (AIS & LUS) has developed a hierarchical system of watershed delineation like region, basin, catchment, sub-catchment, watershed, sub-watershed and micro-watershed. Based on that, 5D1A5c sub-watershed (7710.64 ha) is selected for the study (Anonymous, 2014). Land use / Land cover details of the study area was required

in order to assign the cover management factor values as per the land use / land cover.

Land use / land cover map

Land cover of the study area was classified as per Level II land use classification techniques i.e. single crop and double crop agricultural land, evergreen, mixed and deciduous forest land and land with scrub/pasture and land without scrub with low density resident (Anderson *et al.*, 1976). Supervised classification technique was selected to create the land use / land cover map, because the study area is well recognized in reconnaissance survey. Land use / land cover map was prepared by adopting the following procedure in ERDAS IMAGINE 2013 Interface.

Procedure used for preparation of land use and land cover map is described as under.

1. Landsat 8 image (Figure 3) dated November 6th, 2014 was downloaded from website www.landsat.usgs.gov and clipped the image of study area using "Raster – Raster Processing – Clip" tool of Data Management extension.
2. The image was sharpened with PAN band of study area image in order to convert the image resolution of 30 m to 15 m using "Raster – Raster Processing – Create Pan Sharpen Raster Dataset" tool of Data Management extension (Figure 4).
3. Google Image of study area dated March 7th, 2015 was downloaded using Google image download software (Figure 1).
4. Toposheet (Figure 2) and Google image of the study area was used as base map for creating polygons of training area from Pan Sharpen Landsat 8 image in ERDAS interface.
5. Training area polygons for each land use pattern is selected by using signature editor of supervised classification tab.
6. Minimum 10 training area were selected for each land use type and merged to form one cluster and saved as signature file in .sig format. Average spectral values of each land use class cluster are given in the Table 1.
7. Supervised classification technique of ERDAS software was used to derive the land cover map by using the image and signature file of study area.

Accuracy assessment of land use / land cover map

Land use/ land cover map accuracy assessment is necessary to judge the efficiency of procedure for preparation of land use / land cover map (Kaul and Sopan, 2012). In order to decide whether the map is of acceptable accuracy, a sample of map points was checked against ground data and a probabilistic statement was made about the true accuracy of the map. Total 185 ground truthing sample points were taken using GPS from study area based on weighted area covered by each categories of land use/ land cover. The overall efficiency and Kappa co-efficient were derived using equation 1 and 2, respectively for estimating accuracy of land use/ land cover map.

$$\text{Overall Efficiency } (\%) = \frac{\sum_{i=1}^{r} x_{ii}}{N} \times 100$$

Equation (1)

$$\text{Kappa Co} - \text{efficient(k)} = \frac{N \sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} (x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^{r} (x_{i+} \times x_{+i})}$$

Equation (2)

Where,

N is the total number of sites in the matrix,
r is the number of rows in the matrix,
x_{ii} is the number in row i and column i,
x_{+i} is the total for row i,
x_{i+} is the total for column i.

Preparation of cover management factor map

The C factors for agricultural land of the study area have been derived by using the crop wise C factor value given by Kurothe (1991-92). The average area covered by different crops of the Dediapada block during last 3 years (Annual Progress Report, 2012-13, 2013-14 and 2014-15) was

used to derive the weighted C factor value as shown in Table 2.

The C factor values presented by Singh *et al.* (1981) and Narain *et al.* (1994) for different types of forest and wasteland as per Table 3 was used to derive the C factor map for the study area.

Procedure used for preparation of cover management factor map is described as under.

1. Land use / land cover map was converted from raster to polygon using "Raster to Polygon" tool of Conversion extension.
2. Attribute table of the derived map in step 1 was copied in excel sheet.
3. The crop management factor values (Table 2 and 3) were assigned as per land use categories in attribute table of land use / land cover and saved in .csv file format.
4. The attribute table prepared in step 3 was joined with vector layer of land use/ land cover map by using 'Join and Relates' tool of ArcGIS interface.
5. The cover management factor map was prepared by converting the vector layer (prepared in step 4) into raster layer and selecting C factor values as value field from "Polygon to Raster" tool of Arc GIS Conversion extension and saved as "Cover Management Factor Map"

RESULTS AND DISCUSSION

Land use / land cover map

The area covered by different types of land cover of the selected sub-watershed is shown in land use / land cover map (Figure 5) and presented in the Table 4. The map shows that about 41.55 per cent (3203.55 ha.) land is used for cultivation, while 31.95 per cent area was covered by forest land and 2043.34 ha (26.50 %) area was under both wasteland with scrub/pasture and wasteland without scrub with low density residential area. Land use / land cover map was used to assign the cover management factor value as per the land use categories of the study area.

Accuracy assessment of land use / land cover map

The GPS locations of collected ground truthing points from different land cover categories were used to locate points into land use/land cover map using ArcGIS interface. The confusion matrix was prepared using collected ground truthing sample points and number of points fall into different classes of land use/land cover map as given in Table 5. The overall efficiency and Kappa co-efficient were computes as 0.87 and 0.83, respectively, which are in acceptable range.

Crop/ cover management factor map

The crop management factor map (Figure 6) depicts that maximum area of sub-watershed has cultivated land and the C value or crop management factor of which was found to be 0.358, followed by deciduous forest (0.4); pasture (0.6); wasteland without scrub (1.0); mixed forest (0.08); evergreen forest (0.004) in descending order of area under each type of land cover. C value of 1 has the highest susceptibility of erosion whereas less value indicates lesser erodibility. The lowest value of c factor 0.004 was for evergreen forest, but it covers a very small area in the watershed and maximum area comes under cultivated land, which is prone to erosion.

CONCLUSION

From the study it canc be concluded that area covered by different types of land cover of the selected sub-watershed is shown in land use / land cover map (Figure 5) and presented in the Table 4. The map shows that about 41.55 per cent (3203.55 ha.) land is used for cultivation, while 31.95 per cent area was covered by forest land and 2043.34 ha (26.50 %) area was under both wasteland with scrub/pasture and wasteland without scrub with low density residential area. The lowest value of c factor was 0.004 for evergreen forest, but it covers a very small area in the watershed and maximum area

comes under cultivated land, which is prone to erosion.

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Table 1: Average spectral values of selected training area

Sr. No.	Land Use / Land Cover	R	G	B
1	Single crop land (yellowish brown soil)	0.624	0.620	0.618
2	Single crop land (black cotton soil)	0.486	0.479	0.457
3	Double crop land	0.652	0.668	0.770
4	Evergreen forest	0.053	0.044	0.021
5	Mixed forest	0.159	0.147	0.156
6	Deciduous forest	0.507	0.507	0.502
7	Pasture	0.576	0.575	0.580
8	Wasteland without scrub / Low density resident	0.581	0.576	0.555

Table 2: Weighted C factor value for agricultural land

Sr. No.	Crop	Area	C Factor Value	Area x C Factor Value
1	Cotton	7124	0.31	2208.44
2	Paddy	7086	0.28	1984.08
3	Pigeon pea	8013	0.43	3445.59
4	Maize	1089	0.50	544.50
5	Mungbean	779	0.30	233.70
6	Sorghum	475	0.36	171.00
7	Castor	475	0.79	375.25
8	Groundnut	84	0.42	35.28
9	Total	25125		8997.84
10	Weighted C factor value			0.36

Table 3: C factor values for various land use land cover class

Sr. No.	Land Use / Land Cover	C Factor Value
1	Evergreen forest	0.004
2	Mixed forest	0.08
3	Deciduous forest	0.4
4	Pasture	0.6
5	Wasteland without scrub / Low density resident	1.0

Table 4: Areas under different land use land cover of selected sub-watershed

Sr. No.	Land Use / Land Cover	Area (ha.)	Percent of Total Area
1	Single crop agriculture land	2823.10	36.61
2	Double crop agriculture land	380.45	4.93
3	Evergreen forest	312.37	4.05
4	Mixed forest	875.93	11.36
5	Deciduous forest	1275.64	16.54
6	Pasture / Wasteland with scrub	1038.98	13.47
7	Wasteland without scrub / Low density resident	1004.36	13.03
8	Total	7710.64	100.00

Table 5: Computation of overall efficiency and Kappa co-efficient

No.	Class	1	2	3	4	5	6	Total
1	Agricultural land	67	0	0	0	0	0	67
2	Evergreen forest	0	8	2	0	0	0	10
3	Mixed forest	1	2	17	2	0	0	24
4	Deciduous forest	4	0	1	25	1	0	31
5	Pasture	3	0	0	3	22	3	29
6	Low density resident	0	0	0	0	2	22	24
	Total	75	10	20	30	25	25	185

No.	Item	Value
1	Sum of correct sample points	161
2	Total sample points	185
3	Sum of (Row x Column) of Matrix	7860
4	Overall efficiency	0.87
5	Kappa coefficient	0.83

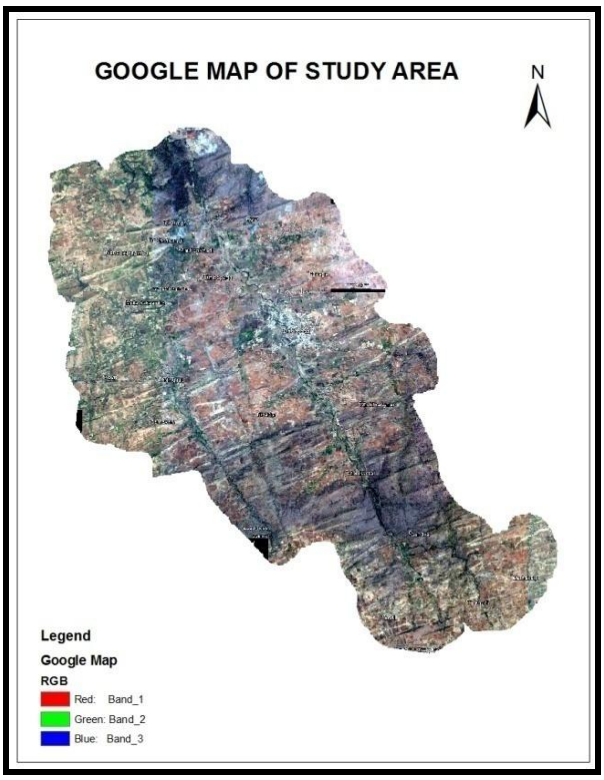

Figure 1: Google image of study area

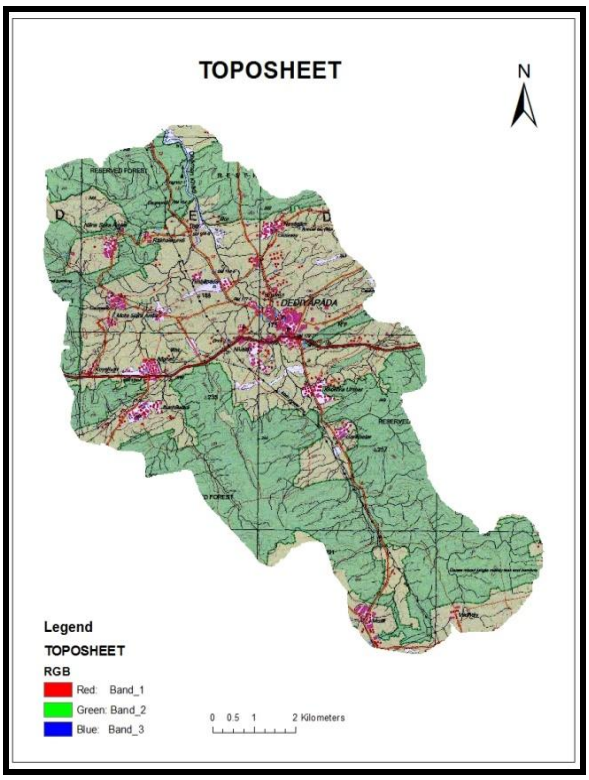

Figure 2: Topo-sheet portion of study area

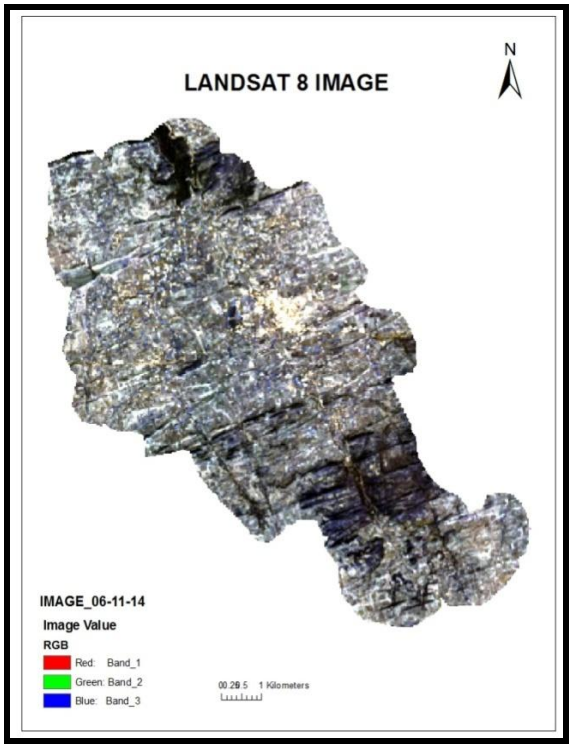

Figure 3: Landsat 8 image (06-11-14)

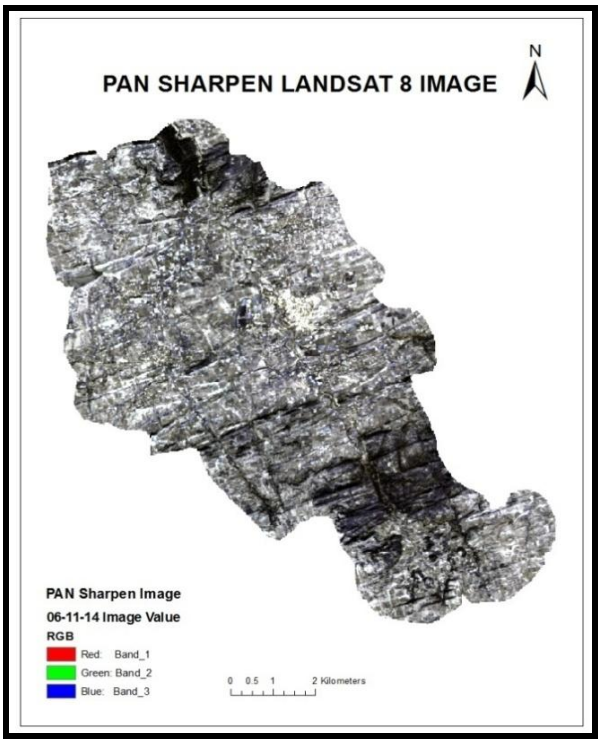

Figure 4: PAN sharpen Landsat 8 image

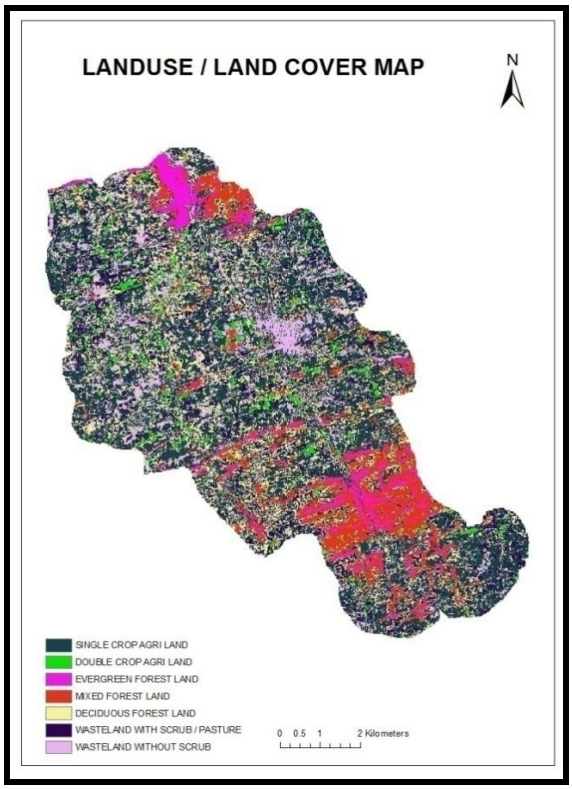

Figure 5: Land use / land cover map

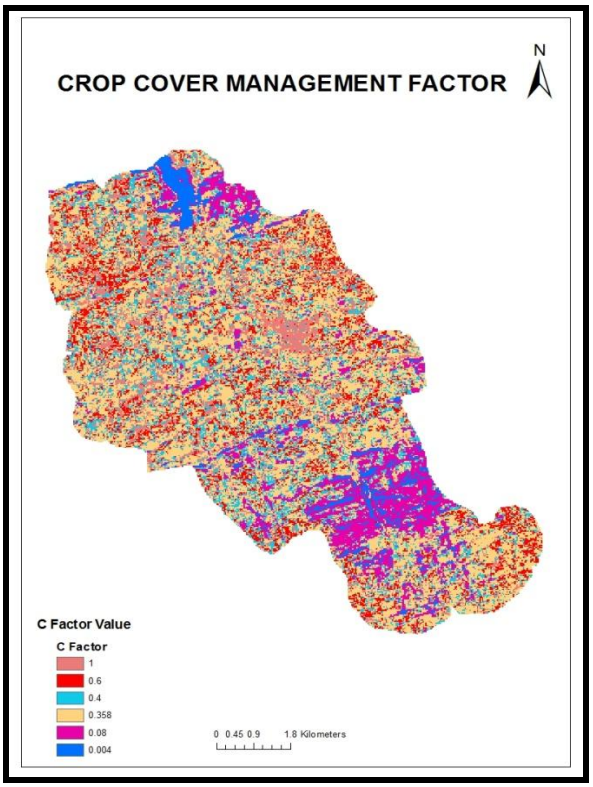

Figure 6: Cover management factor map

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